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Advances in the Management & Treatment Algorithms for Anterior Shoulder Instability

A thesis submitted to the National University of Ireland, Galway as partial fulfilment of the requirements for degree of Doctor of Philosophy (PhD)

By

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Submitted: April 2021

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Certificate of Authorship - Final Thesis Submission

Doctor of Philosophy (PhD)

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Student Name: Eoghan Hurley

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List of Publications & Presentations

PEER-REVIEWED PUBLICATIONS

Chapter 1:

1. **Hurley ET**, Manjunath AK, Bloom DA, Pauzenberger L, Mullett H, Alaia MJ, Strauss EJ. Arthroscopic Bankart Repair versus Conservative Management for First-Time Traumatic Anterior Shoulder Instability - A Systematic Review & Meta-Analysis. *Arthroscopy*. 2020;36(9):2526-2532
2. **Hurley ET**, Fried JW, Strauss EJ, Alaia MJ, Jazrawi LM, Matache BA. Immobilization in External Rotation after First-Time Traumatic Anterior Shoulder Instability Reduces Recurrent Instability - A Meta-Analysis of Randomized Controlled Trials. *Journal of ISAKOS*. 2021 [Epub ahead of print]
3. **Hurley ET**, Anil U, Lim Fat D, Pauzenberger L, Strauss EJ, Mullett H. Operative Treatment of Anterior Shoulder Instability - A Network Meta-Analysis. *Bulletin of the NYU Hospital for Joint Disease*. 2020;78(3):202-209
4. **Hurley ET**, Toale J, Davey MS, Colasanti CA, Strauss EJ, Pauzenberger L, Mullett H. Remplissage for Anterior Shoulder Instability with Hill-Sachs Lesions - A Systematic Review & Meta-Analysis. *Journal of Shoulder & Elbow Surgery*. 2020;29(12):2487-2494
5. **Hurley ET**, Farrington SK, Lim Fat D, Mullett H. Open Versus Arthroscopic Latarjet Procedure For Anterior Shoulder Instability- A Systematic Review & Meta-Analysis. *American Journal of Sports Medicine*. 2019;47(5):1248-1253
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7. Ali ZS, **Hurley ET**, Montgomery C, Jamal MS, Horan MP, Pauzenberger L, Millett PJ, Mullett H. Outcomes of The Open Latarjet Procedure as a Revision Procedure for Failed Prior Stabilization Surgery. *Knee Surgery, Sports Traumatology & Arthroscopy*. 2020 [Epub ahead of print]
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2. **Hurley ET,** Scanlon JP, Davey MS, Pauzenberger L, Moran CJ, Mullett H. 90-Day Complication Rate Following The Latarjet Procedure In A High Volume Centre. *American Journal of Sports Medicine.* 2020;48(14):3467-3471
3. **Hurley ET**, Manjunath AK, Matache BA, Jia N, Virk MS, Jazrawi LM, Meislin RJ. 90-Day Complication Rate Following Open versus Arthroscopic Latarjet Procedure. *Knee Surgery, Sports Traumatology & Arthroscopy*. 2020 [Epub ahead of print]
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5. **Hurley ET**, Lim Fat D, Pauzenberger L, Mullett H. Tranexamic Acid for the Latarjet Procedure – A Randomized Controlled Trial. *Journal of Shoulder & Elbow Surgery*. 2020;29(5):882-885

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5. **Hurley ET**, Davey MS, Mojica ES, Fried JW, Gaafar M, Mullett H, Pauzenberger L. 5-Year Outcomes Following Arthroscopic Bankart Repair in Athletes. *Under Review*
6. **Hurley ET**, Davey MS, Montgomery C, O'Doherty, Gaafar M, Mullett H, Pauzenberger L. Arthroscopic Bankart Repair vs The Open Latarjet Procedure for First Time Shoulder Dislocations in Athletes. *Orthopaedic Journal of Sports Medicine. 2021 [Accepted]*
7. **Hurley ET**, Davey MS, Montgomery C, O'Doherty, Gaafar M, Mullett H, Pauzenberger L. Arthroscopic Bankart Repair vs The Open Latarjet Procedure for Recurrent Shoulder Instability in Athletes. *Orthopaedic Journal of Sports Medicine. 2021 [Accepted]*
8. **Hurley ET,** Davey MS, Montgomery C, Gaafar M, Pauzenberger L, Jazrawi LM, Mullett H. Analysis Of Patients That Did Not Return To Play Following Arthroscopic Bankart Repair. *Surgeon. 2021 [Accepted pending revisions]*
9. **Hurley ET,** Davey MS, Moore DM, Gaafar M, Pauzenberger L, Jazrawi LM, Mullett H. Analysis Of Patients That Did Not Return To Play Following The Open Latarjet Procedure. *Under Review*

Chapter 4:

1. Murphy AI, **Hurley ET**, Hurley DJ, Pauzenberger L, Mullett H. Long-Term Outcomes of The Arthroscopic Bankart Repair – A Systematic Review of Studies at 10-Year Follow-up. *Journal of Shoulder & Elbow Surgery*. 2019;28(11):2084-2089
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4. Toale J, **Hurley ET**, Davey MS, Cassidy JT, Pauzenberger L, Mullett H. Return to Play after Arthroscopic Bankart Repair combined with Open Subpectoral Biceps Tenodesis. *Arthroscopy, Sports Medicine and Rehabilitation*. 2020;2(5):e499-e503
5. **Hurley ET,** Hogan RE, Kilkenny CJ, Moore TK, Rowe DN, Pauzenberger L, Mullett H. Type V superior labral anterior-posterior tears results in lower rates of return to play. *Knee Surgery, Sports Traumatology & Arthroscopy.* 2021 [Epub ahead of print]
6. Pounder EJ, **Hurley ET**, Ali ZS, Pauzenberger L, Mullett H. Return to Sport Following Arthroscopic Repair of 270°-360° Labral Tears. *Arthroscopy, Sports Medicine and Rehabilitation*. 2020;2(3):e237-e240
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9. Davey MS, **Hurley ET**, O'Doherty R, Stafford P, Delahunt E, Gaafar M, Pauzenberger L, Mullett H. Open Latarjet Procedure in Competitive Athletes following Failed Prior Instability Surgery results in Lower Rates of Return to Play. *Arthroscopy. 2021 [Accepted]*
10. Ortega P, **Hurley ET**, Markus DH, Colasanti CA, Jazrawi LM, Meislin RJ. Distal Tibia Allograft for Shoulder Instability After Failed Latarjet. *Under Review*
11. **Hurley ET**, Ben Ari E, Colasanti CA, Lorentz NA, Matache BA, Jazrawi LM, Virk M, Meislin RJ. Open vs Arthroscopic Latarjet for Anterior Shoulder Instability. *Under Review*
12. **Hurley ET,** Colasanti CA, Lorentz N, Matache BA, Campbell KA, Jazrawi LM, Meislin RJ. Arthroscopic Bankart Repair with Remplissage vs Arthroscopic Latarjet for Anterior Shoulder Instability with Engaging Hill-Sachs Lesions. *Under Review*

Chapter 5:

1. **Hurley ET**, Matache BA, Wong I, Itoi E, Strauss EJ, Delaney RA, Neyton L, Athwal GS, Pauzenberger L, Mullett H, Jazrawi LM, *The Anterior Shoulder Instability International Consensus Group.* Anterior Shoulder Instability – Diagnosis, Non-Operative Management, and Bankart Repair – An International Delphi Consensus Statement. *2021 [Accepted pending revisions]*
2. **Hurley ET**, Matache BA, Wong I, Itoi E, Strauss EJ, Delaney RA, Neyton L, Athwal GS, Pauzenberger L, Mullett H, Jazrawi LM, *The Anterior Shoulder Instability International Consensus Group.* Anterior Shoulder Instability – Latarjet, Remplissage, and Glenoid Bone-Grafting – An International Delphi Consensus Statement. *2021 [Accepted pending revisions]*
3. Matache BA, **Hurley ET**, Wong I, Itoi E, Strauss EJ, Delaney RA, Neyton L, Athwal GS, Pauzenberger L, Mullett H, Jazrawi LM, *The Anterior Shoulder Instability International Consensus Group.* Anterior Shoulder Instability – Revision Surgery, Rehabilitation and Return to Play, and Clinical Follow-Up – An International Delphi Consensus Statement. *2021 [Accepted pending revisions]*

PODIUM PRESENTATIONS

1. **Hurley ET**, Toale J, Davey MS, Colasanti CA, Strauss EJ, Pauzenberger L, Mullett H. Remplissage for Anterior Shoulder Instability with Hill-Sachs Lesions - A Systematic Review & Meta-Analysis. *American Academy of Orthopaedic Surgeons (AAOS). San Diego, United States, March 2021.*
2. **Hurley ET**, Davey MS, O'Doherty, Gaafar M, Mullett H, Pauzenberger L. Arthroscopic Bankart Repair vs The Open Latarjet Procedure for First Time Shoulder Dislocations in Athletes. *American Academy of Orthopaedic Surgeons (AAOS). San Diego, United States, March 2021.*
3. Davey MS, **Hurley ET**, Gaafar M, Pauzenberger L, Mullett H. Arthroscopic Bankart Repair for Primary versus Recurrent Instability in Athletes. *AOSSM-AANA Combined 2021 Annual Meeting. Nashville, United States, July 2021.*
4. **Hurley ET**, Matache BA, Colasanti CA, Mojica ES, Manjunath AK, Campbell KA, Strauss EJ, Jazrawi LM. Return to Play Criteria Among Shoulder Surgeons Following Shoulder Stabilization. *Canadian Orthopaedic Association. Virtual, June 2021*.
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6. **Hurley ET**, Davey MS, Montgomery C, Mojica ES, Gaafar M, Pauzenberger L, Jazrawi LM, Mullett H. Analysis of Athletes That Did Not Return to Play Following Arthroscopic Bankart Repair. *Irish Shoulder & Elbow Society Meeting. Virtual, January 2021*
7. Davey MS, **Hurley ET**, O'Doherty R, Stafford P, Delahunt E, Gaafar M, Pauzenberger L, Mullett H. Open Latarjet Procedure in Athletes with Primary Instability versus Recurrent Instability versus Failed Prior Surgery. *Irish Shoulder & Elbow Society Meeting. Virtual, January 2021*
8. **Hurley ET,** Davey MS, Gaafar M, Pauzenberger L, Jazrawi LM, Mullett H. Analysis Of Patients That Did Not Return To Play Following Arthroscopic Bankart Repair. *European Society for Surgery of the Shoulder and the Elbow Virtual Congress, September 2020.*
9. **Hurley ET,** Lim Fat D, Pauzenberger L, Mullett H. Tranexamic Acid for the Latarjet Procedure – A Randomized Controlled Trial. *British Elbow & Shoulder Society Virtual Conference, October 2020*.
10. Davey MS, **Hurley ET**, Colasanti CA, Scanlon JP, Gaafar M, Hogan BA, Pauzenberger L, Mullett H. Clinical Outcomes of Patients with Anterior Shoulder Instability & Glenolabral Articular Disruption Lesions - A Retrospective Comparative Study. *British Elbow & Shoulder Society Virtual Conference, October 2020*.
11. **Hurley ET,** Lim Fat D, Pauzenberger L, Mullett H. Tranexamic Acid for the Latarjet Procedure – A Randomized Controlled Trial. *Irish Orthopaedic Association. Ireland, October 2020*
12. Davey MS, **Hurley ET**, Colasanti CA, Scanlon JP, Gaafar M, Hogan BA, Pauzenberger L, Mullett H. Clinical Outcomes of Patients with Anterior Shoulder Instability & Glenolabral Articular Disruption Lesions - A Retrospective Comparative Study. *Irish Orthopaedic Association. Ireland, October 2020*
13. **Hurley ET,** Scanlon JP, Davey MS, Pauzenberger L, Moran CJ, Mullett H. 90-Day Complication Rate Following The Latarjet Procedure In A High Volume Centre. *European Society for Surgery of the Shoulder and the Elbow Virtual Congress, September 2020.*

14. **Hurley ET,** Davey MS, Gaafar M, Pauzenberger L, Jazrawi LM, Mullett H. Analysis Of Patients That Did Not Return To Play Following Arthroscopic Bankart Repair. *European Society for Surgery of the Shoulder and the Elbow Virtual Congress, September 2020.*
15. **Hurley ET,** Hogan RE, Kilkenny CJ, Moore TK, Rowe DN, Pauzenberger L, Mullett H. Return To Play After Arthroscopic Repair Of Combined Bankart And Type V Superior Labral Anterior-Posterior Tears. *European Society for Surgery of the Shoulder and the Elbow Virtual Congress, September 2020.*
16. **Hurley ET,** Lim Fat D, Pauzenberger L, Mullett H. Tranexamic Acid for the Latarjet Procedure – A Randomized Controlled Trial. *Irish Shoulder & Elbow Society Meeting. Dublin, Ireland, January 2020*
17. Moore TK, **Hurley ET**, Rowe DN, Kilkenny CJ, Hogan RE, Pauzenberger L, Mullett H. Outcomes Following Arthroscopic Bankart Repair in Female Patients. *Irish Shoulder & Elbow Society Meeting. Dublin, Ireland, January 2020*
18. Toale JP, **Hurley ET**, Davey MS, Pauzenberger L, Mullett H. Return to Play after Repair of Type V Superior Labral Anterior-Posterior Tears versus Biceps Tenodesis. *Irish Shoulder & Elbow Society Meeting. Dublin, Ireland, January 2020*
19. **Hurley ET**, Jamal MS, Montgomery C, Ali ZS, Pauzenberger L, Mullett H. Long-Term Outcomes of The Open Latarjet Procedure – A Systematic Review of Studies at 10-Year Follow-up. *International Congress of Shoulder & Elbow Surgeons. Buenos Aires, Argentina, September 2019*
20. **Hurley ET**, Kearney J, Hogan R, Lim Fat D, Pauzenberger L, Mullett H. Arthroscopic Bankart Repair versus Remplissage for Anterior Shoulder Instability with Hill-Sachs Lesions - A Systematic Review & Meta-Analysis**.** *International Congress of Shoulder & Elbow Surgeons. Buenos Aires, Argentina, September 2019*
21. **Hurley ET**, Montgomery C, Jamal MS, Shimozono Y, Ali ZS, Pauzenberger L, Mullett H. Return to Play following The Latarjet Procedure for Anterior Shoulder Instability – A Systematic Review. *International Congress of Shoulder & Elbow Surgeons. Buenos Aires, Argentina 2019*
22. **Hurley ET,** Lim Fat D, Pauzenberger L, Mullett H. Tranexamic Acid for the Latarjet Procedure – A Randomized Controlled Trial. *European Society for Surgery of the Shoulder and the Elbow Congress 2019. Copenhagen, Denmark, August 2019*
23. **Hurley ET**, Maye AB, Anil U, Pazuenberger L, Strauss EJ, Mullett H, Moran CJ, Curley GF. Interscalene Block vs Suprascapular Block for Shoulder Arthroscopy- A Meta-Analysis. *American Academy of Orthopaedic Surgeons (AAOS). Las Vegas, United States, March 2019*
24. **Hurley ET**, Montgomery C, Jamal MS, Shimozono Y, Ali ZS, Pauzenberger L, Mullett H. Return to Play following The Latarjet Procedure for Anterior Shoulder Instability – A Systematic Review. *RCSI Faculty of Sports & Exercise Medcine. Dublin, Ireland, September 2018*
25. **Hurley ET**, Farrington SK, Lim Fat D, Mullett H. The Latarjet Procedure Is The Superior Treatment Method For Anterior Shoulder Instability- A Systematic Review & Meta-Analysis. *European Society for Sports Traumatology, Knee Surgery and Arthroscopy. Glasgow, Scotland, May 2018*.
26. **Hurley ET**, Farrington SK, Lim Fat D, Mullett H. The Latarjet Procedure Is The Superior Treatment Method For Anterior Shoulder Instability- A Systematic Review & Meta-Analysis. *Irish Shoulder & Elbow Society Meeting. Dublin, Ireland, January 2018*.

POSTER PRESENTATIONS

1. **Hurley ET**, Davey MS, O'Doherty, Gaafar M, Mullett H, Pauzenberger L. Arthroscopic Bankart Repair vs The Open Latarjet Procedure for Recurrent Shoulder Instability in Athletes. *American Academy of Orthopaedic Surgeons (AAOS). San Diego, United States, March 2021.*
2. Davey MS, **Hurley ET**, Gaafar M, Pauzenberger L, Mullett H. Arthroscopic Bankart Repair for Primary versus Recurrent Anterior Instability in Athletes – A Retrospective Comparative. *American Academy of Orthopaedic Surgeons (AAOS). San Diego, United States, March 2021.*
3. **Hurley ET**, Ben Ari E, Colasanti CA, Lorentz NA, Matache BA, Jazrawi LM, Virk M, Meislin RJ. Open vs Arthroscopic Latarjet for Anterior Shoulder Instability. *AOSSM-AANA Combined 2021 Annual Meeting. Nashville, United States, July 2021.*
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5. **Hurley ET,** Toale JP, Davey MS, Lim Fat D, Pauzenberger L, Mullett H. Remplissage for anterior shoulder instability with Hill-Sachs lesions - a systematic review & meta-analysis. *European Society for Sports Traumatology, Knee Surgery and Arthroscopy. Milan, Italy, May 2021*.

6. Hogan RE, **Hurley ET,** Kilkenny CJ, Moore TK, Rowe DN, Pauzenberger L, Mullett H. Return to play after arthroscopic repair of combined Bankart and Type V superior labral anterior-posterior tears. *European Society for Sports Traumatology, Knee Surgery and Arthroscopy. Milan, Italy, May 2021*.
7. **Hurley ET,** Lim Fat D, Pauzenberger L, Mullett H. Tranexamic Acid for the Latarjet Procedure – A Randomized Controlled Trial. *European Society for Sports Traumatology, Knee Surgery and Arthroscopy. Milan, Italy, May 2021*.
8. Pounder E, **Hurley ET,** Ali ZS, Pauzenberger L, Mullett H. Return to sport following arthroscopic repair of 270 labral tears. *European Society for Sports Traumatology, Knee Surgery and Arthroscopy. Milan, Italy, May 2021*.
9. Toale JP, **Hurley ET,** Cassidy JT, Pauzenberger L, Mullett H. Return to play following arthroscopic Bankart repair and open subpectoral biceps tenodesis. *European Society for Sports Traumatology, Knee Surgery and Arthroscopy. Milan, Italy, May 2021*.
10. Moore TK, **Hurley ET**, Rowe DN, Kilkenny CJ, Hogan RE, Pauzenberger L, Mullett H. Outcomes Following Arthroscopic Bankart Repair in Female Patients. *European Society for Sports Traumatology, Knee Surgery and Arthroscopy. Milan, Italy, May 2021*.
11. **Hurley ET,** Pauzenberger L, Alaia MJ, Strauss EJ, Mullett H. Return to play following shoulder surgery in athletes - a systematic review. *European Society for Sports Traumatology, Knee Surgery and Arthroscopy. Milan, Italy, May 2021*.
12. **Hurley ET,** Manjunath AK, Hasekl J, Kanakamedala A, Matache BA, Strauss EJ. Arthroscopic Bankart Repair Versus The Open Latarjet Procedure At Long-Term Follow-Up - A Systematic Review & Meta-Analysis. *European Society for Surgery of the Shoulder and the Elbow Virtual Congress, September 2020.*
13. Davey MS, **Hurley ET,** Colasanti CA, Scanlon JP, Gaafar M, Pauzenberger L, Mullett H. Clinical Outcomes Of Patients With Anterior Shoulder Instability & Glenolabral Articular Disruption Lesions - A Retrospective Comparative Study. *European Society for Surgery of the Shoulder and the Elbow Virtual Congress, September 2020.*
14. **Hurley ET,** Bloom DA, Manjunath AK, Jazrawi LM, Strauss EJ. Outcomes Of Revision Surgery For A Failed Prior Latarjet Procedure – A Systematic Review. *European Society for Surgery of the Shoulder and the Elbow Virtual Congress, September 2020.*
15. **Hurley ET,** Colasanti CA, Manjunath AK, Matache BA, Campbell KA, Strauss EJ, Jazrawi LM. Return To Play Criteria Among Shoulder Surgeons Following Arthroscopic Bankart Repair. *European Society for Surgery of the Shoulder and the Elbow Virtual Congress, September 2020.*
16. **Hurley ET,** Colasanti CA, Manjunath AK, Matache BA, Campbell KA, Strauss EJ, Jazrawi LM. Return To Play Criteria Among Shoulder Surgeons Following The Latarjet Procedure. *European Society for Surgery of the Shoulder and the Elbow Virtual Congress, September 2020.*
17. **Hurley ET,** Lim Fat D, Pauzenberger L, Mullett H. Tranexamic Acid For The Latarjet Procedure – A Randomized Controlled Trial. *European Society for Surgery of the Shoulder and the Elbow Virtual Congress, September 2020.*
18. **Hurley ET,** Lim Fat D, Pauzenberger L, Mullett H. Tranexamic Acid for the Latarjet Procedure – A Randomized Controlled Trial. *American Academy of Orthopaedic Surgeons (AAOS). Orlando, United States, March 2019*
19. **Hurley ET**, Ali ZS, Montgomery C, Jamal MS, Horan MP, Pauzenberger L, Millett PJ, Mullett H. Outcomes of The Open Latarjet Procedure as a Revision Procedure for Failed Prior Stabilization Surgery. *International Congress of Shoulder & Elbow Surgeons. Buenos Aires, Argentina 2019*
20. **Hurley ET**, Murphy AI, Pauzenberger L, Mullett H. Long-Term Outcomes of The Arthroscopic Bankart Repair - A Systematic Review of Studies at 10-Year Follow-up. *Arthroscopy Association of North America (AANA), Orlando, May 2019*
21. **Hurley ET**, Lim Fat D, Pauzenberger L, Mullett H. The Latarjet Procedure versus Remplissage for Anterior Shoulder Instability with Hill-Sachs Lesions - A Systematic Review & Meta-Analysis. *Arthroscopy Association of North America (AANA), Orlando, May 2019*
22. **Hurley ET**, Montgomery C, Jamal MS, Shimozono Y, Ali ZS, Pauzenberger L, Mullett H. Return to Play following The Latarjet Procedure for Anterior Shoulder Instability – A Systematic Review. *RCSI Faculty of Sports & Exercise Medcine. Dublin, Ireland 2018*
23. **Hurley ET**, Anil U, Lim Fat D, Farrington SK, Strauss EJ, Mullett H. Operative Treatment of Anterior Shoulder Instability - A Network Meta-Analysis. *European Society for Surgery of the Shoulder and the Elbow Congress 2018. Vienna, Switzerland, September 2018*

24. **Hurley ET**, Farrington SK, Lim Fat D, Mullett H. Open Versus Arthroscopic Latarjet Procedure For Anterior Shoulder Instability- A Systematic Review & Meta-Analysis. *European Society for Sports Traumatology, Knee Surgery and Arthroscopy. Glasgow, Scotland, May 2018*.

SCIENTIFIC EXHIBITS

1. Maye AB, **Hurley ET**, Anil U, Pauzenberger L, Strauss EJ, Moran CJ, Curley GF, Mullett H. Pain Management Strategies After Shoulder Arthroscopy. *Scientific Exhibit, American Academy of Orthopaedic Surgeons (AAOS). Las Vegas, United States, March 2019*.

AWARDS

1. Cappagh Prize National Irish Residents Research Prize 2020
2. Irish Shoulder & Elbow Surgery Research Prize 2017
3. Irish Shoulder & Elbow Surgery Research Prize 2020
4. Irish Orthopaedic Association Research Prize 2020
5. Arthroscopy Association of North America (AANA) International Education Scholarship 2019

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OVERVIEW

Anterior shoulder instability is a common clinical problem, with a reported incidence ranging from 8 to 25 per 100,000 person years in the general population, with higher rates seen in athletic populations.[1-3] However, many aspects of the management of this pathology remain controversial due to a relative lack of high-level evidence to guide treatment.[4] Furthermore, there are often regional philosophical differences in how anterior shoulder instability is approached that result in a dichotomous treatment algorithm between surgeons, further adding to this controversy.[5, 6] The purpose of this thesis was to first evaluate the state of the literature in Chapter 1 via systematic reviews & meta-analyses to determine the optimal treatment algorithms in the management of anterior shoulder instability. Following on from this in Chapter 2, we sought to evaluate the evaluate pain control strategies as well as critically analyze the complications following shoulder stabilization, and then implement strategies to improve them. In Chapter 3, we evaluated the outcomes in athletes and looked at return-to-play specific metrics with a view to optimize the outcomes in this population. Additionally, in Chapter 4, we evaluated the clinical outcomes of those undergoing shoulder stabilization in the Sports Surgery Clinic, Dublin and NYU Langone Health, New York. Finally, in Chapter 5, 65 shoulder surgeons from 14 countries across 5 continents were brought together to participate in consensus statements on anterior shoulder instability utilizing the Delphi Method. Within each chapter the appropriate literature review was conducted in the form of a systematic review to address the question.

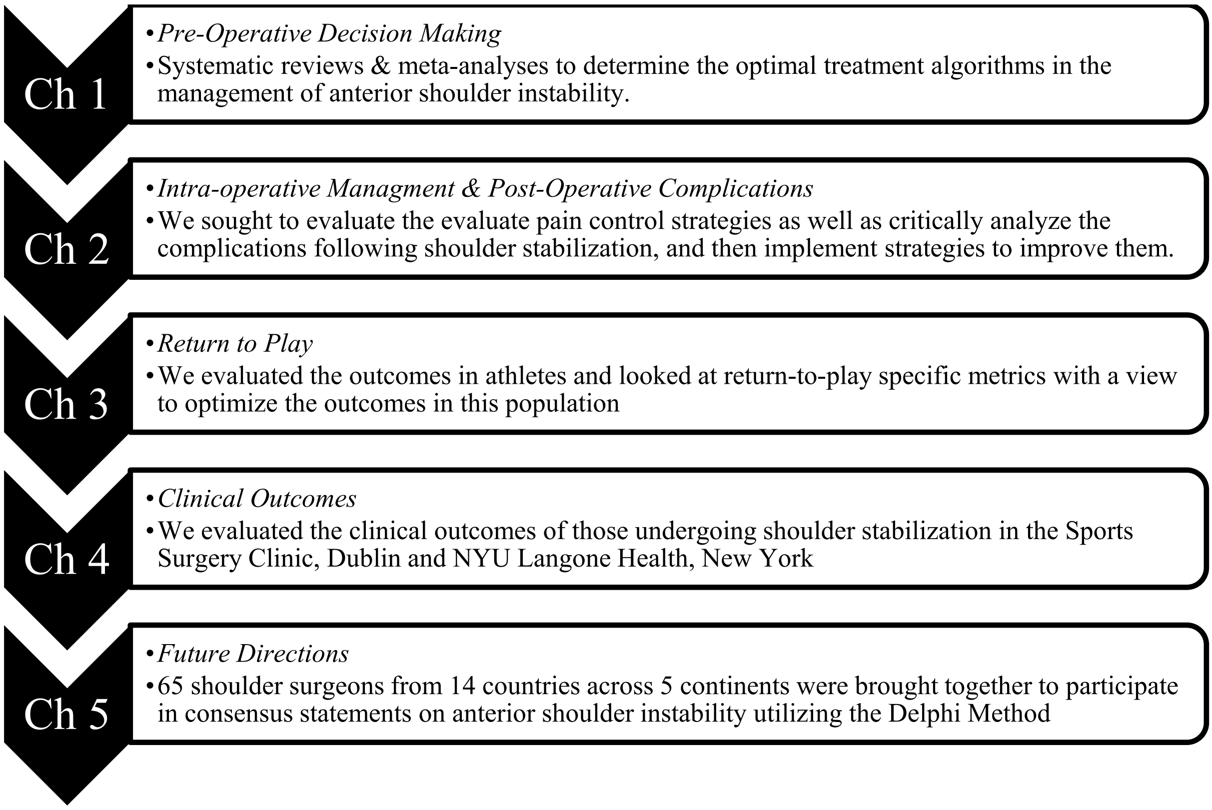


Figure 1: Flowchart showing the evolution of the chapters, and the point of care which they address.

Chapter 1: Decision Making in Anterior Shoulder Instability – A Systematic Review

INTRODUCTION

Historically, patients presenting after a first-time dislocation event have been managed non-surgically. Typically, this consists of immobilization in internal rotation for 3-6 weeks, followed by initiation of a progressive shoulder range-of-motion and strengthening program. However, recurrent dislocation rates of up to 100% have been reported with non-surgical treatment.[7-9] With recurrent instability, there may be an increased incidence of additional intra-articular pathologies which can lead to long-term instability arthropathy.[10, 11] Thus, it is of particular importance to optimize the management of first-time dislocations to minimize the potential for long-term problems.

Itoi et al.[12, 13] initially proposed the concept of shoulder immobilization in an external rotation orthosis after a first-time anterior shoulder instability event. This was based on cadaveric and magnetic resonance imaging (MRI) findings demonstrating that labral separation and displacement were both significantly less when the shoulder is placed in external rotation as compared to internal rotation. The authors subsequently conducted a randomized controlled trial comparing immobilization in external versus internal rotation after first-time anterior shoulder dislocation to assess whether these findings translated to clinically-improved healing rates.[14, 15] They found a significantly reduced recurrence rate and increased compliance rate with immobilization in external rotation. However, this still remains controversial with mixed evidence in the literature. [16-22]

Arthroscopic Bankart repair is the most commonly performed procedure worldwide for anterior shoulder instability, with good outcomes and a low complication rate. While there are still concerns regarding the recurrence rate in patients with glenoid bone loss, studies have shown low rates of post-operative instability in patients appropriately indicated for arthroscopic Bankart repair.[23] Additionally, arthroscopic Bankart repair allows for a high rate of return to sport, with Memon et al. finding 88% of patients returned to sport post-operatively.[24] Thus, several studies have been conducted comparing it to non-operative management for first-time dislocations.

The open Bankart procedure may allow for improved management of capsular deficiency and may be more cost-effective. Although widely performed and generally considered successful, concern exists over the high rate of recurrence following soft tissue repair alone, with rates of up to 30-40% reported in studies at 10 year follow-up.[25] The Latarjet procedure is an alternative treatment, favoured primarily in Europe, involving transferring part of the coracoid process and the attached conjoint tendon to the anterior aspect of the glenoid rim to restore stability. Lower recurrence rates have been reported following the Latarjet procedure, but significant complications such as non-union, hardware problems, and neurovascular injuries have been described.[26-28] While traditionally performed in open fashion, the Latarjet procedure can be performed arthroscopically, whereas the current evidence on this approach is limited albeit promising.[29]

In search of the optimal surgical management for those with an Off-Track Hill-Sachs lesion, Wolf[30] originally described the Remplissage procedure, which involves a capsulo-tenodesis where the infraspinatus tendon and posterior capsule fill the Hill-Sachs lesion to prevent it from engaging with the glenoid. The Remplissage procedure is performed alongside an arthroscopic Bankart, and has drawn increasing interest over the years due to its focused treatment of Hill-Sachs lesions.[31-33] In comparison to arthroscopic Bankart repair alone, this has the potential to reduce recurrent instability rates. The main concern with the procedure has been a possible impairment of postoperative range of motion due to the tenodesis effect of the Remplissage.

Finally, in the setting of a failed instability surgery including arthroscopic Bankart repair and open Latarjet procedure, it is unclear how they should be managed and what the appropriate treatment algorithm is. Therefore, the purpose of this chapter is to perform systematic reviews and meta-analyses of the current evidence in the literature to address these controversies to optimize treatment algorithms to manage anterior shoulder instability. The questions this chapter seeks to address include; 1) arthroscopic Bankart repair versus conservative management for first-time anterior shoulder dislocation, 2) immobilization in external versus internal rotation after first-time anterior shoulder dislocation, 3) open Latarjet procedure versus open Bankart repair versus arthroscopic Bankart repair, 4) arthroscopic Bankart repair versus arthroscopic Bankart repair with Remplissage in those Hill-Sachs lesions, 5) open Latarjet procedure versus arthroscopic Bankart repair with Remplissage in those Hill-Sachs lesions, 6) open versus arthroscopic Latarjet procedure, 7) outcomes of revision arthroscopic Bankart repair, 8) outcomes of open Latarjet procedure as a revision for failed arthroscopic Bankart repair, and 9) outcomes of a failed Latarjet procedure.

METHODS

Study Selection

Two independent reviewers performed the literature search based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and reviewed the search results, with a senior author arbitrating on any disagreement, using specific terms for each study question in MEDLINE, EMBASE, and The Cochrane Library.[34] The title and abstract were reviewed for all search results and potentially eligible studies received a full-text review. Finally, the reference lists of the included studies and literature reviews found in the initial search were manually screened for additional articles meeting the inclusion criteria.

Eligibility Criteria

The inclusion criteria were the following: 1) clinical studies, 2) published in a peer-reviewed journal, 3) published in English, 4) full text of studies available. The exclusion criteria were the following: 1) review studies, 2) cadaver studies, 3) biomechanical studies, 4) abstract only. Of note, comparative studies of the highest level of evidence were selected to answer each study question where possible. Thus, some meta-analyses were conducted only of Level I data, and some required Level IV data to be included.

Data Extraction/Analysis

The relevant information regarding the study characteristics including the study design, the level of evidence (LOE), population, the outcome measures, and the follow-up time points were collected by two blinded reviewers using a predetermined data sheet, with the results compared. When required information was not available in the text, the authors were contacted.

Statistics

Meta-analysis was performed using *Review Manager ((RevMan) [Macintosh]. Version 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014.)*. A p-value of < 0.05 was considered to be statistically significant. Network meta-analysis was performed using R (R Foundation for Statistical Computing, Vienna, Austria). A frequentist approach to network meta-analysis with a random effects model was performed using the *netmeta* package version 0.9-6 in R. Heterogeneity was quantified using the I^2 statistic.[35] To rank the treatments, we used the frequentist analogue to the surface under the cumulative ranking (SUCRA) probabilities called the P-score, which was used to rank studies.[36]

RESULTS

<u>Arthroscopic Bankart Repair versus Non-Operative Management for First Time Dislocations</u>

Ten studies (LOE I; 4, LOE II; 6) compared 270 patients treated with non-operative management to 299 patients treated with the arthroscopic Bankart repair.[37-46] The baseline age, gender and reported instability measures of patients were similar between the cohorts ($p > 0.05$).

Recurrent Instability (Figure 1)

Recurrent instability was reported in 10 studies, with 299 having arthroscopic Bankart repair and 270 patients in the conservative treatment cohort. Overall, 29 patients (9.7%) among the arthroscopic Bankart repair cohort experienced some form of a recurrent instability, while 182 patients (67.4%) in the conservative treatment group experienced recurrent instability. There was a statistically significant difference in favour of arthroscopic Bankart repair (RR 0.15 95% CI, 0.01 to 0.21 , $I^2 = 0\%$, $p < 0.0001$).

Study or Subgroup	ABR Events	ABR Total	Conservative Events	Conservative Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Arciero 1994	3	21	12	15	7.3%	0.18 [0.06, 0.52]
Bottoni 2002	1	9	9	12	4.0%	0.15 [0.02, 0.97]
De Carli 2019	8	60	50	70	24.1%	0.19 [0.10, 0.36]
Dickens 2017	0	9	3	7	2.0%	0.11 [0.01, 1.91]
Gigis 2014	5	38	19	27	11.6%	0.19 [0.08, 0.44]
Jakobsen 2007	3	37	24	39	12.2%	0.13 [0.04, 0.40]
Kirkley 2005	3	16	9	15	4.9%	0.31 [0.10, 0.94]
Larrain 2001	1	28	17	18	10.8%	0.04 [0.01, 0.26]
Robinson 2008	3	42	16	42	8.4%	0.19 [0.06, 0.60]
Shah 2011	2	39	23	25	14.6%	0.06 [0.01, 0.22]
Total (95% CI)		**299**		**270**	**100.0%**	**0.15 [0.10, 0.21]**
Total events	29		182			

Heterogeneity: $Chi^2 = 6.83$, df = 9 (P = 0.65); $I^2 = 0\%$
Test for overall effect: Z = 10.79 (P < 0.00001)

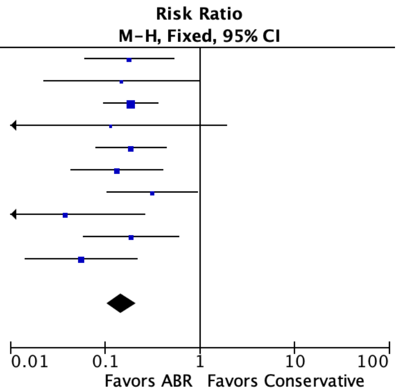


Figure 1 – Forest Plot of Recurrent Instability

Subsequent Instability Surgeries (Figure 2)

Subsequent instability surgery was reported in 6 studies, with 185 having arthroscopic Bankart repair and 180 patients in the conservative treatment cohort. Overall, 11 patients

(5.9%) among the arthroscopic Bankart repair cohort had subsequent surgery for shoulder instability, while 84 patients (46.7%) in the conservative treatment group had subsequent surgery for shoulder instability. There was a statistically significant difference in favour of arthroscopic Bankart repair (RR; 0.13, 95% CI, 0.07 to 0.24, $I^2 = 0\%$, $p < 0.0001$).

	ABR		Conservative			Risk Ratio
Study or Subgroup	**Events**	**Total**	**Events**	**Total**	**Weight**	**M-H, Fixed, 95% CI**
Arciero 1994	1	21	7	15	9.5%	0.10 [0.01, 0.74]
Bottoni 2002	0	9	6	12	6.6%	0.10 [0.01, 1.57]
De Carli 2019	4	60	32	70	34.4%	0.15 [0.05, 0.39]
Kirkley 2005	2	16	7	15	8.4%	0.27 [0.07, 1.09]
Robinson 2008	3	45	13	43	15.5%	0.22 [0.07, 0.72]
Shah 2011	1	34	19	25	25.5%	0.04 [0.01, 0.27]
Total (95% CI)		**185**		**180**	**100.0%**	**0.13 [0.07, 0.24]**
Total events	11		84			

Heterogeneity: $Chi^2 = 3.35$, df = 5 (P = 0.65); $I^2 = 0\%$
Test for overall effect: Z = 6.85 (P < 0.00001)

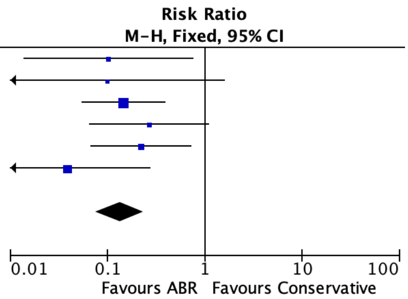


Figure 2 – Forest Plot of Subsequent Instability Surgeries

Return to Play (Figure 3)

Return to play was reported in 6 studies, with 153 having arthroscopic Bankart repair and 156 patients in the conservative treatment cohort. Overall, 142 patients (92.8%) among the arthroscopic Bankart repair cohort returned to play, while 126 patients (80.8%) in the conservative treatment group returned to play. There was a statistically significant difference in favour of arthroscopic Bankart repair (RR; 0.37 , 95% CI, 0.20 to 0.69, $I^2 = 0\%$, $p < 0.0001$).

	ABR		Conservative			Risk Ratio (Non-event)
Study or Subgroup	**Events**	**Total**	**Events**	**Total**	**Weight**	**M-H, Fixed, 95% CI**
Bottoni 2002	9	9	12	12		Not estimable
De Carli 2019	56	60	62	70	24.0%	0.58 [0.18, 1.84]
Dickens 2017	8	9	4	7	11.0%	0.26 [0.03, 1.99]
Gigis 2014	25	27	15	19	15.3%	0.35 [0.07, 1.73]
Kirkley 2005	16	16	14	15	5.0%	0.31 [0.01, 7.15]
Robinson 2008	28	32	19	33	44.8%	0.29 [0.11, 0.80]
Total (95% CI)		**153**		**156**	**100.0%**	**0.37 [0.20, 0.69]**
Total events	142		126			

Heterogeneity: $Chi^2 = 0.93$, df = 4 (P = 0.92); $I^2 = 0\%$
Test for overall effect: Z = 3.12 (P = 0.002)

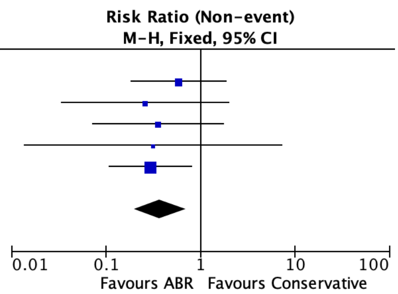


Figure 3 – Forest Plot of Return to Play

<u>Immobilization in External versus Internal Rotation for Non-Operative Management of First Time Dislocations</u>

There were 9 RCTs [14, 47-54] (LOE I) comparing 408 patients immobilized in external rotation to 387 patients immobilized in internal rotation. The majority of these patients (82.4%) were male, with an average age of 29 years, and average follow-up time of 25.5 months. The majority of studies (6) used 3 weeks of immobilization, and the rest (3) used 4 weeks of immobilization; with each study using identical immobilization times for each group. The baseline age, gender, and reported risk factors for recurrent instability were similar between the cohorts ($p > 0.05$).

Recurrent Dislocations (Figure 4 & 5)

The rate of recurrent dislocation was reported in 9 studies, with 401 immobilized in external rotation and 386 patients immobilized in internal rotation. Overall, 89 patients (22.2%) immobilized in external rotation experienced recurrence as compared to 215 patients (33.4%) immobilized in internal rotation. There was a statistically significant difference favouring immobilization in external rotation (RR 0.62 95% CI, 0.42 to 0.92, $I^2 = 55\%$, $p = 0.02$). Additionally, the rate of recurrent dislocations in 20-40 year olds was reported in 5 studies, with 165 immobilized in external rotation and 172 patients immobilized in internal rotation. Overall, 20 patients (12.1%) immobilized in external rotation experienced recurrence as compared to 54 patients (31.4%) immobilized in internal rotation. There was a statistically significant difference favouring immobilization in external rotation (RR 0.36 95% CI, 0.17 to 0.75, $I^2 = 48\%$, $p = 0.006$).

Study or Subgroup	ER Events	ER Total	IR Events	IR Total	Weight	Risk Ratio M-H, Random, 95% CI
Chan 2019	8	33	10	33	11.6%	0.80 [0.36, 1.77]
Finestone 2009	10	27	10	24	13.3%	0.89 [0.45, 1.76]
Heidari 2014	2	51	17	51	5.6%	0.12 [0.03, 0.48]
Itoi 2007	22	85	31	74	17.3%	0.62 [0.39, 0.97]
Liavaag 2011	28	91	23	93	16.9%	1.24 [0.78, 1.99]
Murray 2020	7	24	11	23	12.1%	0.61 [0.29, 1.30]
Taskoparan 2010	1	16	5	17	3.1%	0.21 [0.03, 1.63]
Wang 2011	5	47	16	46	10.0%	0.31 [0.12, 0.77]
Whelan 2014	6	27	8	25	10.1%	0.69 [0.28, 1.72]
Total (95% CI)		**401**		**386**	**100.0%**	**0.62 [0.42, 0.92]**
Total events	89		131			

Heterogeneity: $Tau^2 = 0.17$; $Chi^2 = 17.92$, df = 8 (P = 0.02); $I^2 = 55\%$
Test for overall effect: Z = 2.38 (P = 0.02)

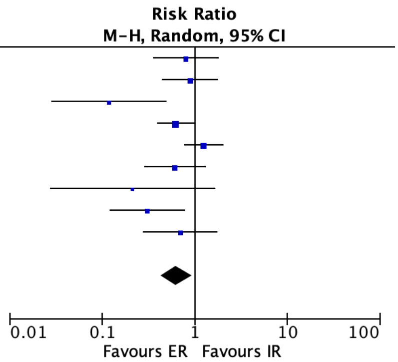


Figure 4 – Forest Plot of Recurrent Dislocations

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Heidari 2014	2	42	16	47	16.7%	0.14 [0.03, 0.57]
Itoi 2007	6	36	14	31	28.0%	0.37 [0.16, 0.84]
Liavaag 2011	9	58	10	63	28.0%	0.98 [0.43, 2.23]
Murray 2020	2	17	9	18	17.1%	0.24 [0.06, 0.94]
Taskoparan 2010	1	12	5	13	10.3%	0.22 [0.03, 1.60]
Total (95% CI)		**165**		**172**	**100.0%**	**0.36 [0.17, 0.75]**
Total events	20		54			

Heterogeneity: $Tau^2 = 0.32$; $Chi^2 = 7.74$, df = 4 (P = 0.10); $I^2 = 48\%$
Test for overall effect: Z = 2.72 (P = 0.006)

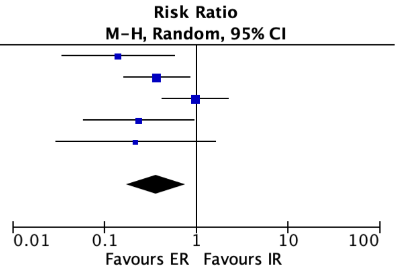


Figure 5 – Forest Plot of Recurrent Dislocations in 20-40-year olds

Compliance (Figure 6)

Compliance with the immobilization protocol was reported in 7 studies, with 345 patients immobilized in external rotation and 324 immobilized in internal rotation. Overall, 258 patients (74.5%) immobilized in external rotation were compliant, as compared to 215 patients (67.4%) immobilized in internal rotation. There was a statistically significant difference favouring immobilization in external rotation (RR 0.75 95% CI, 0.60 to 0.94, I^2 = 44%, p = 0.01). The forest plot for compliance is shown in Figure 6.

Study or Subgroup	ER Events	ER Total	IR Events	IR Total	Weight	Risk Ratio (Non-event) M-H, Fixed, 95% CI
Chan 2019	18	34	16	28	11.7%	1.10 [0.63, 1.92]
Finestone 2009	26	27	24	24	0.5%	2.68 [0.11, 62.81]
Heidari 2014	41	51	48	51	2.7%	3.33 [0.97, 11.41]
Itoi 2007	61	85	39	74	33.2%	0.60 [0.39, 0.90]
Liavaag 2011	63	93	45	95	43.8%	0.61 [0.43, 0.87]
Murray 2020	22	24	19	23	3.6%	0.48 [0.10, 2.37]
Whelan 2014	27	31	24	29	4.6%	0.75 [0.22, 2.52]
Total (95% CI)		**345**		**324**	**100.0%**	**0.75 [0.60, 0.94]**
Total events	258		215			

Heterogeneity: $Chi^2 = 10.78$, df = 6 (P = 0.10); $I^2 = 44\%$
Test for overall effect: Z = 2.51 (P = 0.01)

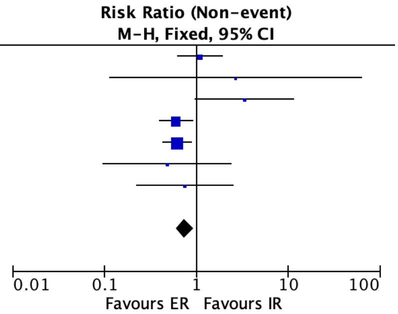


Figure 6 – Forest Plot of Compliance

Return to Play (Figure 7)

The rate of return to play at the same pre-injury level was reported in 2 studies, with 187 immobilized in external rotation and 176 patients immobilized in internal rotation. Overall, 114 patients (60.1%) immobilized in external rotation returned to play, as compared to 75 patients (42.6%) immobilized in internal rotation. There was a statistically significant difference favouring immobilization in external rotation (RR 0.65 95% CI, 0.52 to 0.81, I^2 = 87%, p = 0.0001).

	ER		IR			Risk Ratio (Non-event)
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI
Heidari 2014	43	51	16	51	33.2%	0.23 [0.12, 0.44]
Itoi 2007	20	53	7	39	35.0%	0.76 [0.59, 0.98]
Liavaag 2011	51	83	52	86	31.7%	0.98 [0.67, 1.42]
Total (95% CI)		**187**		**176**	**100.0%**	**0.65 [0.52, 0.81]**
Total events	114		75			

Heterogeneity: Chi^2 = 15.37, df = 2 (P = 0.0005); I^2 = 87%
Test for overall effect: Z = 3.84 (P = 0.0001)

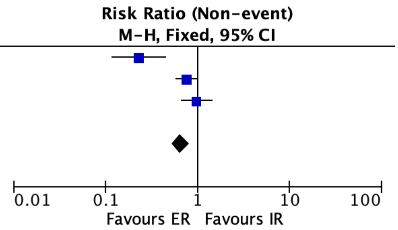


Figure 7 – Forest Plot of Return to play

<u>Arthroscopic Bankart Repair versus Open Bankart Repair versus Open Latarjet Procedure</u>

There were 29 (LOE I; 6, LOE II; 4, LOE II;19) studies comparing; 687 patients with arthroscopic Bankart repair to 685 patients with open Bankart repair (19 studies), 469 patients with arthroscopic Bankart repair to 290 patients with open Latarjet procedure (6 studies), and 173 patients with open Bankart repair to 170 patients with open Latarjet procedure (4 studies).[25, 55-82] The risk factors for instability were not controlled, and those undergoing the open Latarjet procedure had great risk factors for post-operative recurrence.

Total Recurrent Instability (Figure 8)

Total recurrent instability was reported in 24 studies. Open Latarjet procedure resulted in statistically significantly lower rates of recurrent instability compared to open Bankart repair (OR 2.04, CI 1.17-3.55, p = 0.010) and arthroscopic Bankart repair (OR 3.41, CI 2.02-5.76, p < 0.001). There was a statistically significant difference between in favour of open Bankart repair over arthroscopic Bankart repair (OR 1.67, CI 1.13-2.47, p = 0.001). Based on these findings open Latarjet procedure was the treatment with the highest P-score, 0.9971. There was low heterogeneity between the studies (I^2 =16.1%, p = 0.242).

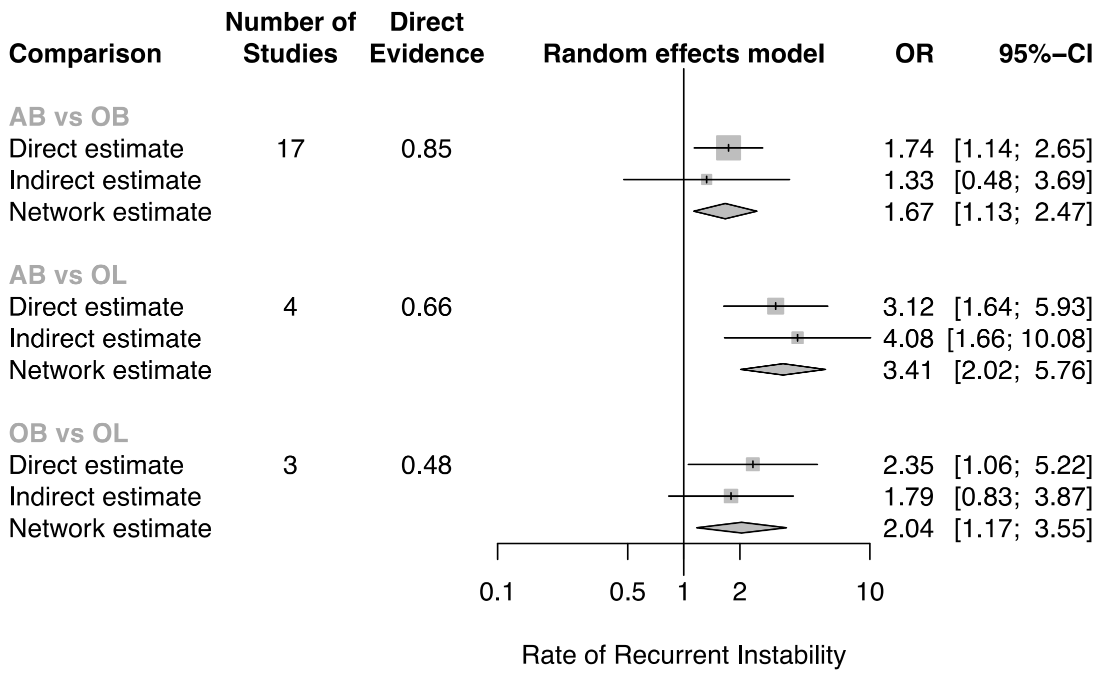


Figure 8 - Forest plot of Total Recurrent Instability

Recurrent Dislocations (Figure 9)

The incidence of recurrent dislocations was reported in 20 studies. Open Latarjet procedure resulted in statistically significantly lower rates of recurrent dislocations compared to arthroscopic Bankart repair (OR 2.90, CI 1.41-5.96, p = 0.004) but not open Bankart repair (OR 1.82, CI 0.85-3.90, p = 0.125). There was no statistically significant difference between open Bankart repair and arthroscopic Bankart repair (OR 1.59, CI 0.99-2.57, p = 0.056). Based on these findings open Latarjet procedure was the treatment with the highest P-score, 0.9679. There was low heterogeneity between the studies (I^2 =7.6%, p = 0.363).

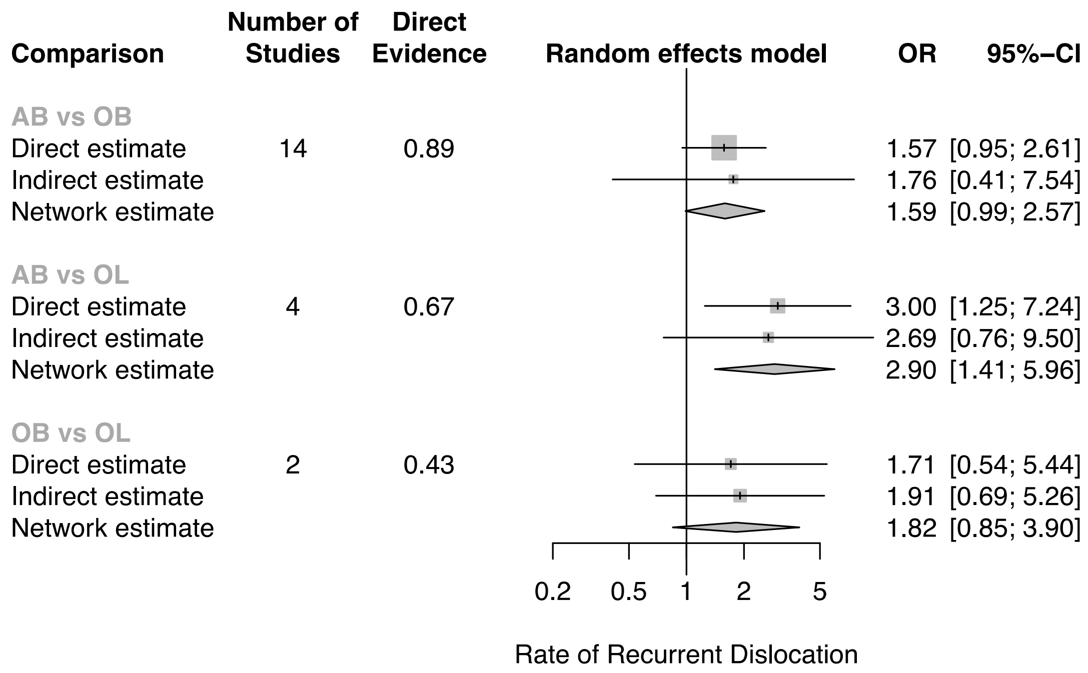


Figure 9 - Forest plot of Recurrent Dislocations

Total Revisions (Figure 10)

The rate of revision procedures was reported in 18 studies. Open Latarjet procedure resulted in statistically significantly lower rates of revisions compared to arthroscopic Bankart repair (OR 2.42, CI 1.33-4.40, $p = 0.004$) but not open Bankart repair (OR 1.67, CI 0.86-3.24, $p = 0.129$). There was no statistically significant difference between open Bankart repair and arthroscopic Bankart repair (OR 1.45, CI 0.88-2.38, $p = 0.150$). Based on these findings open Latarjet procedure was the treatment with the highest P-score, 0.9668. There was low heterogeneity between the studies ($I^2 = 3.7\%$, $p = 0.411$).

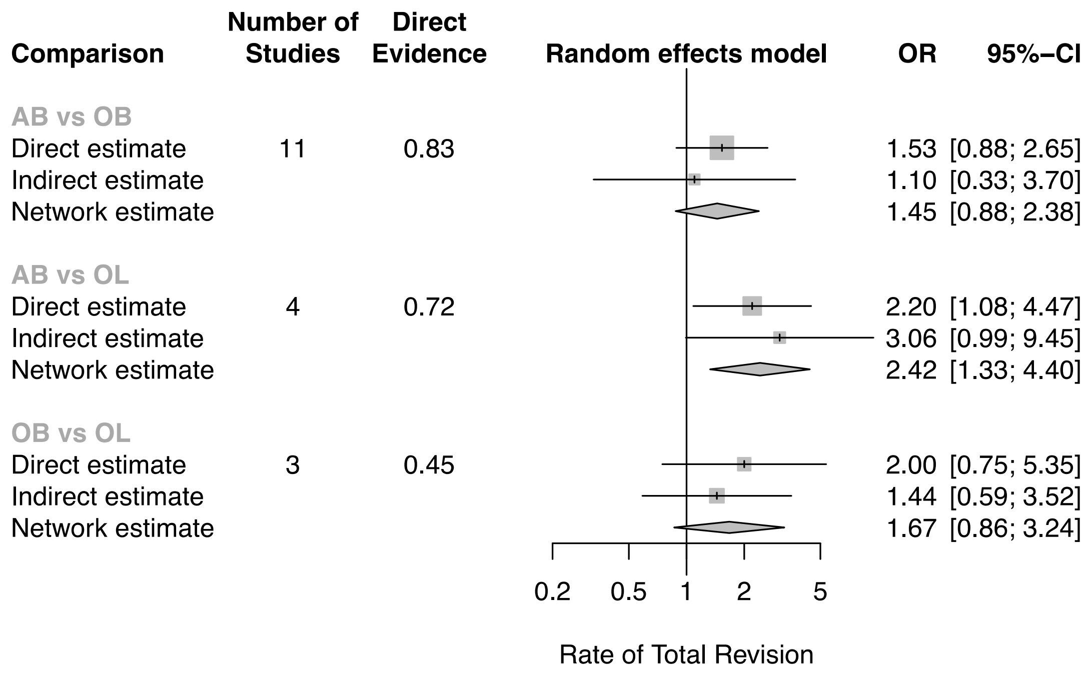


Figure 10 - Forest plot of Total Revisions

Revisions Due to Recurrence (Figure 11)

Revisions due to recurrence were reported in 18 studies. Open Latarjet procedure resulted in statistically significantly lower rates of revisions due to recurrence compared to open Bankart repair (OR 3.22, CI 1.28-8.09, $p = 0.013$) and arthroscopic Bankart repair (OR 6.06, CI 2.50-14.69, $p < 0.001$). There was a statistically significant difference between in favour of open Bankart repair over arthroscopic Bankart repair (OR 1.88, CI 1.09-3.25, $p = 0.023$). Based on these findings open Latarjet procedure was the treatment with the highest P-score, 0.9967. There was low heterogeneity between the studies ($I^2 = 0\%$, $p = 0.628$).

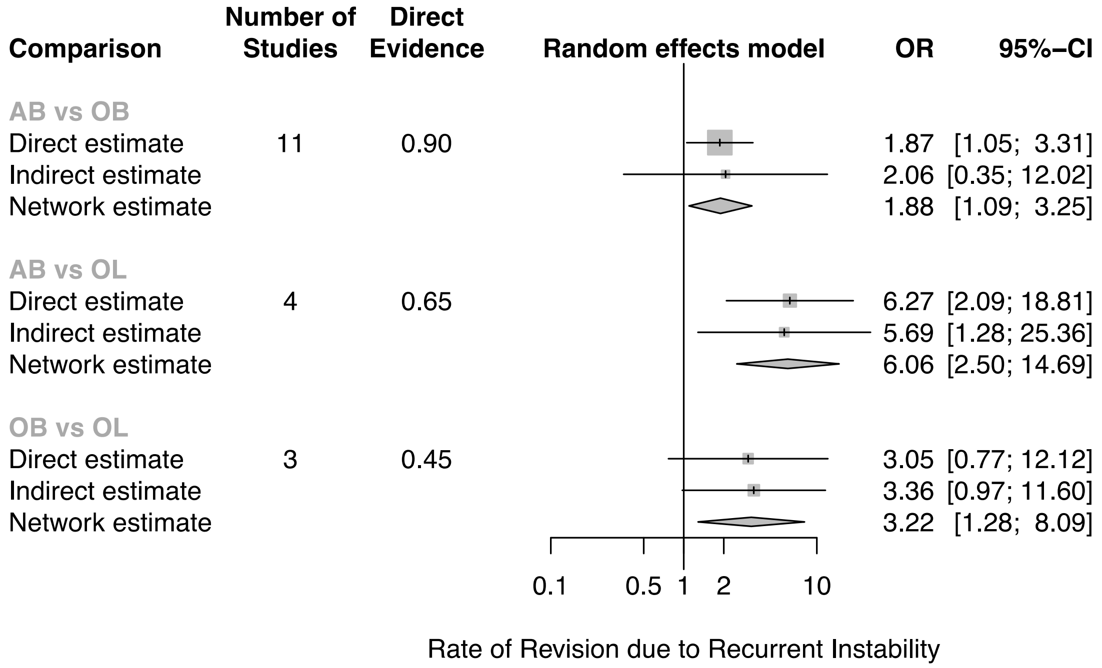


Figure 11 - Forest plot of Revisions due to Recurrent Instability

Return to Play (Figure 12)

Return to play was reported in 10 studies. Open Latarjet procedure resulted in statistically significantly higher rates of return to play compared to arthroscopic Bankart repair (OR 0.62, CI 0.42-0.91, p = 0.016) but not open Bankart repair (OR 0.71, CI 0.44-1.15, p = 0.162). There was no statistically significant difference between open Bankart repair and arthroscopic Bankart repair (OR 0.87, CI 0.51-1.50, p = 0.615). Based on these findings open Latarjet procedure was the treatment with the highest P-score, 0.9554. There was low heterogeneity between the studies (I^2 =0%, p = 0.775).

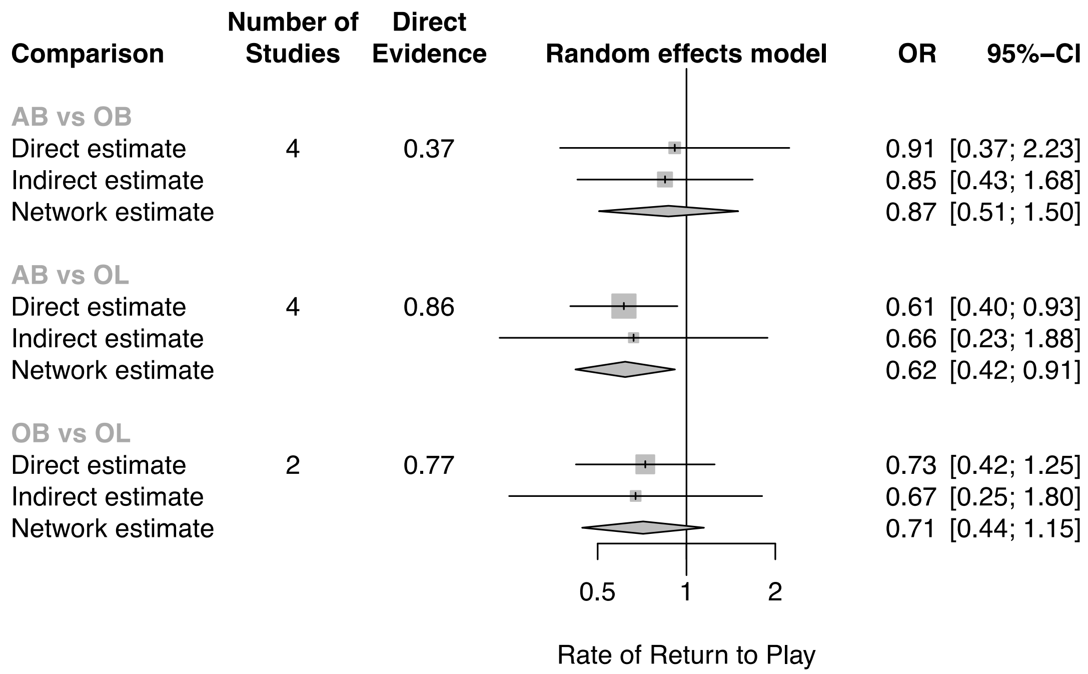


Figure 12 - Forest plot of Return to Play

Total Complications *(Figure 13)*

Complication rates were reported in 15 studies. Open Latarjet procedure resulted in statistically significantly higher rates complications compared to arthroscopic Bankart repair (OR 0.62, CI 0.29-1.31, p = 0.011) but not open Bankart repair (OR 0.36, CI 0.12-1.06, p = 0.065). There was no statistically significant difference between open Bankart repair and arthroscopic Bankart repair (OR 0.62, CI 0.29-1.31, p = 0.208). Based on these findings arthroscopic Bankart repair was the treatment with the highest P-score, 0.9453. There was low heterogeneity between the studies (I^2 =0%, p = 0.804).

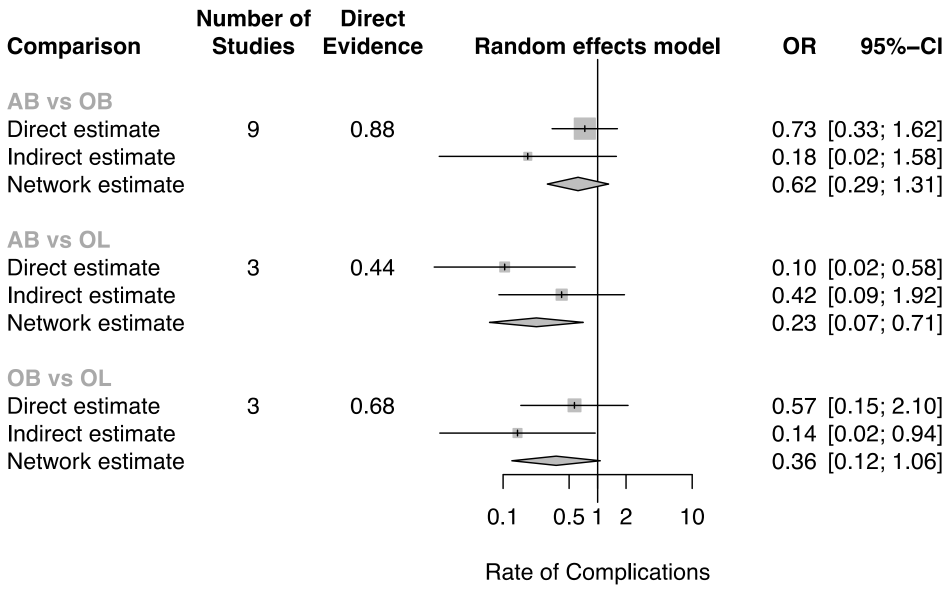


Figure 13 - Forest plot of Total Complications

The P-scores and the raw percentages for clinical outcomes are shown in Table 1 & 2 respectively. It should be noted that the reported percentages of clinical outcomes are not reflective of the odds ratio and p-scores as these are based on both direct and indirect comparisons.

Table 1. P Scores

Recurrent Instability	Recurrent Dislocations	Revisions	Revisions Due to Recurrence	Return to Play	Total Complications
OL: 0.9971	OL: 0.9679	OL: 0.9668	OL: 0.9967	OL: 0.9554	AB: 0.9453
OB: 0.5003	OB: 0.5172	OB: 0.4954	OB: 0.4976	OB: 0.3868	OB: 0.5359
AB: 0.0025	AB: 0.01497	AB: 0.0378	AB: 0.0057	AB: 0.1577	OL: 0.01885

AB: arthroscopic Bankart repair, OB; open Bankart repair, OL; open Latarjet

Table 2. Clinical Outcomes

Recurrent Instability	Recurrent Dislocations	Revisions	Revisions Due to Recurrence	Return to Play	Total Complications
OL: 9.7%	OL: 4.0%	OL: 4.9%	OL: 1.4%	OL: 80.0%	AB: 2.2%
OB: 10.7%	OB: 5.9%	OB: 6.1%	OB: 4.6%	OB: 77.4%	OB: 3.5%
AB: 21.7%	AB: 10.3%	AB: 11.6%	AB: 11.2%	AB: 75.2%	OL: 5.7%

AB: arthroscopic Bankart repair, OB; open Bankart repair, OL; open Latarjet

Arthroscopic Bankart Repair versus Arthroscopic Bankart Repair and Remplissage for Anterior Shoulder Instability with Hill-Sachs Lesions

Eight studies (LOE II; 1, LOE III; 7) including 361 patients compared Remplissage to arthroscopic Bankart repair alone. [83-90] The baseline age, gender and reported instability measures of patients were similar among the cohorts in all studies ($p > 0.05$).

Total Recurrence (Figure 14)

Total recurrent instability (including recurrent dislocations or subluxations) was reported in 7 studies, comprising of 172 arthroscopic Bankart repairs alone and 157 procedures where Remplissage was included. The arthroscopic Bankart repair resulted in 16.8% of patients having recurrent instability, compared with the Remplissage procedures where 3.2% of patients had recurrent instability. There was a statistically significant difference in favour of the additive Remplissage procedure (RR; 3.74, 95% CI, 1.67 to 8.38, $I^2 = 0\%$, $p = 0.001$).

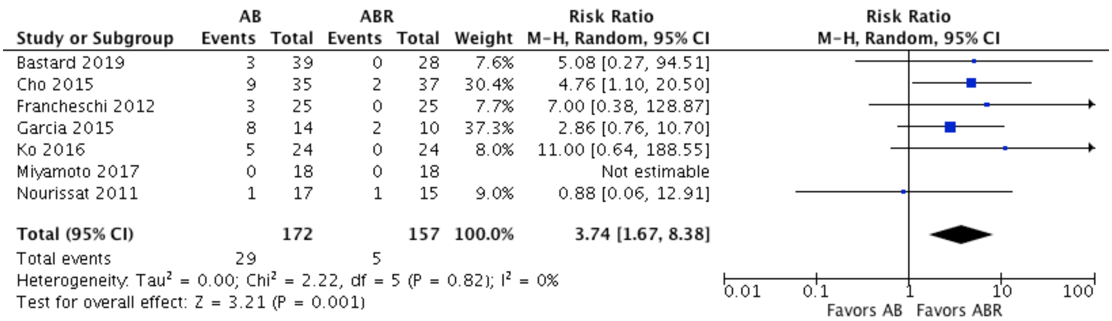


Figure 14. Forest Plot of Total Recurrence

Recurrent Dislocations (Figure 15)

Recurrent dislocations was reported in 8 studies, comprising of 188 arthroscopic Bankart repairs alone and 172 procedures where Remplissage was included. The arthroscopic Bankart repair resulted in 14.8% of patients having a recurrent dislocation, compared with the Remplissage procedures where 1.7% of patients had a recurrent dislocation. There was a statistically significant difference in favour of the additive Remplissage procedure (MD; 4.35, 95% CI, 1.79 to 10.58, $I^2 = 0\%$, p = 0.001).

Study or Subgroup	AB Events	AB Total	ABR Events	ABR Total	Weight	Risk Ratio M-H, Random, 95% CI
Bastard 2019	3	39	0	28	9.3%	5.08 [0.27, 94.51]
Cho 2015	5	35	0	37	9.7%	11.61 [0.67, 202.53]
Francheschi 2012	3	25	0	25	9.3%	7.00 [0.38, 128.87]
Garcia 2015	3	14	0	10	9.7%	5.13 [0.29, 89.57]
Hughes 2018	8	17	2	15	41.3%	3.53 [0.88, 14.10]
Ko 2016	5	24	0	24	9.8%	11.00 [0.64, 188.55]
Miyamoto 2017	1	17	1	15	11.0%	0.88 [0.06, 12.91]
Nourissat 2011	0	18	0	18		Not estimable
Total (95% CI)		**189**		**172**	**100.0%**	**4.35 [1.79, 10.58]**
Total events	28		3			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 2.52$, df = 6 (P = 0.87); $I^2 = 0\%$
Test for overall effect: Z = 3.24 (P = 0.001)

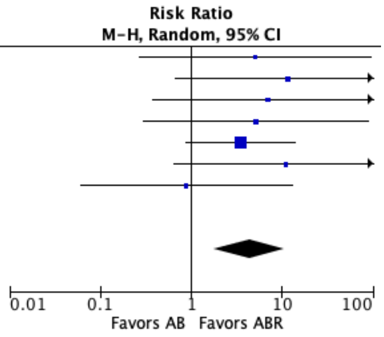


Figure 15. Forest Plot of Recurrent Dislocations

Revisions due to Recurrence (Figure 16)

Revisions due to recurrent instability were reported in 7 studies, comprising of 172 arthroscopic Bankart repairs alone and 157 procedures where Remplissage was included. The arthroscopic Bankart repair resulted in 8.5% of patients having a revision due to recurrent instability, compared with the Remplissage procedures where 1.7% of patients had a revision due to recurrent instability. There was no statistically significant difference between the procedures (RR; 2.54, 95% CI, 0.97 to 6.66, $I^2 = 0\%$, p = 0.06).

Study or Subgroup	AB Events	AB Total	ABR Events	ABR Total	Weight	Risk Ratio M-H, Random, 95% CI
Bastard 2019	2	39	0	28	10.3%	3.63 [0.18, 72.70]
Cho 2015	5	35	0	37	11.4%	11.61 [0.67, 202.53]
Francheschi 2012	3	25	0	25	10.9%	7.00 [0.38, 128.87]
Garcia 2015	1	14	0	10	9.6%	2.20 [0.10, 49.06]
Hughes 2018	4	16	2	15	38.9%	1.88 [0.40, 8.78]
Ko 2016	1	24	0	24	9.3%	3.00 [0.13, 70.16]
Miyamoto 2017	0	18	0	18		Not estimable
Nourissat 2011	0	17	1	15	9.5%	0.30 [0.01, 6.77]
Total (95% CI)		**188**		**172**	**100.0%**	**2.54 [0.97, 6.66]**
Total events	16		3			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 3.66$, df = 6 (P = 0.72); $I^2 = 0\%$
Test for overall effect: Z = 1.90 (P = 0.06)

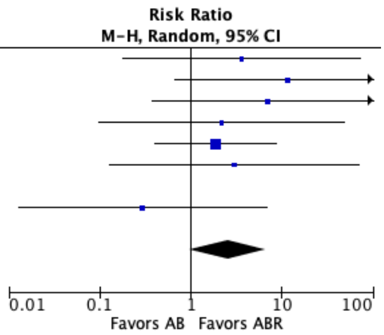


Figure 16. Forest Plot of Revisions due to Recurrence

Return to Play (Figure 17)

Return to play was reported in 3 studies, comprising of 66 arthroscopic Bankart repairs alone and 62 procedures where Remplissage was included. The arthroscopic Bankart repair resulted in 78.8% of patients returning to play, compared with the Remplissage procedures where 83.9% of patients return to play. There was no statistically significant difference between the procedures (RR; 1.00, 95% CI, 0.86 to 1,15, $I^2 = 6\%$, p = 0.55).

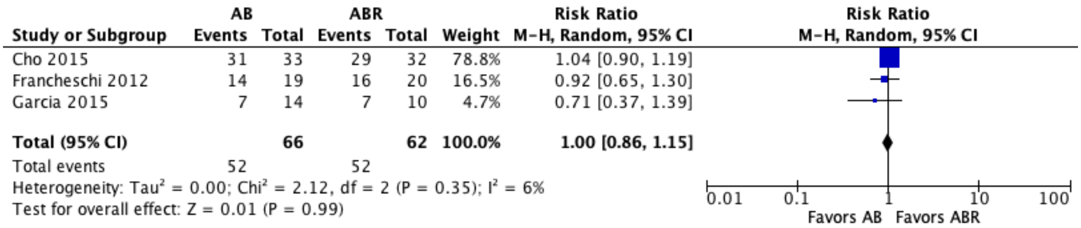


Figure 16. Forest Plot of Return to Play

Range of Motion: Forward Flexion (Figure 18)

Forward flexion was reported in 3 studies, comprising of 78 arthroscopic Bankart repairs alone and 80 procedures where Remplissage was included. The arthroscopic Bankart repair resulted in an average forward flexion was 165.2°, compared with the Remplissage procedure where the average forward flexion was 162.1°. There was no statistically significant difference between the procedures (MD; 3.11, 95% CI, -1.30 to 7.52, $I^2 = 39\%$, p = 0.17).

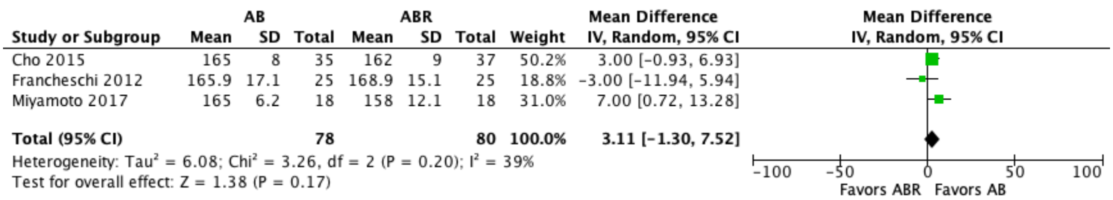


Figure 18. Forest Plot of Forward Flexion

Range of Motion: External Rotation with Arm at Side (Figure 19)

External rotation with arm at side was reported in 3 studies, comprising of 78 arthroscopic Bankart repairs alone and 80 procedures where Remplissage was included. The arthroscopic Bankart repair resulted in an average external rotation with arm at side was 62.7°, compared with the Remplissage procedure where the average external rotation with arm at side was 55.6°,. There was no statistically significant difference between the procedures (MD; 7.20, 95% CI, -6.85 to 21.24, $I^2 = 91\%$, $p = 0.32$).

Study or Subgroup	AB Mean	AB SD	AB Total	ABR Mean	ABR SD	ABR Total	Weight	Mean Difference IV, Random, 95% CI
Cho 2015	65	14	35	66	11	37	34.6%	-1.00 [-6.84, 4.84]
Francheschi 2012	58	15.8	25	56	17.6	25	31.7%	2.00 [-7.27, 11.27]
Miyamoto 2017	65	9.7	18	44.5	11.7	18	33.7%	20.50 [13.48, 27.52]
Total (95% CI)			**78**			**80**	**100.0%**	**7.20 [-6.85, 21.24]**

Heterogeneity: $Tau^2 = 139.48$; $Chi^2 = 22.51$, df = 2 (P < 0.0001); $I^2 = 91\%$
Test for overall effect: Z = 1.00 (P = 0.32)

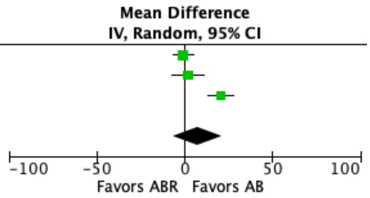


Figure 19. Forest Plot of External Rotation with Arm at the Side

Open Latarjet versus Arthroscopic Bankart Repair and Remplissage for Anterior Shoulder Instability with Hill-Sachs Lesions

Four studies (LOE III; 4) including 379 patients compared arthroscopic Bankart Remplissage to the open Latarjet procedure. [59, 91-93] The baseline age, gender and reported instability measures of patients were similar among the cohorts in all studies ($p > 0.05$).

Total Recurrence (Figure 20)

Total recurrent instability (including recurrent dislocations or subluxations) was reported in 4 studies, comprising of 185 open Latarjet procedures and 194 procedures where Remplissage was included. The open Latarjet procedure resulted in 7.0% of patients having recurrent instability, compared with the Remplissage procedures where 9.8% of patients had a recurrent instability. There was no statistically significant difference between the procedures (RR; 0.74, 95% CI, 0.37 to 1.48, $I^2 = 0\%$, $p = 0.39$).

Study or Subgroup	OL Events	OL Total	ABR Events	ABR Total	Weight	Risk Ratio M-H, Random, 95% CI
Abouelsoud 2015	1	16	0	16	5.0%	3.00 [0.13, 68.57]
Bah 2018	5	43	4	43	31.6%	1.25 [0.36, 4.34]
Cho 2015	2	35	2	37	13.5%	1.06 [0.16, 7.10]
Yang 2018	5	91	13	98	49.9%	0.41 [0.15, 1.12]
Total (95% CI)		**185**		**194**	**100.0%**	**0.74 [0.37, 1.48]**
Total events	13		19			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 2.90$, df = 3 (P = 0.41); $I^2 = 0\%$
Test for overall effect: Z = 0.86 (P = 0.39)

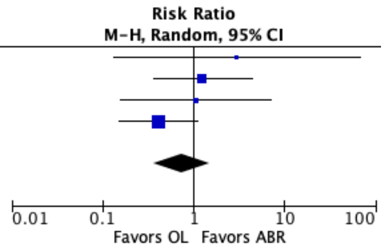


Figure 20. Forest Plot of Total Recurrence

Recurrent Dislocations (Figure 21)

Recurrent dislocations was reported in 2 study comparing 107 open Latarjet procedures and 114 procedures where Remplissage was included. The open Latarjet procedure resulted in 3.7% of patients having a recurrent dislocation, compared with the Remplissage procedures where 4.4% of patients had a recurrent dislocation. There was no statistically significant difference between the procedures (RR; 0.84, 95% CI, 0.23 to 3.00, $I^2 = 0\%$, p = 0.38).

	OL		ABR			Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI
Abouelsoud 2015	1	16	0	16	16.7%	3.00 [0.13, 68.57]
Yang 2018	3	91	5	98	83.3%	0.65 [0.16, 2.63]
Total (95% CI)		**107**		**114**	**100.0%**	**0.84 [0.23, 3.00]**
Total events	4		5			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.77$, df = 1 (P = 0.38); $I^2 = 0\%$
Test for overall effect: Z = 0.28 (P = 0.78)

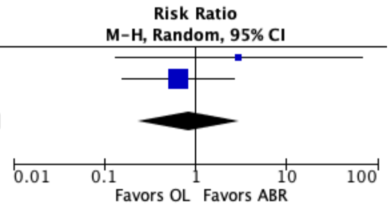


Figure 21. Forest Plot of Recurrent Dislocations

Revisions due to Recurrence (Figure 22)

Revisions due to recurrent instability were reported in 4 studies, comprising of 185 open Latarjet procedures and 194 procedures where Remplissage was included. The open Latarjet procedure resulted in 1.6% of patients having a revision due to recurrent instability, compared with the Remplissage procedures where 2.1% of patients had a revision due to recurrent instability. There was no statistically significant difference between the procedures (RR; 0.79, 95% CI, 0.18 to 3.49, $I^2 = 0\%$, p = 0.76).

	OL		ABR			Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI
Abouelsoud 2015	0	16	0	16		Not estimable
Bah 2018	1	43	1	43	29.4%	1.00 [0.06, 15.48]
Cho 2015	0	35	0	37		Not estimable
Yang 2018	2	91	3	98	70.6%	0.72 [0.12, 4.20]
Total (95% CI)		**185**		**194**	**100.0%**	**0.79 [0.18, 3.49]**
Total events	3		4			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.04$, df = 1 (P = 0.84); $I^2 = 0\%$
Test for overall effect: Z = 0.31 (P = 0.76)

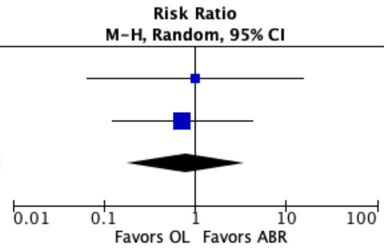


Figure 22. Forest Plot of Revisions due to Recurrence

Total Revisions (Figure 23)

Total revisions were reported in 4 studies, comprising of 185 Latarjet procedures and 194 procedures where Remplissage was included. The open Latarjet procedure resulted in 3.7% of patients having a revision, compared with the Remplissage procedures where 5.7% of patients had a revision. Revisions following the Latarjet procedure were performed due to recurrence, screw removal, irrigation of hematoma, and bone block fracture. Revisions following the Remplissage procedure were performed due to recurrence, subacromial decompression and glenohumeral debridement. There was no statistically significant difference between the procedures (RR; 0.68, 95% CI, 0.27 to 1.69, $I^2 = 0\%$, p = 0.41).

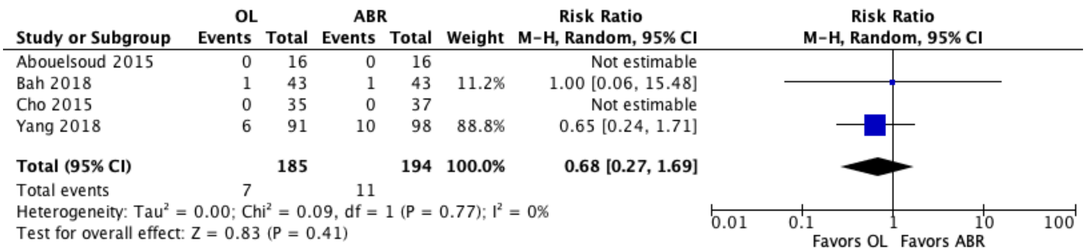


Figure 23. Forest Plot of Total Revisions

Total Complications (Figure 24)

Total complication rates were reported in 4 studies, comprising of 185 Latarjet procedures and 194 procedures where Remplissage was included. The open Latarjet procedure resulted in 8.6% of patients having a complication, compared with the Remplissage procedures where 0.5% of patients had a complication. The complications in the patients who underwent an open Latarjet procedure included; 4 deep wound infections, 4 painful/loose hardware, 3 malunions, 2 graft fractures, 1 non-union, 1 transient suprascapular nerve palsy, and 1 post-operative stiffness. There was 1 deep infection in a patient who underwent a Remplissage. There was a statistically significant difference in favour of the additive Remplissage procedure (RR; 11.77, 95% CI, 0.2.25 to 61.49, $I^2 = 0\%$, p = 0.003).

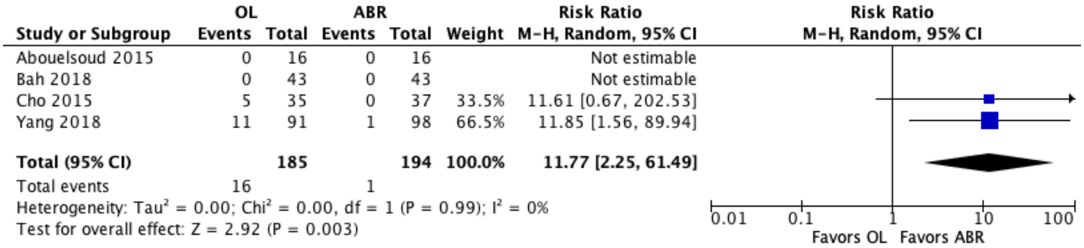


Figure 24. Forest Plot of Total Complications

Return to Play (Figure 25)

Return to play was reported in 1 studies, comprising of 52 open Latarjet procedures and 52 procedures where Remplissage was included. Both procedure resulted in an average return to play was 90.6%. There was no statistically significant difference between the procedures (MD; 1.00, 95% CI, 0.85 to 1.17, $I^2 = 0\%$, p = 1.00).

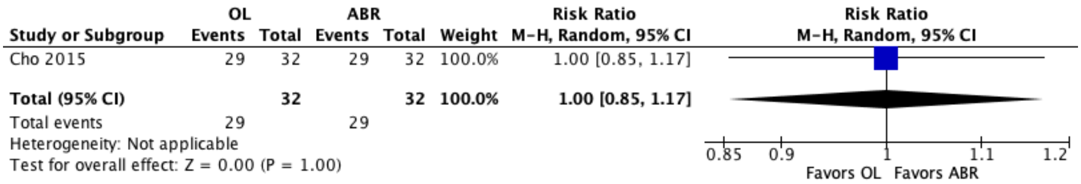
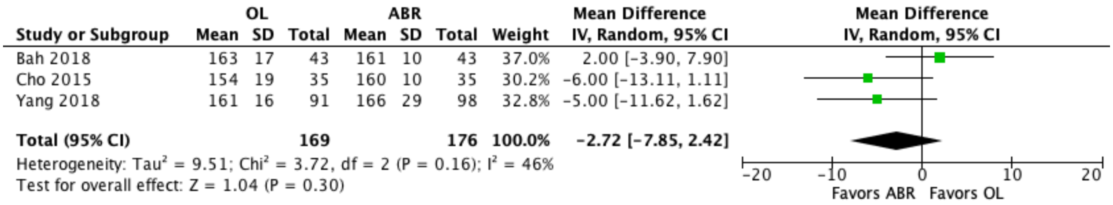


Figure 25. Forest Plot of Return to Play

Rane of Motion: Forward Flexion (Figure 26)

Forward flexion was reported in 3 studies, comprising of 169 open Latarjet procedures and 176 procedures where Remplissage was included. The open Latarjet procedure resulted in an average FF was 159.6°,, compared with the Remplissage procedure where the average FF was 162.4°,. There was no statistically significant difference between the procedures (MD; -2.72, 95% CI, -7.85 to 2.42, $I^2 = 46\%$, p = 0.30).



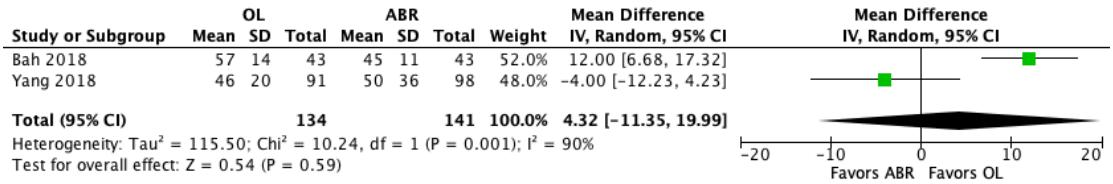
Study or Subgroup	OL Mean	OL SD	OL Total	ABR Mean	ABR SD	ABR Total	Weight	Mean Difference IV, Random, 95% CI
Bah 2018	163	17	43	161	10	43	37.0%	2.00 [-3.90, 7.90]
Cho 2015	154	19	35	160	10	35	30.2%	-6.00 [-13.11, 1.11]
Yang 2018	161	16	91	166	29	98	32.8%	-5.00 [-11.62, 1.62]
Total (95% CI)			**169**			**176**	**100.0%**	**-2.72 [-7.85, 2.42]**

Heterogeneity: Tau² = 9.51; Chi² = 3.72, df = 2 (P = 0.16); I² = 46%
Test for overall effect: Z = 1.04 (P = 0.30)

Figure 26. Forest Plot of Forward Flexion

Range of Motion: External Rotation of Arm at Side (Figure 27)

External rotation of arm at side was reported in 2 studies, comprising of 134 open Latarjet procedures and 141 procedures where Remplissage was included. The open Latarjet procedure resulted in an average external rotation of arm at side was 51.7°, compared with the Remplissage procedure where the average external rotation of arm at side was 47.4°. There was no statistically significant difference between the procedures (MD; 4.32, 95% CI, -11.35 to 19.99, $I^2 = 90\%$, $p = 0.59$).



Study or Subgroup	OL Mean	OL SD	OL Total	ABR Mean	ABR SD	ABR Total	Weight	Mean Difference IV, Random, 95% CI
Bah 2018	57	14	43	45	11	43	52.0%	12.00 [6.68, 17.32]
Yang 2018	46	20	91	50	36	98	48.0%	-4.00 [-12.23, 4.23]
Total (95% CI)			**134**			**141**	**100.0%**	**4.32 [-11.35, 19.99]**

Heterogeneity: Tau² = 115.50; Chi² = 10.24, df = 1 (P = 0.001); I² = 90%
Test for overall effect: Z = 0.54 (P = 0.59)

Figure 27. Forest Plot of External Rotation of Arm at the Side

Range of Motion: Internal Rotation of Arm (Figure 28)

Internal rotation of the arm was reported in 2 studies, comprising of 134 open Latarjet procedures and 141 procedures where Remplissage was included. The open Latarjet procedure resulted in an average internal rotation of arm was 57.6°, compared with the Remplissage procedure where the average internal rotation of arm was 53.4°. There was no statistically significant difference between the procedures (MD; 4.26, 95% CI, -10.43 to 18.95, $I^2 = 81\%$, $p = 0.57$).

Study or Subgroup	OL Mean	OL SD	OL Total	ABR Mean	ABR SD	ABR Total	Weight	Mean Difference IV, Random, 95% CI
Bah 2018	62	11	43	65	13	43	51.6%	-3.00 [-8.09, 2.09]
Yang 2018	53	22	91	41	29	98	48.4%	12.00 [4.69, 19.31]
Total (95% CI)			**134**			**141**	**100.0%**	**4.26 [-10.43, 18.95]**

Heterogeneity: Tau² = 102.18; Chi² = 10.90, df = 1 (P = 0.0010); I² = 91%
Test for overall effect: Z = 0.57 (P = 0.57)

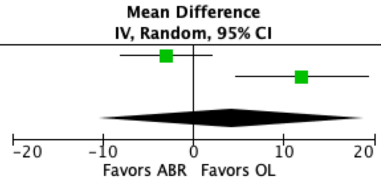


Figure 28. Forest Plot of Internal Rotation

Open versus Arthroscopic Latarjet Procedure

Six studies (LOE II; 4, LOE III; 2) compared 339 patients treated with the open Latarjet procedure to 547 treated with the arthroscopic Latarjet procedure.[94-99] The baseline age, gender and reported instability measures of patients were similar between the cohorts ($p > 0.05$).

Total Recurrence *(Figure 29)*

Total recurrent instability (including recurrent dislocations or subluxations) was reported in 5 studies, comprising of 254 open Latarjet procedures and 458 arthroscopic Latarjet procedures. The open Latarjet procedure resulted in 2.0% of patients having recurrent instability, compared with the arthroscopic Latarjet procedure where 2.4% of patients had a recurrent instability. There was no statistically significant difference between the procedures (RR; 0.85, 95% CI, 0.32 to 2.24, $I^2 = 0\%$, $p = 0.75$).

Study or Subgroup	Open Events	Open Total	Arthroscopic Events	Arthroscopic Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Cunningham 2015	0	36	1	28	19.4%	0.26 [0.01, 6.18]
Kordasiewicz 2016	3	48	3	62	30.3%	1.29 [0.27, 6.12]
Marion 2016	0	22	1	36	13.3%	0.54 [0.02, 12.61]
Metais 2016	2	104	6	286	37.0%	0.92 [0.19, 4.47]
Zhu 2016	0	44	0	46		Not estimable
Total (95% CI)		**254**		**458**	**100.0%**	**0.85 [0.32, 2.24]**
Total events	5		11			

Heterogeneity: Chi² = 0.90, df = 3 (P = 0.82); I² = 0%
Test for overall effect: Z = 0.32 (P = 0.75)

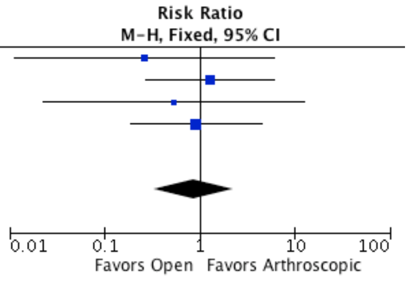


Figure 29 - Forest plot of Total Recurrent Instability

Recurrent Dislocations (Figure 30)

Recurrent dislocations were reported in 3 studies, comprising of 84 open Latarjet procedures and 90 arthroscopic Latarjet procedures. The open Latarjet procedure resulted in 1.6% of patients having a recurrent dislocation, compared with the arthroscopic Latarjet procedures where 1.6% of patients had a recurrent dislocation. There was no statistically significant difference between the procedures (RR; 1.05, 95% CI, 0.21 to 5.42, $I^2 = 23\%$, p = 0.95).

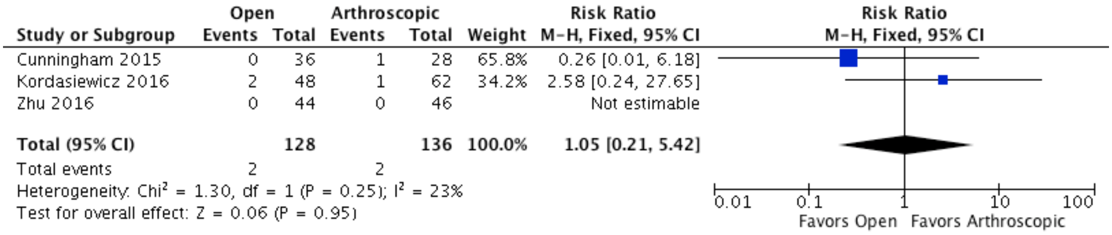


Figure 30 - Forest plot of Recurrent Dislocations

Persistent Apprehension (Figure 31)

Persistent Apprehension was reported in 2 studies, comprising of 84 open Latarjet procedures and 90 arthroscopic Latarjet procedures. The open Latarjet procedure resulted in 10.2% of patients having persistent apprehension, compared with the arthroscopic Latarjet procedures where 35.7% of patients had persistent apprehension. There was a statistically significant difference in favour of the open Latarjet procedure (RR; 0.47, 95% CI, 0.28 to 0.79, $I^2 = 37\%$, $p < 0.01$).

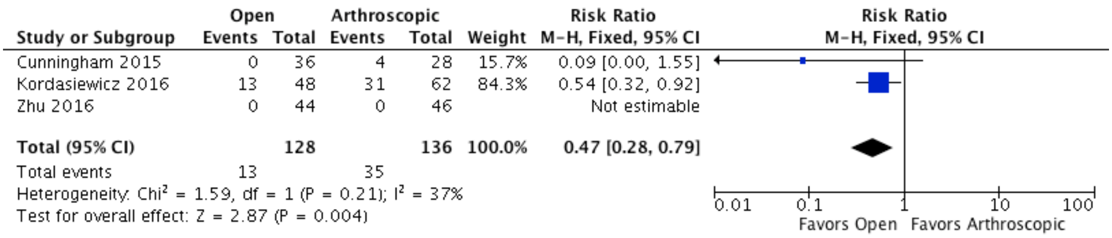


Figure 31 - Forest plot of Persistent Apprehension

Total Revisions (Figure 32)

Total revisions were reported in 4 studies, comprising of 210 Latarjet procedures and

412 arthroscopic Latarjet procedures. Revisions were performed due to recurrence, screw removal, irrigation of haematoma, and bone block fracture. The open Latarjet procedure resulted in 2.4% of patients having a revision, compared with the arthroscopic Latarjet procedures where 5.4% of patients had a revision. There was no statistically significant difference between the procedures (RR; 0.42, 95% CI, 0.17 to 1.04, $I^2 = 0\%$, p = 0.06).

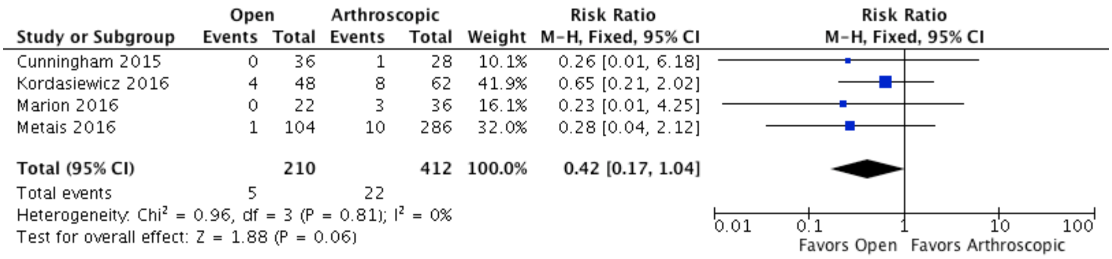


Figure 32 - Forest plot of Total Revisions

Revisions due to Recurrence (Figure 33)

Revisions due to recurrent instability were reported in 4 studies, comprising of 106 open Latarjet procedures and 126 arthroscopic Latarjet procedures. The open Latarjet procedure resulted in 2.0% of patients having a revision due to recurrent instability, compared with the arthroscopic Latarjet procedures where 2.9% of patients had a revision due to recurrent instability. There was no statistically significant difference between the procedures (RR; 0.81, 95% CI, 0.24 to 2.75, $I^2 = 0\%$, p = 0.74).

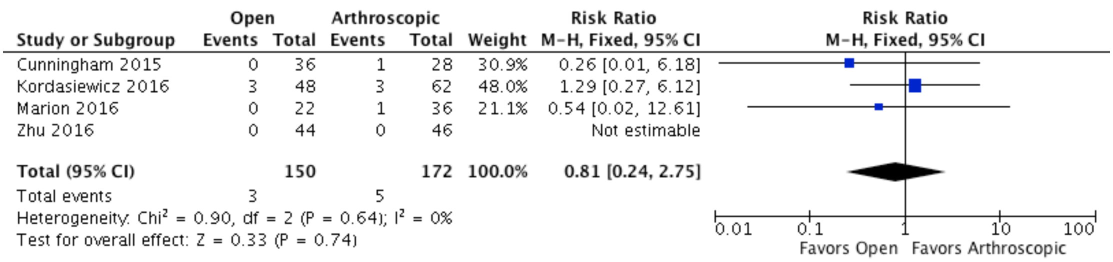


Figure 33 - Forest plot of Revisions due to Recurrent Instability

Post-operative Pain

The post-operative pain levels were reported in 2 studies, comprising of 107 open Latarjet procedures and 135 arthroscopic Latarjet procedures. It was not possible to meta-analyse these findings due to under-reporting of data, but both studies found a significant improvement in post-operative pain with the arthroscopic Latarjet procedure. Marion et al.[95] found that there was a significantly lower VAS score in the first week (1.2 vs 2.2, $p < 0.07$), but this did not result in lower narcotics consumption. Nourissat et al.[94] found that up to one week there was a significantly lower VAS score with the arthroscopic approach (2.2 vs 3, $p < 0.07$), but this did not significantly differ at one month (1.2 vs 1.6, $p = 0.14$).

Operation Time *(Figure 34)*

The operation time was reported in 3 studies, comprising of 106 open Latarjet procedures and 126 arthroscopic Latarjet procedures. With the open Latarjet procedure the average operation time was 95.1 minutes, and with the arthroscopic Latarjet procedure the average operation time was 108.6 minutes. There was no statistically significant difference between the procedures (MD; -21.74, 95% CI, -52.69 to 9.20, $I^2 = 0\%$, $p = 0.40$).

	Open			Arthroscopic				Mean Difference
Study or Subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, Random, 95% CI**
Cunningham 2015	82	24	36	146	51	28	31.0%	-64.00 [-84.45, -43.55]
Kordasiewicz 2016	120	33	48	110	35	62	33.8%	10.00 [-2.77, 22.77]
Marion 2016	62	13	22	77	14	36	35.2%	-15.00 [-22.10, -7.90]
Total (95% CI)			**106**			**126**	**100.0%**	**-21.74 [-52.69, 9.20]**

Heterogeneity: Tau² = 695.08; Chi² = 36.60, df = 2 (P < 0.00001); I² = 95%
Test for overall effect: Z = 1.38 (P = 0.17)

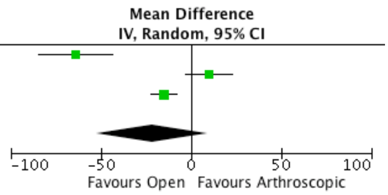


Figure 34 - Forest plot of Operation Time

<u>Revision Arthroscopic Bankart Repair</u>

There were 14 studies (LOE III; 3, LOE IV; 11) with 433 patients.[100-112]

Recurrent Instability

The overall rate of recurrent instability was reported in 12 studies with 328 shoulders demonstrating 86 instability events (26.2%). The rate of recurrent instability due to dislocation was reported in 7 studies (n = 176) with 19 events (10.8%) while the rate of subluxation was reported in 4 studies (n = 76) with 6 events (7.9%). The rate of apprehension was reported in 5 studies (n = 99) with 13 cases (13.1%).

Return to Play

Ten studies reported the rate of return to play for patients participating in sports. The overall rate was 78.5% with 47.5% returning to their pre-injury level of play.

<u>Open Latarjet Procedure as a Revision for Failed Arthroscopic Bankart Repair</u>

There were 11 studies (LOE III; 1, LOE IV; 10) with 466 patients.[113-123]

Recurrent Instability

Recurrent instability was reported in ten out of 11 studies, with data available for 345 shoulders. There were 32 cases of recurrent instability events (9.3%). There were five cases of recurrent dislocations (1.6%) and 22 cases of recurrent subluxations (6.9%). In three studies, there were eight reported cases of apprehension out of 79 total shoulders (7.6%).

Return to Play

Three studies reported on athletes return to play (RTP). Two studies reported on the overall rate of return to play, and all but one patient returned to sport (70/71, 98.6%). Three studies reported on the rate of return to play at the same level, and of the 89 patients returning to sport, 78 returned to at least the same level of competition as prior to the procedure (87.6%).

Management of a Failed Latarjet Procedure

There were 7 studies (LOE IV; 7) with 161 patients (162 shoulders).[124-130] Four studies utilized a bone-block procedure with 91 shoulders, with 2 consisting entirely of Eden-Hybinettes, 1 entirely on distal tibial allograft, and 1 on a combination of Eden-Hybinettes and repositioning of the coracoid graft. Three studies performed an arthroscopic soft-tissue stabilization with 71 shoulders. Overall, 86.6% of the patients were male, with an average age of 28.3 years old and the mean follow-up was 39.8 months.

Recurrent Instability

Recurrent instability was reported in all 7 studies. Overall, 9.7% had recurrent instability (bone-block transfer; 8.1%, arthroscopic soft-tissue stabilization; 11.3%), with 3.6% having recurrent dislocations (bone-block transfer; 4.1%, arthroscopic soft-tissue stabilization; 3.8%). Additionally, 4.2% required a revision surgery (bone-block transfer; 1.3 %, arthroscopic soft-tissue stabilization; 7.1%), with all being for recurrent instability.

Return to Play

Five studies reported on athletes return to play (RTP), including an overall 73.8% rate of return to play. However, in the two studies that reported return to play at the same level of play, 64.2% of patients were able to return, all of whom were treated with a bone-block transfer.

DISCUSSION

Arthroscopic Bankart repair is the most commonly performed procedure worldwide for anterior shoulder instability.[131] However, a small percentage of patients who have undergone this procedure go on to have recurrent instability.[37, 39, 41] Thus, clinicians may offer a Latarjet or Remplissage augmentation over an arthroscopic Bankart repair for patients with specific identifiable risk factors. The Instability Severity Index Score (ISIS) stratifies patients based on risk, with age < 20, competitive sport, contact athlete, hyperlaxity, Hill-Sachs lesions, and glenoid bone-loss being considered significant risk factors. Overall, the rate of recurrent instability was seven times higher in those who underwent conservative management compared to initial surgical treatment of a first time dislocator. Arthroscopic Bankart repair following recurrent instability has a higher recurrence rate than following a first-time dislocation, which may suggest that patients should not delay surgical intervention.[132-134] Additionally, further instability events increase the risk of having bone and cartilage injuries, which increase the risk for long-term arthropathy.[133]

The decision to treat a patient non-surgically after a traumatic first-time anterior shoulder dislocation should be individualized based on their risk factors for recurrence, namely age, hand dominance, participation in sports, timing in season, and amount of glenohumeral bone-loss.[135-137] Surgeons have an important responsibility to appropriately counsel their patients and discuss the various treatment options available to them, while emphasizing the risk of recurrence associated with each plan. Allowing patients with multiple risk factors for recurrence to return to play can lead to further instability events and increased glenohumeral bone-loss. This may result in the patient necessitating a more invasive procedure at the time of surgery, when an arthroscopic Bankart repair may have otherwise sufficed.[138, 139]

In those who are treated non-operatively, immobilization in external rotation reduces the rate of recurrent dislocation by placing the Bankart lesion in a more anatomic position, allowing for healing to occur[12, 13]. Itoi et al.[12, 13] used the term "coaptation" to refer to the position in external rotation where the Bankart lesion approximates the glenoid, and this has been validated by other MRI studies.[140-144] Additionally, this position leads to increased subscapularis tension which creates an intra-articular tamponade effect, thereby reducing the formation of a hematoma and further improving the approximation of the Bankart to the glenoid. Liavaag et al.[141] found that immobilization in external rotation resulted in greater labral healing on MRI, and that the separation distance was less than with internal rotation. Although, it remains unclear how long patients need to be immobilized for healing to occur. Scheibel et al.[145] found that in a prospective study that immobilization in external rotation for 5 weeks lead to a lower recurrence rate than those immobilization for 3 weeks. However, Itoi et al.[146] found that prolonged immobilization after 3 weeks did not reduce recurrence.

In regards to a patient's decision on their management, Warth et al. found that the ability to return to play is the single most important driving factor, more so than the possibility of recurrent instability.[147] Arthroscopic Bankart repair was found to result in a higher rate of return to play compared to conservative management, but lower rates of return to play than those undergoing the Latarjet procedure in the network meta-analysis. Where reported, Remplissage and Latarjet show equally high rates of return to play. Unfortunately, return to play has been insufficiently reported following Remplissage procedure. This suggests the need for future research to address the question of return to play for various sports after Remplissage compared to that of the Latarjet procedure for those patients who have chronic anterior shoulder instability in the setting of a significant Hill-Sachs lesion. The timing of return to play may be fastest with non-operative management as it may allow for return to play during the same season, and to plan for definitive management in the off-season. However, of those undergoing operative management the timing of return to play with the Latarjet procedure could be slightly advantageous over soft tissue repairs, as the time taken for bone-healing may be faster than soft tissue healing.

The presence of engaging Hill-Sachs lesions has been shown to increase recurrent instability rates.[148] Of particular interest, which may dictate surgical management, is whether the Hill-Sachs lesion is "on-track" or "off-track".[149, 150] When "off-track" humeral lesions are present, the Remplissage or Latarjet procedures are considered superior to that of Bankart repair alone, because these procedures address and mitigate the engagement of the Hill-Sachs lesion with the anterior glenoid rim. Remplissage acts to fill the defect using the infraspinatus and posterior-inferior capsule. As a result, engagement of the Hill-Sachs lesion is prevented and the lesion remains "on-track", particularly in external rotation and abduction, which is not addressed by a Bankart repair alone. A recent biomechanical systematic review validated these findings and reported that Remplissage consistently prevented engagement of the Hill-Sachs lesion on the anterior glenoid in the majority of the studies in the literature.[32] This biomechanical data has translated to reduced rates of recurrent instability in vivo, as highlighted in our data set where the combine arthroscopic Bankart repair and Remplissage cohort had a five-times lower rate of recurrence than those who underwent arthroscopic Bankart repair alone.

In contrast, the Latarjet procedure acts to widen the glenoid articular surface while simultaneously providing stability by way of the sling effect provided by the transposed conjoint tendon.[151, 152] These two effects in combination reduce the chances of Hill-Sachs lesion engagement. While there is still ongoing debate as to what is the best surgical option for patients with recurrent shoulder instability and evidence of a significant Hill Sachs lesion, this meta-analysis demonstrates that there are significantly lower rates of recurrent instability after Latarjet and Remplissage compared with arthroscopic Bankart repair alone. Additionally, it is important to note the amount of glenoid bone-loss in the setting of an "off-track" Hill-Sachs lesion that is critical to failure is still undefined. However, Yang et al.[93] found that with greater than 10% glenoid bone-loss, the outcomes were worse with those who received a Remplissage procedure than the Latarjet procedure. Although, this requires further study.

With such mixed results in the current literature, many orthopaedic surgeons have raised concerns about the Remplissage procedure and whether it will lead to decreased range of motion postoperatively.[90, 153, 154] Our systematic review and meta-analysis demonstrates no statistically significant difference in range of motion following arthroscopic Bankart repair with Remplissage to that of Bankart repair alone or that of the Latarjet procedure. However, while not statistically significant it is important for treating orthopaedic surgeons to be mindful of patient characteristics (e.g. sport played, occupation), because, for some, a small deficit in range of motion can have a drastic impact on their performance. Garcia et al.[155] highlighted only a 50% return to play in baseball players following Remplissage compared to 95.5% return to play in non-baseball players. Such findings suggest that deficits, which could be considered negligible for a majority of patients, may have significant implications for certain athletes, in whom other treatment modalities may be more appropriate.[24]

Lafosse et al.[29] originally described the arthroscopic Latarjet procedure with suggested advantages of decreased stiffness, decreased wound complications and quicker rehabilitation.

The low rates of recurrent instability in these patients are encouraging as they are often selected due to their high-risk factors for further recurrence such as glenoid bone loss and a high number of previous dislocations. Authors noted that there was slightly better graft positioning and screw placement in the open procedure.[95-97] These results suggest that this may have a minor impact on the postoperative stability of the joint. Operative times were similar overall, this was in a large number of patients in high volume centres and there is still a significant learning curve associated with this for experienced arthroscopic surgeons, and one study found 10 procedures were needed to reduce the need for conversion from arthroscopic to open, and 20 procedures were needed to have similar operating times.[96] The significant learning curve associated with this suggests the arthroscopic procedure may be only advisable to perform in high-volume centres with experienced arthroscopists, as previous studies have shown that low volume shoulder centres have increased complications even in routine procedures.[156]

In addition, there was a relatively high rate of recurrent shoulder instability, with 22.5% of patients experiencing any form of instability following revision ABR. In light of these outcomes, previously reported causes for failure following primary ABR include inadequate postoperative immobilization, wide rotator intervals, and technical errors such as improper anchor placement.[157] Neviaser et al.[158] found that anchors placed excessively medially or superiorly predispose a patient for failure following primary open or arthroscopic Bankart repair. Given these findings, it is imperative that anatomic restoration of the capsulolabral bumper is performed during primary ABR to minimize the risk of failure. However, it is also important to consider tissue quality in those who had a failed prior ABR. A failed primary ABR may incur a cost to the structural integrity of the capsuloligamentous complex within the shoulder, thus predisposing patients to further failures in the revision setting.

In a report that investigated risk factors for failure following revision anterior shoulder stabilization among 92 patients, Su et al.[112] identified an instability recurrence rate of 42%. Independent predictors of recurrence included an off-track lesion, age younger than 22 years, and ligamentous laxity. Among those patients with bipolar lesions that failed, 64% had off-track lesions with glenoid defects less than 20% and mild Hill-Sachs lesions. Given these results, substantial caution should be exercised when considering revision ABR, particularly in patients with the aforementioned risk factors. In these patients, consideration of osseous augmentation procedures such as the Latarjet procedure or allograft bone grafting should be considered.

The recurrence rate with the open Latarjet procedure is slightly lower than that found in a following revision arthroscopic Bankart procedure after failed anterior shoulder stabilization procedure. However, glenohumeral bone loss is one of the primary causes of recurrence, which the Latarjet procedure addresses. Additionally, the stabilizing effect of the Latarjet has been shown to be durable over time with the majority of recurrent instability events occurring early in the first two years postoperatively, while the results of the arthroscopic Bankart repair seem to deteriorate over time.[25] It is possible that the recurrence rate may be higher in the Latarjet done as a revision rather than a primary surgery. Yang et al. found that all cases of recurrence occurred in patients with the open Latarjet as a revision procedure for a previously failed shoulder stabilization surgery and no cases of recurrence in patients with a primary open Latarjet in a population of 52 patients.[123] Similarly, Shah et al. found that all cases of recurrence following the Latarjet occurred in patients with failed prior shoulder stabilization surgery.[122]

There are multiple treatment options and due to the surgical approach and the alterations in anatomy, there are concerns regarding how to manage a failed Latarjet. There was however a moderate rate of further recurrent instability with all three treatment options, and a low rate of further revision surgery, which may be even more technically demanding due to further scar-tissue in the deltopectoral region. However, there is a paucity of studies on this topic with no comparative studies, despite the clinical increase in performing the Latarjet procedure for anterior shoulder instability.

Limitations

This study has several limitations and potential biases, including the limitations of the included studies themselves. While all of the included studies were prospective studies, only three were randomized, thus potentiating selection bias. Additionally, it was not possible to adjust for age, gender, type of sports played, however, overall there was no significant difference between the two groups for these demographic variables for the majority of the comparative groups. However, in the network meta-analysis comparing arthroscopic Bankart repair, open Bankart repair and open Latarjet, there were differences between the groups in their demographics and risk factors for recurrent instability and in spite of those undergoing the Latarjet procedure having the highest risk factors, they still had the lowest recurrence rate. Furthermore, it was not possible to meta-analyze the open Latarjet procedure and arthroscopic Bankart repair as revision procedures as they were uncontrolled case series. Finally, in a minority of the outcomes, overall heterogeneity (i.e. statistical measure of differences between studies) was high indicating inconsistency between the results in the studies.

Conclusions

- Arthroscopic Bankart repair resulted in a 7-fold lower recurrence rate and a higher rate of return to play compared to conservative management. Thus, arthroscopic Bankart repair may be advisable to perform routinely for first-time dislocators who participate in sports.

- Immobilization of the shoulder in external rotation after a traumatic first-time anterior shoulder dislocation results in a higher compliance rate, a lower recurrent dislocation rate, and a higher rate of return to play as compared to immobilization in internal rotation.
- The network meta-analysis found the open Latarjet procedure had the lowest recurrence rates, lowest revisions rates and highest rates of return to play in the surgical treatment of anterior shoulder instability. However, the Latarjet procedure has been shown to result in a higher complication rate, which needs to be considered when deciding which stabilization procedure to perform.
- In patients with Hill-Sachs lesions and sub-critical glenoid bone loss, arthroscopic Bankart repair with Remplissage resulted in lower rates of recurrent instability compared to arthroscopic Bankart repair alone, while resulting in similar recurrence rates, similar patient reported outcomes, with lower morbidity and fewer complications than that of the Latarjet procedure.
- Both the open and arthroscopic Latarjet procedure result in significant improvements in patient function and outcome scores, with low rates of recurrent instability. While technically challenging, the arthroscopic procedure has been shown to be a safe and viable alternative. However, there is a significant learning curve associated with the arthroscopic Latarjet procedure. The significant learning curve associated with this suggests the arthroscopic procedure may be only advisable to perform in high volume centres with experienced arthroscopists.
- Revision arthroscopic Bankart repair for anterior shoulder instability has been shown

to result in high rate of recurrent shoulder instability. Additionally, the rate of patients reporting good or excellent outcomes was modest. There was a relatively poor rate of return to sport among athletes, and only about half of the patients were able to return at or above their pre-operative ability.

- The Latarjet procedure as a revision procedure for failed prior shoulder instability surgery provides excellent functional outcomes, low rates of recurrence and complications, and a high rate of return to sport among athletes.
- Surgical management following a failed Latarjet procedure results in moderate rates of recurrent instability, with a low intra-/post-operative complication rate. Additionally, the results across all techniques appear similar, with no procedure being identified as the gold-standard in the literature. However, there was a concerning rate of instability arthropathy which may be related to the failure of a bony procedure.

Chapter 2: Management of Post-Operative Pain & Complications following Anterior Shoulder Instability Surgery

INTRODUCTION

Post-operative pain is a common complaint following shoulder surgery, and due to the increasing rise in opioid abuse among orthopaedic patients, alternative management strategies have become increasingly important.[159] In addition to the significant discomfort to patients, severe postoperative pain results in discharge delays and unexpected hospital readmission. It is crucial to ensure that pain is adequately managed in an effort to improve patient outcomes and recovery, as well as enable shorter hospital stays and reduce costs of outpatient arthroscopic shoulder procedures. In reducing postoperative pain, there are a plethora of options depending on the clinical indications, with outcomes, associated side effects, and contra-indications that must be considered in the optimal management strategy.[160] Additionally, multidisciplinary input is required with anaesthesiology involvement, as the main stay modality for reducing immediate post-operative pain is regional anaesthesia.[160-162] Additionally, other modalities include oral medications, nerve block adjuncts, cryotherapy, electrical stimulation, as well as the increasing and often overlooked role of patient education.[163]

The Latarjet procedure is indicated in patients with anterior shoulder instability and high risk factors for recurrence, including failed prior soft-tissue stabilization and severe glenoid bone-loss.[135, 164-166] The Latarjet procedure functions primarily by providing a “sling” effect of the conjoint tendon acting on the subscapularis and capsule, and a “bony effect” by extending the glenoid surface area.[167] Despite the long-term shoulder stability conferred by the Latarjet procedure, concern exists about the surgical complication rate associated with this technique. A previous systematic review by Griesser et al.[28] found a total complication rate of

30% following the Latarjet procedure, with 75% of these complications occurring within the first year. However, subsequent to that study's publication in 2013, several large studies have shown lower complication rates, thus suggesting that this rate may in fact be lower than previously reported.[168, 169] Additionally, with the advent of the arthroscopic Latarjet procedure, there has been an increased interest in the study of this technique due to concerns that its complexity may lead to an increase in complication rates.[29, 170, 171] Therefore, an updated systematic review is warranted, as well as an evaluation of the complication rate in our own series and the experiences of early adopter of the arthroscopic approach.

Haematoma formation is a common complication of the Latarjet procedure and occurs due to continued blood loss resulting in painful postoperative swelling. Painful postoperative swelling may necessitate increased postoperative opioid administration, cause delays in hospital discharge, and result in prolonged shoulder immobilization, while a clinically significant hematoma may even need surgical drainage.[172] Tranexamic acid (TXA) is a synthetic derivate of the amino acid lysine that primarily inhibits plasminogen activation through blocking a lysine binding site, stopping plasmin from binding to fibrin or fibrinogen following clot formation, leading to reduced fibrinolysis and stabilisation of physiological thrombi[3]. TXA is commonly used in orthopaedic surgery to reduce perioperative bleeding and the need for transfusion.[173-175] The use of TXA in shoulder arthroplasty has been shown to have a significant effect not only on postoperative blood loss, but also on postoperative pain levels.[172, 173, 176]

The purpose of this chapter is to first systematically review the RCTs on pain control following shoulder arthroscopy in the acute post-operative setting, and ascertain the best-available evidence in managing pain after shoulder arthroscopy to optimize patient outcomes.

Then an evaluation of the complications and the 90-day complication rate following the Latarjet procedure in a high volume centre (Sports Surgery Clinic, Dublin, Ireland) will be performed. Furthermore, there will be an evaluation of the complications and the 90-day complication rate following the arthroscopic Latarjet procedure in a centre (NYU Langone Health) with an early adopter to assess whether there is a difference in the early complications due to its technical complexity. Following on from this, an updated systematic review will be conducted evaluating the complication rates following the Latarjet procedure. Finally, based on our experiences; a randomized controlled trial (RCT) will be conducted to assess whether TXA could reduce the incidence of postoperative swelling and hematoma formation, pain and opioid use in the early postoperative period following the Latarjet procedure.

Pain Control Following Shoulder Arthroscopy: A Systematic Review of Randomized Controlled Trials with A Network Meta-Analysis

METHODS

Search Strategy & Study Selection

Two independent reviewers performed the literature search based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and reviewed the search results, with a senior author arbitrating on any disagreement, using specific terms in MEDLINE, EMBASE, and The Cochrane Library.[34] The title and abstract were reviewed for all search results and potentially eligible studies received a full-text review. Finally, the reference lists of the included studies and literature reviews found in the initial search were manually screened for additional articles meeting the inclusion criteria.

Eligibility Criteria

Studies were included if they were a RCT evaluating an intervention to reduce post-operative pain control following shoulder arthroscopy, regarding one of the following; (1) nerve blocks, (2) nerve block adjuncts, (3) sub-acromial injections, (4) patient-controlled analgesia, (5) oral medications or (6) other modalities, and were published in a peer-reviewed journal. Studies were excluded if they compared drug dosing regimens, did not compare to a standardized control such as a placebo, or did not evaluate pain or opioid use. Intra-articular pain pumps were also excluded as they are no longer standard of care, due to their association with chondrolysis[177].

Data Extraction/Analysis

The study characteristics including study design, level of evidence (LOE), patient population, and outcome measures were collected by two independent reviewers using a predetermined data sheet. The data collection from each reviewer were compared, and any instances of discrepancy were resolved by consultation of the senior author.

Statistical Analysis

Network meta-analyses were performed using R (**R 4.0.1 2020**, R Foundation for Statistical Computing, Vienna, Austria). A frequentist approach to network meta-analysis with a random effects model was performed using the *netmeta* package version 0.9-6 in R[36]. Heterogeneity was quantified using the I^2 statistic[178]. To rank the treatments, we used the frequentist analogue to the surface under the cumulative ranking (SUCRA) probabilities called the P-score[36, 179]. Studies were ranked according to their P-score. Meta-analysis was performed where using *Review Manager ((RevMan) [Macintosh]. Version 5.3*. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014.). A p-value of < 0.5 was considered to be statistically significant. Additionally, Qualitative analysis was performed for each study.

RESULTS

Overall, 83 RCTs (LOE I; 83) on pain control following shoulder arthroscopy with 6369 patients were included.

Regional Nerve Blocks

Overall, 40 RCTs were found evaluating the use of nerve blocks for post-operative pain control. ISB was chosen as the gold standard to be compared against based on prior literature. At all time points except 12 hours there was no statistically significant difference between the different nerve blocks with post-hoc Tukey analysis, but general anaesthesia did perform significantly worse. At 12 hours, the SSB-SCB resulted in significantly lower pain. The P-Scores are shown in table 1, and forest plots of the VAS score and Opioid use are shown in Figure 2-7.

Table 1. P Scores

VAS in PACU	VAS 2 Hours	VAS 6 Hours	VAS 12 Hours	VAS 24 Hours	Opioid Use
ISB: 0.7942	cISB: 0.9105	cISB: 0.7355	SSB + SCB: 0.9999	cISB: 0.9713	cISB: 0.8948
SSB + AX: 0.6927	ISB: 0.5397	SSB + AX: 0.6925	cISB: 0.7225	SCB + AX: 0.6598	ISB: 0.6600
SCB: 0.6769	SCB: 0.5294	SCB: 0.6760	ISB: 0.4844	SSB + AX: 0.5245	SSB: 0.4917
SSB: 0.4976	SSB: 0.4391	ISB: 0.6623	SSB + AX: 0.4830	ISB: 0.4964	SCB: 0.4455
SCB + AX: 0.2194	GA: 0.0813	SSB + SCB: 0.4325	SCB: 0.4678	SSB + SCB: 0.4767	GA: 0.0080
GA: 0.1191		SSB: 0.4088	SSB: 0.2247	SSB: 0.4172	
		SCB + AX: 0.3777	GA: 0.1177	SCB: 0.4062	
		GA: 0.0147		GA: 0.0478	

VAS; visual analogue scale, ISB; interscalene block, SSB; suprascapular block, Ax; axillary, SCB; supraclavicular block, GA; general anaesthesia, cISB; continuous ISB

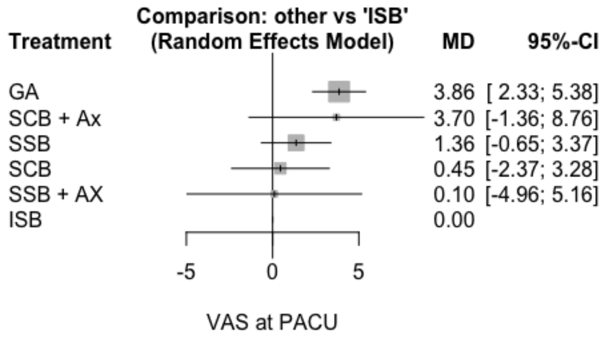


Figure 2: Forest Plot of VAS in the PACU

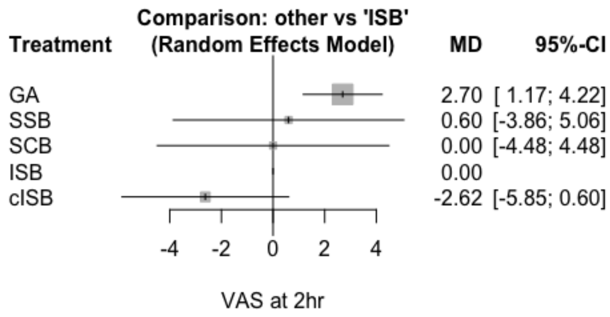


Figure 3: Forest Plot of VAS at 2 Hours

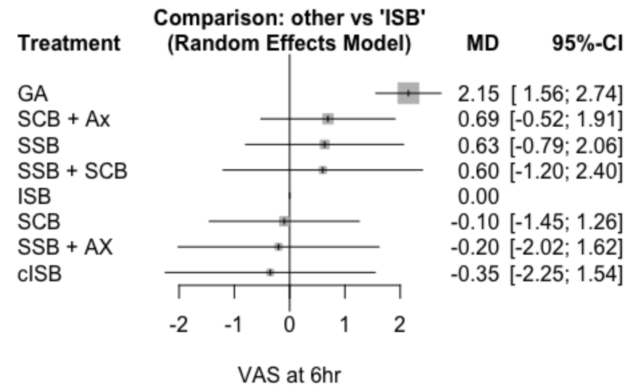


Figure 4: Forest Plot of VAS at 6 Hours

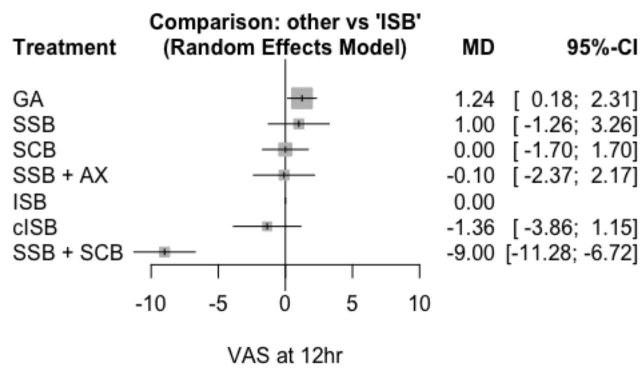


Figure 5: Forest Plot of VAS at 12 Hours

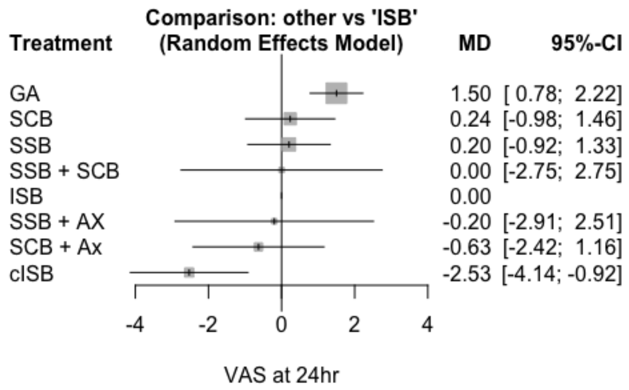


Figure 6: Forest Plot of VAS at 24 Hours

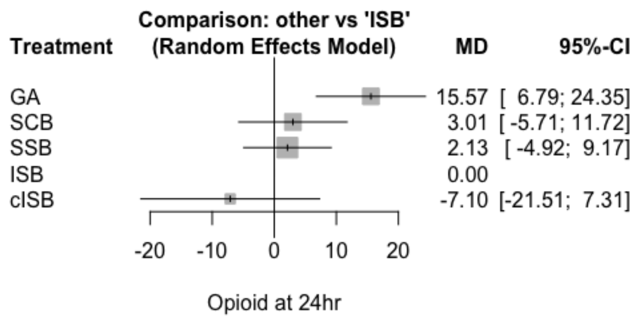


Figure 7: Forest Plot of Opioid Consumption at 24 Hours

Nerve Block Adjuncts

Dexamethasone

Fifteen RCTs evaluated the effects of dexamethasone, in either perineural form, intravenous (IV) form, or comparing them. Seven studies evaluated perineural dexamethasone versus a control, in the studies that evaluated it; 5 out of 6 found perineural dexamethasone prolonged the analgesic effect, 5 out 6 found reduced VAS score, and both of the 2 evaluating it found a reduction in opioid use. In the one study which found it did not improve the operative time, the authors concluded they had underpowered the study. Four studies evaluated IV dexamethasone versus a control, in the studies that evaluated it; all 3 found IV dexamethasone prolonged the analgesic effect, 2 out of 4 found reduced VAS score, and 1 out of 3 found a reduction in opioid use. Six studies compared perineural and IV, in the studies that evaluated it; 5 out of 6 found perineural dexamethasone prolonged the analgesic effect, 0 out of 5 found reduced VAS score, and 2 out of 5 found a reduction in opioid use

Dexmedetomidine

Three RCTs were performed evaluating dexmedetomidine as a nerve block adjunct, two of whom used perineural dexmedetomidine and 1 used IV dexmedetomidine. All 3 studies found reduced post-operative pain, and the 2 studies that evaluated it found reduced opioid consumption and increased patient satisfaction.

Magnesium Sulphate

Lee et al.[180] evaluated magnesium sulphate as a nerve block adjunct. They found it significantly prolonged the nerve block time, reduced post-operative pain at 12-hours, but did not alter opioid consumption.

Subacromial Infusion

There were 8 RCTs comparing continuous subacromial infusion to a placebo. All of these studies were included in a recent meta-analysis by Ahn et al.[181] They found pooled analysis revealed no clinically significant difference in pain scores at 6, 12, 24, or 24 hours. Additionally, they found no significant difference in opioid consumption at 24 or 48 hours.

Patient Controlled Analgesia

Five RCTs have evaluated the efficacy of post-operative PCA in the setting of shoulder arthroscopy. Two studies evaluated PCA against a control, and both found decreased pain scores but no significant difference in opioid consumption. Cho et al.[182] compared subacromial PCA to IV PCA in those undergoing shoulder arthroscopy, and found a significantly lower VAS at 24 and 48 hours with subacromial PCA, although the difference was at most 0.6 and not clinically significant. Kim et al.[183] compared PCA to ISB and found ISB reduced post-operative pain in the first 12 hours, but after the rebound affect they found PCA reduced post-operative pain at 12 and 24 hours. Oh et al.[184] performed a multigroup RCT, where they established intralesional infiltration reduced post-operative pain compared to IV PCA. Han et al.[185] compared IV PCA to multimodal analgesia and found although multimodal analgesia had a lower score by 1.7 points in the first two hours that over the first 48 hours they required more rescue analgesia, but there was no difference in patient satisfaction.

Oral Medications

Gabapentinoids

Six RCTs have evaluated the efficacy of pre-operative administration of gabapentinoids in the setting of shoulder arthroscopy. Four RCTs evaluated oral gabapentin pre-operatively, pooled analysis of 4 of the studies found a significant difference in post-operative pain at 24 hours in favor of Gabapentin (VAS; 4.3 vs 5.1, p = 0.01). Pooled analysis was not possible due to discrepancies in data reporting on opioid consumption, but of the three studies evaluating this, only one found a significant difference in favor of gabapentin. One additional study included shoulder arthroscopy among other surgeries, and found gabapentin did not significantly reduce post-operative pain, but it had a modest effect on time to opioid cessation. Ahn et al.[181] evaluated pregabalin, and found a significant reduction in pain and opioid use up to 48 hours post-operatively.

	Gabapentin			Control				Std. Mean Difference
Study or Subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, Random, 95% CI**
Adam 2006	3.6	2.4	27	3.5	2.8	26	13.4%	0.10 [−1.31, 1.51]
Bang 2010	4.3	0.9	23	5.6	1	23	39.1%	−1.30 [−1.85, −0.75]
Mardani-Kivi 2016	4.7	1.4	37	5.3	1.1	34	37.4%	−0.60 [−1.18, −0.02]
Spence 2011	4.2	3.2	26	4.5	3.2	31	10.2%	−0.30 [−1.97, 1.37]
Total (95% CI)			**113**			**114**	**100.0%**	**−0.75 [−1.33, −0.17]**

Heterogeneity: Tau² = 0.15; Chi² = 5.45, df = 3 (P = 0.14); I² = 45%
Test for overall effect: Z = 2.52 (P = 0.01)

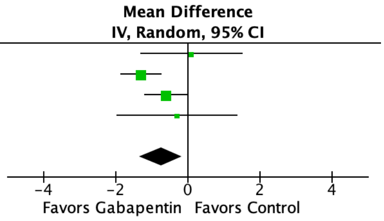


Figure 8: Forest Plot of VAS score at 24 Hours with Gabapentin

<u>COX-II Inhibitors</u>

Toivonen et al.[186] performed an RCT comparing pre-operative etoricoxib preoperatively to a placebo in 60 patients undergoing shoulder arthroscopy. They found the patients who received etoricoxib reported significantly lower VAS score, longer time to first analgesic use, less opioid requirement and earlier discharge when compared to controls.

Other Modalities

<u>Cryotherapy</u>

Two RCTs evaluated post-operative compression cryotherapy versus ice wraps, with neither study finding a significant difference for reduction in postoperative pain or analgesia use between the two groups.

<u>Education</u>

Syed et al.[163] won the 2018 ASES Neer Award for their RCT evaluating preoperative education on opioid consumption and pain following shoulder arthroscopy. They found that patient education resulted in significantly lower opioid consumption 6 weeks and 3 months postoperatively. Additionally, despite reduced opioid consumption there was no significant difference in pain scores.

Tranexamic Acid

Liu et al.[187] performed an RCT of 74 patients comparing intravenous tranexamic acid (TXA) and a placebo in patients. They found TXA resulted in a significantly lower VAS score, and less opioid requirement at the day 1 post-operatively.

Transcutaneous Electrinerve Stimulation (TENS)

Mahure et al.[188] performed an RCT of 37 patients comparing TENS and a placebo in patients. Patients who received TENS reported significantly lower VAS score at 12-hours and 1 week post-operatively, and less opioid requirement at 48-hours and 1-week post-operatively.

90-Day Complication Rate Following the Latarjet Procedure in A High-Volume Centre & The Impact of an Early Adopter of the Arthroscopic Approach on Complication Rates

METHODS

A retrospective review of patients who underwent an open Latarjet procedure at the Sports Surgery Clinic was conducted over a 5-year period between January 2015 and December 2019 was performed. All patients treated with either an open or arthroscopic Latarjet procedure between January 2012 and October 2019 in NYU Langone Health were identified and chart reviewed for eligibility. The inclusion criteria of the current study was; age > 16 at the time of surgery, skeletal maturity, and a minimum follow-up of 90-days. Patients with a prior anterior bone-grafting procedure or incomplete follow-up were excluded.

Data collection

Data on patient characteristics and pre-operative demographics were collected; including, age, gender, laterality and previous shoulder surgeries. Intra-operative and post-operative complications including recurrence, graft complications, screw complications, wound infections, haematoma and neurological complications. Additionally, it was recorded whether a patient required readmission for a complication, or a subsequent procedure within 90 days. Follow-up examinations were performed by the operating surgeon at 3 and 12 weeks post-operatively.

Statistical Analysis

Statistical analysis was performed using SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Macintosh, Version 22.0. Armonk, NY: IBM Corp.). For all continuous and categorical variables, descriptive statistics were calculated. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages. Categorical variables were analysed using Fisher's exact or chi-squared test. The independent or paired *t*-test for normally distributed variables, or the nonparametric Mann-Whitney U test or Wilcoxon signed-rank test was performed to compare continuous variables. A value of $p < 0.05$ was considered to be statistically significant.

RESULTS

The Latarjet Procedure in A High-Volume Centre

A total of 441 consecutive patients underwent the Latarjet procedure for anterior shoulder instability by two fellowship trained surgeons at a single institution.

Complications

There were 19 total complications in 18 patients within 90 days of surgery, for an overall short-term complication rate of 4.3%. Haematomas were the most common complication, occurring in 12 (2.7%) patients, with 9 requiring a return to the operating theatre during their stay for an evacuation (2.0%), while two haematomas occurred within the first three weeks post-operatively. Of the 19 total complications, four patients (0.9%) required a readmission for a re-operation. While two patients underwent irrigation and debridement of a surgical site infection, one patient underwent evacuation of a haematoma, and one patient underwent biceps tenodesis for severe bicipital pain. Four (0.9%) patients had infectious complications with one returning to the operating theatre for irrigation and debridement during their initial stay for a suspected acute infection and two requiring readmission for irrigation and debridement. Two patients showed signs of superficial wound infections and were managed conservatively. Symptoms resolved in all patients following both surgical and conservative management with concomitant antibiotic treatment. There were 2 (0.5%) intra-operative complications, 1 coracoid fracture and 1 anaphylactic reaction to vancomycin. All of the patients who experienced a complication were male. Of those with a history of prior surgery, 7 sustained a complication (7.5%) and 3 required readmission (3.2%) compared with 11 complications in those without prior shoulder surgery (3.2%) and 1 patient who required readmission (0.3%), ($p = 0.0746$, $p = 0.0309$ respectively). All of the complications experienced by patients included in this study resolved after, except for the bicipital pain experienced by the patient who had ongoing bicipital discomfort following a revision biceps tenodesis. The complications are described in Table 2.

Table 2. Complications of the Open Latarjet Procedure

90-day Complications	18
Readmissions	4
Reoperations	12
Haematoma	12
Infectious complications	4
Hardware/Graft Complications	1
Recurrent instability	0
Vascular complications	0
Neurologic Complications	0

Open versus Arthroscopic Latarjet Procedure

A total of 150 consecutive patients (150 shoulders) identified from the practice of three participating surgeons at NYU Langone Health were included, with 110 having undergone open Latarjet and 40 having undergone arthroscopic Latarjet. There was no significant difference between the two groups in terms of patient demographics.

90-Day Complications

There were no intra-operative complications with either approach, and no patients undergoing the arthroscopic Latarjet procedure required a conversion to open. There was no significant difference in overall complications between groups ($p = 0.66$), and all patients who had a complication had prior shoulder instability surgery. There were 4 (3.6%) patients in the open Latarjet group and 2 (5%) patients in the arthroscopic Latarjet group who experienced a postoperative complication. Three patients required a readmission within the 90-day period; one patient in both groups required a revision Latarjet for graft fracture, and one patient in the open Latarjet required irrigation and debridement for deep infection and 1 patient in each group required readmission for surgery ($p > 0.99$). In the open Latarjet group, 1 patient (0.9%) was readmitted for an irrigation and debridement of a deep wound infection, and 1 (0.9%) patient required a revision to distal tibial allograft for graft fracture. In the same group, 2 other patients (1.8%) had minor complications, with 1 (0.9%) requiring antibiotics for a superficial wound infection, and another (0.9%) having a sensory neuropraxia of the axillary nerve which resolved after 3 weeks of expectant management. In the arthroscopic Latarjet group, 1 patient (2.5%) required a revision to distal tibial allograft for graft fracture, and another patient (2.5%) had drainage from one of the portals and was treated with antibiotics as an outpatient for a suspected infection. The complications are described in Table 3.

Table 3. Complications of the Open & Arthroscopic Latarjet Procedure

	Open	Arthroscopic	p value
Intra-Operative Complications	0 (0%)	0 (0%)	-
90-day Complications	4 (3.6%)	2 (5%)	0.6576
Readmissions	2 (1.8%)	1 (2.5%)	> 0.99
Reoperations	2 (1.8%)	1 (2.5%)	> 0.99
Nerve Complications	1 (0.9%)	1 (2.5%)	0.4635
Vascular Complications	0 (0%)	0 (0%)	-
Wound Complications	2 (1.8%)	1 (2.5%)	> 0.99
Hardware/Graft Complications	1 (0.9%)	1 (2.5%)	0.4635
Recurrent Instability	0 (0%)	0 (0%)	-

Short Term Complications of the Latarjet Procedure – A Systematic Review

METHODS

Search Strategy & Study Selection

Two independent reviewers performed the literature search based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and reviewed the search results, with a senior author arbitrating on any disagreement, using specific terms in MEDLINE, EMBASE, and The Cochrane Library.[34] The title and abstract were reviewed for all search results and potentially eligible studies received a full-text review. Finally, the reference lists of the included studies and literature reviews found in the initial search were manually screened for additional articles meeting the inclusion criteria.

Inclusion Criteria

The inclusion criteria consisted of 1) clinical studies of arthroscopic or open Latarjet repairs, 2) studies of a minimum 5 participants, 3) reporting on complications, 4) published in English and 5) studies published from peer-reviewed journals.

Data Extraction/Analysis

The relevant information regarding the study characteristics including the study design, LOE, population, complications, and the follow-up time points were collected by two blinded reviewers using a predetermined data sheet, with the results compared.

Statistics

All statistical analysis was performed utilizing GraphPad Prism 8.3 (GraphPad, La Jolla, CA). For all continuous and categorical variables, descriptive statistics were calculated.

Meta-analysis was performed using *Review Manager ((RevMan) [Macintosh]. Version 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014.)*. Fixed-effects models were used. Results were presented as risk ratio (RR) for dichotomous outcomes and, with a 95% confidence interval (95% CI). Heterogeneity between studies was quantified using the I^2 statistic.[178] An I^2 value of < 25% was chosen to represent low heterogeneity. A p-value of < 0.05 was considered to be statistically significant.

RESULTS

Study Characteristics and Patient Demographics

Overall, 89 studies (LOE I: 2, LOE II: 2, LOE III: 24, LOE IV: 61), including 7 studies comparing the open and arthroscopic Latarjet procedures were included. Of the 7,175 shoulders, 5,035 underwent the open Latarjet procedure and 2,140 underwent the arthroscopic Latarjet procedure.

Complications following the Open Latarjet Procedure

The overall complication rate following the open Latarjet procedure was 6.8%, with the most common complication being graft complications (1.9%), with non-union (1.6%) accounting for the vast majority. Hardware complications occurred in 1.1% of patients, with symptomatic hardware (0.4%) and screw break/loosening (0.4%) making up a similar proportion. Additionally, wound complications occurred in 1.1% of patients, with the majority being either superficial infections (0.5%) or wound dehiscence (0.05%), and deep wound infections were rare (0.1%). Furthermore, nerve complications occurred in 0.9% of patients, with the musculocutaneous nerve (0.3%) being the most common nerve affected. Other complications occurred in 1.2% of patients, with hematomas accounting for the majority (0.9%). These are further illustrated in Table 4.

Table 4. Open Latarjet Complication Rates

	N (%)	N Studies
Total Complications	308 (6.1%)	60
Graft Complications	96 (1.9%)	31
Non-union	80 (1.6%)	23
Graft fracture	8 (0.2%)	7
Vascular necrosis	2 (0.05%)	2
Unspecified	6 (0.1%)	5
Hardware Problems	54 (1.1%)	25
Symptomatic hardware	22 (0.4%)	11
Screw broken/loose	22 (0.4%)	10
Unspecified	10 (0.2%)	4
Wound Complications	55 (1.1%)	24
Superficial infection	23 (0.5%)	14
Deep infection	6 (0.1%)	4
Wound dehiscence	3 (0.05%)	3
Unspecified	23 (0.5%)	10
Nerve Complications	45 (0.9%)	19
Musculocutaneous	13 (0.3%)	10
Axillary	8 (0.2%)	7
Suprascapular	3 (0.05%)	3
CRPS	2 (0.05%)	2
Radial	2 (0.05%)	2
Ulnar	1 (0.02%)	1
Unspecified	16 (0.3%)	6
Other Complications	58 (1.2%)	23
Hematoma	47 (0.9%)	20
Venous Thrombus	3 (0.05%)	2
Contracture	3 (0.05%)	1
Frozen shoulder	3 (0.05%)	1
Pulmonary embolus	1 (0.02%)	1
Humerus fracture	1 (0.02%)	1

N; number, CRPS; chronic regional pain syndrome

Complications following the Arthroscopic Latarjet Procedure

The overall complication rate following the arthroscopic Latarjet procedure was 6.8%, with the most common complication being graft complications (3.2%), with graft fracture (1.3%) being the most common complication. Hardware complications occurred in 1.9% of patients, with screw break/loosening (1.0%) and symptomatic hardware (0.9%) making up a similar proportion. Additionally, wound complications occurred in 0.5% of patients, with the majority being either superficial infections (0.2%), with no deep wound infections reported. Furthermore, nerve complications occurred in 0.7% of patients, with musculocutaneous nerve (0.1%) and suprascapular (0.1%) being the most common nerves affected. Other complications occurred in 0.5% of patients, with hematomas accounting for the majority (0.2%). These are further illustrated in Table 5.

Table 5. Arthroscopic Latarjet Complication Rates

	N (%)	N studies
Total Complications	145 (6.8%)	23
Graft Complications	69 (3.2%)	15
Graft fracture	28 (1.3%)	10
Non-union	23 (1.1%)	7
Unspecified	18 (0.8%)	4
Hardware Complications	40 (1.9%)	9
Screw broken/loose	21 (1.0%)	5
Symptomatic hardware	19 (0.9%)	7
Wound Complications	10 (0.5%)	7
Superficial	4 (0.2%)	4
Unspecified	5 (0.2%)	2
Nerve Complications	15 (0.7%)	11
Suprascapular	3 (0.1%)	2
Musculocutaneous	3 (0.1%)	2
CRPS	2 (0.1%)	1
Antebrachial nerve	1 (0.05%)	1
Axillary nerve	1 (0.05%)	1
Unspecified	5 (0.2%)	4
Other Complications	11 (0.5%)	6
Hematoma	6 (0.2%)	5
Frozen Shoulder	5 (0.2%)	2

N; number, CRPS; chronic regional pain syndrome

Open vs Arthroscopic Latarjet

Complications were reported in 7 studies comparing 379 patients treated with the open Latarjet procedure and 531 treated with the arthroscopic Latarjet procedure. There were no statistically significant differences observed between groups (RR 1.07 95% CI, 0.64 to 1.77 , $I^2 = 24\%$, $p = 0.81$). Additionally, subgroup analysis found no difference in graft, hardware, wound or nerve complications ($p > 0.05$ for all). The forest plot for complications is shown in Figure 9.

	OL		AL			Risk Ratio
Study or Subgroup	**Events**	**Total**	**Events**	**Total**	**Weight**	**M-H, Random, 95% CI**
Ali 2020	3	15	4	33	11.5%	1.65 [0.42, 6.47]
Cunningham 2015	4	36	8	28	16.5%	0.39 [0.13, 1.16]
Hurley 2020	4	110	2	40	8.3%	0.73 [0.14, 3.82]
Kordasiewicz 2016	9	48	8	62	22.9%	1.45 [0.61, 3.48]
Marion 2016	0	22	3	36	2.9%	0.23 [0.01, 4.25]
Metais 2016	16	104	30	286	37.9%	1.47 [0.83, 2.58]
Zhu 2016	0	44	0	46		Not estimable
Total (95% CI)		**379**		**531**	**100.0%**	**1.07 [0.64, 1.77]**
Total events	36		55			

Heterogeneity: $Tau^2 = 0.09$; $Chi^2 = 6.55$, df = 5 (P = 0.26); $I^2 = 24\%$
Test for overall effect: Z = 0.24 (P = 0.81)

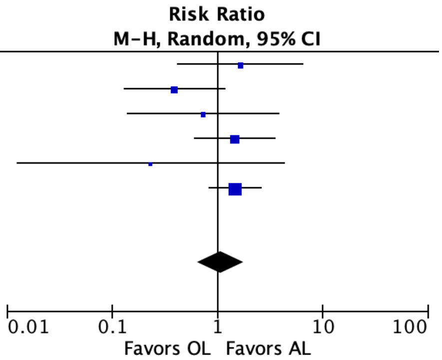


Figure 9. Forest plot of complications in studies comparing the Open & Arthroscopic Latarjet Procedure

Tranexamic Acid for the Latarjet Procedure – A Randomized Controlled Trial

METHODS

The study protocol was approved by the ethics committee of our institution, and registered at Clinicaltrials.gov (NCT03458468) prior to the start of the study. All patients scheduled to undergo the Latarjet procedure for anterior shoulder instability by one fellowship trained shoulder surgeon between March 2018 and March 2019 were considered for inclusion in the study. Exclusion criteria were refusal to participate in the study, revision shoulder stabilization, known allergy to TXA, anticoagulative medication, history of arterial or venous thromboembolic events, coagulopathy, hematological disorders, or history of seizures. Informed consent was obtained from all included patients.

A priori power analysis was performed based on the VAS score as primary endpoint, which revealed that a minimum of 39 patients would be required in each group to detect a clinically important difference in the VAS score (1.4) with a power of 0.8.[189] Thus, 50 patients each were recruited for the intervention and placebo groups for a total of 100 patients to allow for a 20% loss to follow-up. Randomization was performed according to a computerized random number sequence generator. An investigator not involved in the procedure informed the anesthetist of the patient's allocation, and both the surgeon and patient remained blinded to the group allocation. In the control group, 100 ml saline was administered 15 minutes prior to skin incision, while in the intervention group (TXA group), 1 g TXA (Pfizer Inc., New York City, New York) was administered intravenously in 100 ml saline 15 minutes prior to skin incision.

Data Collection

At the time of surgery, intraoperative blood loss and operative time were recorded. Subsequently, patients were evaluated one day postoperatively for 1) haematoma formation and grade, 2) drain output, 3) visual analogue scale (VAS score), and 4) opioid consumption, by a single examiner, who was not directly involved in the procedures and blinded to the group allocation. Grading of hematoma formation and postoperative swelling was based on a previously published scale Grade 0) no haematoma or swelling, Grade 1) mild haematoma and swelling: visible but not painful on palpation, Grade 2) moderate haematoma: visible swelling, painful on palpation, or Grade 3) severe haematoma: progressively painful swelling or other accompanying symptoms (e.g. neurological signs) requiring operative drainage.[172] Patients were followed for up to 4 months as part of our routine postoperative assessment for complications.

Statistical Analysis

Statistical analysis was performed using SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Macintosh, Version 22.0. Armonk, NY: IBM Corp.). Descriptive statistics were calculated for all continuous and categorical variables. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages. Fisher's exact or chi-squared test was used to analyze categorical variables. The independent or paired *t*-test for normally distributed variables, or the nonparametric Mann-Whitney U test or Wilcoxon signed-rank test was performed to compare continuous variables. A value of $p < 0.05$ was considered statistically significant.

RESULTS

Clinical Outcomes

TXA resulted in significantly lower levels of blood loss intra-operatively ($p < 0.05$). There was a significant difference at day 1 postoperatively in VAS score (3 ± 1.5 vs 1.7 ± 1.5, $P < 0.0001$). There was also a significant difference at day 1 postoperatively in total haematoma formation (74% vs 30%, $P < 0.0001$), with TXA also resulting in lower rates of moderate haematoma formation (32% vs 4%, $P < 0.0001$). There was a significant difference between the two groups in opioid consumption, with the TXA group requiring less opioids (9.4 ± 13.8mg vs 22 ± 20.4mg, $P < 0.0001$). Additionally, the grade of postoperative swelling was shown to correlate to increased VAS score and opioid use ($P < 0.0001$). There was no difference in operative time ($p = 0.79$) between the groups. The clinical outcomes are shown in Table 6, and the effect of postoperative swelling is shown in Table 7.

Table 6. Clinical Outcomes

	TXA	Control	p-value
Blood Loss (mls)	60.9 ± 21.5	68.9 ± 27.0	0.176
Operation Time (mins)	42.5 ± 7.2	45.2 ± 8.0	0.079
Revisions	0	1	N/A
Drain Output (mls)	29.6 ± 27.4	64.9 ± 37.8	< 0.001
VAS Score	1.7 ± 1.5	3 ± 1.5	< 0.001
Haematoma Grade None/Mild/Moderate/Severe	35/12/2/1	13/21/16/0	< 0.001
Opioids (mg)	9.4 ± 13.8	22 ± 20.4	< 0.001

mg; milligram, mls; milliters, mins; minutes, VAS; visual analogue scale

Table 7. Effect of Haematoma Grade

	None	Mild	Moderate	p-value
N	48	33	18	
Drain Output (mls)	22.5 ± 18.5	51.7 ± 28.7	76.4 ± 32.1	< 0.001
VAS Score	1.2 ± 0.7	2.8 ± 1.3	4.3 ± 1.0	< 0.001
Opioids (mg)	4.4 ± 7.6	19.8 ± 16.6	34.4 ± 19	< 0.001

mg; milligram, mls; milliters, N; number, VAS; visual analogue scale

DISCUSSION

In recent years, there has been an increased interest in the study of post-operative pain control due to opioid crisis in the United States, with increasing legislature over the regulation over opioid prescriptions[190]. This problem is very prevalent to orthopaedic surgery, as oorthopaedic surgeons are thought to be responsible for approximately a tenth of opioid prescriptions and are the third most common prescribers of opioids[190]. Similarly, Kumar et al.[191] found in a prospective study that a median of 60 opioid pills are prescribed following outpatient shoulder surgery. Post-operative shoulder pain is notoriously difficult to control, with intra-operative swelling due to fluid and it's highly innervated structures playing a role. No specific nerve block was found to be superior in our study, although cISB was shown to have the highest P-Score at most time points. The advantage of a network meta-analysis is that it allows for comparison of all nerve blocks with the ability to rank them based on outcomes using the P-Score. The P-score represents the probability that the nerve block is the ideal block for optimal pain control and provides a method of ranking the possible options[36]. However, the optimal method of comparing treatments should be to look at the Odds Ratio and their confidence interval. It is important to understand that the P-score does not represent the magnitude of difference between the methods, just the probability that one nerve block is more likely to result in a better outcome than the other. Thus, surgeons may feel comfortable in choosing whatever pain control method is standard of care in their institution.

There are other considerations besides pain control in choosing which nerve block to use, and there may be a role for utilizing different nerve blocks depending on the case. ISB has long been considered the gold standard, however, it must be delivered by an anesthetist and is time consuming, with the potential for serious complications including pneumothorax, vascular damage and persistent nerve deficits[160]. In contrast, SSB has been gaining popularity recently as it can be given intra-operatively by a surgeon using anatomical landmarks[192]. Although we did not evaluate it in our study, the choice of nerve blocks may also affect post-operative complications, with SSB being associated with significantly fewer complications than ISB including the rebound pain phenomenon[161]. Other nerve blocks such as SCB are newer, and promising with similar results shown, although it primarily is used in elbow and hand surgery due to the nerve distribution. The addition of nerve blocks adjuncts was shown to provide prolonged pain control from the nerve blocks, with a few studies showing overall superior pain control.

The Latarjet procedure has a high-rate of reported complications due to its non-anatomic nature and proximity to critical neurovascular structures, with Frank et al.[169] reporting a 7.5% 90-day complication rate, and Griesser et al.[28] reporting that 75% of complications occur within the first year. In contrast, the complication rate following the arthroscopic Bankart repair is minimal due to its minimally invasive approach.[193] However, the incidence of those requiring revision surgery for a post-operative complication in both of the included series was low, and all patients who had a complication had undergone previous arthroscopic Bankart repair. Furthermore, in the updated systematic review, the overall complication rate was approximately a fifth of that in the series by Griesser et al.[28]

Several patients had an infection after the open Latarjet procedure, with the majority requiring an irrigation and debridement and a short course of antibiotics, all of them subsequently resolved without further issues. This is one of the purported advantages of the arthroscopic technique, as it is minimally invasive and may have less associated soft tissue and wound complications. Infections in the shoulder area have the potential for significant morbidity, especially in the case of C. Acnes which can grow insidiously, is difficult to treat, and may result in lingering pain due to subclinical infection.[194]

The most commonly reported complication in the systematic review was graft-complications. Screws are the most common method of fixation but are associated with significant morbidity and hardware complications. With the advent of the arthroscopic Latarjet procedure, there has been interest in using suture-buttons to fix the coracoid, as suture-button fixation has been shown in other joints to reduce complications compared to screw fixation.[195, 196] Provencher et al.[197] found in a cadaver model that suture-buttons have similar biomechanical strength for coracoid bone block fixation as screws. Further advances in this area may also make the arthroscopic technique more viable. However, in our experience, we have found the use of solid screws to be reliable both regarding intraoperative handling and outcomes in our patient population.

The musculocutaneous nerve is most commonly injured followed by the axillary, ulnar, radial and median nerve. Neurologic injury is a serious complication that has been attributed to traction, patient malpositioning and inadvertent suturing.[198, 199] Delaney et al.[27] found that the risk of neurologic injury was greatest during glenoid exposure and graft insertion stages of the Latarjet procedure. Furthermore, they also found a prolonged total operative time to be a statistically significant predictor of postoperative nerve deficit.

Hematoma is another one of the most commonly reported complications after this procedure and was the most commonly reported complication in the Sports Surgery Clinic. Patients who undergo Latarjet procedures at our centre typically have large muscle bulk which may complicate trying to find deep oozing vessels. Additionally, the coracoid donor site may be a source of continual bleeding, although we do apply bone wax to this area. Even though a hematoma may be subclinical and not require and evacuation, it may still be a significant source of pain in the early postoperative period. Thus, we conducted an RCT to evaluate the use of TXA in this population. Our study found that postoperative haematoma formation and swelling was associated with a corresponding increase in pain and opioid use. This highlights the importance of haematoma formation as a significant source of postoperative pain. TXA was subsequently shown to decrease the incidence of swelling and hematoma formation, and subsequently decreased pain levels and opioid use.

While the results from our study are promising, there are certain aspects regarding the use of TXA in the Latarjet procedure warranting further study. Our study only evaluated a single, standardized dose of TXA preoperatively, while repeated doses or weight-adjusted dosing regimens may further reduce postoperative haematoma and painful swelling. Wang et al.[200] found multiple doses further reduce blood loss following total hip arthroplasty, compared to a single preoperative bolus. Pauzenberger et al.[172] used a pre- and postoperative TXA bolus in their study, evaluating haematoma formation following shoulder arthroplasty, and found no painful swelling in the TXA group. Further study of repeating or weight adjusting TXA dosages in the Latarjet procedure are warranted to evaluate whether such measures could provide even greater reduction of postoperative hematoma formation, swelling, pain, and subsequently opioid consumption.

The series at the Sports Surgery Clinic is the largest in the literature, and we believe the lower complication rate in our series is attributable to the high-volume of cases performed, as shoulder surgeon volume has been shown to correlate with outcomes.[156, 201] Three strategies that we believe may be of value in reducing complications are the use of TXA, solid screws, and removing the Hohmann retractor prior to coracoid preparation. We believe that the results in our series will mitigate some of the concerns surrounding the Latarjet procedure as well as inform surgeons and patients. Furthermore, the experience in NYU Langone Health has shown it is possible to move towards performing the Latarjet procedure arthroscopically without an increase in complications.

Limitations

There are potential limitations in this chapter. This systematic review has several limitations and potential biases, including the limitations of the included studies themselves. In the included pooled analyses, the standardization of reporting limited our analysis. Thus, some nerve blocks could not be added to comparisons at certain time points. Additionally, as the majority of studies reported on mixed pathologies, it introduces heterogeneity, but this is standard in shoulder pain control research as the majority does not focus on a single pathology. Similarly, there is the potential of confounding with different medications and dosing regimens with the nerve blocks. However, we mitigated the heterogeneity by random effects models to control for this. The study also evaluated complications that occurred within 90 days. Therefore, any late complications that may have occurred outside of this window were not evaluated. Furthermore, patients were assessed by the operating surgeon at follow-up, which may be a source of potential bias. In the RCT, postoperative swelling and haematoma assessment is subjective. However, assessment was performed by an examiner, who was blinded to the treatment group of the patients.

Conclusions

- CISB resulted in the lowest pain levels at most time points, although this was not significantly different compared to the other nerve blocks. Additionally, nerve block adjuncts may prolong the post-operative block time, and improve pain control. There is promising evidence for some oral medications and newer modalities to control pain and reduce opioid use. However, we found there is no evidence to support the use of subacromial infusions or PCA.

- The Latarjet procedure has a low 90-day complication rate when performed at a high volume centre. Haematomas were the most common complication experienced by patients who undergo the Latarjet procedure, while there was no recurrent instability, neurological or hardware complications reported among the 441 patients included in this study.
- The safety, and 90-day complication and readmission profile of arthroscopic Latarjet is similar to open Latarjet procedure.
- Our systematic review established that the overall complication rate following the Latarjet procedure is lower than previously reported. Furthermore, based on the current evidence in the literature, there is no significant difference in the complication rate between the open and arthroscopic Latarjet procedures.
- TXA significantly reduced postoperative blood loss, painful postoperative swelling and hematoma formation, and subsequently reduced postoperative pain and opioid use following the Latarjet procedure.

Chapter 3: Return to Play after Anterior Shoulder Instability

INTRODUCTION

Several studies have demonstrated that athletes may be able to return to play at a high level following shoulder instability.[24, 37, 38, 202, 203] Additionally, non-operative management may be advocated for in athletes who wish to return to play (RTP) during the same season, before undergoing definitive surgery in the off-season. Athletes with anterior shoulder instability are primarily concerned with their ability to RTP after injury, and this has been shown to affect decision-making about treatment more so than other factors like shoulder stability.[147] Despite the importance of the role of non-operative management in the treatment of primary anterior shoulder instability, to our knowledge, no systematic review of the literature exists on the reported rate of RTP and subsequent recurrent instability in this patient population. Additionally, there are currently no validated criteria for safe return to play following a first-time anterior dislocation. Furthermore, while rates of return the rate of RTP and criteria for RTP have been evaluated following arthroscopic Bankart repair, but not for those undergoing the open Latarjet procedure.[24, 204] Finally, it is unclear what surgeons are actually doing in their practice.

Warth et al.[147] previously evaluated patients undergoing shoulder arthroscopy pre-operatively, and found the ability to RTP was one of the main determinants for undergoing surgery, even more so than recurrence. However, it is still unclear which post-operative factors influence satisfaction and shoulder function at mid-term follow-up, including how their ability to RTP and post-operative recurrence influence this. Furthermore, it is still unclear how arthroscopic Bankart repair and the open Latarjet procedure compare in athletic populations, and whether there is a difference in rate or timing of RTP. Furthermore, it is unclear how arthroscopic Bankart repair and open Latarjet procedure differ in functional outcomes in athletes. Additionally, the factors that prevent athletes from returning are still unclear and have not been fully elucidated in the literature. Tjong et al.[205] evaluated 25 patients that underwent arthroscopic Bankart repair and identified fear of reinjury, shifts in priority, mood, social support, and self-motivation as all having effects on a patients desire to RTP. Thus, further analysis of the factors affecting RTP is warranted, as there is still scant literature on the topic.

The purpose of this chapter was to evaluate criteria for RTP following non-operative management of first-time dislocations, and to evaluate criteria for RTP following the open Latarjet procedure. Furthermore, a survey was conducted of the members of North American and European shoulder surgery & sports medicine societies to evaluate their criteria for deciding when an athlete can safely RTP following shoulder stabilization surgery. Additionally, we sought to evaluate the outcomes of athletes 5-years post-operatively following arthroscopic Bankart repair, and to evaluate factors associated with satisfaction and shoulder function, as defined by subjective shoulder value. Furthermore, comparisons of those undergoing arthroscopic Bankart repair and the open Latarjet procedure for those with primary of recurrent instability were performed, with a focus on RTP metrics. Finally, those that did not RTP following the arthroscopic Bankart repair and the open Latarjet procedure were evaluated.

Return to Play & Criteria for Return following Non-Operative Management & the Open Latarjet Procedure

METHODS

Study Selection

Two independent reviewers performed the literature search based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and reviewed the search results, with a senior author arbitrating on any disagreement, using specific terms for each study question in MEDLINE, EMBASE, and The Cochrane Library.[34] The title and abstract were reviewed for all search results and potentially eligible studies received a full-text review. Finally, the reference lists of the included studies and literature reviews found in the initial search were manually screened for additional articles meeting the inclusion criteria.

Eligibility Criteria

The inclusion criteria were the following: 1) a; study evaluating outcomes of non-operative management of primary anterior shoulder instability in athletes, b; study evaluating outcomes the open Latarjet procedure in athletes 2) published in a peer-reviewed journal, 3) published in English, 4) full text of studies available. The exclusion criteria were the following: 1) review studies, 2) cadaveric studies, 3) biomechanical studies, 4) abstract only.

Data Extraction/Analysis

The relevant information regarding the study characteristics, including the study design, level of evidence, population, return to play quality of evidence (RTPQ), outcome measures, and follow-up time points were collected by two blinded reviewers using a predetermined data sheet, with the results compared. When required information was not available in the text, the authors were contacted. The RTPQ was based on the previously published criteria of Zaman et al.[206] This consisted of return to play timeline, conditional criteria, measurement of conditional criteria and rehabilitation protocol (timeline of immobilization postoperatively). A score of 4 indicated well-defined return to play criteria, a score of 1-3 indicated poorly defined criteria, and a score of 0 indicated no return to play criteria.

Statistical Analysis

All statistical analysis was performed utilizing GraphPad Prism 8.3 (GraphPad, La Jolla, CA).

RESULTS

Non-Operative Management for First-Time Dislocations

There were 22 studies (LOE I: 13, LOE III: 5, LOE IV: 4) evaluating 1,310 patients. The mean RTP-QOE was 1 (range: 0-2).

Return to Play (Table 1)

Overall, 76.5% of athletes were able to return to play, with 51.5% able to return to play at their pre-injury level following non-operative management of primary anterior shoulder instability. Among the included Level 1 studies, 77.9% of athletes were able to return to play, with 51.5% able to return to play at their pre-injury level. Among collision athletes, 88.1% were able to return to play.

Table 1. Return to Play following Non-Operative Management

Outcome	N	Studies
Overall RTP	76.5% (520/680)	16
RTP at Pre-Injury Level	51.5% (268/520)	8
RTP in Level I Studies	77.9% (278/357)	10
RTP at Pre-Injury Level in Level I Studies	51.5% (268/520)	8
RTP Collision Athletes	88.1% (141/160)	6

RTP; return to play

Return to Play Timeline and Criteria

The timing of return to play was reported in 3 studies, at a mean of 2.4 months following their instability event (range: 1.5-4.3 months). In 9 studies, the timing of allowed return to play after completion of a rehabilitation program was a minimum of 3 months in 2 studies, 4 months in 5 studies, and 6 months in 2 studies. Only 1 study reported on the conditional criteria for return to play, which consisted of restoration of shoulder range of motion and strength that was comparable to the contralateral side.

Recurrent Instability (Table 2)

Overall, the pooled recurrence rate among athletes was 53.7%. Best-case analysis revealed that the recurrence rate could be as low as 50.7% in those able to return to play, while worst-case analysis revealed that the recurrence rate could be as high as 67.7% in those able to return to play. Among collision athletes, the pooled recurrence rate was 78.7%.

Table 2. Recurrence

Outcome	N	Studies
Pooled Recurrence	54.7% (390/713)	13
Best Case Analysis	50.7% (264/520)	16
Worst Case Analysis	67.7% (352/520)	16
Recurrence among Collision Athletes	78.7% (70/89)	2

Return to Play following the Open Latarjet Procedure

There were 36 studies (LOE III: 10, LOE IV: 26) evaluating 2,134 patients. The mean RTP-QOE was 2.2 (range: 0-4).

Return to Play (Table 3)

The overall rate of return to play was 88.8%, with 72.6% returning to the same level of play. Among collision athletes, the overall rate of return to play was 88.2%, with 69.5% returning to the same level of play. In overhead athletes, the overall rate of return to play was 90.3%, with 80.6% returning to the same level of play. The mean time of return to play was 5.8 months (range 3.2-8).

Table 3. Return to Play Following the Open Latarjet Procedure

Outcome	Studies	Result (N)
Total RTP	32	88.8% (1463/1650)
RTP Same/Higher Level	31	72.6% (1122/1527)
Total RTP C	12	88.2% (591/670)
RTP Same/Higher Level C	11	69.5% (401/577)
Total RTP OH	2	90.3% (28/31)
RTP Same/Higher Level OH	2	80.6% (25/31)

RTP; return to play, C; collision athletes, OH; overhead athletes

Return to Play Criteria

The overall return to play criteria was reported in the majority of the studies (69.4%), with the most commonly report item being time (66.7%). There was a wide discrepancy in reported time of return; all ranging 3-6 months, with 3 months being the most commonly used time point (35.4%). Other criteria including; imaging using CT to assess bone-union (25%), clinical exam/decision (11.1%), strength (11.1%), pain (8.3%), and range of motion (5.6%) were less commonly reported.

Return to Play Criteria Among Shoulder Surgeons Following Shoulder Stabilization

METHODS

Questionnaire Development

A 20-question survey was developed to evaluate surgeons' criteria for allowing athletes to RTP following shoulder stabilization. The survey consisted of three major sections focusing on 1) surgeon demographics, 2) RTP criteria following arthroscopic Bankart repair, and 3) RTP criteria following the Latarjet procedure. The questions were derived from criteria identified by Ciccotti et al.[204] and our systematic review on RTP following the arthroscopic Bankart repair and Latarjet procedures. The survey was created using REDCap.

Survey Distribution

The American Shoulder & Elbow Surgeons (ASES), American Orthopaedic Society for Sports Medicine (AOSSM), European Society for Sports & Knee Arthroscopy (ESSKA), and European Society for Surgery of the Shoulder and the Elbow (SECEC) all approved the survey and distributed it to their members via REDCap. Responses were kept anonymous and confidential.

Statistical Analysis

All statistical analysis was performed utilizing GraphPad Prism 8.3 (GraphPad, La Jolla, CA). Descriptive statistics were calculated for all continuous and categorical variables. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages.

RESULTS

Surgeon Demographics

Overall, 317 surgeons completed our survey, with the majority from North America (58.4%).

Return to Play Criteria Following Arthroscopic Bankart Repair (Table 4)

The most commonly-reported criteria was time (98.7%), with the majority of surgeons also reporting strength (74.8%) and range of motion (70%) as independent factors affecting their decision to allow athletes to RTP. The most common time point was 4 months (43.8%), and the majority reported waiting an additional period of time, most commonly 2 months (38.2%), before allowing a collision athlete to RTP (75.4%). The addition of a Remplissage procedure did not affect decision-making regarding RTP in most cases (92.1%).

Table 2. Return to Play following Arthroscopic Bankart Repair

RTP Criteria	
Time	313 (98.7%)
Range of Motion	222 (70%)
Strength	237 (74.8%)
Pain	148 (46.7%)
Proprioception	130 (41%)
Sport	269 (84.9%)
Time to RTP	
None	4 (1.3%)
3 months	62 (19.6%)
4 months	139 (43.8%)
6 months	104 (32.8%)
9 months	7 (2.2%)
12 months	1 (0.3%)
Difference in RTP Timing in Collision Athletes	
No	78 (24.6%)
1 months	53 (16.7%)
2 months	121 (38.2%)
3 months	56 (27.7%)
6 months	9 (2.8%)
Remplissage Affect RTP	25 (7.9%)

RTP; Return to Play

Return to Play Criteria Following Open Latarjet Procedure (Table 5)

The most commonly-reported criteria was time (98.4%), with the majority of surgeons also reporting strength (67.5%) and range of motion (65.9%) as independent factors affecting their decision to allow athletes to RTP. Less than half utilized imaging to assess for radiographic union before allowing patients to RTP (47%), and the most common imaging modality was plain radiography (80%). The most common time point was 4 months (33.1%), and the majority reported waiting an additional period of time, most commonly by 2 months (25.9%), before allowing a collision athlete to RTP (59.6%).

Table 5. Return to play following the Latarjet Procedure

RTP Criteria	
Time	312 (98.4%)
Range of Motion	209 (65.9%)
Strength	214 (67.5%)
Pain	148 (46.7%)
Proprioception	118 (37.2%)
Imaging	149 (47%)
Sport	227 (71.6%)
Time to RTP	
None	15 (4.7%)
3 months	93 (2.9%)
4 months	105 (33.1%)
6 months	95 (30%)
9 months	8 (2.5%)
12 months	1 (0.3%)
Difference in RTP Timing in Collision Athletes	
No	128 (40.4%)
1 months	60 (18.9%)
2 months	82 (25.9%)
3 months	41 (12.9%)
6 months	6 (1.9%)

RTP; Return to Play

Evaluation of Factors Associated with Successful 5-Year Outcomes Following Arthroscopic Bankart Repair in Athletes

METHODS

Patient Selection

A retrospective review was carried out to identify all athletes who underwent arthroscopic Bankart repair by a single surgeon. Patients were indicated for arthroscopic Bankart repair based on counselling of their risk factors for post-operative recurrent instability, including collision athletes, those with severe glenoid bone-loss, those with Hill-Sachs lesions, or those with prior failed soft-tissue stabilization.[207, 208]

Clinical Outcomes

Evaluation of post-operative patient reported outcomes was carried out following telephone survey including; Rate, level and timing of RTP, and Shoulder Instability-Return to Sport after Injury (SIRSI) score were evaluated. Additionally, recurrent instability, Visual Analogue Scale (VAS) score, Subjective Shoulder Value (SSV), satisfaction, sleep trouble (due to their shoulder), and whether they would undergo the same surgery again was evaluated. Satisfaction was graded on a scale of 1-5, with 1 representing very dissatisfied and 5 representing very satisfied. Sleep trouble was graded on a scale of 1-5, with 1 representing no trouble and 5 representing difficulty every night.

Statistical Analysis

All statistical analysis was performed utilizing GraphPad Prism 8.4.2 (GraphPad, La Jolla, CA). For all continuous and categorical variables, descriptive statistics were calculated. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages. Linear and

Logistic regression models were used to evaluate factors affecting postoperative Satisfaction, and SSV level. Factors in the model included VAS, SIRSI, SSV, sleep trouble, RTP Same/Higher level, RTP timing, revision, and redislocation. A value of $p < 0.05$ was considered to be statistically significant.

RESULTS

Patient Demographics

Overall, there were 144 arthroscopic Bankart repairs included in this study.

Clinical Outcomes (Table 6)

At final follow up, the mean VAS score was 2.1 ± 2, the mean SIRSI score was 63.7 ± 25.7, the mean SSV was 85.8 ± 14.4, 82.6% were satisfied/very satisfied, 61.8% had no sleep trouble due to their shoulder, and 84.1% would undergo surgery again. Overall, the rate of RTP was 80.5%, with 63.9% returning at the same level at a mean of 6.2 ± 2.7 months.

Table 6. Clinical Outcomes

VAS	2.1 ± 2
SIRSI	63.7 ± 25.7
SSV	85.8 ± 14.4
Sleep Trouble 1-5	89/10/22/13/10
Satisfaction Level 1-5	1/6/18/43/76
Surgery Again?	121 (84.0%)
RTP	116 (80.5%)
RTP S/H level	92 (63.9%)
RTP Timing	6.2 ± 2.7

VAS; Visual Analogue Scale, SIRSI; Shoulder Instability-Return to Sport after Injury, SSV; Subjective Shoulder Value, RTP; return to play, S/H; same or higher level

Revisions & Recurrent Instability (Table 7 & Figure 1)

Overall, there were 18 (12.5%) cases of recurrent instability post- arthroscopic Bankart repair, with 15 (10.4%) suffering re-dislocation, and 3 (2.1%) further subluxation. A further stabilization was performed in 8 (5.6%) patients. Additionally, 7 (4.9%) other patients required a further procedure, 2 patients underwent an arthroscopic release, 2 underwent arthroscopic rotator cuff repair, 1 underwent biceps tenodesis, 1 underwent a plate fixation for a clavicle fracture, and 1 underwent a subacromial decompression.

Table 7. Revisions & Recurrent Instability

Revisions	15 (10.4%)
Recurrence	18 (12.5%)
Redislocation	15 (10.4%)
Subluxation	3 (2.1%)

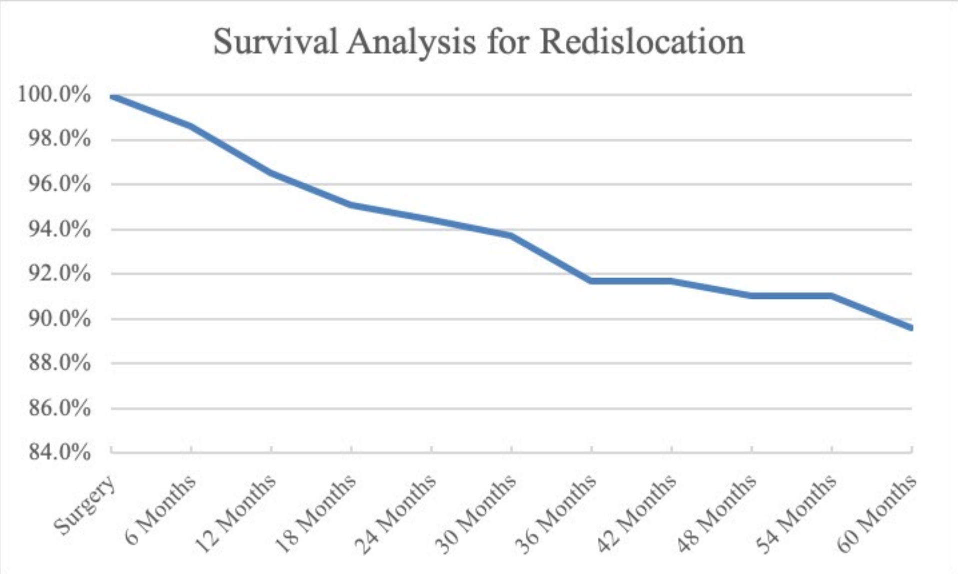


Figure 1. Survival Analysis for Redislocation

Linear and Logistic Regression of Factors Associated with Satisfaction (Table 8 & 9)

Linear regression revealed that the SIRSI score ($p < 0.0001$), VAS score ($p < 0.0031$), sleep trouble ($p = 0.0129$), SSV ($p < 0.0001$) were factors associated with satisfaction. Logistic regression revealed whether a patient required revision surgery ($p = 0.0029$), return-to-play at the same level ($p = .0005$), or had re- dislocation ($p = 0.0031$) were also associated with satisfaction.

Table 8. Linear Regression of Factors Associated with Satisfaction

	R^2	p-value
VAS	0.06468	*0.0031*
SIRSI	0.3105	*<0.0001*
SSV	0.1814	*<0.0001*
Sleep Trouble	0.04432	*0.0129*
RTP Timing	0.01779	0.1552

VAS; Visual Analogue Scale, SIRSI; Shoulder Instability-Return to Sport after Injury, SSV; Subjective Shoulder Value, RTP; Return-to-Play

Table 9. Logistic Regression of Factors Associated with Satisfaction

	|Z|	p-value
RTP S/L	3.46	*0.0005*
Redislocation	2.956	*0.0031*
Revision	2.974	*0.0029*

RTP; Return-to-Play of Same Level

Linear and Logistic Regression of Factors Associated with SSV (Table 10 & 11)

Linear regression revealed that the SIRSI score ($p < 0.0001$), VAS score ($p < 0.0001$), and sleep trouble ($p <0.0001$), were the factors that were associated with SSV. Logistic regression found that RTP of the same level ($p = 0.0117$) was found to be associated with SSV.

Table 10. Linear Regression of Factors Associated with SSV

	R^2	p-value
VAS	0.2190	*<0.0001*
SIRSI	0.3181	*<0.0001*
Sleep Trouble	0.2416	*<0.0001*
RTP Timing	0.0007	0.3772

VAS; Visual Analogue Scale, SIRSI; Shoulder Instability-Return to Sport after Injury, SSV; Subjective Shoulder Value, RTP; return to play

Table 11. Logistical Regression of Factors Associated with SSV

	|Z|	p-value
Revision	1.055	0.2916
Re-dislocation	1.007	0.3138
RTP S/L	2.522	*0.0117*

SSV; Subjective Shoulder Value, RTP S/L; Return-to-Play at Same Level

Arthroscopic Bankart Repair vs The Open Latarjet Procedure for Athletes

METHODS

Patient Selection

A retrospective review was carried out to identify all patients who underwent arthroscopic Bankart repair or open Latarjet procedure by a single surgeon was conducted. The indications for open Latarjet procedure over arthroscopic Bankart repair in this population were those considered at high risk for recurrence, including those with glenohumeral bone loss. Subsequently patient matching between arthroscopic Bankart repair and open Latarjet procedure based on patient demographics (age, gender, sport, level of pre-operative play, and follow-up length) was performed to generate two comparable groups. As there were more arthroscopic Bankart repairs performed for primary instability, these were matched 2:1 for first time dislocations, but 1:1 for recurrent dislocations.

Clinical Outcomes

Evaluation of post-operative patient reported outcomes was carried out following telephone survey including; Rate, level and timing of RTP, and SIRSI score were evaluated. In order to assess apprehension patients were asked if they have subjective instability at extreme range of motion. Additionally, recurrence, VAS score, SSV, Rowe score, satisfaction, and whether they would undergo the same surgery again were compared. A SIRSI score > 56 is considered a passing score for being psychologically ready to RTP.[209] Furthermore, the sport specific outcomes were analyzed in collision athletes.

Statistical Analysis

Statistical analysis was carried out using SPSS version 22 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). For all continuous and categorical variables, descriptive statistics were calculated. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages. Categorical variables were analysed using Fisher's exact or chi-squared test. The independent or paired *t*-test for normally distributed variables, or the nonparametric Mann-Whitney U test or Wilcoxon signed-rank test was performed to compare continuous variables. A value of $p < 0.05$ was considered to be statistically significant.

RESULTS

First-Time Dislocators

Following analysis, 80 athletes treated with arthroscopic Bankart repair were matched with 40 athletes treated with open Latarjet procedure.

Return to Play (Table 12)

Overall, there was no significant difference between the mean time of RTP in the arthroscopic Bankart repair group and the open Latarjet procedure group (6.4 ± 2.7 months versus 5.9 ± 2.5 months; p = 0.38). Similarly, there was no significant difference in the total rate of RTP (81.3% vs 80%, p = 0.1), or return at the same/higher level (66.3% vs 62.5%, p = 0.69). Additionally, there was no difference in SIRSI score (67.1 ± 24.3 vs 70.2 ± 21.6, p = 0.50), or in the rate of those passing the SIRSI score (68.8% vs 72.5%, p = 0.83).

Table 12. Return to Play

	ABR	OL	p-value
RTP	65 (81.3%)	32 (80%)	1.0
RTP S/H	53 (66.3%)	25 (62.5%)	0.6900
RTP Timing (mo.)	6.4 ± 2.7	5.9 + 2.5	0.3820
SIRSI Score	67.1 ± 24.3	70.2 ± 21.6	0.4960
SIRSI Pass (%)	55 (68.8%)	29 (72.5%)	0.8330

ABR; arthroscopic Bankart repair, OL; open Latarjet, RTP; return to play, S/H; same/higher level, mo; months, SIRSI; Shoulder Instability-Return to Sport after Injury

Patient Reported Outcomes (Table 13)

At final follow up, there was no difference between those that underwent arthroscopic Bankart repair or open Latarjet procedure in VAS score (2.4 ± 2.2 vs 1.9 ± 1.8, p = 0.22), SSV (84.8 ± 17.4 vs 85.3 ± 12, p = 0.87), Rowe score (80.1 ± 19 vs 87.6 ± 13.1, p = 0.46), satisfaction (85% vs 90%, p = 0.57), or whether they would undergo surgery again (88.8% vs 85%, p = 0.57).

Table 13. Patient Reported Outcomes

	ABR	OL	p-value
SIRSI Score	67.1 ± 24.3	70.2 ± 21.6	0.4960
SIRSI Passed	55 (68.8%)	29 (72.5%)	0.8330
VAS Score	2.4 ± 2.2	1.9 ± 1.8	0.2161
SSV	84.8 ± 17.4	85.3 ± 12	0.8706
Rowe Score	80.1 ± 19	87.6 ± 13.1	0.4563
Satisfied	68 (85%)	36 (90%)	0.5743
Would Undergo Surgery Again	71 (88.8%)	34 (85%)	0.5686

ABR; arthroscopic Bankart repair, OL; open Latarjet, SIRSI; Shoulder Instability-Return to Sport after Injury, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value

Recurrent Instability (Table 14)

Overall, there was 7 (8.3%) patients in the arthroscopic Bankart repair group and 1 (2.5%) patient in the open Latarjet procedure group suffered recurrent instability (p = 0.27); although there was a difference in redislocation rate with 5 patients in the arthroscopic Bankart repair group and 0 patients in the OL group, this did not reach statistical significance (6.3% vs 0%, p = 0.17). There were no other intra-operative or immediate postoperative complications in our series.

Table 4. Recurrent Instability

	ABR	OL	p-value
Total Recurrence	7 (8.8%)	1 (2.5%)	0.2664
Redislocation	5 (6.3%)	0 (0%)	0.1708
Subluxation	2 (2.5%)	1 (2.5%)	1.00000
Apprehension	29 (36.3%)	11 (27.5%)	0.4132

ABR; arthroscopic Bankart repair, OL; open Latarjet

Outcomes in Collision Athletes (Table 15)

Overall, there was no significant difference between the mean time of RTP in the arthroscopic Bankart repair group and the open Latarjet procedure group (6.4 ± 2.7 months versus 5.9 ± 2.5 months; p = 0.38). Similarly, there was no significant difference in the total rate of RTP (85% vs 83.3%, p = 1), or return at the same/higher level (71.6% vs 66.7%, p = 0.6338). Additionally, there was no difference in SIRSI score (70.6 ± 24 vs 69.3 ± 20.1, p =

0.82), or in the rate of those passing the SIRSI score (75% vs 73.3%, p = 1). Additionally, there was no significant difference in rate of recurrent instability (p = 0.30).

Table 15. Outcomes in Collision Athletes

	ABR	OL	p-value
N	60	30	-
RTP	51 (85%)	25 (83.3%)	1
RTP S/H	43 (71.6%)	20 (66.7%)	0.6338
RTP Timing (mo.)	6.5 ± 2.8	5.9 ± 2.3	0.3564
SIRSI	70.6 ± 24	69.3 ± 20.1	0.8161
SIRSI Pass	45 (75%)	22 (73.3%)	1.0
Total Recurrence	4 (6.7%)	0 (0%)	0.2969
Redislocation	3 (5%)	0 (0%)	0.5480
Subluxation	1 (1.7%)	0 (0%)	1.0000
Apprehension	21 (35%)	9 (30%)	0.8129

ABR; arthroscopic Bankart repair, OL; open Latarjet, N; number, RTP; return to play, S/H; same/higher level, mo; months, SIRSI; Shoulder Instability-Return to Sport after Injury

<u>Recurrent Instability</u>

Following analysis, 62 athletes treated with arthroscopic Bankart repair were matched with 62 athletes treated with open Latarjet procedure.

Return to Play (Table 16)

Overall, there was no significant difference between the mean time of RTP in the arthroscopic Bankart repair group and the OL group (5.6 ± 2.2 months vs 5.5 ± 2.7 months, p = 0.82). Similarly, there was no significant difference in the total rate of RTP (83.9% vs 93.5%, p = 0.15), or return at the same/higher level (75.8% vs 80.6%, p = 0.66). Additionally, there was no difference in SIRSI score (70.1 ± 20.6 vs 74.8 ± 19.5, p = 0.19), or in the rate of those passing the SIRSI score (75.8% vs 80.6%, p = 0.66).

Table 16. Return to Play

	ABR	OL	p-value
RTP	53 (88.3%)	58 (93.5%)	0.1541
RTP S/H	47 (75.8%)	50 (80.6%)	0.6640
RTP Timing (mo.)	5.6 ± 2.2	5.5 ± 2.7	0.8215
SIRSI Score	70.1 ± 20.6	74.8 ± 19.5	0.1945
SIRSI Pass (%)	47 (75.8%)	50 (80.6%)	0.6640

ABR; arthroscopic Bankart repair, OL; open Latarjet, RTP; return to play, S/H; same/higher level, mo; months, SIRSI; Shoulder Instability-Return to Sport after Injury

Patient Reported Outcomes (Table 17)

At final follow up, there was no significant difference in VAS score for arthroscopic Bankart repair vs open Latarjet procedure groups (1.4 ± 1.6 vs 1.8 ± 1.8, p = 0.19), SSV (83.8 ± 21.7 vs 87.6 ± 13.2, p = 0.24), satisfaction (85.5% vs 90.3%, p = 0.58), or whether they would undergo surgery again (93.5% vs 95.2%, p = 0.70), although there was a significantly higher Rowe score with OL (82.2 ± 20.8 vs 90.5 ± 12.2, p = 0.46).

Table 17. Patient Reported Outcomes

	ABR	OL	p-value
VAS Score	1.4 ± 1.6	1.8 ± 1.8	0.1934
SSV	83.8 ± 21.7	87.6 ± 13.2	0.2411
Rowe Score	82.2 ± 20.8	90.5 ± 12.2	0.0077
Satisfied	53 (85.5%)	56 (90.3%)	0.5831
Would Undergo Surgery Again	58 (93.5%)	59 (95.2%)	0.6972

ABR; arthroscopic Bankart repair, OL; open Latarjet, SIRSI; Shoulder Instability-Return to Sport after Injury, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value

Recurrent Instability (Table 18)

Overall, there were 10 (16.1%) patients in the arthroscopic Bankart repair group and 1 (1.6%) patient in the open Latarjet procedure group suffered recurrent instability (p = 0.01); with a significant difference in re-dislocation rate (12.9% vs 1.6%, p = 0.03). There were no other intra-operative complications in our series. However, in those undergoing OL, 2 patients required a washout for hematoma during their admission, and one patient had a superficial wound infection which resolved with antibiotics.

Table 18. Recurrent Instability

	ABR	OL	p-value
Total Recurrence	10 (16.1%)	1 (1.6%)	0.0085
Redislocation	8 (12.9%)	1 (1.6%)	0.0324
Subluxation	2 (3.2%)	0 (0%)	0.4959
Apprehension	16 (25.8%)	11 (20%)	0.3844

ABR; arthroscopic Bankart repair, OL; open Latarjet

Outcomes in Collision Athletes (Table 19)

Overall, there was no significant difference between the mean time of RTP in the arthroscopic Bankart repair group and the open Latarjet procedure group (5.8 ± 2.2 months versus 5.5 ± 2.7; p = 0.52). Similarly, there was no significant difference in the total rate of RTP (89.1% vs 94.5%, p = 0.48), or return at the same/higher level (83.6% vs 80%, p = 0.81). Additionally, there was no difference in SIRSI score (70.4 ± 24.8 vs 73.8 ± 19.6, p = 0.43), or in the rate of those passing the SIRSI score (80% vs 80%, p = 1.00). However, there was a significant difference in rate of recurrent instability (p = 0.03).

Table 19. Outcomes in Collision Athletes

	ABR	OL	p-value
N	55	55	
RTP	49 (89.1%)	52 (94.5%)	0.4890
RTP S/H	46 (83.6%)	44 (80%)	0.8053
RTP Timing (mo.)	5.8 ± 2.2	5.5 ± 2.7	0.5243
SIRSI	70.4 ± 24.8	73.8 ± 19.6	0.4268
SIRSI Pass (%)	44 (80%)	44 (80%)	1.0
Total Recurrence	8 (14.5%)	1 (1.8%)	0.0316
Redislocation	7 (12.7%)	1 (1.8%)	0.0604

ABR; arthroscopic Bankart repair, OL; open Latarjet, N; number, RTP; return to play, S/H; same/higher level, mo; months, SIRSI; Shoulder Instability-Return to Sport after Injury

Analysis of Patients Unable to Return to Play Following Arthroscopic Bankart Repair and the Open Latarjet Procedure

METHODS

Patient Selection

A retrospective review was carried out to identify all patients who underwent arthroscopic Bankart repair or open Latarjet procedure by a single surgeon was conducted. The operative notes of all patients were analysed with further analysis of those playing sports pre-operatively. Subsequently patient matching between who did and did not RTP based on patient demographics (age, gender, sport, level of pre-operative play, and follow-up length) was performed to generate two comparable groups. As the majority of athletes undergoing successfully returned to play, these were matched 3:1 for arthroscopic Bankart repair and 2:1 for open Latarjet procedure, with those who did not RTP.

Clinical Outcomes

Evaluation of post-operative patient reported outcomes was carried out following telephone survey including; RTP, and SIRSI score were evaluated. Additionally, VAS score, SSV, satisfaction, and whether they would undergo the same surgery again were compared. A SIRSI score > 56 was considered a passing score for being psychologically ready to RTP.[209]

Statistical Analysis

All statistical analysis was performed utilizing GraphPad Prism 8.4.2 (GraphPad, La Jolla, CA). For all continuous and categorical variables, descriptive statistics were calculated. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages. Multi-logistic regression models were used to evaluate factors affecting RTP. Factors in the model included individual components of the SIRSI, VAS and SSV. A value of $p < 0.05$ was considered to be statistically significant.

RESULTS

Analysis of Patients Unable to Return to Play Following Arthroscopic Bankart Repair

The study included a total of 52 patients who were unable to RTP and 156 who did RTP.

Comparison of Outcomes (Table 20)

In those who did not RTP, 19.2% passed the SIRSI benchmark of 56 with a mean overall score of 39.8 ± 24.6, which were significantly lower than those who did RTP as 73.1% passed the SIRSI benchmark of 56 with a mean overall score of 68.9 ± 22.0 ($p < 0.0001$ for both). Additionally, there was a significant difference between the two groups in every component of the SIRSI score. Furthermore, there was a higher SSV score in those who did RTP (88.5 ± 11.6 vs 72.4 ± 26.2, $p < 0.0001$), and they were more likely to be satisfied (91.7% vs 66.1%, $p = 0.0006$), and willing to undergo surgery again if required (92.3% vs 60.7%, $p < 0.0001$). However, there was no significant difference in the VAS score (2 ± 2.1 vs 2.4 ± 2, $p = 0.23$). The clinical outcomes are further illustrated in Table 2.

Table 20. Clinical Outcomes

	DNR	RTP	p-value
SIRSI	39.8 ±24.6	68.9 ± 22.0	< 0.0001
SIRSI Passed	10 (19.2%)	144 (73.1%)	< 0.0001
VAS	2.4 ± 2	2 ± 2.1	0.23
SSV	72.4 ± 26.2	88.5 ± 11.6	< 0.0001
Satisfied	37 (66.1%)	143 (91.7%)	0.0006
Surgery Again?	34 (60.7%)	144 (92.3%)	< 0.0001

DNR; did not return, RTP; returned to play, SIRSI; Shoulder Instability-Return to Sport after Injury, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value,

Logistic Regression Analysis of Factors Affecting Rate of Return to Play (Table 21 & 22)

A simple logistic regression was revealed that SIRSI, and SSV were significantly associated ($p < .05$) and SSV and SIRSI positively correlated with RTP, whereas there was no correlation with VAS. Multi-linear regression revealed that among the SIRSI questions that 4 of the 12 components the SIRSI score were the factors that were associated with RTP. The logistic regressions are further illustrated in Table 3 and 4.

Table 21. Multi-Linear Regression Analysis of Factors Affecting Rate of Return to Play

	|Z|	p-value	Sig
Are you confident that you can perform at your previous level of sport participation?	3.362	0.0008	***
Do you think you are likely to re-injure you shoulder playing sport?	1.926	0.0541	ns
Are you nervous about playing your sport?	1.976	0.0481	*
Are you confident that your shoulder will remain stable when playing your sport?	1.279	0.2009	ns
Are you confident that you could play sports without concern for your shoulder?	1.764	0.0778	ns
Do you find it frustrating having to consider your shoulder when playing your sport?	0.09773	0.9221	ns
Are you fearful of re-injuring your shoulder when playing your sport?	1.12	0.2625	ns
Are you confident of your shoulder holding up under pressure?	0.07893	0.9371	ns
Are you afraid of accidentally re-injuring your shoulder when playing your sport?	2.417	0.0157	*
Do thoughts of having to go through surgery and rehabilitation again prevent you from playing your sport?	2.034	0.042	*
Are you confident about your ability to perform well at your sport?	1.181	0.2375	ns
Do you feel relaxed about playing your sport?	0.1664	0.8678	ns

Table 22. Simple-Logistical Regression Analysis of SIRSI, SSV, and VAS Affecting Return to Play

	|Z|	p-value	Significance
VAS	1.165	0.2442	ns
SSV	4.694	<0.0001	****
SIRSI	5.943	<0.0001	****

VAS; visual analogue scale, SSV; simple shoulder value, SIRSI; Shoulder Instability-Return to Sport after Injury

Reasons for Not Returning to Play

The most common primary reasons for not returning were 21 felt physically unable to return with persistent apprehension (51.9%), 13 felt it was a natural end to their career (25.0%), 8 noted their lifestyle had changed (15.4%), 6 felt physically unable to return with persistent pain (11.5%), and 4 did not return due to other injuries (7.7%).

Analysis of Patients Unable to Return to Play Following the Open Latarjet Procedure

The study included a total of 35 patients who were unable to RTP and 70 who did RTP.

Comparison of Outcomes (Table 23)

In those who did not RTP, 20% passed the SIRSI benchmark of 56 with a mean overall score of 41.5 ± 21.9, which were significantly lower than those who did RTP as 81.4% passed the SIRSI benchmark of 56 with a mean overall score of 74.5 ± 19.8 ($p < 0.0001$ for both). Additionally, there was a significant difference between the two groups in every component of the SIRSI score. Furthermore, there was a higher SSV score in those who did RTP (88.0 vs 75.7, $p = 0.0001$), a lower VAS score (1.7 vs 2.8, $p = 0.0046$) and they were more likely to be satisfied (91.7% vs 66.1%, $p = 0.0002$), and willing to undergo surgery again if required (92.3% vs 60.7%, $p = 0.0003$).

Table 23. Clinical Outcomes

	DNR	RTP	p-value
SIRSI	41.5 ± 21.9	74.5 ± 19.8	p < 0.0001
SIRSI Passed	7 (20%)	57 (81.4%)	p < 0.0001
VAS	2.9 ± 2.5	1.7 ± 1.7	0.0046
SSV	75.7 ± 16.9	88.0 ± 11.1	p < 0.0001
Satisfied	25 (71.4%)	68 (97.1%)	0.0002
Surgery Again?	24 (68.6%)	67 (95.7%)	0.0003

DNR; did not return, RTP; returned to play, SIRSI; Shoulder Instability-Return to Sport after Injury, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value

Logistic Regression Analysis of Factors Affecting Rate of Return to Play (Table 24 & 25)

A simple logistic regression was revealed that VAS, SIRSI, and SSV were all significantly associated ($p < .05$) with VAS negatively correlated and SSV and SIRSI positively correlated with RTP. Multi-logistic regression revealed that among the SIRSI questions "thoughts of having to go through surgery and rehabilitation again" was the only one associated with lower RTP ($p < 0.05$). The logistic regressions are further illustrated in Table 3 and 4.

Table 24. Simple-Logistical Regression Analysis of SIRSI, SSV, and VAS Affecting Return to Play

	|Z|	p-value	Sig
VAS	2.703	0.0069	**
SSV	3.746	0.0002	****
SIRSI	4.846	<0.0001	****

SIRSI; Shoulder Instability-Return to Sport after Injury, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value

Table 25. Multi-Logistical Regression Analysis of Factors Affecting Rate of Return to Play

	|Z|	p-value	Sig
Are you confident that you can perform at your previous level of sport participation?	0.7773	0.437	ns
Do you think you are likely to re-injure you shoulder playing sport?	1.083	0.279	ns
Are you nervous about playing your sport?	1.921	0.0548	ns
Are you confident that your shoulder will remain stable when playing your sport?	0.06402	0.949	ns
Are you confident that you could play sports without concern for your shoulder?	0.6983	0.485	ns
Do you find it frustrating having to consider your shoulder when playing your sport?	1.617	0.1058	ns
Are you fearful of re-injuring your shoulder when playing your sport?	0.9581	0.338	ns
Are you confident of your shoulder holding up under pressure?	0.005832	0.9953	ns
Are you afraid of accidentally re-injuring your shoulder when playing your sport?	1.282	0.1998	ns
Do thoughts of having to go through surgery and rehabilitation again prevent you from playing your sport?	2.374	0.0176	*
Are you confident about your ability to perform well at your sport?	0.2706	0.7867	ns
Do you feel relaxed about playing your sport?	1.369	0.171	ns

Reasons for Not Returning to Play

The most common primary reasons for not returning were 12 patients felt physically unable to return with persistent pain (51.4%), 11 felt it was a natural end to their career (31.4%), 6 patients felt physically unable to return with persistent apprehension (17.1%), while 6 patients noted their lifestyle had changed/or other factors in their life prevented them returning to play (17.1%).

DISCUSSION

Overall, there a moderate rate of RTP in non-operatively-treated athletes with a primary anterior shoulder dislocation. Although these findings support other literature that reports successful return to sport with non-operative management, they also highlight a concerning rate of inability to return pre-injury level of play. Conversely, there exists level I evidence demonstrating that arthroscopic Bankart repair significantly reduces the rate of recurrent instability and increases the rate of RTP in patients with primary shoulder instability.[38, 42, 44, 46, 210] A randomized controlled trial by Robinson et al.[44] showed that there was a significantly higher rate of RTP with arthroscopic Bankart repair as compared to non-operative management (87.5% vs. 57.6%, respectively). Additionally, Warth et al.[147] found that the ability to RTP is the single most important driving factor in a patient's decision to have their shoulder stabilized, more so than the risk of recurrent instability with non-surgical treatment. Given these findings, the ability to return to sport must be discussed with every athlete who sustains a primary instability event in order to be able to provide appropriate treatment recommendations.

In comparison to other systematic reviews assessing the rate of RTP after surgical stabilization, our study found an inferior rate of RTP in athletes who had non-operative treatment. In a systematic review that included 1,923 shoulders treated with arthroscopic Bankart repair for primary anterior instability, Memon et al.[24] reported RTP rates as high as 82%, with 72% of patients able to return to their preinjury level of play. Additionally, in our systematic review on the open Latarjet procedure the rate of RTP was 88.8% with arthroscopic Bankart repair and 72.6% following the open Latarjet procedure. These numbers are notably better than the 76.5% overall rate of RTP and 54.7% rate of recurrence reported in the current study following non-operative treatment, suggesting superiority in these outcomes with surgical intervention.

Initial non-operative management with delayed surgical treatment in the off-season may be an appropriate treatment plan for athletes who wish to RTP during the same season. However, Larrain et al.[43] found that the mean time to RTP did not differ significantly between patients treated non-operatively and those treated operatively (4.5 vs. 5.3 months, respectively). Additionally, their rehabilitation protocol prevented patients in both groups from returning to play for at least four months after initiation of therapy. However, many athletes are able to return quicker than this. Lu et al.[211] found that NBA players returned at a mean of 1.5 months after their initial dislocation when treated non-operatively. Similarly, Madea et al.[203] found a mean time of RTP of 1.7 months in amateur rugby players, but 81% of these experienced a recurrent instability event. Given these findings, the notion that non-operative management of primary anterior shoulder instability allows athletes to safely RTP more rapidly than those treated with surgery should be questioned.

The criteria for RTP following treatment of anterior shoulder instability is poorly defined in the literature. These findings highlight the need for developing validated RTP criteria to guide treatment. Overall, the most commonly-used criteria in the literature for allowing safe RTP after shoulder stabilization is time from surgery.[204, 212] In our study, we found that a higher proportion of surgeons allowed patients to RTP at 3 months following the Latarjet procedure, which may be due to surgeons' perception that the time to bony-union may be faster than soft tissue healing. However, our clinical studies established that ultimately there is no difference in RTP timing between those who undergo arthroscopic Bankart repair and the open Latarjet procedure. Furthermore, there is concern with utilizing this approach, as Frantz et al.[213] showed that nearly half of patients evaluated at 6-months after the Latarjet procedure were found to have residual strength deficits and to have failed 1 or more RTP testing parameters. Aside from time to RTP, pain, strength, range of motion, stability, proprioception, and radiographic imaging were noted in both studies. Deficits in any of these criteria may predispose patients to a higher risk of recurrent instability upon RTP. Thus, early identification of such deficits may allow for the development of a focused rehabilitation plan that targets these deficiencies. While this has been identified as a priority in the ACLR literature, future research is required to assess this following shoulder stabilization surgery.

Overall, the functional outcomes reported in our study of athletes undergoing arthroscopic Bankart repair at 5-years were excellent, with the vast majority of patients satisfied or very satisfied with their surgery and would undergo the same procedure again if needed. Additionally, the VAS score was shown to factor into patient's perception of a normal shoulder. Furthermore, there was a high reported rate of RTP in this cohort, although, there was a concerningly low rate of RTP at pre-injury levels. Due to the high proportion of patients returning to play, it made for an almost linear dependent variable and it was not possible to evaluate this. Therefore, we were only able to analyze RTP at their pre-injury level, which was not found to correlate with satisfaction. However, the initial timing of RTP was found to be important in satisfaction at 5-years post-operatively, indicating that this is an important factor for athletes undergoing arthroscopic Bankart repair. The SIRSI score was shown to be a significant factor for both satisfaction and shoulder function, which is a measure of a patient's psychological readiness to RTP and participate in sports.[209] Thus, patient psychological confidence in their shoulder is an important outcome to assess in athletes.

There was a moderate rate of recurrent instability in our cohort, with the majority being further dislocations. There was a continual decline in the shoulder stability over time as shown in the survival analysis. Similarly, Zimmermann et al.[25] found in their long-term analysis that this continued at up to 15-years following arthroscopic Bankart repair, and in contrast found with the Latarjet procedure that half of all recurrences occurred within the first year. Thus, there is a concern following arthroscopic Bankart repair that recurrence may continue, with a systematic review by Murphy et al.[214] showing that with a minimum of 10-year follow-up there is a 31% recurrence rate and 16% suffering a further re-dislocation. Additionally, several patients required a further shoulder procedure. Both recurrent instability and revision procedures were associated with a low satisfaction, but not SSV. This is an interesting finding to note that while it did not impact patient function, it did impact how satisfied they are with the procedure, and also highlights the difference between satisfaction and function.

Overall, we established that there was no difference in any RTP metric between those undergoing arthroscopic Bankart repair and the open Latarjet procedure, including rate, timing and psychological readiness. Our study evaluated athletes for their psychological readiness to return to sport using the SIRSI score. There was no significant difference between those treated with either procedure for overall score or pass rate. This indicates that both procedures are equally efficacious in restoring patient confidence in their shoulder following operative management. The SIRSI is based on adaptation of the anterior cruciate ligament (ACL) RSI score, where several studies demonstrating a higher score in those who are able to successfully RTP.[215-218] There was a high rate of RTP among collision athletes. Studies have evaluated the outcomes of the open Latarjet procedure in collision athletes and found high rates of RTP with low recurrence rates.[212] However, while studies have shown a high rate of return with arthroscopic Bankart repair in collision athletes, there is a concern over the high rate of recurrent instability in this cohort,.[24, 135] Nonetheless, with both procedures we found a low recurrence rate in collision athletes, which highlights the importance of appropriate patient selection and counselling. Our study found similarly high rates of RTP, with a similar time to

RTP, and similar SIRSI scores with either procedure in this population, indicating both may be effective in allowing collision athletes to RTP.

The patients who do not RTP exhibited poor psychological readiness to RTP, with multi-linear regression revealing the SIRSI questions associated with fear of re-injury were associated with a lower rate of RTP. Furthermore, patients who did not RTP had significantly lower satisfaction rates than those who did RTP, and were also significantly less likely to be willing to undergo surgery again if it was required. The SIRSI score was shown to be significantly higher in those who did RTP, with the majority passing the SIRSI benchmark of 56 to RTP, and in contrast the vast majority of those who did not RTP did not pass the SIRSI benchmark. The findings of this study follow Pareto Distribution, more commonly known as the 80/20 rule.[219] When applying this rule to the athletes of this study, 80% of those who RTP pass the benchmark, however the converse is also true in that 80% of those who did not RTP did not pass the benchmark. Additionally, we identified several parameters of the SIRSI score which multi-linear regression were associated with RTP. The majority of these were associated with fear of re-injury/risk of further surgery, alongside one of the parameters assessing confidence in ability to perform.

Tjong et al[205]. identified fear of reinjury, shifts in priority, mood, social support, and self-motivation can have effects on patients desire to RTP in their study on 25 patients following arthroscopic Bankart repair. However, to our knowledge, there has not been a similar study evaluating patients following the open Latarjet procedure that did not RTP. Our study determined that of those who did not RTP approximately half reported shoulder issues as their primary reason for not returning, with lifestyle factors also being reported. However, of the lifestyle factors listed, nearly many it was a natural end to their career and retired from sport, which itself may be influenced by pain and a lack of confidence in their shoulder.

Satisfaction was shown to be significantly lower in patients who were unable to RTP, with a lower rate of willingness to undergo this procedure again in this group. Therefore, surgeons must be aware of the importance of successful RTP in athletes undergoing shoulder stabilization. Despite the findings of this study, further research is still required on patients who did not RTP. Furthermore, the implementation and subsequent assessment of interventions such as post-operative counselling and its effect on reported patient confidence in their shoulder, as well as subsequent ability to RTP, remains an area requiring further study.

Limitations

This study has several limitation. First, given the study design as a systematic review, it was subject to the same limitations as the literature that was included for analysis. We included a number of level IV studies, and these likely contained elements of selection bias. Second, due to the heterogeneity in reporting of data between studies, we were unable to analyse multiple factors, such as demographic information and patient reported outcomes scores, as potential risk factors for preventing RTP. While we surveyed across a few different subspecialty organizations, the response rate was low despite several emails. Additionally, this represents an aggregate of expert opinions, rather than outcomes-based reporting. Additionally, this study includes a matched control group. Although every effort has been made for this control group to match and reflect the experimental group, discrepancies will inherently exist. While all patients were matched for gender, sport and level of sport pre-operatively, there was a slight, albeit non-statistically significant, difference in age, but this was also matched as closely as possible. Furthermore, those undergoing arthroscopic Bankart repair and the open

Latarjet procedure had discrepancies in terms of glenoid bone-loss. However, there still was a significantly lower recurrence rates in those undergoing the open Latarjet procedure.

Conclusions

- The current study demonstrates that non-operative management of athletes with primary anterior shoulder dislocation results in a low rate of success. While the majority of athletes are able to RTP, there is a low rate of return to their pre-injury level of play, and there is a high rate of recurrent instability.
- The overall rate of RTP was reportedly high following the Latarjet procedure in the literature. However, almost a fifth of athletes returning were not able to return to sports at the same level. Further development of validated criteria for safe return to sports could potentially improve clinical outcomes and reduce recurrence rates.
- Despite the absence of evidence-based guidelines on when athletes can safely RTP following shoulder stabilization surgery, there exists minimal variability in recommendations between North American and European shoulder surgeons. Further research is required to better define criteria for RTP after the arthroscopic Bankart repair and Latarjet procedures.
- There was a high rate of satisfaction at 5-year follow-up, with excellent patient reported outcomes and a high rate of RTP among athletes. However, there was a moderate rate of recurrent instability and further revision surgery. Our study identified that the SIRSI, VAS score, sleep trouble and ability to RTP at the same level were associated with both satisfaction and SSV score.
- Both arthroscopic Bankart repair and open Latarjet procedure result in excellent clinical outcomes, with high rates of RTP in athletes and no differences between the two procedures in RTP metrics. However, the OL results in lower recurrence rates in those

with greater risk factors for recurrence.

- Following arthroscopic Bankart repair, those that do not RTP exhibit poor psychological readiness to RTP, with multi-linear regression revealing the SIRSI questions associated with fear of re-injury were associated with a lower rate of RTP. Additionally, functional limitations were found to be associated with a lower rate of RTP.
- Following the open Latarjet procedure, those that do not RTP exhibit poor psychological readiness to RTP. Additionally, patients who did not RTP reported higher pain scores, and lower SSV.

Chapter 4: Clinical Outcomes Following Anterior Shoulder Instability Surgery

INTRODUCTION

Anterior shoulder instability is a common pathology in young athletic populations, often leading to pain and dysfunction.[220-222] The arthroscopic Bankart repair is the most commonly performed surgical procedure for anterior shoulder instability on a global basis, with the majority of surgeons favouring it as an initial surgical treatment.[223] Several systematic reviews and meta-analyses have shown using suture-anchors and modern arthroscopic techniques results in similar outcomes to an open Bankart repair.[224, 225] The Latarjet procedure is indicated in patients with anterior shoulder instability who have a high-risk of failure of arthroscopic Bankart repair, including multiple previous dislocations, an engaging Hill-Sachs lesion, and glenoid bone-loss.[226] However, despite the early success with both procedures the long-term outcomes are uncertain, as well as the progression of instability arthropathy.

While the risk factors for recurrence following arthroscopic Bankart repair have been well studied, the impact of concomitant pathologies has received less attention. Glenolabral articular disruption (GLAD) lesions are a less commonly reported concomitant injury in the setting of anterior shoulder instability, which may increase the risk of postoperative failure following arthroscopic Bankart repair. Currently, there remains a dearth of literature describing clinical outcomes following ABR in patients who have a GLAD lesion[227]. Pogorzelski et al. reported in a cohort of 7 patients that patients with concomitant Bankart and GLAD lesions who undergo ABR lesion have higher rates of failure[228]. Additionally, superior labral anterior-posterior (SLAP) tears can occur alongside Bankart lesions in anterior shoulder instability, and classified as Type V SLAP Tears.[229] Currently the literature suggests that SLAP lesions may occur in 22-43% of patients suffering with anterior shoulder instability.[229] SLAP lesions are most commonly associated with overhead throwing activities, and overall, poor rates of return to play (RTP) are noted after isolated SLAP repair.[230, 231] Furthermore, there is scant literature on those with rare pathologies such as pan-labral tears, as well as female patients with the majority of patients in the literature being male.[232, 233] Additionally, despite it becoming increasingly utilized in our institution for those with bicipital pathology, there is no reported outcomes of those with arthroscopic Bankart repair and biceps tenodesis. Finally, it is unclear how recurrent instability and failed prior surgery impacts the outcomes of surgery.

In those who have a failed Latarjet procedure distal tibial allograft because it provides an adequate bone stock with similar curvature to the glenoid bone, which can address coracoid graft resorption or other complications related to failed Latarjet procedure. It also provides a cartilaginous surface for smooth articulation. Distal tibial allograft has preliminarily been shown to provide good clinical outcomes and low rates of recurring shoulder instability as a revision surgery for a failed Latarjet, however the literature is sparce, comprised of a few small case series.[234, 235]

Historically, the Latarjet procedure has been performed via an open approach, but an arthroscopic technique described by Lafosse et al. has recently gained popularity due to its minimally invasive approach and improved intra-articular visualization. These factors potentially allow for more accurate graft placement, less postoperative stiffness, fewer wound complications, and a quicker rehabilitation.[29, 236] Arthroscopic Bankart repair with Remplissage is an alternative option to the Latarjet procedure for patients with anterior shoulder instability and an engaging Hill-Sachs lesion.[31-33] Originally described by Wolf[30] et al., arthroscopic Bankart repair with Remplissage involves tenodesing the infraspinatus tendon and posterior capsule into the humeral defect, thus rendering it extra-articular and preventing engagement.

The purpose of this chapter was to evaluate the clinical outcomes following anterior shoulder stabilization surgery. This included evaluate the evidence in the literature following the arthroscopic Bankart repair and the open Latarjet procedure at a minimum of 10-years follow-up. Additionally, we sought to evaluate the impact of concomitant pathologies on the outcomes of arthroscopic Bankart repair, and to evaluate the outcomes in rare populations (those with pan-labral tears, concomitant biceps tenodesis, and female patients). Furthermore, we sought to evaluate the impact of recurrent instability on outcomes following arthroscopic Bankart repair, and to evaluate the impact of recurrent instability or failed prior surgery on those undergoing the open Latarjet procedure. Additionally, we evaluated the outcomes of distal tibial allograft for a failed Latarjet procedure. Finally, we evaluated the arthroscopic Latarjet procedure and compared to the open Latarjet procedure, as well as compared to the arthroscopic Bankart repair with Remplissage in those with Hill-Sachs lesions.

Long-Term Outcomes of Arthroscopic Bankart Repair & The Open Latarjet Procedure – A Systematic Review

METHODS

Study Selection

Two independent reviewers performed the literature search based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and reviewed the search results, with a senior author arbitrating on any disagreement, using specific terms for each study question in MEDLINE, EMBASE, and The Cochrane Library.[34] The title and abstract were reviewed for all search results and potentially eligible studies received a full-text review. Finally, the reference lists of the included studies and literature reviews found in the initial search were manually screened for additional articles meeting the inclusion criteria.

Eligibility Criteria

The inclusion criteria were (1) clinical study on arthroscopic Bankart repair or open Latarjet procedure, (2) 10-year follow-up, (3) full-text published in a peer-reviewed journal, and (4) published in English. The exclusion criteria included (1) open Bankart repair, (2) review studies, (3) biomechanical studies, (4) cadaver studies, and (5) abstract only.

Data Extraction/Analysis

The relevant information regarding the study characteristics were collected by two blinded reviewers using predetermined data sheet, with the results analysed and compared by a third independent reviewer. The study characteristics include the study design, the level of evidence (LOE), population, clinical outcome measures, and the follow-up time points.

Statistics

Using SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Macintosh, Version 22.0. Armonk, NY: IBM Corp.), a quantitative statistical analysis was performed for pooled analysis.

RESULTS

Long-Term Outcomes of Arthroscopic Bankart Repair

Study Characteristics/Patient Demographics

There were 9 studies (LOE III; 2, LOE IV; 7) with 810 patients and 822 shoulders.

Functional Outcomes & Return to Play (Table 1)

The overall rate of return to play was reported in 4 studies, with 219 patients. The overall rate of return to play was 77.6%. The commonly utilized functional outcome score was the Rowe score with a weighted mean average of 87.0 (n = 281) at final follow-up. Overall, 85.6% (220/257) were satisfied with the procedure.

Table 1. Functional Outcomes & Return to Play

Outcome	Studies	N (%)
Total RTP	4	77.6% (170/219)
Rowe	5	87 (281)
Constant Score	3	76.2 (275)
Satisfaction	3	85.6% (220/257)

N; number, RTP; return to play

Recurrent Instability & Revisions (Table 2)

The overall rate of recurrent instability was reported in 6 studies with 547 shoulders, there were 171 recurrent instability events (31.2%). Seven studies reported the rate of recurrent dislocation as 16.0% (102/637), and 4 studies reported the rate of recurrent subluxations as 17.1% (62/362). The rate of persistent apprehension was reported in 4 studies, with 26.0% (102/392) having persistent apprehension. The overall revision rate was reported in 6 studies, with 599 shoulders. Overall, there were 102 revisions (17.0%). In the included studies, no patient underwent revision surgery for a reason other than recurrent instability.

Table 2. Recurrent Instability & Revisions

Outcome	Studies	N (%)
Revisions due to Recurrence	6	17.0% (102/599)
Total Recurrence	6	31.2% (171/547)
Redislocations	7	16.0% (102/637)
Subluxations	4	17.1% (62/362)
Apprehension	4	26.0% (102/392)

N; number

Instability Arthropathy (Table 3)

The overall rate of instability arthropathy at final follow-up was reported in 5 studies, with 281 shoulders. The rate of overall instability arthropathy was 59.4% (167/281). At final follow-up there were grade I arthritic changes in 35.4% (64/181), grade II changes in 8.8% (64/181), and grade III changes in 1.7% (3/181). No patient in the included studies underwent shoulder arthroplasty due to instability arthropathy during the reported follow-up.

Table 3. Instability Arthropathy

Outcome	Studies	N (%)
	Grade at Final Follow-up	
Any Grade	5	59.4% (267/281)
Grade I	4	35.4% (64/181)
Grade II	4	8.8% (16/181)
Grade III	4	1.7% (3/181)

N; number

Long-Term Outcomes of The Open Latarjet Procedure

Study Characteristics/Patient Demographics

There were 12 studies (LOE IV; 12) with 822 patients and 845 shoulders.

Functional Outcomes & Return to Play (Table 4)

The overall rate of return to play was reported in eight studies. The overall rate of return to play was 84.9%, with 76.3% returning to the same level of play. The commonly utilized functional outcome score was the Rowe score with a weighted mean average of 88.5 (n = 353) at final follow-up. Overall, 86.0% (265/308) of patients having good-excellent outcomes, and 94.8% (383/404) were satisfied with the procedure.

Table 4. Functional Outcomes & Return to Play

Outcome	Studies	Result (N)
Total RTP	8	84.9% (529)
RTP Same/Higher Level	5	76.3% (299)
Rowe	6	88.5 (353)
Constant	2	83.2 (72)
Walch-Duplay	3	88.5 (224)
SSV	6	89.1 (319)
Good/Excellent Outcomes	5	86.0% (308)
Satisfaction	6	94.8% (404)

N; number, RTP; return to play, SSV; subjective shoulder value

Recurrent Instability (Table 5)

The overall recurrent instability rate was reported in all studies, with 845 shoulders. Overall, there were 72 recurrent instability events (8.5%). The rate of recurrent instability and recurrent subluxations was reported in 12 studies, with 728 shoulders. There were 23 shoulders with recurrent dislocations (3.2%), and 47 shoulders with recurrent subluxations (6.7%). The rate of persistent apprehension was reported in 6 studies, with 487 shoulders. There were 48 shoulders with persistent apprehension (9.9%).

Table 5. Recurrent Instability

Outcome	Studies	Percentage (N)
Total Recurrence	13	8.5% (72/845)
Redisclosations	12	3.2% (23/728)
Subluxations	12	6.7% (47/702)
Apprehension	6	9.9% (48/487)

N; number

Revisions (Table 6)

The overall revision rate was reported in 11 studies, with 714 shoulders. Overall, there were 26 revisions (3.7%), mostly due to recurrence, or removal of hardware. The revision rate due to recurrence was reported in 12 studies, with 728 shoulders. There were 12 revisions

(1.6%) due to recurrence. The most common reason for revision other than recurrence was screw removal in 7 patients (1.0%), and other reasons for revisions included infection washout, haematoma removal, arthroplasty, acromioplasty, superior-labral anterior-posterior repair, posterior stabilization, and hardware removal (all in 1 patient).

Table 4. Revisions

Outcome	Studies	Percentage (N)
Total Revisions	11	3.7% (26/714)
Revisions due to Recurrence	12	1.6% (12/728)

N; number

Instability Arthropathy (Table 7)

The overall rate of instability arthropathy at final follow-up was reported in 11 studies, with 541 shoulders. At final follow-up there were grade I arthritic changes in 26.5% (143/540), grade II changes in 6.1% (33/540), and grade III changes in 6.1% (30/520). Only one shoulder (0.12%) went on to have a shoulder arthroplasty in the included studies. Changes in arthropathy status from baseline was reported in 6 studies with 313 shoulders. Arthritic changes in those without preoperative arthritis was reported to be grade I changes in 16.7% (46/274), grade II changes in 3.6% (10/274), and grade III changes in 2.2% (6/274), with no arthritic changes were noted in 77.4% (212/274). Arthropathy in those with preoperative grade 1 was reported to be grade II arthropathy in 14.7% (5/34), and grade III arthropathy in 8.9% (3/34), with no arthritic changes were noted in 76.5% (26/34). Arthropathy in those with preoperative grade 2 was reported to progress to grade III arthropathy in 20% (1/5), while no arthritic changes were noted in 80% (4/5).

Table 7. Instability Arthropathy

Outcome	Studies	Percentage (N)
Arthroplasty	13	1/845 (0.12%)
Grade at Final Follow-up		
Grade 0	11	61.9% (334/540)
Grade I	11	26.5% (143/540)
Grade II	11	6.1% (33/540)
Grade III	11	5.6% (30/540)
Without Preoperative Arthropathy		
Grade 0	6	77.4% (212/274)
Grade I	6	16.7% (46/274)
Grade II	6	3.6% (10/274)
Grade III	6	2.2% (6/274)
With Preoperative Grade I Arthropathy		
Grade I	5	76.5% (26/34)
Grade II	5	14.7% (5/34)
Grade III	5	8.9% (3/34)
With Preoperative Grade II Arthropathy		
Grade II	2	20% (1/5)
Grade III	2	80% (4/5)

N; number

Residual Pain (Table 8)

Residual pain was reported in 8 studies, with 499 shoulders. Overall, residual pain was reported in 35.7% (178/499) of cases, including daily pain in 4.8% (24/499), and occasional pain in 30.9% (154/499). Only one study reported the Visual Analogue Scale (VAS) score in 37 shoulders, with a mean of 1.5 (0-5.5).

Table 8. Residual Pain

Outcome	Studies	Percentage (N)
Residual Pain	8	35.7% (178/499)
Daily Pain	8	4.8% (24/499)
Occasional Pain	8	30.9% (154/499)

N; number

Clinical Outcomes of Patients with Anterior Shoulder Instability & Concomitant Pathologies

METHODS

Patient Selection

A retrospective review was carried out to identify all patients who underwent arthroscopic Bankart repair by a single surgeon at the Sports Surgery Clinic. The operative notes of all patients who underwent arthroscopic Bankart repair were analyzed with further analysis of those who had a GLAD lesion or Type V SLAP tear identified on their operative diagnostic scope. Of those excluded on the basis of no reported GLAD lesion or Type V SLAP tear, subsequent patient matching for a control group based on patient demographics was performed retrospectively in order to generate a comparable control arm in a 2:1 ratio.

Clinical Outcomes

Evaluation of post-operative patient reported outcomes was carried out following telephone survey including; (1) VAS score, (2) Shoulder Instability Return to Sport after Injury (SIRSI), (3) Subjective Shoulder Value (SSV), (4) Rowe scores, (5) rates of RTP, and (6) level of RTP. Retrospective review of medical notes was carried out for outcomes including; (1) post-operative complications, and (2) further operations to ipsilateral shoulder.

Statistical Analysis

Statistical analysis was carried out using SPSS version 22 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). For all continuous and categorical variables, descriptive statistics were calculated. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages. Categorical variables were analysed using

Fisher's exact or chi-squared test. The independent or paired *t*-test for normally distributed variables, or the nonparametric Mann-Whitney U test or Wilcoxon signed-rank test was performed to compare continuous variables. A value of $p < 0.05$ was considered to be statistically significant.

RESULTS

Glenolabral Articular Disruption Lesions

Following analysis, 22 patients had GLAD lesions identified on their arthroscopic Bankart repair findings and were matched with 44 patients as a matched control group.

Patient Reported Outcomes (Table 9)

At final follow up, there was no significant difference between the GLAD and control groups in all of the clinical outcome measures utilized ($p > 0.05$ for all measures). Similarly, there was no significant difference between the groups in the rates of satisfied patients (81.8% vs 90.1%, p = 0.45) or the rate that would undergo surgery again (86.4% vs 90.1%, p = 0.68).

Table 9. Patient Reported Outcomes

	GLAD	Control Group	P-value
Pre-Op VAS Score	4.3 ± 1.6	3.5 ± 1.6	0.06
Post-Op VAS	1.7 ± 2.1	1.6 ± 1.6	0.83
Pre-Op Rowe Score	33.9 ± 15.6	40.2 ± 12.1	0.07
Post-Op Rowe Score	83.9 ± 21.9	88.2 ± 13.7	0.33
SIRSI Score	64.5 ± 30.4	72.1 ± 23.3	0.27
SSV Score	83.0 ± 20.6	91.0 ± 12.8	0.06
Satisfied	18 (81.8%)	40 (90.1%)	0.43
Dissatisfied	1 (4.5%)	1 (2.3%)	1.00
Neutral	3 (13.6%)	3 (6.8%)	0.43
Would Have Surgery Again	19 (86.4%)	40 (90.1%)	0.68
Would Not Have Surgery Again	2 (9.1%)	2 (4.5%)	0.60
Unsure	1 (4.5%)	2 (4.5%)	1.00

GLAD; Glenolabral Articular Disruption, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value, SIRSI; Shoulder Instability-Return to Sport after Injury

Return to Play (Table 10)

Overall, there was no significant difference between the mean time of RTP in the GLAD group and the control group (6.3 ± 6.6 months versus 6.4 ± 2.5; p = 0.98). Similarly, there was no significant difference in the total rate of RTP (90.1% vs 86.4%, p = 0.71), or return at the same/higher level (68.2% vs 72.7%, p = 0.78). Similarly, analysis of collision athletes revealed no difference in total rate of RTP (94.1% vs 88.2%, p = 0.65), or return at the same/higher level (70.6% vs 79.4%, p = 0.50).

Table 10. Return to Play

	GLAD	Control Group	P-value
Total	22	44	-
Time to RTP (months)	6.3 ± 6.6	6.4 ± 2.5	0.98
Total RTP	20 (90.1%)	39 (88.6%)	> 0.99
RTP Same/Higher Level	15 (68.2%)	32 (73.7%)	0.78
No RTP - Shoulder Issue	2 (9.1%)	3 (6.8%)	> 0.99
Collision Athletes RTP	16 (94.1%)	30 (88.2%)	0.65
Competitive Athletes RTP	16 (94.1%)	30 (88.2%)	0.65

GLAD; Glenolabral Articular Disruption; RTP; Return To Play

Complications (Table 11)

Overall, there was 1 patient in the GLAD group and 2 patients in the control group who suffered recurrent instability requiring further shoulder stabilization surgery; there was no significant difference in revision rates for instability (4.5% vs 4.5%, p > 0.99). There were 2 further surgeries to the ipsilateral shoulder in GLAD group (1 arthroscopic capsular release and 1 arthroscopic rotator cuff repair) and none in the control group; there was no significant difference between the groups. There were no other intra-operative or immediate postoperative complications in our series.

Table 11. Complications

	GLAD	Control Group	p-value
Intra-operative	0 (0%)	0 (0%)	-
Recurrent Instability	1 (4.5%)	2 (4.5%)	> 0.99
Revision Surgeries	1 (4.5%)	2 (4.5%)	> 0.99
Further Surgeries	3 (13.6%)	2 (4.5%)	0.32

GLAD; Glenolabral Articular Disruption

Type V SLAP Tears

Following analysis, 32 patients had Type V SLAP tears identified on their arthroscopic Bankart repair findings and were matched with 64 patients as a matched control group.

Return to Play (Table 12)

Overall, there was no significant difference in the total rate of RTP between the SLAP and control groups (81.3% vs 87.5%, p = 0.5406), however the control group reported significantly higher rates of RTP at the same/higher level (43.6% vs 67.2%, p = 0.0463). Additionally, analyses of the collision and competitive athletes revealed no difference in total rate of RTP (p > 0.05 for both), however there was a significantly higher rate of RTP at the same/higher level in competitive athletes in the ABR control group (55% vs 82.5%, p = 0.0323). There was no significant difference in mean time to RTP (6.0 ± 2.4 vs 6.0 ± 2.9, p > .99).

Table 12. Return to Play

	ABR	Type V SLAP Repair	p-value
Total	56 (87.5%)	26 (81.3%)	0.5406
Total RTP S/H	43 (67.2%)	14 (43.6%)	0.0463
Collision RTP	35 (92.1%)	15(78.9%)	0.2064
Collision RTP S/H	30 (78.9%)	11 (57.9%)	0.1231
Competitive RTP	37 (92.5%)	18 (90%)	> 0.99
Competitive RTP S/H	33 (82.5%)	11 (55%)	0.0323
Time to RTP (mo.)	6.0 ± 2.9	6.0 ± 2.4	> 0.99

ABR; arthroscopic Bankart repair, SLAP; superior labrum anterior-posterior, RTP; return to play, mo; month

Clinical Outcomes (Table 13)

At final follow-up, patients in the control group reported higher SIRSI scores when compared to the SLAP V group (57.8 ± 23.6 vs 66.3 ± 21.0, p = 0.0761). Despite this, there was no significant differences in any patient reported outcome measure utilized in this study (p > 0.05 for all). Additionally, there were no significant differences in the rate of patient satisfaction (71.8% vs 85.9%, p = 0.1059) or the rate that would undergo surgery again (75.0% vs 89.1%, p = 0.1332).

Table 13. Patient Reported Outcomes

Outcome	ABR	Type V SLAP Repair	p-value
Rowe Score	83.8 ± 15.7	80.8 ± 16.1	0.3837
SIRSI Score	66.3 ± 21.0	57.8 ± 23.6	0.0761
VAS Score	1.9 ± 1.9	2.3 ± 1.8	0.3251
SSV	85.3 ± 14.2	83.9 ± 16.6	0.6681
Satisfied	55 (85.9%)	23 (71.8%)	0.1059
Would have surgery again	57 (89.1%)	24 (75%)	0.1332

ABR; arthroscopic Bankart repair, SLAP; superior labrum anterior-posterior, SIRSI; Shoulder Instability-Return to Sport after Injury, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value

Complications (Table 14)

Overall, there was no significant differences in recurrent instability (18.8% vs 7.8%, p = 0.1717) between those who underwent Type V SLAP repair and the control group. There was a significant difference in the revision rates (15.6% vs 3.1%, p = 0.0392). Of the 5 patients in the Type V SLAP repair group who required surgical revision, 3 of these were for recurrent traumatic anterior instability (2 Latarjets, and 1 revision arthroscopic Bankart repair), while 1 patient needed arthroscopic release for stiffness and 1 patient was revised to a tenodesis for residual biceps symptoms. Of the 2 patients in the control group who required surgical revision, 1 was for recurrent instability (1 Latarjet procedure) and the other was an arthroscopic rotator cuff repair. There were no other intra-operative or immediate post-operative complications in our series.

Table 14. Complications

	ABR	Type V SLAP Repair	p-value
Intra-operative	0 (0%)	0 (0%)	_
Recurrent Instability	5 (7.8%)	6 (18.8%)	0.1717
Re-dislocation	4 (6.3%)	5 (15.6%)	0.1548
Subluxation	1 (1.6%)	1 (3.1%)	1.00
Revision Surgeries	2 (3.1%)	5 (15.6%)	0.0392

ABR; arthroscopic Bankart repair, SLAP; superior labrum anterior-posterior

Clinical Outcomes of Under-Reported Populations with Anterior Shoulder Instability

METHODS

Patient Selection

A retrospective review was carried out to identify all patients who underwent arthroscopic Bankart by a single surgeon at the Sports Surgery Clinic. The operative notes of all patients who underwent arthroscopic Bankart were analyzed with further analysis of those who had a pan-labral tear (minimum 270°), underwent a concomitant biceps tenodesis for a Type V SLAP tear, or were female.

Clinical Outcomes

Evaluation of post-operative patient reported outcomes was carried out following telephone survey including; (1) VAS score, (2) SIRSI score, (3) SSV, (4) Rowe scores, (5) rates of RTP, and (6) level of RTP. Retrospective review of medical notes was carried out for outcomes including; (1) post-operative complications, and (2) further operations to ipsilateral shoulder.

Statistical Analysis

Statistical analysis was carried out using SPSS version 22 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). For all continuous and categorical variables, descriptive statistics were calculated. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages. Categorical variables were analysed using Fisher's exact or chi-squared test. The independent or paired *t*-test for normally distributed variables, or the nonparametric Mann-Whitney U test or Wilcoxon signed-rank test was performed to compare continuous variables. A value of $p < 0.05$ was considered to be statistically significant.

RESULTS

Pan-Labral Repairs

A total 25 patients were included with pan-labral tears.

Return to Play (Table 15)

At final follow up, 76.0% (19/25) returned to sport. The mean time of return to sport was 6.8 ± 2.6 months. Of these 25 patients, 15 (60.0%) returned to the same/higher level of sport, while four patients returned to a lower level of their respective sport. Only one of these four patients reported this was due to the shoulder injury, while the remaining three patients linked this to other life factors. Of the 19 collision athletes, 15 (78.9%) returned and of the 6 non-collision athletes, four (66.7%) returned. Of the 6 patients who did not return to sport, only one said that this was directly related to the shoulder injury, while the remaining five stated that it was because they decided to stop playing their sport due to a combination of their latest injury and external life factors.

Table 2. Return to Play

	N (%)
Overall	19/25 (76%)
Same/Higher Level	15/25 (60%)
Collision Athletes	15/19 (79%)
Non-Collision Athletes	4/6 (67%)
Returned 3-6 mo	9/19 (47%)
Returned 6-9 mo	7/19 (37%)
Returned 9-12 mo	0/19 (0%)
Returned >12 mo	3/19 (16%)

N; number, Mo; months

Patient Reported Outcomes (Table 16)

Overall, 80.0% (20/25) were satisfied/very satisfied. When asked if they would undergo surgery again, 20 (80.0%) would, 3 (12.0%) were unsure and 2 (8.0%) would not. The mean

Rowe score at final follow up was 80.6 (60-100). The mean SIRSI at follow up was 61.8 (25-99). The mean SSV was 86.4 (50 -100). The average VAS score was 2.2 (0-5)

Table 16. Patient Reported Outcomes

Outcome	Median Score(Interquartile Range)
Rowe Score	75 (70-95)
SIRSI Score	75.87 (43.5-86.67)
VAS Score	2 (0-3.5)
SSV	90 (75-100)
Satisfied/Very Satisfied	20/25 (80%)

SIRSI; Shoulder Instability-Return to Sport after Injury, SSV; subjective shoulder value, VAS; visual analogue scale

Complications

One patient (3.8%) reported recurrent subluxations, but no recurrent dislocation. No patients underwent further ipsilateral shoulder surgery. There were no other intra-operative or immediate post-operative complications documented in our series.

Arthroscopic Bankart Repair & Biceps Tenodesis

A total 14 patients were included with arthroscopic Bankart repair and biceps tenodesis.

Return to Play (Table 17)

At follow up, 13 (93%) of patients were able to RTP. Of these patients, 9 (64.3%) returned to the same/higher level of play. Of those who returned at a lower level, 3 (75%) were due to residual shoulder symptoms postoperatively (e.g., recurrent instability, recurring pain). and 1 (25%) was due to social/family factors. The mean time of RTP was 4.8 ± 1.2 months. Of the 8 collision athletes, 7 (86%) returned to sport and all returned at the same or higher level. All of these returned between three to six months. In the competitive/professional athlete group, all 8 (100%) athletes returned. Six (75%) returned at the same or higher level of play and 2 (25%) returned at a lower level. All of the 5 professional rugby players returned to play at the same level.

Table 17. Return to Play

	Overall	Collision	Competitive/ Professional
N	14	8	8
Total RTP	13 (93%)	7 (87.5%)	8 (100%)
Same/Higher Level	9 (64.3%)	7 (87.5%)	6 (75%)
Lower Level	4 (31%)	0 (0%)	2 (25%)
Time to RTP (mo.)	4.8 (3-9)	4.5 (3-6)	4.9 (3-9)

N; number, RTP; return to play, mo; month

Patient Reported Outcomes (Table 18)

Of 14 patients, the mean Rowe score was 80 ± 16.3. The mean SIRSI score was 57.3 ± 25.6. The mean VAS score was 2.6 ± 1.5. The mean SSV was 80 ± 15.1.

Table 18. Patient Reported Outcomes

Outcome	Mean Score
Rowe Score	80 ± 16.3
SIRSI Score	57.3 ± 25.6
VAS Score	2.6 ± 1.5
SSV	80 ± 15.1

SIRSI; Shoulder Instability-Return to Sport after Injury, SSV; Subjective Shoulder Value, VAS; Visual Analogue Scale,

Complications

Overall, one patient (7%) suffered a redislocation, this was a competitive cricket player who redislocated 3 years later due to a collision with a bat. No other patient had either redislocation, subluxation or revision surgery. Additionally, no patients complained of popeye deformity.

Primary versus Recurrent versus Revision Surgery for Anterior Instability

METHODS

A retrospective review was carried out to identify all patients who underwent arthroscopic Bankart repair or open Latarjet procedure by a single surgeon at the Sports Surgery Clinic. Subsequently patient matching of those with primary (first time dislocation) and recurrent instability (i.e. ≥ 2 dislocations) groups based on patient demographics (age, gender, sport, level of pre-operative play, and follow-up length) was performed to generate two comparable groups in a ratio of 1:1 for those undergoing arthroscopic Bankart repair. Furthermore, patient matching in order to generate pair-matched groups between patients who underwent open Latarjet procedure for primary instability, recurrent instability or failed prior surgery was carried out in the ratio of 1:2:1 based on patient demographics (age, gender, sport, level of pre-operative play, and follow-up length).

Clinical Outcomes

Evaluation of post-operative patient reported outcomes was carried out following telephone survey including; Rate, level and timing of RTP, and SIRSI score were evaluated. Additionally, recurrence, VAS score, SSV, Rowe score, satisfaction, and whether they would undergo the same surgery again were compared.

Statistical Analysis

Statistical analysis was carried out using SPSS version 22 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). A power calculation was performed for rate of recurrent instability, with an alpha of 0.05 and a power of 0.8 revealing 200 patients were required for the study to be adequately powered. For all continuous and categorical variables, descriptive statistics were calculated. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages. Categorical variables were analysed using Fisher's exact or chi-squared test. The independent or paired *t*-test for normally distributed variables, or the nonparametric Mann-Whitney U test or Wilcoxon signed-rank test was performed to compare continuous variables. A value of $p < 0.05$ was considered to be statistically significant.

RESULTS

Arthroscopic Bankart Repair

Following analysis, 100 athletes treated with arthroscopic Bankart repair for primary instability were matched with 100 athletes treated with arthroscopic Bankart repair for recurrent instability

Return to Play (Table 19)

Overall, there was a significant difference between the mean time of RTP in the primary and recurrent instability groups (6.9 ± 2.9 months versus 5.9 ± 2.5; p = 0.0207). There was no significant difference in the total rate of RTP (80% vs 79%, p = 0.8607), or return at the same/higher level (65% vs 65%, p = 1.00). In those undergoing arthroscopic Bankart repair for primary instability; the reasons for not returning included shoulder injury in 11 (55%), lifestyle reasons in 6 (30%), and other injuries in 3 (15%). In those undergoing arthroscopic Bankart repair for recurrent instability; the reasons for not returning included shoulder injury in 10 (47.6%), lifestyle reasons in 9 (42.9%), and other injuries in 2 (9.5%).

Table 19. Return to Play

	Primary Instability	Recurrent Instability	p-value
RTP	80 (80%)	79 (79%)	0.8607
RTP S/H	65 (65%)	65 (65%)	1.00
RTP Timing (mo.)	6.9 ± 2.9	5.9 + 2.5	0.0207
SIRSI Score	64.9 ± 27.1	61.4 ± 27.2	0.3631

ABR; arthroscopic Bankart repair, RTP; return to play, S/H; same/higher level, mo; months, SIRSI; Shoulder Instability-Return to Sport after Injury

Patient Reported Outcomes (Table 20)

At final follow up, there was no difference between those that underwent arthroscopic Bankart repair for primary versus recurrent instability in reported SIRSI score (64.9 ± 27.1 vs 61.4 ± 27.2, p = 0.3631), VAS score (2.3 ± 2.3 vs 1.8 ± 1.9, p = 0.0953), SSV (84.9 ± 15.3 vs

83.6 ± 20, p = 0.0.6062), Rowe score (82.3 ± 19.6 vs 77.8 ± 20.5, p = 0.1142), satisfaction (86% vs 84%, p = 0.8433), or whether they would undergo surgery again (88% vs 82%, p = 0.3222).

Table 20. Patient Reported Outcomes

	Primary Instability	Recurrent Instability	p-value
SIRSI Score	64.9 ± 27.1	61.4 ± 27.2	0.3631
VAS Score	2.3 ± 2.3	1.8 ± 1.9	0.0953
SSV	84.9 ± 15.3	83.6 ± 20.5	0.6062
Rowe Score	82.3 ± 19.6	77.8 ± 13.1	0.1142
Satisfied	86 (86%)	84 (84%)	0.8433
Would Undergo Surgery Again	88 (88%)	82 (82%)	0.3222

ABR; arthroscopic Bankart repair, SIRSI; Shoulder Instability-Return to Sport after Injury, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value

Recurrent Instability (Table 21)

Overall, there was 10 patients in the primary instability group and 16 patient in the recurrent instability group who suffered recurrent instability post-arthroscopic Bankart repair (10% vs 16%, p = 0.2931); with no significant difference in rates of re-dislocation (6% vs 9%, p = 0.2931), subluxation (4% vs 7%, p = 0.5371) or apprehension (31% vs 34%, p = 0.7628). There were no other intra-operative or immediate postoperative complications in our series.

Table 21. Recurrent Instability

	Primary Instability	Recurrent Instability	p-value
Total Recurrence	10 (10%)	16 (16%)	0.2931
Redislocation	6 (6%)	9 (9%)	0.4204
Subluxation	4 (4%)	7 (7%)	0.5371
Apprehension	31 (31%)	34 (34%)	0.7628

<u>Open Latarjet Procedure</u>

Overall, 50 athletes treated with an open Latarjet procedure for primary instability were pair-matched with 100 athletes treated with the open Latarjet procedure for recurrent instability as well as 50 patients treated with the open Latarjet procedure for a failed prior procedure.

Return to Play (Table 22)

There were significant differences in the rate of overall RTP and RTP at same or higher levels between those who had an open Latarjet procedure for primary or recurrent instability and those who had OL for a failed prior surgery (88% vs 91% vs 64%; $p < 0.0001$, and 66% vs 78% vs 56%; $p = 0.0184$ respectively). There was no significant between those with primary or recurrent instability for overall rate of RTP or RTP at same or higher levels ($p = 0.5637$, and $p = 0.1143$ respectively). However, those who had an open Latarjet procedure for a failed prior surgery had a significantly lower rate of RTP overall than both those with primary or recurrent instability ($p < 0.0001$ for both) and a lower rate of RTP at same or higher levels than those with recurrent instability ($P = 0.0053$). Additionally, there was no significant difference in the time of RTP (6.4 ± 2.0 vs 6.5 ± 2.7 vs 5.9 ± 1.9, $p = 0.4730$). Furthermore, there was no difference in SIRSI score in those who had OL for primary instability, recurrent instability or following a failed prior surgery (70.2 ± 20.5 vs 72.6 ± 22.2 vs 64.8 ± 24.2, $p = 0.1718$).

Table 22. Return to Play

	Primary Instability	Recurrent Instability	Failed Prior Surgery	p-value
RTP	44 (88%)	91 (91%)	32 (64%)	<0.0001
RTP S/H	33 (66%)	78 (78%)	28 (56%)	0.0184
RTP Timing (mo.)	6.4 ± 2.0	6.5 ± 2.7	5.9 + 1.9	0.4730
SIRSI Score	70.2 ± 20.5	72.6 ± 22.2	64.8 ± 24.2	0.1718

DNR; did not return, OL; open Latarjet, RTP; return to play, S/H; same/higher level, mo; months

Patient Reported Outcomes (Table 23)

At final follow up, there was no significant difference in the reported VAS scores in those who had an open Latarjet procedure for primary instability, recurrent instability or following a failed prior surgery (2.0 ± 1.8 vs 1.9 ± 2.0 vs 2.7 ± 2.2, $p = 0.0640$). However, there was no significant difference in SSV (84.2 ± 13.4 vs 84.8 ± 16.4 vs 84.5 ± 17.4, p =

0.9760), Rowe score (88.1 ± 13.0 vs 90.2 ± 13.2 vs 85.7 ± 20.6, p = 0.2706), satisfaction (94% vs 95% vs 84%, p = 0.8974). However, there was a significant difference in whether they would undergo surgery again (94% vs 92% vs 76%, p = 0.0056).

Table 23. Patient Reported Outcomes

	Primary Instability	Recurrent Instability	Failed Prior Surgery	p-value
VAS Score	2 ± 1.8	2.0 ± 2.0	2.7 ± 2.2	0.0640
SSV	84.2 ± 13.4	84.8 ± 16.4	84.5 ± 17.4	0.9760
Rowe Score	88.1 ± 13	90.2 ± 13.2	85.7 ± 20.6	0.2706
Satisfied	47 (94%)	94 (95%)	42 (84%)	0.8974
Would Undergo Surgery Again	47 (94%)	92 (92%)	38 (76%)	0.0056

SIRSI; Shoulder Instability-Return to Sport after Injury, SSV; Subjective Shoulder value, VAS; Visual Analogue Scale

Recurrent Instability & Complications (Table 24)

Overall, there was 3 patients (6%) with primary instability, 5 patients (5%) with recurrent instability and 3 patients (6%) who underwent open Latarjet procedure following failed prior surgery, that suffered recurrent instability (p = 0.9530). In those with primary instability, 2 patients had a post-operative hematoma. In those with recurrent instability, 1 patient had an intra-operative graft fracture, 4 patients had a post-operative hematoma and 1 patient had a superficial wound infection. In those with a failed prior surgery, 2 patients had a post-operative hematoma and 1 patient had a superficial wound infection. There was no significant difference in complication rate (4% vs 6% vs 6%, p = 0.8656).

Table 24. Recurrent Instability

	Primary Instability	Recurrent Instability	Failed Prior Surgery	p-value
Total Recurrence	3 (6%)	5 (5%)	3 (6%)	0.9530
Redislocation	2 (4%)	3 (3%)	1 (2%)	0.8421
Subluxation	1 (2%)	2 (2%)	2 (4%)	0.7351
Apprehension	15 (30%)	22 (22%)	14 (28%)	0.5111

Distal Tibia Allograft for Shoulder Instability After Failed Latarjet

METHODS

Patient Selection

A retrospective review was carried out to identify all patients who underwent distal tibial allograft at NYU Langone Health. The operative notes of all patients who underwent distal tibial allograft after failed Latarjet for shoulder instability were analyzed.

Data Collection & Clinical Outcomes

Evaluation of post-operative patient reported outcomes was carried out following telephone survey including; VAS score, SSV, Western Ontario Stability Index (WOSI) score, satisfaction, and whether they would undergo the same surgery again. Additionally, the rate and timing of RTP, rate of return to work (RTW), and SIRSI score were evaluated. Finally, recurrent instability (including dislocations & subluxations) was recorded.

Statistical Analysis

All statistical analysis was performed utilizing GraphPad Prism 8.3 (GraphPad, La Jolla, CA). For all continuous and categorical variables, descriptive statistics were calculated. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages.

RESULTS

Patient Demographics

Overall, there were 9 patients treated with DTA for a failed Latarjet procedure.

Functional Outcomes (Table 25)

At final follow up, the mean WOSI score was 32%, the mean VAS score was 2.0 (3.0), the mean VAS during sports was 2.6 (3.0) the mean SSV score was 67.1 (26.1), and the mean SIRSI score was 59.5 (22.3). The mean satisfaction was 65.2% and 88.9% stated they would undergo surgery again.

Table 2. Functional Outcomes

	DTA
WOSI (%)	32.0% ± 23.0
WOSI Physical (%)	25.0% ± 22.5
WOSI Sport (%)	35.0% ± 22.0
WOSI Lifestyle (%)	35.0% ± 29.0
WOSI Emotional (%)	38.0% ± 28.0
VAS	2.0 ± 3.0
VAS Sport	2.7 ± 3.0
SSV	67.1 ± 26.1
SIRSI	59.5 ± 22.3
Satisfaction	65.2% ± 28.8
Would Undergo Surgery Again	8 (88.9%)

DTA; distal tibial allograft, WOSI; Western Ontario Shoulder Instability score, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value, SIRSI; Shoulder Instability-Return to Sport after Injury

Return to Play & Work (Table 26)

The mean rate of RTP was 50.0%, and the mean timing of RTP was 12 months. The mean rate of RTW is 77.8%.

Table 26. Return to Play/Work

	DTA
RTP	4 (50.0%)
RTP Timing (mo.)	12 ± 4.2
RTW	7 (77.8%)

DTA; distal tibial allograft, RTP; return to play, RTW; return to work, Mo; months

Recurrent Instability and Complications

There were no patient reported recurrent instability or complications.

Outcomes of the Arthroscopic Latarjet Procedure versus 1) the Open Latarjet Procedure, and 2) Arthroscopic Bankart Repair with Remplissage

METHODS

Patient Selection

A retrospective review was carried out to identify all patients who underwent arthroscopic Bankart repair with Remplissage or arthroscopic Latarjet procedure at NYU Langone Health. The results of those who underwent arthroscopic Latarjet procedure was compared against those who underwent open Latarjet procedure, and those who arthroscopic Bankart repair with Remplissage.

Data Collection & Clinical Outcomes

Evaluation of post-operative patient reported outcomes was carried out following telephone survey including; VAS score, SSV, WOSI score, satisfaction, and whether they would undergo the same surgery again. Additionally, the rate and timing of RTP, rate of RTW, and SIRSI score were evaluated. Finally, recurrent instability (including dislocations & subluxations) was recorded.

Statistical Analysis

All statistical analysis was performed utilizing GraphPad Prism 8.3 (GraphPad, La Jolla, CA). For all continuous and categorical variables, descriptive statistics were calculated. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages. Categorical variables were analysed using Fisher's exact or chi-squared test. The independent or paired *t*-test for normally distributed variables, or the nonparametric Mann-Whitney U test or Wilcoxon signed-rank test was performed to compare continuous variables. A value of $p < 0.05$ was considered to be statistically significant.

RESULTS

Arthroscopic versus Open Latarjet Procedure

Overall, there 72 patients treated with the open Latarjet procedure and 30 treated with the arthroscopic Latarjet included.

Functional Outcomes (Table 27)

At final follow up, there was no difference between those that underwent the open Latarjet procedure or arthroscopic Latarjet procedure in reported WOSI score (22.4% vs 27.1%, p = 0.43) or any of its components, VAS score (0.9 vs 1.3, p = 0.40), VAS during sports (1.8 vs 2.2, p = 0.51), SSV (84.9 vs 83.6, p = 0.6062), SIRSI score (65.5 vs 66.7, p = 0.85), satisfaction (81.6% vs 85.6%, p = 0.50), or whether they would undergo surgery again (82.6% vs 93.7%, p = 0.30).

Table 27. Functional Outcomes

	OL	AL	p-value
WOSI (%)	24.9% ± 26.9%	27.1% ± 25.7%	0.70
WOSI Physical (%)	22.6% ± 24.1%	26.5% ± 25.2%	0.46
WOSI Sport (%)	24.7% ± 28.8%	26.2% ± 27.6	0.81
WOSI Lifestyle (%)	23.5% ± 27.1%	21.8% ± 24.4	0.77
WOSI Emotional (%)	29.1% ± 29.1%	32.5% ± 32.2	0.60
VAS	1 ± 2.2	1.3 ± 2	0.52
VAS Sport	1.5 ± 2.2	2.2 ± 2.7	0.17
SSV	74.1 ± 24.2	75.7 ± 22.1	0.76
SIRSI	67 ± 24.1	66.7 ± 25.6	0.96
Satisfaction	88.3% ± 17%	85.6% ± 17.7%	0.47
Repeat Surgery	69/72 (95.8%)	28/30 (93.3%)	0.63

OL; Open Latarjet, AL; Arthroscopic Latarjet, WOSI; Western Ontario Shoulder Instability score, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value, SIRSI; Shoulder Instability-Return to Sport after Injury

Return to Play & Work (Table 28)

Overall, there was no significant difference in the total rate of RTP (65% vs 60.9%, p = 0.74), or timing of RTP (8.1 months vs 7 months, p = 0.35). Additionally, there was no significant difference in the total rate of RTW (93.5% vs 95.5%, p = 0.75).

Table 28. Return to Play/Work

	OL	AL	p-value
RTP	26/40 (65%)	14/23 (60.9%)	0.74
RTP Timing (mo.)	8.1 ± 3.7	7 ± 3	0.35
RTW	58/62 (93.5%)	21/22 (95.5%)	0.75

OL; Open Latarjet, AL; Arthroscopic Latarjet, RTP; return to play, RTW; return to work, Mo; months

Recurrent Instability (Table 29)

Overall, 5 patients in the open Latarjet procedure group and 2 patients in the arthroscopic Latarjet procedure group had recurrent instability events (6.9% vs 6.7%, p = 0.96), with no significant difference in the rate of recurrent dislocation between the groups (4.2% vs 3.3%, p = 0.84). Four patients in the open Latarjet procedure (5.6%) patient required a revision to distal tibial allograft for recurrent instability, and no patients required a revision in the arthroscopic Latarjet procedure group.

Table 29. Recurrent Instability

	OL	AL	p-value
Total Recurrence	5 (6.9%)	2 (6.7%)	0.96
Redislocations	3 (4.2%)	1 (3.3%)	0.84
Subluxation	2 (2.7%)	1 (3.3%)	0.88

OL; Open Latarjet, AL; Arthroscopic Latarjet

Arthroscopic Latarjet Procedure versus Arthroscopic Bankart Repair with Remplissage

Overall, there 41 patients treated with the arthroscopic Latarjet procedure and 26 treated with the arthroscopic Bankart repair with Remplissage included. There were no significant differences in demographic variables between the groups, except for the amount glenoid bone-loss and prior surgery, which were both higher in the AL group.

Functional Outcomes (Table 30)

At final follow up, there was no difference between those that underwent arthroscopic Bankart repair with Remplissage or arthroscopic Latarjet procedure in reported WOSI score (21.8% vs 28.2%, p = 0.33) or any of its components, VAS score (0.9 vs 1.4, p = 0.32), VAS during sports (1.7 vs 2.4, p = 0.29), SSV (78.4 vs 74,5, p = 0.32), SIRSI score (69.3 vs 62.8, p = 0.34), satisfaction (81.6% vs 85.6%, p = 0.54), or whether they would undergo surgery again (85.4% vs 96.1%, p = 0.16).

Table 30. Functional Outcomes

	ABRR	AL	p-value
WOSI (%)	21.8% +- 25.2	28.2% +- 27.1	0.3288
WOSI Physical (%)	22% +- 25	28.7% +- 26.3%	0.2987
WOSI Sport (%)	18.4% +- 23.1	25.9% +- 28.7	0.2432
WOSI Lifestyle (%)	17.1% +- 25.3	22.1% +- 25.9	0.4376
WOSI Emotional (%)	26.8% +- 29.3	32.6% +- 31.7	0.3553
VAS	0.9 +- 1.9	1.4+- 2.1	0.3174
VAS Sport	1.7 +- 2.5	2.4 +- 2.8	0.2904
SSV	78.4 +- 19.4	74.5 +- 23.2	0.4603
SIRSI	69.3 +- 24.7	62.8 +- 29.9	0.3373
Satisfaction	81.6% +- 30	85.6% +- 17.7	0.5411
Repeat Surgery	35 (85.4%)	25 (96.1%)	0.1595

ABRR; arthroscopic Bankart repair & Remplissage, AL; Arthroscopic Latarjet, WOSI; Western Ontario Shoulder Instability score, VAS; Visual Analogue Scale, SSV; Subjective Shoulder Value, SIRSI; Shoulder Instability-Return to Sport after Injury

Return to Play & Work (Table 31)

Overall, there was no significant difference in the total rate of RTP (60.9% vs 66.7%, p = 0.70), or timing of RTP (7.7 months vs 7 months, p = 0.17). Additionally, there was no significant difference in the total rate of RTW (100% vs 100%, p > 0.99).

Table 31. Return to Play/Work

	ABRR	AL	p-value
RTP	14/23 (60.9%)	12/18 (66.7%)	0.7021
RTP Timing (mo.)	9.1 +- 5.2	6.7 +- 2.8	0.1660
RTW	29/29 (100%)	17/17 (100%)	>.99

ABRR; arthroscopic Bankart repair & Remplissage, AL; Arthroscopic Latarjet, RTP; return to play, RTW; return to work, Mo; months

Recurrent Instability (Table 32)

Overall, 5 patients in the arthroscopic Bankart repair with Remplissage group and 2 patients in the arthroscopic Latarjet procedure group had recurrent instability events (12.2% vs 7.7%, p = 0.70), with no significant difference in the rate of recurrent dislocation between the groups (12.2% vs 3.8%, p = 0.39). Further analysis of the arthroscopic Bankart repair with Remplissage group revealed no significant difference in recurrence with those >10% or <10% glenoid bone-loss (14.3% (3/21) vs 9.5% (2/20), p > 0.99), or in those >15% or <15% glenoid bone-loss (18.2 % (2/11) vs 10% (3/30), p = 0.60). Additionally, there was no difference in recurrence between patients with arthroscopic Bankart repair with Remplissage and arthroscopic Latarjet procedure in those with >10% glenoid bone-loss (14.3% vs 7.7%, p = 0.66), or in those with >15% glenoid bone-loss (18.2% vs 8%, p = 0.57).

Table 32. Recurrent Instability

	ABRR	AL	p-value
Total Recurrence	5 (12.2%)	2 (7.7%)	0.6972
Redislocations	5 (12.2%)	1 (3.8%)	0.3925
Subluxation	0	1 (3.8%)	0.4098

ABRR; arthroscopic Bankart repair & Remplissage, AL; Arthroscopic Latarjet

Complications

There was no significant difference in the overall complication rate between arthroscopic Bankart repair with Remplissage and arthroscopic Latarjet procedure (4.9% vs 7.7%, p = 0.57). In the arthroscopic Bankart repair with Remplissage group, 1 patient had a prominent suture-anchor at the glenoid causing pain which was loose and had to be removed at 2-months post-operatively. In the arthroscopic Latarjet procedure group, 1 patient (3.3%) required a revision to distal tibial allograft for graft fracture and dislocation at 2 months post-operatively, and another patient (3.3%) had drainage from one of the portals and was treated with antibiotics for a suspected infection.

DISCUSSION

The high rate of recurrent instability in the long-term following arthroscopic Bankart repair is concerning, as almost a third of patients reported a recurrent instability event. Zimmerman et al.[25] found in their study that shoulder stability declined steadily over time until 10-years and then remained stable over time. In contrast, the open Latarjet procedure was shown to have a low rate of recurrence. In recent years, further research on the risk factors for postoperative recurrence has led to the introduction of tools such as the Instability Severity Index Score (ISIS) that is supposed to appropriately identify which patients are candidates for an ABR or a Latarjet procedure.[135] Appropriate identification of patients who are suitable for arthroscopic Bankart repair may have the potential to significantly reduce the postoperative recurrence rate. Additionally, Leroux et al.[237] highlighted the importance of adequate patient selection by showing that recurrence rates could be reduced by half in collision athletes by limiting the ABR to patients with minimal glenoid bone-loss.

Recurrent shoulder instability is a significant risk factor for the development and progression of glenohumeral arthropathy. Marx et al.[238] found that the risk of severe arthrosis may be as high as 10- to 20- fold among patients who have previously dislocated their shoulders compared to those who have not. The literature showed that there was a high rate of instability arthropathy in the long-term following shoulder stabilization. These findings support the theory that instability arthropathy has its origin in the primary trauma with initially not detectable damage to cartilage and subchondral bone that progresses over time. Additionally, there may be a component of micro-instability postoperatively that plays a role in the development and progression of instability arthropathy despite a clinically stable shoulder.[239] Plath et al.[240] showed multiple potential risk factors for the development of instability arthropathy including age at primary dislocations and at surgery, number of preoperative dislocations, time from initial dislocation to surgery, number and type of fixation devices used during surgery, recurrence of instability and an external rotation deficit at time of follow up. Although, the vast majority of the instability arthropathy was mild, with very few patients experiencing severe changes and no patients requiring an arthroplasty.

Initially, we hypothesized that patients with GLAD lesions undergoing ABR for anterior shoulder instability would demonstrate worse clinical outcomes and higher rates of recurrence when compared to a control group. Patients who suffer from a GLAD lesion typically have anterior shoulder pain, which supported the rationale for our hypothesis that this unaddressed source of pain would result in worse clinical outcomes. However, our study showed that this was not the case, and GLAD lesions did not impair clinical outcomes when compared to a control group. Nevasier et al.[227] had previously recommended cartilage debridement in these patients who did not present with anterior shoulder instability but rather presented with pain. Our cohort of patients presented with shoulder instability and not pain as their primary complaint. This may explain why our cohort of patients did not have significant postoperative pain and subsequent worse clinical outcomes. However, when deciding whether or not to address the GLAD lesion, the orthopaedic surgeon must be mindful of its propensity to become an unstable loose body, leading to both post-operative pain as well as reduced shoulder function, especially in high performing athletes.

In those undergoing Type V SLAP repair, our initial hypothesis was that rates of RTP would be similar to those found after arthroscopic Bankart repair alone. The rationale was, if the presenting complaint was anterior shoulder instability, then this would be the most important factor, and that the SLAP lesion would be deemed a secondary issue. This is supported by previous studies which demonstrated that repairs of isolated SLAP lesions have been shown to yield unsatisfactory outcomes.[231] However, the patients who underwent Type V SLAP repair included in this study reported high levels of patient satisfaction, satisfactory functional outcomes as well as low residual pain levels, which were similar to those reported in the control group. These findings were consistent with a meta-analysis by Feng et al.[241], which also reported satisfactory outcomes across functional scores for patients receiving Type V SLAP repair. Although this study found a higher rate of revisions in those with a Type V SLAP tear, but not a higher recurrence rate. Similarly, Hantes et al.[242], previously found a higher incidence of recurrence following Type V SLAP repair when compared to arthroscopic Bankart repair alone.

In those who fail non-operative and undergo ABR for recurrent instability they were shown to have similar clinical outcomes, and recurrence rates, to those treated with ABR for primary. However, it is worth noting that recurrent instability is not a benign event with further bone-loss and cartilage damage reported, which may warrant a more invasive procedure and increased risk of long-term instability arthropathy[243]. Thus, patients should be still counseled on their risk of recurrence before undergoing either operative or non-operative management for primary instability. However, we found that athletes who underwent ABR for recurrent shoulder instability managed to RTP significantly faster than those in the primary instability group. However, both groups found that athletes required approximately 6 months post-ABR to RTP, regardless of their initial stabilization indication, which is slightly faster than the reported time in the literature as Memon et al.[24] found in their systematic review a mean of approximately 9 months before RTP following ABR[24]. Although it is still unclear why this group returned faster, this may be due to them having already missed a larger amount of time due to a second injury, or that prior rehabilitation for their initial instability event served as a form of pre-habilitation, as in our experience we have noted many of these athletes with prior instability continue to focus on strengthening their shoulders in order to prevent this second instability event.

The open Latarjet procedure has had a resurgence of interest recently in treating patients with severe glenoid bone loss and those at high risk of further recurrence regardless of their instability status.[244] Werthel et al.[245] reported that patients who underwent the open Latarjet procedure following a failed arthroscopic Bankart repair had significantly worse functional outcomes and pain scores when compared to those with primary instability. The current study found low reported levels of residual pain in athletes following the open Latarjet procedure for primary or recurrent instability. However, this was not the case for those who failed a prior shoulder stabilization procedure, which may be due to further residual pain from the prior procedure. Although, despite the higher pain levels, our study demonstrates that patients undergoing the open Latarjet procedure reported excellent patient reported outcomes in all three groups at medium-term follow-up, with similar SSV scores across the groups. Our study found that although similarly high rates of RTP were reported in patients with primary or recurrent instability, there was a clinically significant lower rate of RTP in those undergoing OL following a failed prior stabilization surgery.[246] In these patients, the lower rate of RTP may be due to psychological barriers or residual pain as patients across all three groups reported similar shoulder function as measured by SSV, but there is a slightly lower SIRSI and VAS score in this group, which would support this.

Several different management strategies have been described in the revision setting which include arthroscopic soft tissue stabilization, iliac crest autograft (Eden-Hybinette procedure), or allograft—including glenoid, iliac crest, distal tibia, femoral head or humeral head. Iliac crest autograft is the most studied glenoid bone-graft procedure and has successfully been used to restore stability in high-risk populations along with serving as a revision method after failed Latarjet.[247-251] Allograft tissue offers all the benefits of avoiding donor-site morbidity that is frequently associated with coracoid transfer or autograft procedures. When comparing allografts, the lateral one-third of the articular surface of the distal tibia has been found to most closely match the radius of curvature of the native glenoid and be congruent with the humeral head throughout a full range of motion.[252] Bhatia et al.[253] demonstrated in a cadaveric study that distal tibia allograft allows for improved joint congruity and lower peak forces at 60 degrees of abduction and abduction external rotation. In our study, the clinical outcomes were shown to be excellent without recurrence in the early post-operative period. However, this is an area that requires further study.

Overall, our study found no differences in any outcome measure following the open and arthroscopic Latarjet procedures. The primary functional outcome measure utilized was the WOSI score. This has been validated to assess the impact of shoulder instability across a variety of lifestyle domains, all of which showed no significant difference between the two groups.[254] Furthermore, there was no difference in the current study in SSV, satisfaction or willingness to undergo surgery again. There was no difference in overall rate of RTP between the two groups, and while the rate may seem lower than quoted in the literature, this may be due to a large portion of these patients having a prior surgery and the average age being in their 30s, which both are risk factors for not returning to play in our experience. While there was a small difference in timing of RTP by one month favouring arthroscopic Latarjet procedure, the potential for quicker rehabilitation following arthroscopic Latarjet procedure is an often discussed advantage and does warrant further study. Finally, there was no significant difference in recurrent instability between the two groups, suggesting both are equally efficacious in treating anterior shoulder instability.

The arthroscopic Bankart repair with Remplissage and arthroscopic Latarjet procedure procedures are both recent advancements in the arthroscopic management of anterior shoulder, with Wolf[30] describing the arthroscopic Bankart repair with Remplissage in 2008 and Lafosse[29] describing the AL in 2007. The arthroscopic Bankart repair with Remplissage was developed to address engaging Hill-Sachs lesions which has increasingly been recognised as a risk factor for post-operative recurrence. Arthroscopic Bankart repair with Remplissage fills the Hill-Sachs defect using the infraspinatus and posterior-inferior capsule. As a result, engagement of the Hill-Sachs lesion is prevented and the lesion remains "on-track", which is not addressed by an arthroscopic Bankart repair alone. In contrast to the arthroscopic Bankart repair with Remplissage, the arthroscopic Latarjet procedure widens the glenoid articular surface while simultaneously providing stability by way of the sling effect provided by the transposed conjoint tendon, which both reduce the chances of the Hill-Sachs engaging.[151, 152] The arthroscopic approach has been advocated for, due to its minimally invasive approach, which potentially result in decreased stiffness, decreased wound complications and quicker rehabilitation.[29, 236] Overall, there was no significant difference in any outcome measure between those undergoing arthroscopic Bankart repair with Remplissage and arthroscopic Latarjet procedure, with a high rate of satisfaction and willingness to undergo the procedure again if required. Finally, the amount of glenoid bone-loss in the setting of an "off-track" Hill-Sachs lesion that is critical to failure following arthroscopic Bankart repair with Remplissage is still undefined. In contrast, Yang et al.[93] found that in their series patients who had >10% glenoid bone-loss, the outcomes were worse with those who received arthroscopic Bankart repair with Remplissage procedure than a Latarjet procedure. Although in our series, half of the patients who underwent arthroscopic Bankart repair with Remplissage had >10% glenoid bone loss and there was no difference in recurrence rate compared to those with < 10% glenoid bone loss.

Limitations

The limitations of this systematic review were directly related to the limitations of the included studies themselves. There are several inherent limitations to systematic reviews, including publication bias, search bias, selection bias and heterogeneity of results. The clinical studies were retrospective analyses with a follow-up rate of approximately 75%, and thus subject to potential bias. While in the majority of the studies with a control they were matched to ensure similar baseline demographics, small discrepancies may exist. However, in the study comparing arthroscopic Bankart repair with Remplissage procedure and the arthroscopic Latarjet procedure there were differences in the amount of glenoid-loss and in the between the two cohorts, although this represents differences in clinical indications. Finally, several of the included studies did not have a control.

Conclusions

- The arthroscopic Bankart repair for anterior shoulder instability has been shown to result in excellent long-term functional outcomes despite a relatively high rate of recurrent instability necessitating revision surgery. Additionally, a high rate of instability arthropathy is a concern following arthroscopic Bankart repair in the long-term.
- The Latarjet procedure for anterior shoulder instability has been shown to result in excellent functional outcomes at long-term and a high rate of return to sport among athletes. However, varying rates of recurrence, residual pain, and progression of instability arthropathy are still of concern.

- Following arthroscopic repair, patients with GLAD lesions had similar mid-term outcomes when compared to a control group without GLAD lesions.
- Following arthroscopic repair, patients with Type V SLAP tears had a similar overall rate of RTP when compared directly to a control group of patients who underwent arthroscopic Bankart repair alone. However, those who underwent Type V SLAP repair reported significantly lower rates of RTP at the same or higher level compared to the control group.
- Patients undergoing arthroscopic Bankart repair combined with open subpectoral biceps tenodesis had a high rate of RTP with a low rate of recurrent instability.
- Female patients with anterior shoulder instability treated with arthroscopic Bankart repair have low recurrence rates, with good patient reported outcomes, and high satisfaction rates. Of those participating in sport prior to surgery, there was a high rate of return to play. The overall rate of complications was low, with a low rate of revision surgery.
- Patients with 270° labral tears who were treated with arthroscopic repair showed an overall high rate of return to sport. Despite a low rate of recurring instability, not all patients were able to return to their previous level of sports.
- Arthroscopic Bankart repair results in excellent clinical outcomes, high rates of RTP, and low recurrence rates for athletes with both primary and recurrent instability.
- The open Latarjet procedure results in excellent clinical outcomes, and low recurrence rates for primary shoulder instability, those with recurrent instability, or those undergoing the open Latarjet procedure for failed prior instability surgery. However, in those undergoing the open Latarjet procedure for failed prior stabilization surgery there was a lower rate of return to play.
- Distal tibial allograft following a failed Latarjet procedure resulted in excellent clinical

outcomes, with high satisfaction. Furthermore, there were no recurrent dislocations or subluxations reported in this series.

- In patients with anterior shoulder instability both the open and arthroscopic Latarjet procedure are reliable treatment options, with a low rate of recurrent instability, and excellent patient reported outcomes.
- In patients with anterior shoulder instability and a concomitant Hill-Sachs lesions both arthroscopic Bankart repair with Remplissage and the arthroscopic Latarjet procedure were shown to be reliable treatments, with a low rate of recurrent instability, and excellent patient reported outcomes in appropriately selected patients. Although our study could not determine whether there was a critical glenoid bone-loss for those undergoing arthroscopic Bankart repair with Remplissage, and surgeons should still exercise caution in performing arthroscopic Bankart repair with Remplissage in patients with high-grade glenoid bone-loss or in those with failed prior stabilizations.

Chapter 5: Anterior Shoulder Instability –An International Delphi Consensus Statement

INTRODUCTION

Anterior shoulder instability occurs in a wide range of patient populations with different needs that require an individualized treatment strategy.[255, 256] However, many aspects of the management of this pathology remain controversial due to a relative lack of high-level evidence to guide treatment.[4] Furthermore, there are often regional philosophical differences in how anterior shoulder instability is approached that result in a dichotomous treatment algorithm between surgeons, further adding to this controversy.[5, 6]

Bone-loss is a challenging problem in the setting of anterior shoulder instability as it is difficult to treat and increases the risk of recurrent instability.[135, 257, 258] Glenoid-sided bone-loss is commonly treated with the Latarjet procedure, which acts to widen the glenoid articular surface while simultaneously providing stability in abduction by way of the sling effect provided by the transposed conjoint tendon.[259] Alternatively, glenoid bone-grafting by means of a free graft transfer, be it from autogenous or allogenic sources, may be utilized to reconstruct the anterior aspect of the glenoid.[260] Humeral-sided bone loss resulting in an "off-track" and/or engaging Hill-Sachs lesion is commonly treated either indirectly with one of the above procedures, or directly by means of a Remplissage.[261] Remplissage acts to fill the lesion and render it extra-articular through tenodesis of the infraspinatus and posterior-inferior capsule into the defect.[32, 33, 262, 263] However, the indications for these procedures are often based on surgeon preference and are ill-defined.[6, 257]

Following shoulder stabilization surgery, and post-operative rehabilitation protocols and follow-up are often dictated by surgeon experience and personal biases.[204, 210, 212, 264, 265]

Furthermore, in the setting of failed shoulder stabilization, the optimal treatment algorithm lacks definition owing to a wide variety in patient populations, geographical and philosophical differences affecting surgical decision-making, and a relative lack of high-level evidence to guide treatment.[4, 6, 257] Given the current state of the literature, consensus statements generated by agreement between experts in the field are an important source of evidence to help guide the treatment of patients with anterior shoulder instability.

Several previous societies have developed both national and international consensus statements on a variety of topics utilizing the Delphi method.[264, 266-270] The Delpi method requires multiple rounds of questionnaires to encompass expert opinion on a topic, to ultimately lead to defined consensus statements. The Neer Circle of the American Shoulder and Elbow Surgeons created consensus statements based on clinical scenarios aimed at individualizing the treatment of patients with first-time anterior shoulder instability.[264] While this group succeeded in providing important recommendations on the management of this pathology in the United States, its focused approach also served as a stimulus for the creation of a global initiative aimed at identifying commonalities between how surgeons approach various key aspects of anterior shoulder instability. Thus, the Anterior Shoulder Instability International Consensus Group (ASI-ICG) was created with a mandate to establish clinical guidelines for 9 key aspects of the treatment of this pathology, including 1) Diagnosis, 2) Non-operative Management, 3) Bankart Repair, 4) Latarjet Procedure, 5) Remplissage, 6) Glenoid Bone-Grafting, 7) Revision Surgery, 8) Rehabilitation and Return to Play, and 9) Follow-up. The purpose of this chapter was to establish consensus statements via the Delphi process on the management anterior shoulder instability.

METHODS

Consensus Working Groups

Sixty-five shoulder surgeons from 14 countries across 5 continents participated in these consensus statements on anterior shoulder instability, with 69 initially being invited and 4 declining. The participants composed primarily of members of AANA, AOSSM, ASES, ESSKA, and SECEC, and were invited due to their active interest and study on the anterior shoulder instability. Experts were assigned to one of 9 working groups defined by specific subtopics of interest within anterior shoulder instability, including 1) Diagnosis, 2) Non-operative Management, 3) Bankart Repair, 4) Latarjet Procedure, 5) Remplissage, 6) Glenoid Bone-Grafting, 7) Revision Surgery, 8) Rehabilitation and Return to Play, and 9) Follow-up. This study represents three of the working groups topics, and two separate companion manuscripts focus on the other topics. Working groups were kept geographically balanced to limit bias and ensure the groups were representative of the field at large. Thus, each working group was assigned surgeons from at least 2 different continents, and all groups had surgeons from at least 3 different countries involved in an effort to minimize regional bias. Furthermore, the participants were instructed to answer the questionnaires based on the best available evidence rather than personal preference. A liaison (ETH) served as the primary point of contact and facilitated communication and the distribution of surveys to ensure consistency across the working groups. Additionally, they formulated each subsequent round of questionnaires based on the prior round's responses. To reduce the potential for bias in the data analysis and/or literature review, the liaison did not submit answers to the questionnaires or partake in the voting process.

Delphi Consensus Method

Nine working groups covering the principal topics of interest in the area of anterior shoulder instability were established. A set of questions pertaining to each working group was generated based on clinical relevance and areas of controversy identified through systematic review of the literature and by the nine experts on the steering committee. The Delphi method was used to generate consensus statements for each working group, with groups completing 3 initial rounds of questionnaires, followed by amendments, and lastly a final vote. All of the questionnaire responses and votes were anonymized. Questions progressed from an open-ended to a more structured format, and were designed to elucidate areas of agreement and disagreement between group members. Once a preliminary consensus statement was generated within a working group, participants were asked whether they "agreed" or "disagreed" with it. If there was unanimous agreement within a group on a preliminary consensus statement, this statement was elevated to a final vote. If the agreement was not unanimous within a group, these questions were subject to further discussion by members of the entire consensus group, with statements being amended where there was agreement with the proposed change. The final voting process allowed all study participants to assess the consensus statements generated by the other working groups and vote on whether they "agreed" or "disagreed" with them, thus all statements were voted on by all 65 participants. Surveys were distributed in a blinded fashion using RedCap.

Final Voting

After the final votes for each question occurred, the degree of agreement was expressed using a percentage rounded to the nearest whole number. Consensus was defined as 80-89%, whereas strong consensus was defined as 90-99%, and unanimous consensus was indicated by receiving 100% of the votes in favor of a proposed statement.

RESULTS

Diagnosis

Of the 10 total questions and consensus statements in this group, 1 achieved unanimous consensus, 7 achieved strong consensus, and 2 achieved consensus. The statement achieving unanimous consensus was that the following aspect of patient history should be evaluated: a) age, b) gender, c) mechanism of injury, d) occupation, e) sport played & position, f) level of sport, g) whether it required reduction, and h) hyperlaxity. All of these statements are shown in Table 1.

Non-Operative Management

Of the 9 total questions and consensus statements in this group, 1 achieved unanimous consensus, 6 achieved strong consensus, 1 achieved consensus, and 1 did not achieve consensus. The statement achieving unanimous consensus was that the prognostic factors that are important to consider specifically in those undergoing non-operative management include: a) age, b) athletic demands/activity level, c) collision/contact athlete, d) number and method of instability events, e) glenoid bone-loss, f) Hill-Sachs lesion, and g) hyperlaxity. Additionally, the statement that did not achieve consensus was that if patients are immobilized, then they should be immobilized in either neutral or external rotation, which had 66% consensus. All of these statements are shown in Table 2.

Operative Management

Of the 12 total questions and consensus statements in this group, 3 achieved unanimous consensus, 8 achieved strong consensus, and 1 achieved consensus. The statements achieving unanimous consensus were; the following prognostic factors should be considered in patients undergoing a Bankart repair: a) younger age, b) glenoid bone-loss, c) Hill-Sachs lesion, d) male, e) competitive athlete, f) overhead athlete, g) number of pre-operative dislocations, h) prior shoulder surgery, i) hyperlaxity, j) expectations, and k) ability to comply with post-operative rehabilitation. Complications, other than recurrence, are rare following a Bankart repair procedure. However, the following can be used to reduce recurrence: a) well-defined rehabilitation protocol, b) inferior anchor placement, c) multiple anchor fixation points, d) small anchors to minimize postage stamp fractures, e) treat concomitant pathologies, f) careful capsulolabral debridement & reattachment, g) appropriate indication & assessment of risk factors. Finally, anchors should be placed 5-8mm apart when performing a Bankart repair. All of these statements are shown in Table 3.

Latarjet Procedure

Of the 10 total questions and consensus statements in this group, none achieved unanimous consensus, 9 achieved strong consensus, and 1 achieved consensus. The most clinically relevant statements were that the primary relative indications for a Latarjet procedure are a) recurrent instability, b) failed prior surgery, c) collision athlete, d) critical glenoid bone-loss (>15-20%), and e) bipolar bone-loss resulting in "off-track" lesion, and the primary relative contraindication for a Latarjet procedure are a) multidirectional instability, b) voluntary dislocators, c) uncontrolled epilepsy/seizure disorder, d) irreparable rotator cuff tear, and e) glenoid bone-loss exceeding that which can be addressed with the coracoid. Additionally, the arthroscopic technique is a viable alternative and results in similar outcomes. However, it is a technically challenging procedure and is only advisable to perform in a high-volume setting. All of these statements are shown in Table 4.

Remplissage

Of the 8 total questions and consensus statements in this group, none achieved unanimous consensus, 7 achieved strong consensus, 1 achieved consensus. The most clinically relevant statements were that the primary relative indications for a Remplissage procedure are in the setting of a large Hill-Sachs lesion, either a) off-track on pre-operative imaging, or b) engaging at the time of arthroscopy and primary relative contraindications for a Remplissage procedure are relative, but include a) small Hill-Sachs lesion, either on-track on pre-operative imaging or non-engaging at arthroscopy, b) severe glenoid bone-loss, c) pre-operative stiffness, d) infraspinatus compromise, and e) overhead athlete. Additionally, Loss of external range of motion is a small concern and unlikely to be clinically significant in most patients. This can be minimized by fixing the tendon via the safe-zone and not over medializing the fixation. All of these statements are shown in Table 5.

Glenoid Bone-Grafting

Of the 10 total questions and consensus statements in this group, 2 achieved unanimous consensus, 7 achieved strong consensus, and 1 achieved consensus. The statements achieving unanimous consensus were; the prognostic factors that are important to consider specifically in those undergoing a glenoid bone-grafting procedure include a) age, b) activity level, c) Hill-Sachs Lesion, d) extent of glenoid bone-loss, e) hyperlaxity, f) prior surgeries, g) arthritic changes. It is unclear whether a capsular repair is routinely required with a glenoid bone graft, but it may be beneficial in some cases. All of these statements are shown in Table 6.

Revision Surgery

Of the 10 total questions and consensus statements in this group, 4 achieved unanimous consensus, and 6 achieved strong consensus. The statements achieving unanimous consensus were; the primary relative indications for revision surgery include a) symptomatic apprehension or recurrent instability, b) further intra-articular pathologies, and c) symptomatic hardware failure. The following factors should be considered in determining the choice of revision procedure a) age, b) subscapularis integrity, c) glenoid/humeral bone loss, d) number of instability episodes, and e) activity level/sport. The following may impact a subsequent revision procedure a) subscapularis integrity, b) subscapularis approach (take-down or split), c) hardware utilized and whether it is possible to remove them, d) bone augmentation procedures that alter anatomy, and e) revision procedures do worse than primary procedures. The following different/additional considerations can be made in the evaluation of a failed revision procedure a) new glenoid bone-loss, or was not addressed at initial surgery, b) new Hill-Sachs lesion, or was not addressed at initial surgery, c) hyperlaxity, d) nerve function, e) patient activity, f) patient aspirations, g) rotator cuff function, and h) failure of prior hardware. All of these statements are shown in Table 7.

Rehabilitation and Return to Play

Of the 8 total questions and consensus statements in this group, 3 achieved unanimous consensus, and 5 achieved strong consensus. The statements achieving unanimous consensus were; psychological factors should be considered in the rehabilitation process following operative stabilization for anterior shoulder instability. However, it is unclear how to build this in return to play protocols or testing. The following should be considered when allowing an athlete to return to play in the same season as the injury without surgery a) timing in season, b) risk of re-injury vs. benefit of continued play, c) the importance of the season & athlete's role, d) mechanism of injury, e) recovery of range of motion, f) recovery of strength, g) resolution of apprehension, h) pain, i) associated bone-loss, and j) ability to brace/protect the shoulder. The following prognostic factors should be considered a) age, b) sport (including overhead or collision sports), c) the number of episodes, d) initial mechanism of injury, e) ease and timing of reduction, f) glenoid and humeral bone-loss, g) extent of labral tear, h) other associated pathologies (i.e., nerve damage and rotator-cuff tear), i) compliance with rehabilitation, j) apprehension, k) restoration of strength, and l) restoration of range of motion. All of these statements are shown in Table 8.

Clinical Follow-up

Of the 7 total questions and consensus statements in this group, none achieved unanimous consensus, 5 achieved strong consensus, and 2 achieved consensus. The most clinically relevant statements were that treatment success following operative or non-operative management should be defined as a stable, pain-free shoulder with a return to full pre-morbid function. Additionally, patients who underwent non-operative or surgical stabilization be clinically followed-up for a minimum of 12-months or until return to full pre-morbid function activities, whichever occurs later and then as needed. All of these statements are shown in Table 9.

Table 1: Diagnosis

Questions & Answers	Agreement	Consensus
Q: Which aspect(s) of the patient history should be evaluated in the setting of suspected/known primary anterior shoulder instability? A: The following should be evaluated a) age, b) gender, c) mechanism of injury, d) occupation, e) sport played & position, f) level of sport, g) whether it required reduction, and h) hyperlaxity.	100%	Unanimous
Q: Which aspect(s) of the patient history should be evaluated in the setting of suspected/known recurrent anterior shoulder instability? A: The following aspects of the patient history should be evaluated in the setting of suspected/known recurrent anterior shoulder instability a) age, b) age at first instability event, c) number of dislocations, d) original and most recent mechanism of injury, e) pain, f) instability symptoms, g) occupation, h) sport played & position, i) level of sport, j) hand dominance, k) whether they require reduction/can self-reduce, l) hyperlaxity, m) instability with low energy, n) prior treatment(s), and o) other injuries/surgical history.	95%	Strong Consensus
Q: Which aspect(s) of the physical examination should be performed in the setting of suspected/known anterior shoulder instability? A: The following aspect(s) of the physical examination should be performed in the setting of suspected/known anterior shoulder instability a) rotator cuff strength testing, b) neurological exam, c) anterior/posterior apprehension, d) load and shift, e) ABER apprehension/relocation, f) sulcus sign, g) Beighton score/hyperlaxity of the shoulder at external rotation at side > 85°, h) Gagey test, and i) findings on inspection.	95%	Strong Consensus
Q: In the acute setting, are radiographs required prior to attempting reduction of a dislocated shoulder? Are post-reduction images required? A: In the acute setting, radiographs should be performed prior to attempting reduction of a dislocated shoulder, and post-reduction images should be obtained. However, closed reductions can be performed on the field/training room without concern for pre-reduction radiographs, but post-reduction images should still be obtained.	90%	Strong Consensus
Q: Which plain radiographic views should be obtained to evaluate suspected/known shoulder instability? A: The following plain radiographic views should be obtained to evaluate suspected/known shoulder instability a) AP, b) axillary, and c) scapular-Y.	92%	Strong Consensus
Q: When should advanced imaging (MRI/CT) be performed in a patient presenting with suspected/known anterior shoulder instability? A: Advanced imagining should be performed in the following scenarios a) irreducible in ED, b) pre-operatively, c) patient is high-risk for recurrence, or d) suspected rotator cuff injury.	90%	Strong Consensus
Q: Which advanced imaging modality is preferred for a patient presenting with suspected/known anterior shoulder instability, CT, or MRI? A: CT should be performed if there is suspected bone-loss, and otherwise, MRI should be performed.	84%	Consensus
Q: How should glenoid bone loss be quantified? A: Glenoid bone loss should be quantified via the circle method using an enface view of a 3D CT.	87%	Consensus
Q: How should humeral bone loss be quantified? A: Humeral bone loss should be quantified using 3D CT, and the glenoid track should be evaluated.	93%	Strong Consensus
Q: What limitations should be considered with radiological imaging when extrapolating to expected surgical findings in anterior shoulder instability? A: Radiographic approximation of glenoid bone-loss may underestimate that identified during surgical evaluation with anterior shoulder instability.	90%	Strong Consensus

Table 2: Non-Operative Management

Questions & Answers	Agreement	Consensus
Q: What are the indications for non-operative management? A: The primary relative indications for non-operative management include a) low risk of recurrence, b) patient preference to avoid surgery, c) low functional demand, d) primary instability, e) no glenoid bone-loss, f) > 30 years old or < 14 years old, and g) timing in-season to allow for return to play.	92%	Strong Consensus
Q: What are the contraindications for non-operative management? A: The primary relative contraindications for non-operative management include a) multiple instability events, b) high risk for further recurrence, c) severe glenoid bone-loss or large bony-fragment, d) instability in low energy mechanisms, e) collision athletes, and f) competitive athletes.	92%	Strong Consensus
Q: What prognostic factors should be considered in patients undergoing non-operative management? A: The prognostic factors that are important to consider specifically in those undergoing non-operative management include a) age, b) athletic demands/activity level, c) collision/contact athlete, d) number and method of instability events, e) glenoid bone-loss, f) Hill-Sachs lesion, and g) hyperlaxity.	100%	Unanimous
Q: Does immobilization play a role in the non-operative management of anterior shoulder instability? If so, for what duration of time? A: Immobilization may play a role in the early phase of non-operative management of anterior shoulder instability; however, it is unclear how long patients may require to be immobilized.	92%	Strong Consensus
Q: If shoulder immobilization is indicated, should the shoulder be immobilized in neutral, internal, or external rotation? A: If patients are immobilized, then they should be immobilized in either neutral or external rotation.	66%	No Consensus
Q: When should patients start shoulder range-of-motion exercises? A: Patients should start shoulder range-of-motion exercises after 1-2 weeks once comfort permits.	90%	Strong Consensus
Q: When should patients start resistance training exercises? A: Patients should start resistance training exercises once full range of motion is restored, and patients can perform the exercises without apprehension.	95%	Strong Consensus
Q: When should patients start sport-specific training exercises? A: Patients should start sport-specific training exercises once full range of motion and strength are restored, dependent on the timing in the season.	98%	Strong Consensus
Q: Do corticosteroids or orthobiologics play a role in non-operative management? A: There is no role for corticosteroids or orthobiologics in non-operative management.	85%	Consensus

Table 3: Bankart Repair

Questions & Answers	Agreement	Consensus
Q: What are the indications for a Bankart repair? A: The primary relative indications for a Bankart repair are a) primary or recurrent instability, b) high-risk for failure with non-operative management, c) minimal glenoid-bone loss, d) on-track Hill-Sachs lesion, e) patient preference for surgery over non-operative management, f) symptomatic instability on exam, g) MRI confirmation of labrum tear/Bankart lesion.	97%	Strong Consensus
Q: What are the contraindications for Bankart repair? A: The primary relative contraindications for a Bankart repair are a) severe glenoid bone-loss, b) off-track Hill-Sachs lesion, c) uncontrolled epilepsy, d) posterior instability, e) multi-directional instability, and f) likelihood of poor compliance with post-operative rehabilitation.	93%	Strong Consensus
Q: Should Bankart repair performed arthroscopically or via an open approach? If so, is there an indication for open Bankart repair? A: A Bankart repair should be performed arthroscopically. However, an open Bankart repair may be indicated in patients with high-risk for recurrence but minimal glenoid bone-loss.	80%	Consensus
Q: Is there an amount of glenoid bone-loss above which a Bankart repair should not be performed? A: A Bankart repair should not be performed in patients with >15-20% glenoid bone-loss.	90%	Strong Consensus
Q: Which prognostic factors should be considered in patients undergoing a Bankart repair? A: The following prognostic factors should be considered in patients undergoing a Bankart repair a) younger age, b) glenoid bone-loss, c) Hill-Sachs lesion, d) male, e) competitive athlete, f) overhead athlete, g) number of pre-operative dislocations, h) prior shoulder surgery, i) hyperlaxity, j) expectations, and k) ability to comply with post-operative rehabilitation.	100%	Unanimous
Q: What are the indications for performing concomitant procedures with a Bankart repair? A: In the setting of a Bankart repair, other pathologies contributing to instability, such as posterior or superior labral tears or Hill-Sachs lesion, should be addressed when performing Bankart repair.	98%	Strong Consensus
Q: Should Bankart repair be performed in the beach/captain's chair or lateral decubitus position? A: It is based on surgeon preference whether a Bankart repair is performed in the beach/captain's chair or lateral decubitus position.	92%	Strong Consensus
Q: What steps should be taken to minimize complications following a Bankart repair procedure? A: Complications, other than recurrence, are rare following a Bankart repair procedure. However, the following can be used to reduce recurrence a) well-defined rehabilitation protocol, b) inferior anchor placement, c) multiple anchor fixation points, d) small anchors to minimize postage stamp fractures, e) treat concomitant pathologies, f) careful capsulolabral debridement & reattachment, g) appropriate indication & assessment of risk factors.	100%	Unanimous
Q: What is the optimal number of anchors when performing a standard Bankart repair? A: A minimum of 3 anchors should be used when performing a standard Bankart repair; however, this may be greater in a more extensive labral tear.	94%	Strong Consensus
Q: How far apart should anchors be placed when performing a Bankart repair? A: Anchors should be placed 5-8mm apart when performing a Bankart repair.	100%	Unanimous
Q: Where should the lowest anchor be placed when performing a Bankart repair in a right shoulder?	89%	Consensus

A: The lowest anchor should be placed at 5:30-6 when performing a Bankart repair.		
Q: When should a rotator interval closure be performed? A: A rotator interval closure may not be routinely recommended but can be considered in those with hyperlaxity.	97%	Strong Consensus

Table 4: Latarjet Procedure

Questions & Answers	Agreement	Consensus
Q: What are the indications for a Latarjet procedure? A: The primary relative indications for a Latarjet procedure are a) recurrent instability, b) failed prior surgery, c) collision athlete, d) critical glenoid bone-loss (>15-20%), and e) bipolar bone-loss resulting in "off-track" lesion.	97%	Strong Consensus
Q: What are the contraindications for a Latarjet procedure? A: The primary relative contraindication for a Latarjet procedure are a) multidirectional instability, b) voluntary dislocators, c) uncontrolled epilepsy/seizure disorder, d) irreparable rotator cuff tear, and e) glenoid bone-loss exceeding that which can be addressed with the coracoid.	92%	Strong Consensus
Q: Is there an amount of glenoid bone loss above which a Latarjet procedure should be performed? A: The Latarjet procedure should be performed in patients with >15-20% glenoid bone-loss.	92%	Strong Consensus
Q: What prognostic factors should be considered in patients undergoing a Latarjet procedure? A: The prognostic factors that are important to consider specifically in those undergoing a Latarjet procedure include a) smoking, b) prior ipsilateral instability surgery, c) patient aspirations, d) arthritis, e) age, f) pre-operative stiffness, g) hyperlaxity, h) glenoid bone-loss, and i) Hill-Sachs lesions.	97%	Strong Consensus
Q: Should the Latarjet procedure be performed arthroscopically? If so, is there a minimum number of cases to achieve proficiency? A: The arthroscopic technique is a viable alternative and results in similar outcomes. However, it is a technically challenging procedure and is only advisable to perform in a high-volume setting.	98%	Strong Consensus
Q: To what degree are complications a concern following a Latarjet procedure? How can complications be reduced? A: Complications are a concern following a Latarjet procedure, and the following strategies can be used to reduce them a) careful dissection, b) identifying the musculocutaneous and axillary nerves, c) preventing over-lateralization of the graft and contour flush to native cartilage, d) TXA to reduce blood loss, e) accurate screw placement, and f) careful preparation of the glenoid neck and coracoid.	90%	Strong Consensus
Q: Should the coracoid transfer procedure be performed using the classic or congruent-arc technique? A: The coracoid transfer procedure should be performed using the classic technique.	87%	Consensus
Q: What is the optimal method of fixation of a coracoid graft? A: Two screws are the optimal method of fixation for a coracoid graft.	94%	Strong Consensus
Q: Is a capsular repair required in a Latarjet procedure? A: A capsular repair is not required with a Latarjet, but it may be beneficial in some cases.	95%	Strong Consensus
Q: Should a subscapularis split or partial/complete takedown be used in a Latarjet procedure? A: A subscapularis split should be used to access the glenohumeral joint in a Latarjet procedure.	95%	Strong Consensus

Table 5: Remplissage

Questions & Answers	Agreement	Consensus
Q: What are the indications for a Remplissage procedure? A: The primary relative indications for a Remplissage procedure are in the setting of a large Hill-Sachs lesion, either a) off-track on pre-operative imaging, or b) engaging at the time of arthroscopy.	93%	Strong Consensus
Q: What are the contraindications for a Remplissage procedure? A: The primary relative contraindications for a Remplissage procedure are relative, but include a) small Hill-Sachs lesion, either on-track on pre-operative imaging or non-engaging at arthroscopy, b) severe glenoid bone-loss, c) pre-operative stiffness, d) infraspinatus compromise, and 5) overhead athlete.	95%	Strong Consensus
Q: Should a Remplissage procedure ever be indicated in isolation? A: A Remplissage procedure may be indicated in isolation in the setting of a previous Latarjet procedure with recurrent instability where there is a large Hill-Sachs lesion.	82%	Consensus
Q: What prognostic factors should be considered in patients undergoing a Remplissage? A: The prognostic factors that are important to consider specifically in those undergoing a Remplissage procedure include: a) activity level, b) Hill-Sachs size, c) Hill-Sachs track, d) glenoid bone-loss, e) connective tissue disorder.	98%	Strong Consensus
Q: To what degree are complications a concern following a Remplissage procedure? How can complications be reduced? A: Loss of external range of motion is a small concern and unlikely to be clinically significant in most patients. This can be minimized by fixing the tendon via the safe-zone and not over medializing the fixation.	98%	Strong Consensus
Q: How should the infraspinatus/posterior capsule be fixed to the Hill-Sachs defect? A: There is no ideal fixation method for the infraspinatus/posterior capsule to the Hill-Sachs defect.	98%	Strong Consensus
Q: If knotted anchors are utilized, should the sutures be tied under direct visualization in the subacromial space? A: Sutures do not need to be tied under direct visualization in the subacromial space.	97%	Strong Consensus
Q: Should the addition of a Remplissage procedure to a Bankart repair alter the postoperative rehabilitation protocol? A: The addition of a Remplissage procedure to a Bankart repair should not alter the postoperative rehabilitation protocol; however, it is important to consider the infraspinatus and external rotation in the first few weeks.	98%	Strong Consensus

Table 6: Glenoid Bone-Grafting

Questions & Answers	Agreement	Consensus
Q: What are the indications for glenoid bone-grafting? When would you consider performing glenoid bone grafting instead of a Latarjet procedure? A: The primary relative indications for glenoid bone-grafting are a) > 20% bone-loss, b) failed prior Latarjet procedure, and c) epilepsy. Additionally, the relative indications for glenoid bone-grafting over a Latarjet procedure is a) bone-loss greater than can be treated with a coracoid graft, b) surgeon preference, c) Failed prior Latarjet or glenoid bone-grafting procedure, and d) epilepsy.	93%	Strong Consensus
Q: What are the contraindications for glenoid bone-grafting? A: The primary relative contra-indications for glenoid bone-grafting are a) minimal glenoid bone-loss, b) infection, and c) axillary nerve damage.	92%	Strong Consensus
Q: What prognostic factors should be considered in patients undergoing glenoid bone-grafting? A: The prognostic factors that are important to consider specifically in those undergoing a glenoid bone-grafting procedure include a) age, b) activity level, c) Hill-Sachs Lesion, d) extent of glenoid bone-loss, e) hyperlaxity, f) prior surgeries, g) arthritic changes.	100%	Unanimous
Q: Is there a preferred bone-graft for treating anterior shoulder instability? A: There is no optimal bone-graft, and the choice should be based on surgeon preference.	98%	Strong Consensus
Q: Is autologous or allogeneic bone preferable for treating anterior shoulder instability? A: Either autologous bone or fresh allogeneic bone are preferable for treating anterior shoulder instability. However, other sources of allogeneic bone-graft may be inferior.	92%	Strong Consensus
Q: To what degree are complications a concern following glenoid bone-grafting? How can complications be reduced? A: Complications following glenoid bone-grafting are less of a concern than following the Latarjet procedure. The following strategies may be used to reduce complications a) careful dissection and identification of neurovascular structures, b) preventing over-medialization of the graft, and contouring flush to native cartilage.	93%	Strong Consensus
Q: Is resorption of the bone graft correlated with an inferior outcome after glenoid bone grafting? A: Remodeling is normal, but true resorption is correlated with an inferior outcome after glenoid bone grafting.	95%	Strong Consensus
Q: What is the optimal method of fixation for a glenoid bone graft? A: The optimal fixation of glenoid bone-graft is based on surgeon preference using either screw fixation or a J-bone graft.	95%	Strong Consensus
Q: Is a capsular repair required with a glenoid bone graft? A: It is unclear whether a capsular repair is routinely required with a glenoid bone graft, but it may be beneficial in some cases.	100%	Unanimous
Q: Should a subscapularis split or partial/complete takedown be used with a glenoid bone graft? A: A subscapularis split should be used to access the joint with a glenoid bone graft.	85%	Consensus

Table 7: Revision Surgery

Questions & Answers	Agreement	Consensus
Q: How can treatment failure be defined? A: Treatment failure can be defined as a) recurrent instability, b) persistent apprehension, c) functional limitations, d) loss of functional range of motion, e) pain, f) failure to return to pre-injury function/sports, g) subscapularis deficiency in the setting of an open stabilization, and h) symptomatic bone graft non-union or hardware failure in the setting of a bone graft procedure.	98%	Strong Consensus
Q: What are the indications for revision surgery? A: The primary relative indications for revision surgery include a) symptomatic apprehension or recurrent instability, b) further intra-articular pathologies, and c) symptomatic hardware failure.	100%	Unanimous
Q: What are the contraindications for revision surgery? A: The primary relative contraindications for revision surgery include a) uncontrolled seizures, b) arthritis, c) infection, d psychiatric disorder, and e) lack of compliance with rehabilitation.	93%	Strong Consensus
Q: What factors should be considered in determining the choice of revision procedure? A: The following factors should be considered in determining the choice of revision procedure a) age, b) subscapularis integrity, c) glenoid/humeral bone loss, d) number of instability episodes, and e) activity level/sport.	100%	Unanimous
Q: When can a revision soft-tissue stabilization be performed? A: A revision soft-tissue stabilization can be performed in a non-contact athlete, with minimal bone-loss and good tissue quality. Additionally, a soft-tissue repair with a Remplissage may be performed if there are minimal glenoid bone-loss and a Hill-Sachs lesion that was not addressed in the initial surgery.	97%	Strong Consensus
Q: How does a previous procedure impact the results of a subsequent revision procedure? A: The following may impact a subsequent revision procedure a) subscapularis integrity, b) subscapularis approach (take-down or split), c) hardware utilized and whether it is possible to remove them, d) bone augmentation procedures that alter anatomy, and e) revision procedures do worse than primary procedures.	100%	Unanimous
Q: What different/additional considerations can be made in the evaluation of a failed revision procedure? A: The following different/additional considerations can be made in the evaluation of a failed revision procedure a) new glenoid bone-loss, or was not addressed at initial surgery, b) new Hill-Sachs lesion, or was not addressed at initial surgery, c) hyperlaxity, d) nerve function, e) patient activity, f) patient aspirations, g) rotator cuff function, and h) failure of prior hardware.	100%	Unanimous
Q: What revision procedure should be performed after a failed coracoid transfer? A: A glenoid bone-graft procedure should be performed after a failed Latarjet procedure. However, if the coracoid is healed and a Hill-Sachs lesion has not been addressed, this should be addressed via a Remplissage procedure or a humeral head allograft.	95%	Strong Consensus
Q: What revision procedure should be performed after a failed glenoid bone grafting procedure? A: A Latarjet procedure should be performed after a failed glenoid bone-grafting procedure if it was not done prior, or if one was done prior, then a revision glenoid bone-grafting procedure should be performed. Furthermore, if a Hill-Sachs lesion has not been addressed, this should be addressed via a Remplissage procedure or a humeral head allograft.	95%	Strong Consensus
Q: How many failed stabilizations are necessary to consider a salvage procedure? A: Consideration of a salvage procedure is not dependent on the number of prior stabilizations but the age of the patient, activity level, degree of osteoarthritis, rotator cuff integrity.	97%	Strong Consensus

Table 8: Rehabilitation & Return to Play

Questions & Answers	Agreement	Consensus
Q: How long should patients be immobilized post-operatively? A: There is no clear time point for post-operative sling use/immobilization as there is no high-level evidence to guide this, and is based on surgeon preference.	97%	Strong Consensus
Q: Should psychological factors be considered in the rehabilitation process following operative stabilization for anterior shoulder instability? If so, how? A: Psychological factors should be considered in the rehabilitation process following operative stabilization for anterior shoulder instability. However, it is unclear how to build this in return to play protocols or testing.	100%	Unanimous
Q: What should be considered when allowing an athlete to return to play in the same season as the injury without surgery? A: The following should be considered when allowing an athlete to return to play in the same season as the injury without surgery a) timing in season, b) risk of re-injury vs. benefit of continued play, c) the importance of the season & athlete's role, d) mechanism of injury, e) recovery of range of motion, f) recovery of strength, g) resolution of apprehension, h) pain, i) associated bone-loss, and j) ability to brace/protect the shoulder.	100%	Unanimous
Q: What prognostic factors should be considered when determining the patient's likelihood to return to play successfully (i.e., return to play without re-dislocation) following non-operative management of anterior shoulder instability? A: The following prognostic factors should be considered a) age, b) sport (including overhead or collision sports), c) the number of episodes, d) initial mechanism of injury, e) ease and timing of reduction, f) glenoid and humeral bone-loss, g) extent of labral tear, h) other associated pathologies (i.e., nerve damage and rotator-cuff tear), i) compliance with rehabilitation, j) apprehension, k) restoration of strength, and l) restoration of range of motion.	100%	Unanimous
Q: What criteria should be considered when deciding to return an athlete to play following non-operative management/operative stabilization for anterior shoulder instability? Are there any procedure-specific criteria? Is there a minimum time point before allowing athletes to return to play? A: The following criteria should be considered a) restoration of strength, b) restoration of range of motion, c) free of apprehension, d) pain-free, e) sport-specific skills, and f) restoration of proprioception. In those undergoing a Latarjet procedure/glenoid bone-graft radiographic imaging may be useful to assess graft healing. The minimum time point before allowing athletes to return to play is unknown.	98%	Strong Consensus
Q: Should different considerations be made in deciding when collision athletes may return? A: Yes, collision athletes may take longer to return due to their higher risk for recurrence.	93%	Strong Consensus
Q: Should different considerations be made in deciding when/overhead athletes may return? A: Yes, overhead athletes may take longer to return due to the time needed to recover skill and range of motion.	97%	Strong Consensus
Q: Should different considerations be made in deciding when elite/non-elite athletes may return? A: Elite athletes may have different considerations in returning to play due to their financial considerations, superior pre-morbid conditioning, easier-access to high-quality rehabilitation & medical evaluation, and implications of re-injury and recurrent instability for their career.	98%	Strong Consensus

Table 9: Clinical Follow-up

Questions & Answers	Agreement	Consensus
Q: How should treatment success be defined? A: Treatment success following operative or non-operative management should be defined as a stable, pain-free shoulder with a return to full pre-morbid function.	98%	Strong Consensus
Q: Which aspect(s) of the physical examination should be performed on patients after the treatment of anterior shoulder instability? A: The following aspect(s) of the physical examination should be performed on patients after treatment of anterior shoulder instability a) range of motion, b) apprehension, c) relocation test, d) load and shift, and e) strength.	98%	Strong Consensus
Q: For how long should patients being treated non-operatively be followed-up? A: Patients being treated non-operatively be clinically followed-up for a minimum of 12-months or until they have returned to full sports for a season, whichever occurs later and then as needed.	87%	Consensus
Q: For how long should patients who underwent surgical stabilization be followed-up? A: Patients who underwent surgical stabilization be clinically followed-up for a minimum of 12-months or until return to full pre-morbid function activities, whichever occurs later and then as needed.	85%	Consensus
Q: What routine follow-up time points should be used for research purposes? A: The following time points should be used to routinely follow-up patients for research purposes a) pre-operative, b) 3 months, c) 6 months, d) 12 months, e) 2 years, f) 5 years, and g) 10 years.	98%	Strong Consensus
Q: What components should be included in a patient-reported outcome measure for anterior shoulder instability? A: The following components should be included in a patient-reported outcome measure for anterior shoulder instability a) function/limitations, b) impact on activities of daily living, c) return to sport/activity, d) instability symptoms (including apprehension and recurrence), e) confidence in their shoulder, and f) satisfaction.	98%	Strong Consensus
Q: Should any routine imaging be performed at follow-up? If not, is there any patient population that should undergo follow-up imaging? A: Those undergoing a Latarjet procedure should have routine imaging performed at follow-up visits.	90%	Strong Consensus

DISCUSSION

The diagnosis and appropriate work-up is essential to appropriately individualize the treatment of anterior shoulder instability, and this requires extracting the necessary information from a detailed patient history. There was unanimous consensus within this working group that the aspects of patient history that need to be evaluated after an acute instability event include patient age, mechanism of injury, occupation, sport played and position, level of sport, whether it required reduction, and hyperlaxity. All of these factors are related to patient demand, and subsequently their risk of recurrent instability.[135, 207, 265, 271] There was also strong consensus with regards to the aspects of patient history that need to be evaluated in the setting of recurrent instability, which include the number of dislocations, presence of low-energy mechanism of dislocation, and antecedent procedural history. While these patients are similar in terms of their unifying diagnosis of ASI, their history of recurrence requires a more thorough work-up to understand the gamut of pathology present and how to best manage it.

The majority of the statements on diagnostic imaging did not reach strong consensus, which may be as a result of differences in available technology across different hospital settings and is an important external factor to be appreciated. The use of advanced imaging was agreed upon for those at high-risk of recurrence and for the purpose of pre-operative planning, with 3D-CT strongly deemed to be preferrable in the setting of suspected humeral bone-loss. This is supported in the literature, with a recent systematic review by Vopat et al.[272] showing that 3D-CT demonstrated the greatest intra- and interobserver reliabilities for Hill-Sachs measurement and glenoid track calculation. However, there are still some concerns over its use due to the potential concern for radiation exposure in what is primarily a younger population. Thus, some of the authors who have the access and capability prefer to use 3D-MRI, as recent advances in this technology have shown it may have the potential to accurately measure bone-loss. [273] Furthermore, the best-fit circle and glenoid track methods were deemed to be the optimal method for measuring glenohumeral bone-loss, and these are the most commonly utilized methods in the literature.[274] Interestingly, while there was strong consensus that radiographic calculations may underestimate the amount of glenoid bone-loss encountered at the time of arthroscopy, there exists recent literature to rebut this statement.[275] However, this finding may be at least partially reconciled with our consensus statement by the fact that in many parts of the world where universal healthcare exists, there often exists a significant delay between the dates of surgical booking and surgery, during which time additional micro/macro instability events might occur that could conceivably alter the degree of glenoid bone loss encountered at the time of arthroscopy. Therefore, it may be the case that these time-zero findings may not be generally applicable.

Non-operative management for anterior shoulder instability is important to discuss with all patients, but high rates of failure have been reported.[276] A recent meta-analysis demonstrated that nearly half of all patients who underwent non-operative management for primary anterior shoulder instability ultimately required surgery.[210] Additionally, it should be noted that further instability events are not benign and may cause further tissue attenuation, cartilage injury, and bone-loss, predisposing to higher risks of failure of arthroscopic Bankart repair and the requirement for a more invasive surgical procedure.[133, 139, 277, 278] The Neer Circle created consensus statements on the decision-making algorithm for operative versus non-operative management of primary anterior shoulder instability, and the indications/contraindications in our consensus statements are complimentary to that effort.[264]

The only statement not achieving consensus agreement for non-operative management is the preferred position of immobilization of the shoulder in either external or neutral rotation, with only 69% of participants agreeing with this statement. Itoi et al.[12, 13] initially proposed the use of immobilization in external rotation based on cadaveric and MRI findings which showed that the separation and displacement of the labrum were both significantly less in external as compared to internal rotation. Thus, they subsequently conducted a randomized controlled trial that established that immobilization in external rotation for a period of three weeks reduced the recurrence rate by 46.1%.[14, 15] While meta-analyses looking at the outcomes of immobilization in external versus internal rotation have yielded differing results, the most recent and largest one performed by Shinagawa et al. support a short period of immobilization in external rotation following a primary anterior shoulder instability event.[17-19, 21, 22, 279] Many of the participants in our international consensus group expressed strong and mixed opinions on this subject, with concerns voiced about discomfort and a lower compliance rate with immobilization in external rotation, which had led some to subsequently adopt a more neutral position. Additionally, several participants preferred immobilization in internal rotation as they felt that outcomes were comparable, thus not justifying the increased cost of external rotation braces, and that it satisfies the primary purpose of immobilization which is patient comfort. Furthermore, some participants felt that immobilization in external or neutral rotation were not equivalent entities and therefore ultimately disagreed with the unifying statement produced. Thus, while this is actually one of the subtopics with the greatest number of supporting randomized trials to help guide treatment, it was a challenging question to obtain consensus on due to a variety of opinions and dogmatic practices. Finally, there was strong consensus on the stepwise return to play based on individual patient goals rather than time-based criteria, which have been advocated for in recent years.[204, 212]

Arthroscopic Bankart repair is the most common procedure performed worldwide for anterior shoulder instability. The majority of statements in this working group achieved strong consensus, with several being unanimously agreed upon, despite many philosophical differences in treatment among the participants based on their location of practice.[5] However, one of the more controversial topics pertained to the role of open Bankart repair, with several participants having abandoned its use in high-risk patients in favor of a Latarjet procedure, while others still prefer it due to its comparatively lower complication profile. This trend was observed in a database study by Riff et al., who showed that there was a 15% increase and 9% decrease per year in the number of Latarjet and open Bankart procedures being performed in the United States, respectively.[280] The indications for Bankart repair and prognostic factors all achieved strong consensus, although it should be noted that this is one of the best researched topics in the area of shoulder instability, with many large-scale studies evaluating the risk factors for recurrence and treatment algorithms based on this.[207, 281, 282] The extent of critical bone-loss that may predispose a patient to having a high-risk of post-operative recurrence remains controversial, with studies ranging from 15%-25%.[257, 258] However, it is generally agreed upon that the critical threshold may be on the lower end of that spectrum, and this notion is reflected in the consensus that 15-20% is a reasonable cut-off for performing a Bankart repair.

All of the technical factors in performing a Bankart repair achieved strong or unanimous consensus, including the minimum number of anchors to be used (3), location of the first anchor (5:30-6 o'clock), and the spacing between anchors (5-8 mm).[283, 284] This was very interesting due to the wide varieties in training philosophies among members of this group. However, given the several clinical and biomechanical studies evaluating the factors associated with technical success that have been published in recent years, as well as the ease of dissemination of this information through technique journals and online videos, it is unsurprising that this level of consensus was reached. With regards to intra-operative patient positioning, while many surgeons have positioning preferences due to personal bias, familiarity, and training, they agreed that this should be surgeon dependent. Finally, while a recent editorial noted that "rotator interval closure continues to be a challenge in consensus", this group found strong consensus among the participants that rotator interval closure is a potentially useful technique to reduce capsular volume in patients with hyperlaxity.[285, 286] However, rotator interval closure should be avoided in those with isolated anterior shoulder instability as it may cause iatrogenic stiffness.

The Latarjet procedure was agreed with strong consensus to be indicated in patients with a high risk of post-operative recurrent instability.[135, 261, 287-289] This can be attributed to the historically low rate of recurrence associated with this procedure at long-term follow-up.[25, 290-292] Additionally, the ASI-ICG achieved strong consensus on only a few relative contraindications to performing the Latarjet procedure, including glenoid bone-loss in excess of that which a coracoid transfer can correct. The maximum amount of glenoid bone-loss that a coracoid transfer can treat is unclear and surgeon-dependent given the lack of comparative literature. In contrast, the critical amount of glenoid bone-loss for which a Latarjet procedure is indicated has been an area of keen scientific interest and has shown to range between 15-20%.[6, 257, 258]

In recent years, there has been increased interest in performing the Latarjet procedure arthroscopically, with Lafosse et al. pioneering this technique in 2007.[29, 170, 289] The initial results have been shown to result in similar outcomes as compared to the open approach, but this remains a technically challenging procedure that is only advisable in high-volume settings to reduce the potential for complications, as this group has advised.[171, 236] However, despite comparable clinical outcomes, there appears to be a difference in graft positioning between the open and arthroscopic technique, the long-term implications of which are unknown.[293-295] Additionally, due to the non-anatomic nature and proximity to neurovascular structures, there is a concern about the Latarjet procedure's complication rate.[28] This may in part be due to the difficult learning curve associated with this procedure.[123, 296] While some initial studies reported a 30% complication rate, more recent ones have shown this to range between 4%-7% in the hands of high-volume users.[28, 169, 171, 297, 298] Delaney et al.[27] used intraoperative neuromonitoring to show that the axillary and musculocutaneous nerves were most at risk of injury during glenoid exposure and graft insertion. There were several proposed strategies by this group to reduce the complication rate during a Latarjet procedure, including careful identification of the at-risk neurovascular structures and avoidance of graft over-medialization. Additionally, a recent randomized controlled trial by Hurley et al.[299] found that the use of tranexamic acid reduced post-operative hematoma formation and subsequent pain following the open Latarjet procedure.

Recent literature suggests equivalency between the classic and congruent arc methods of Latarjet graft placement.[300-302] While consensus that the Latarjet procedure should be performed using the classic technique was achieved, some participants preferred the congruent arc method owing to the increased arc width it affords. However, the congruent arc technique may not be feasible in patients with thin coracoids (decreased sagittal thickness). Additionally, there was strong consensus that the coracoid should be fixated with two screws, as several biomechanical and clinical studies have shown higher failure rates with suture-button fixation.[303-305] Furthermore, the role of capsular and labral repair remains unclear, and while it is not required in all cases, it may be beneficial in some patients. Finally, while the majority of surgeons prefer the subscapularis split rather than a take-down to minimize damage to the tendon, subscapularis weakness and/or fatty infiltration is still a known sequela of this procedure.[306-308]

Remplissage is primarily indicated in the setting of a Bankart repair in patients with an "off-track" Hill-Sachs lesion due to its ability to fill in the defect, thus rendering the bone defect extra-articular and preventing it from engaging with the glenoid.[32, 33, 262, 263] However, there was strong consensus that a Remplissage is relatively contraindicated in a throwing athlete given the risk of post-operative reduction in range of motion following this procedure.[155] Furthermore, it is unclear whether there exists a threshold for subcritical glenoid bone-loss above which a Remplissage should be abandoned in favor of a Latarjet or glenoid bone-grafting procedure. Nevertheless, Yang et al.[93] found that with greater than 10% glenoid bone-loss, the outcomes were worse in those who received a Bankart repair and Remplissage instead of a Latarjet procedure. The only statement in this group that did not achieve strong consensus was that a Remplissage may be indicated in isolation for patients with recurrent instability who had a previous Latarjet with an unaddressed Hill-Sachs lesion, possibly due to a lack of literature on this topic.

There was strong consensus on all of the technical aspects of the Remplissage procedure. Firstly, it was agreed that external range of motion loss is unlikely to be clinically significant but can be minimized by tenodesing the infraspinatus and posterior capsule within its safe-zone and not over medializing the fixation.[309, 310] Furthermore, it was agreed that there was no optimal fixation method and that if knotted anchors were used, they did not need to be tied under direct visualization. Finally, there was strong consensus agreement that a Remplissage procedure need not alter the rehabilitation protocol of an isolated Bankart repair.

Glenoid bone-grafting is primarily used as a salvage procedure or in patients with more severe glenoid bone-loss.[260, 311] However, a recent randomized controlled trial by Moroder et al.[249] found that iliac crest bone graft transfer resulted in similar clinical results as the Latarjet procedure. Additionally, glenoid bone-grafting may have several potential advantages over the Latarjet procedure, including its ability to accommodate a greater degree of glenoid bone-loss and reduced risk of convulsion-related graft failure in patients with epilepsy.[312] However, it should be noted that uncontrolled epilepsy is a relative contraindication to any stabilization procedure given the higher risk of failure.

The technical aspects of glenoid bone-grafting were agreed to be similar to the Latarjet procedure, but the risk of complications was felt to be lower. Additionally, glenoid bone-grafts may not require hardware for fixation, as the J-bone has been shown to have successful long-term outcomes and has the potential to restore normal glenoid anatomy and can be performed arthroscopically.[313-316] However, the optimal glenoid graft is undefined, with strong consensus that this decision should be based on surgeon preference. Additionally, it was further agreed that only autologous or fresh allogenic bone-graft should be used, as freeze-dried bone-graft result in inferior outcomes.[260] Finally, this group agreed that it was important to differentiate between remodeling and resorption, as true resorption is correlated with inferior outcomes after glenoid bone-grafting.[317-319]

Revision anterior shoulder instability surgery is incredibly complex and is associated with inferior outcomes, a lower rate of return to play, and a higher complication rate as compared to primary surgery. All 10 statements generated by the revision surgery working group achieved >90% agreement among study participants. Notably, there was strong consensus agreement that a revision soft-tissue stabilization can be performed in a non-contact athlete, with minimal bone-loss and good tissue quality. This statement is supported by the limited available literature pertaining to the subject, with a mean rate of recurrence of 15.3% following revision soft tissue stabilization that compares favorably to the rate of recurrence following primary surgery (3-18%).[109, 237, 283, 320] The second part of this statement, that a Remplissage procedure in addition to revision Bankart repair can be performed in the setting of a Hill-Sachs lesion, is supported by a study by Lavoué et al.[321], as they were able to achieve an 81% overall rate of return to play following revision Bankart repair, but outcomes were inferior in patients with medium or deep Hill-Sachs lesions.

Strong consensus was also achieved on the choice of surgical procedure following a failed coracoid transfer and no Hill-Sachs lesion, with the preference being a glenoid bone-grafting procedure. A number of recent studies have described both open and arthroscopic techniques of grafting the anterior glenoid in the setting of a failed Latarjet procedure using either autologous or allogenic bone graft.[234, 247, 248, 322] The French Shoulder and Elbow Society[322] retrospectively reviewed the short-term outcomes of 46 patients treated with the Eden-Hybinette procedure for a failed Latarjet and showed that 86% of shoulders were stable and 80% of patients were satisfied at a mean follow-up of 38 months. However, only 60% were able to return to play, with only 19.5% able to do so at their pre-injury level, and the rate of return to play was significantly correlated with patient age, development of arthritis, and time elapsed between the index and revision procedures. Provencher et al.[234] reviewed their series of 31 patients treated with a fresh distal tibial allograft following a failed Latarjet procedure and found significant improvements in the American Shoulder and Elbow Surgeons (ASES), Single Assessment Numerical Evaluation (SANE), and Western Ontario Shoulder Instability Index (WOSI) scores at a mean follow-up of 47 months as compared to pre-operative values. In addition, despite the 78% rate of coracoid graft resorption pre-operatively, 92% of distal tibial allografts were healed at final follow-up.

Rehabilitation following shoulder stabilization and the timing to return to play are essential factors to consider when treating patients with anterior shoulder instability. Despite the differences between study participants in terms of practice setting and geography, there was unanimous agreement on several of the various statements pertaining to post-operative rehabilitation and return to play. This includes the statement that psychological factors should be considered in the rehabilitation process following operative stabilization for anterior shoulder instability, but that it is unclear how to build this in return to play protocols or testing. Mental readiness, resiliency, and "grit" have recently been identified as an important factor affecting a patient's ability to return to play and their outcome following anterior shoulder stabilization.[205, 323] Weekes et al.[323] showed that 51% of patients treated with arthroscopic stabilization had symptoms of depression on pre-operative screening. While this improved to 24% post-operatively, patients who exhibited continued signs of depression at 1 year had lower WOSI scores than those who did not. Tjong et al.[205] conducted semi-structured qualitative interviews on 25 patients who had undergone anterior stabilization and identified a number of psychological factors impeding their ability to return to play. This included fear of reinjury, mood, self-awareness issues, and self-motivation. Both of these studies highlight the importance of incorporating the assessment of psychological factors in the rehabilitation process. While there was unanimous agreement between study participants that there is a lack of clarity on how to appropriately do so, the recent validation of the Shoulder Instability-Return to Sport after Injury (SIRSI) scale[209] for objective assessment of psychological readiness to return to play provides some hope for demystifying this subject.

The consensus statements pertaining to clinical follow-up yielded >90% agreement for all except three, with the first two stating that patients treated either non-surgically or with stabilization should be followed-up for a minimum of 12 months or until they have returned to full sports for a season, then as needed. Given that treatment success should be defined by a stable, pain-free shoulder with a return to full pre-morbid function, it follows that the majority of participants felt that patients should be followed-up until that milestone was achieved. However, the duration of follow-up is mostly surgeon-dependent and lacks clear evidence-based guidelines, which explains the relatively lower level of consensus achieved on these statements. The third consensus statement that achieved <90% agreement stated that those undergoing a Latarjet procedure should have routine imaging performed at follow-up visits. Many surgeons will obtain a radiograph at the first post-operative visit following a Latarjet procedure to ensure appropriate graft and hardware positioning, and once again after 3 months to ensure graft union before allowing a patient to resume sport-specific training. However, the number of post-operative radiographs obtained is highly surgeon- and center-dependent, which explains the <90% agreement reached on this statement.

Limitations

This study has several potential limitations. Firstly, consensus statements are considered to be Level V data as they represent expert-opinion, which makes them susceptible to inherent biases in the selection and allocation of participants.[269, 324] However, we sought to include surgeons who have an active interest and level of expertise in this area, as evidenced by their clinical and academic achievements on the topic. Furthermore, the questions and topics addressed may represent a potential source of bias as there was no standardized process for generating them. Instead, they were each selected and agreed upon by the group leaders. Additionally, while it was not possible to have in-person meetings to openly discuss these statements, all authors had the opportunity to amend statements which they did not agree upon through virtual communication means. Lastly, all of the included authors had the opportunity to contribute to the manuscript and raise points for discussion. This was done in a blinded fashion in an effort to further reduce potential sources of bias.

Conclusions

These consensus statements represent expert agreement on the management of anterior shoulder instability. The majority of statements reached unanimous or strong consensus, and ultimately these statements may provide surgeons with guidelines for treating patients with anterior shoulder instability.

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