

Clinical Outcomes of Shoulder Stabilization in Females With Glenoid Bone Loss

Rachel M. Frank,^{*†} MD, Hytham S. Salem,[†] MD, Catherine Richardson,[‡] BS, Michael O'Brien,[‡] BS, Jon M. Newgren,[‡] MA, Brian J. Cole,[‡] MD, MBA, Nikhil N. Verma,[‡] MD, Gregory P. Nicholson,[‡] MD, and Anthony A. Romeo,[§] MD

Investigation performed at Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, Illinois, USA

Background: Nearly all studies describing shoulder stabilization focus on male patients. Little is known regarding the clinical outcomes of female patients undergoing shoulder stabilization, and even less is understood about females with glenoid bone loss.

Purpose: To assess the clinical outcomes of female patients with recurrent anterior shoulder instability treated with the Latarjet procedure.

Study Design: Case series; Level of evidence, 4.

Methods: All cases of female patients who had recurrent anterior shoulder instability with $\geq 15\%$ anterior glenoid bone loss and underwent the Latarjet procedure were analyzed. Patients were evaluated after a minimum 2-year postoperative period with scores of the American Shoulder and Elbow Surgeons form, Simple Shoulder Test, and pain visual analog scale.

Results: Of the 22 patients who met our criteria, 5 (22.7%) were lost to follow-up, leaving 17 (77.2%) available for follow-up with a mean \pm SD age of 31.7 ± 12.9 years. Among these patients, 16 (94.1%) underwent 1.6 ± 0.73 ipsilateral shoulder operations (range, 1-3) before undergoing the Latarjet procedure. Preoperative indications for surgery included recurrent instability with bone loss in all cases. After a mean follow-up of 40.2 ± 22.9 months, patients experienced significant score improvements in the American Shoulder and Elbow Surgeons form, Simple Shoulder Test, and pain visual analog scale ($P < .05$ for all). There were 2 reoperations (11.8%). There were no cases of neurovascular injuries or other complications.

Conclusion: Female patients with recurrent shoulder instability with glenoid bone loss can be successfully treated with the Latarjet procedure, with outcomes similar to those of male patients in the previously published literature. This information can be used to counsel female patients with recurrent instability with significant anterior glenoid bone loss.

Keywords: shoulder instability; females; glenoid reconstruction

Anterior shoulder instability remains a growing concern, with recurrence rates approaching 90% or greater in the setting of clinically significant anterior glenoid bone loss.^{25,26} Among the various types of shoulder instability, anterior shoulder instability is the most common, affecting an estimated 1.7% of the general population.¹⁵ Patients with recurrent anterior instability often have soft tissue pathology, including a Bankart lesion, as well as bony pathology in the form of anterior glenoid bone loss. Bony defects greater than 15% to 25% of the glenoid surface are known to result in a biomechanically unstable glenohumeral joint.¹⁸ In cases of critical bone loss, soft tissue stabilization alone is insufficient to restore shoulder stability, and a procedure aimed at restoring the bone stock is indicated.^{5,19,23,25}

Anterior glenoid reconstructive options include the Latarjet procedure;^{8,29} iliac crest autograft reconstruction; and osteochondral allograft reconstruction of the glenoid with a variety of allografts, such as iliac crest bone graft, fresh glenoid allograft, and distal tibial allograft. Among these options, the Latarjet procedure is the most common method of bony glenoid reconstruction.²⁹ It provides shoulder stability via a synergistic effect of 2 mechanisms: the bone-block effect from the transferred coracoid graft and the sling effect produced by the subscapularis and the transferred conjoint tendon.^{14,34} Given the inherent morphologic differences between male and female glenohumeral anatomy,²⁰ sex-specific analyses of the Latarjet procedure may be beneficial additions to the current literature.

The majority of patients who present with shoulder instability are male.³⁵ Thus, most studies reporting outcomes of shoulder stabilization surgery focus on male patients. Specifically, recent large-scale studies addressing shoulder instability have been composed of only 18% to 21%

The Orthopaedic Journal of Sports Medicine, 9(5), 23259671211007525
DOI: 10.1177/23259671211007525
© The Author(s) 2021

This open-access article is published and distributed under the Creative Commons Attribution - NonCommercial - No Derivatives License (<https://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits the noncommercial use, distribution, and reproduction of the article in any medium, provided the original author and source are credited. You may not alter, transform, or build upon this article without the permission of the Author(s). For article reuse guidelines, please visit SAGE's website at <http://www.sagepub.com/journals-permissions>.

of female patients.^{21,30} Sex-specific outcome data are lacking to help guide surgeons considering shoulder stabilization surgery in females who have glenoid bone loss. To this end, the purpose of the present study is to assess clinical outcomes in female patients with recurrent anterior shoulder instability and glenoid bone loss treated with the Latarjet procedure. We hypothesized that females with glenoid bone loss who are treated with the Latarjet procedure could be successfully treated with the Latarjet procedure.

METHODS

Sample Selection

After institutional review board approval, a retrospective analysis of prospectively collected data was performed. Female patients who underwent the Latarjet procedure at 1 of 2 institutions between June 2007 and November 2014 were included. Exclusion criteria included patients with evidence of systemic hyperlaxity, ipsilateral arm neurologic injury, and posterior and/or multidirectional instability.

From an initial group of 136 patients, 22 met our criteria. Five patients were lost to follow-up, leaving 17 in the final cohort. A flowchart of the enrollment process is shown in Figure 1.

Clinical Indications

Indications for surgery were recurrent shoulder instability with anterior glenoid bone loss >15% of the glenoid surface area. The amount of glenoid bone loss was assessed via the perfect circle method,³² determined by the percentage of missing glenoid relative to the surface area of the glenoid on the en face axial 3-dimensional reconstruction view, with the inferior portion of the glenoid assumed to be estimated by a circle of best fit.

In all cases, patients underwent a brief diagnostic arthroscopy in the beach-chair position prior to the procedure and then underwent the Latarjet coracoid bone transfer. The status of the humeral head was assessed via preoperative imaging and intraoperative assessment.

Surgical Technique

All surgical procedures were performed by senior fellowship-trained sports medicine and shoulder surgeons (B.J.C., N.N.V., G.P.N., A.A.R.). The surgical techniques for reconstruction of the anterior glenoid rim with a coracoid transfer procedure have been described.^{2,10,27,28} After a brief diagnostic arthroscopy in the beach-chair position, the head of the bed was lowered to approximately 40°, with the arm placed in a commercially available arm holder. A modified deltopectoral exposure was performed in all cases.

The conjoined tendon and coracoid process were identified, and the coracoid process was freed from soft tissues superiorly (coracoacromial ligament), medially (pectoralis minor), and along its undersurface with a periosteal elevator. A ruler was used to ensure that at least 20 to 22 mm of coracoid graft could be harvested. A 90° oscillating saw was used to osteotomize the coracoid just anterior to the coracoclavicular ligament insertion at the coracoid base. An osteotome was then used to complete the osteotomy. Care was taken to protect the neurovascular structures during harvest of the coracoid process. The inferior edge of the coracoid surface was subsequently decorticated with a burr to prepare for eventual compression with the anterior rim of the glenoid, resulting in flush joining of the lateral edge of the coracoid anterior glenoid articular surface. Two bicortical drill holes were placed along the longitudinal axis of the coracoid graft about 1 cm apart, and the graft was stored distally while the glenoid was exposed.

After superficial dissection, exposure of the glenohumeral capsule was achieved via a subscapularis splitting approach.³ After capsulotomy, the joint was exposed, and any viable capsule-labral tissue was elevated from the anterior glenoid rim. A high-speed burr was then used to decorticate the anterior glenoid rim to a bleeding surface for future articulation with the bone graft.

The coracoid graft was retrieved from the wound, brought to the anterior rim of the glenoid, and secured into place with K-wires through the previously established drill holes. The bone graft was subsequently fixed into place via a lag technique with 2 fully threaded bicortical interference screws with washers or a miniplate. For the

*Address correspondence to Rachel M. Frank, MD, Department of Orthopaedic Surgery, School of Medicine, University of Colorado, 12631 E 17th Avenue, Mail Stop B202, Aurora, CO 80045, USA (email: rachel.frank@ucdenver.edu) (Twitter: @RachelFrankMD).

[†]Department of Orthopaedic Surgery, School of Medicine, University of Colorado, Aurora, Colorado, USA.

[‡]Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, Illinois, USA.

[§]Department of Orthopaedic Surgery, DuPage Medical Group, Joliet, Illinois, USA.

Final revision submitted November 20, 2020; accepted December 21, 2020.

One or more of the authors has declared the following potential conflict of interest or source of funding: R.M.F. has received grant support from Arthrex and educational support from Arthrex/Medwest and Smith & Nephew. B.J.C. has received research support from Aesculap/B. Braun, Arthrex, and Regentis; educational support from Medwest; consulting fees from Acumed, Anika Therapeutics, Arthrex, Bioventus, Flexion Therapeutics, Geistlich Pharma, Smith & Nephew, Vericel, and Zimmer Biomet; speaking fees from Arthrex, GE Healthcare, and Lifenet Health; and royalties from Arthrex, Elsevier, DJO, and *Operative Techniques in Sports Medicine*. B.J.C. also has stock/stock options in Ossio and Regentis. N.N.V. has received research support from Arthrex, ArthroSurface, Athletico, ConMed Linvatec, DJO, Miomed, Mitek, Ossur, and Smith & Nephew; consulting fees from Arthrex, Minivasive, and Orthospace; and royalties from Smith & Nephew and Vindico Medical-Orthopedics Hyperguide. N.N.V. also has stock/stock options in Cymedica, Minivasive, and Omeros. G.P.N. has received consulting fees from Tornier and Wright Medical, speaking fees from ArthroSurface, and royalties from Innomed and Wright Medical. A.A.R. has received research support from Aesculap/B. Braun, Arthrex, Histogenics, Medipost, NuTech, OrthoSpace, Smith & Nephew, and Zimmer; consulting fees and speaking fees from Arthrex; other financial or material support from Major League Baseball; and royalties from Arthrex, Saunders/Mosby-Elsevier, and SLACK. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Ethical approval for this study was obtained from Rush University Medical Center (11072904IRB01-CR05).

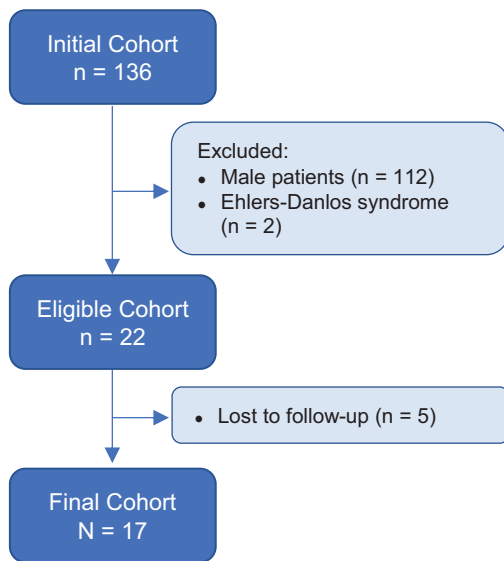


Figure 1. Enrollment flowchart.

majority of patients, the screws were typically 32 to 38 mm in length. However, it has been shown that males have larger glenoids and coracoids in all dimensions than females.^{17,24} Thus, female patients were likely to require shorter screw lengths than their male counterparts.

Rehabilitation

A shoulder sling with an abduction pillow was used to support the arm for the first 4 to 6 weeks after surgery. Pendulums and passive range of motion in the scapular plane were permitted after week 2. Active assisted range of motion was permitted at week 4. Use of the sling was discontinued between weeks 4 and 6, and gentle strengthening was permitted at week 6. Full return to activity was expected at approximately 4 to 6 months postoperatively, with contact sports restricted until at least 6 months postoperatively.

Data Collection

Patients were evaluated preoperatively and after a minimum of 2 years postoperatively with the American Shoulder and Elbow Surgeons (ASES) form, Simple Shoulder Test (SST), and visual analog scale (VAS) for pain. Clinical assessments for range of motion were performed with patients in the standing position using a goniometer. At final follow-up, all postoperative complications, reoperations, and episodes of recurrent instability were collected from patient medical records and recorded for analysis.

Statistical Analysis

Descriptive analysis consisted of frequencies and percentages for categorical data, while means and standard deviations as well as medians and interquartile ranges (IQRs) were reported for continuous data. After using the Shapiro-

TABLE 1
Patient Demographics^a

	Original Population (n = 22)	Final Cohort (n = 17)
Age, y	33.4 ± 12.6	31.7 ± 12.9
Body mass index, kg/m ²	24 ± 4.9	23.8 ± 5.2
Glenoid defect size, %	27.1 ± 8.5	24.0 ± 6.5
Smoking status		
Yes	1	1
No	21	16
Prior surgery		
Yes	21	16
No	1	1
No. of prior ipsilateral surgical procedures	1.6 ± 0.7	1.6 ± 0.7
Postoperative dislocation		
Yes	1	1
No	21	16
Reoperation		
Yes	8	6
No	13	10
Unknown	1	1

^aData are reported as mean ± SD or No. of patients.

Wilk test to confirm that the collected data followed normal distributions, paired *t* tests were performed to compare pre- and postoperative measures, including ASES, SST, and VAS scores (SPSS Statistics Version 21.0; IBM). Statistical significance was assumed at *P* < .05.

RESULTS

Demographics

Table 1 shows the demographics of the initial and final cohorts (5 patients [22.7%] lost to follow-up). Of the 17 patients included for analysis, 16 (94.1%) had undergone a mean ± SD 1.6 ± 0.7 ipsilateral shoulder operations (range, 1-3) before undergoing the Latarjet procedure (Table 2). All patients had a history of recurrent anterior instability. Preexisting conditions were fibromyalgia (n = 1; 5.9%), seizure disorder (n = 1; 5.9%), and abnormal involuntary movement disorder (n = 1; 5.9%). Intraoperatively, no patients had clinically significant or engaging Hill-Sachs lesions that required concomitant surgical management (remplissage or humeral head bone grafting). The mechanism of injury was available for 13 (76.5%) of the 17 patients (Table 3).

Clinical Outcomes

Clinical outcome data were available at a mean 40.2 ± 22.9 months (range, 24-116 months) postoperatively. There were significant pre- to postoperative improvements in ASES, SST, and VAS outcome scores (*P* < .05 for all) (Table 4). The median ASES score was 38.3 (IQR, 27.5-60.8) preoperatively and 93.3 (IQR, 63.3-97.5)

TABLE 2
Prior Surgery

Prior Surgery	No. of Procedures	Years Before Index Latarjet
No. 1 (16 patients)		
Arthroscopic soft tissue repair	11	3.7
Arthroscopic capsulorrhaphy	2	9.9
Putti-Platt procedure	1	31.9
Open soft tissue repair	1	15.8
Arthroscopic rotator cuff repair	1	3.8
No. 2 (7 patients) ^a		
Arthroscopic soft tissue repair	5	3.4
Open soft tissue repair	1	3.9
Capsular shift	1	13.9
Arthroscopic rotator cuff repair	1	1.8
No. 3 (2 patients)		
Arthroscopic soft tissue repair	2	3.9

^aThe sum of procedures is 8 because 1 patient underwent rotator cuff repair with concomitant soft tissue repair.

TABLE 3
Mechanism of Injury

Water skiing accident
Lock dislocation during seizure
Lifting a heavy duffle bag
Fall on outstretched arm (not during sport activity)
Fall off monkey bars
Fall on outstretched arm while playing racquetball
15-y history of recurrent dislocations of unknown origin
Fall on outstretched arm while playing soccer
Fall from a tree
Fall on outstretched arm while playing basketball
Diving to make a catch while playing softball
Fall down the stairs
Yoga

TABLE 4
Clinical Outcome Scores^a

	Preoperative	Postoperative	P Value
ASES	42.8 ± 19.5 (11.7-71.7)	80.7 ± 21.0 (34.1-100)	.001
ASES functional	10.9 ± 8.5 (0-25)	23.9 ± 16.3 (13-30)	.001
SST	37.5 ± 24.1 (0-83.3)	79.9 ± 19.7 (50-100)	.003
VAS pain	4.5 ± 2.5 (2-10)	1.4 ± 2.6 (0-7.5)	.001

^aData are reported as mean ± SD (range). ASES, American Shoulder and Elbow Surgeons; SST, Simple Shoulder Test; VAS, visual analog scale.

postoperatively. The median SST score was 33.3 (IQR, 16.7-50.0) preoperatively and 91.7 (IQR, 58.3-95.8) postoperatively. The median VAS pain score was 4 (IQR, 0-5.3) pre- and 0 (IQR, 0-2.5) postoperatively.

At final follow-up, the median range of motion values were 160° (IQR, 137.5°-175°) of forward flexion,

TABLE 5
Range of Motion^a

	Range of Motion, deg
Forward flexion	150.5 ± 33.2 (70-180)
Internal rotation at 90°	40.5 ± 16.9 (15-75)
External rotation at 90°	76.5 ± 13.2 (60-95)
Extension	55.3 ± 13.2 (35-75)
Abduction	146.4 ± 46.7 (47-180)

^aData are reported as mean ± SD (range).

35° (IQR, 32.5°-50°) of internal rotation at 90° abduction, 75° (IQR, 66°-90°) of external rotation at 90° abduction, 55° (IQR, 46.5°-67.5°) of extension, and 170° (IQR, 132.5°-178°) of abduction (Table 5).

Complications and Reoperations

There were 2 complications (11.8%), both of which required reoperation (Table 6). One of the complications was in a patient who had a self-reported abnormal involuntary movement disorder. This patient experienced wound dehiscence and infection at 10 weeks postoperatively, which resolved with antibiotic treatment. Eight months after surgery, this patient experienced rotator cuff tendonitis and ultimately underwent arthroscopic debridement with subacromial decompression 1 year after Latarjet. Approximately 3.5 years later, this same patient experienced continued pain and was diagnosed with a rotator cuff tear and biceps tendonitis. She underwent an open proximal biceps tenodesis and arthroscopic cuff debridement 4.5 years after the Latarjet procedure. The other patient requiring reoperation experienced flattening of the medial aspect of the humeral head and recurrent instability. She underwent a total shoulder arthroplasty 6 months after the Latarjet procedure. This procedure failed, and the patient underwent reverse total shoulder arthroplasty 9 months afterward. This was the only patient who reported instability after the glenoid reconstruction; therefore, the recurrent instability rate for the entire cohort was 5.9%.

DISCUSSION

The principal findings of this study show that female patients with recurrent anterior shoulder instability and glenoid bone loss can be successfully treated with the Latarjet procedure. Our results demonstrated similar outcomes at nearly 4-year follow-up as compared with historical male controls.^{9,13} Notably, in this series, female patients with recurrent anterior instability experienced significant improvements in ASES, SST, and VAS scores. Only 1 patient in our cohort who underwent the Latarjet for glenoid bone augmentation experienced recurrent instability, for an overall recurrence rate of 5.9%, consistent with previously published rates of 1% to 8%.^{4,11,31} In this case, the patient was a 45-year-old woman who experienced flattening of the medial aspect of the humeral head, recurrent instability, and proprioceptive issues that led to eventual

TABLE 6
Complications and Reoperations^a

Age at Surgery, y	Prior Surgery	Complications	Required Surgery?	Intervention	Comorbidities
26	(1) Soft tissue stabilization 5 y before Latarjet; (2) Repeat soft tissue stabilization 4.5 y before Latarjet; (3) Arthroscopy, debridement, and removal of prior metal suture anchors	(1) Wound dehiscence and infection at 10 wk after surgery; (2) RC tendonitis 8 mo after surgery; (3) Continued pain, RC tear, biceps tendinitis	(1) No; (2) Yes; (3) Yes	(1) Resolved with antibiotics; (2) SAD and debridement 1 y after Latarjet; (3) Open proximal biceps tenodesis and arthroscopic debridement 4.5 y after Latarjet.	Abnormal involuntary movement disorder; Sweet syndrome
45	None	(1) Flattening of the medial aspect of the humeral head, instability, proprioceptive issue; (2) Persistent instability	(1) Yes; (2) Yes	(1) TSA 6 mo after Latarjet; (2) RTSA 9 mo after Latarjet	None

^aRC, rotator cuff; RTSA, reverse total shoulder arthroplasty; SAD, subacromial decompression; TSA, total shoulder arthroplasty.

conversion to total shoulder arthroplasty 6 months after the Latarjet procedure. The arthroplasty ultimately failed, requiring revision arthroplasty 9 months after the Latarjet.

At a mean follow-up of 40.2 months, we observed a complication rate of 11.8% (2 of 17 patients), similar to previously described rates in patients undergoing the Latarjet procedure.^{1,31} In a case series by Shah et al,³¹ 47 patients underwent the Latarjet procedure for anterior shoulder instability and glenoid bone deficiency. Patients were evaluated at a mean follow-up of 9.4 months, and the authors reported a complication rate of 25%. This included a postoperative infection rate of 6%, recurrent instability rate of 8%, and a neurologic injury rate of 10%. Athwal et al¹ reported on a series of 83 patients undergoing the Latarjet procedure for anterior shoulder instability with a mean follow-up of 17 months. The authors observed a 24% complication rate, with 4% of patients experiencing early recurrent instability. In light of the similar results from these studies evaluating both males and females, our findings indicate that female patients with recurrent shoulder instability and glenoid bone loss can be successfully treated with Latarjet and expect similar clinical outcomes and complication rates as compared with historically male-dominated cohorts.

Anatomic studies have identified morphologic variations between male and female shoulders that may have implications related to biomechanics of the Latarjet procedure.^{16,20,22} Ljungquist et al²² performed a cadaveric study to compare the bony dimensions of the coracoid and glenoid between male and female scapulae. They found that the width and length of the glenoid and coracoid were significantly larger in male versus female specimens. Furthermore, the mean thickness of the coracoid was 35.4% of the glenoid width in male specimens, as compared with 34.4% in female samples ($P = .039$). Moreover, Chahla et al⁶ reported that the mean distance between the coracoid apex and trapezoid ligament was 28.1 mm for male specimens and 22.0 mm for female specimens. This may

represent a clinically relevant sex-related difference when performing a coracoid osteotomy in the setting of a Latarjet procedure.

Sex-related differences in sport participation are important to consider when comparing the outcomes of shoulder-stabilization surgery in males and females. Although female participation in athletics has consistently increased over the past several decades, male athletes continue to make up a larger proportion of sport participants.⁷ In a recent multicenter study evaluating return to play after the Latarjet procedure, 91% of patients were men.¹² Another multicenter study including 308 patients undergoing the Latarjet reported that 91.5% of participants were competitive or recreational athletes.³³ In the current study, only 5 of 17 female patients (29.4%) who underwent the Latarjet procedure were injured during athletic participation. This indicates that sex-related differences may exist in the mechanism of injury and postoperative expectations among male and female patients who undergo the Latarjet procedure.

The present study has several strengths. To our knowledge, it is the first attempt to assess clinical outcomes in female patients with recurrent anterior shoulder instability treated with the Latarjet procedure. Furthermore, a consecutive cohort of patients was analyzed to minimize the introduction of selection bias. Finally, a standardized rehabilitation protocol was implemented to avoid effect modification by differing rehabilitation regimens.

Limitations

Our study is limited by a relatively small sample of patients. In addition, a relatively low follow-up rate (77.2%) may have introduced attrition bias, thereby limiting the internal validity of our results. Last, this was not a single-surgeon study; therefore, differing levels of experience and/or technical skill may have influenced our results.

CONCLUSION

Female patients with recurrent shoulder instability with glenoid bone loss can be successfully treated via the Latarjet procedure, with outcomes similar to those of historically male-dominated cohorts. This information can be used to counsel female patients who have recurrent instability with significant anterior glenoid bone loss.

REFERENCES

- Athwal GS, Meislin R, Getz C, Weinstein D, Favorito P. Short-term complications of the arthroscopic Latarjet procedure: a North American experience. *Arthroscopy*. 2016;32(10):1965-1970.
- Bhatia S, Frank RM, Ghodadra NS, et al. The outcomes and surgical techniques of the Latarjet procedure. *Arthroscopy*. 2014;30(2):227-235.
- Boileau P, Mercier N, Roussanne Y, Thelu CE, Old J. Arthroscopic Bankart-Bristow-Latarjet procedure: the development and early results of a safe and reproducible technique. *Arthroscopy*. 2010;26(11):1434-1450.
- Burkhart SS, de Beer JF, Barth JR, Cresswell T, Roberts C, Richards DP. Results of modified Latarjet reconstruction in patients with anterior inferior instability and significant bone loss. *Arthroscopy*. 2007;23(10):1033-1041.
- Burkhart SS, de Beer JF, Tehrani AM, Parten PM. Quantifying glenoid bone loss arthroscopically in shoulder instability. *Arthroscopy*. 2002;18(5):488-491.
- Chahla J, Marchetti DC, Moatshe G, et al. Quantitative assessment of the coracoacromial and the coracoclavicular ligaments with 3-dimensional mapping of the coracoid process anatomy: a cadaveric study of surgically relevant structures. *Arthroscopy*. 2018;34(5):1403-1411.
- Deaner RO, Geary DC, Puts DA, et al. A sex difference in the predisposition for physical competition: males play sports much more than females even in the contemporary US. *PLoS One*. 2012;7(11):e49168.
- Degen RM, Camp CL, Werner BC, Dines DM, Dines JS. Trends in bone-block augmentation among recently trained orthopaedic surgeons treating anterior shoulder instability. *J Bone Joint Surg Am*. 2016;98(13):e56.
- du Plessis JP, Dachs RP, Vrettos BC, et al. The modified Latarjet procedure in female patients: clinical outcomes and complications. *J Shoulder Elbow Surg*. 2018;27(1):e9-e15.
- Frank RM, Romeo AA, Provencher MT. Glenoid reconstruction with distal tibia allograft for recurrent anterior shoulder instability. *Orthopedics*. 2017;40(1):e199-e205.
- Frank RM, Romeo AA, Richardson C, et al. Outcomes of Latarjet versus distal tibia allograft for anterior shoulder instability repair: a matched cohort analysis. *Am J Sports Med*. 2018;46(5):1030-1038.
- Frantz TL, Everhart JS, Cvetanovich GL, et al. Are patients who undergo the Latarjet procedure ready to return to play at 6 months? A Multicenter Orthopaedic Outcomes Network (MOON) shoulder group cohort study. *Am J Sports Med*. 2020;48(4):923-930.
- Gilat R, Haunschild ED, Lavoie-Gagne OZ, et al. Outcomes of the Latarjet procedure versus free bone block procedures for anterior shoulder instability: a systematic review and meta-analysis. *Am J Sports Med*. 2021;49(3):805-816.
- Giles JW, Boons HW, Elkinson I, et al. Does the dynamic sling effect of the Latarjet procedure improve shoulder stability? A biomechanical evaluation. *J Shoulder Elbow Surg*. 2013;22(6):821-827.
- Hettrich CM, Cronin KJ, Raynor MB, et al. Epidemiology of the Frequency, Etiology, Direction, and Severity (FEDS) system for classifying glenohumeral instability. *J Shoulder Elbow Surg*. 2019;28(1):95-101.
- Iannotti JP, Gabriel JP, Schneck SL, Evans BG, Misra S. The normal glenohumeral relationships: an anatomical study of one hundred and forty shoulders. *J Bone Joint Surg Am*. 1992;74(4):491-500.
- Imma, II, Nizlan NM, Ezamin AR, Yusoff S, Shukur MH. Coracoid process morphology using 3D-CT imaging in a Malaysian population. *Malays Orthop J*. 2017;11(2):30-35.
- Itoi E, Lee SB, Berglund LJ, Berge LL, An KN. The effect of a glenoid defect on antero-inferior stability of the shoulder after Bankart repair: a cadaveric study. *J Bone Joint Surg Am*. 2000;82(1):35-46.
- Itoi E, Yamamoto N, Kurokawa D, Sano H. Bone loss in anterior instability. *Curr Rev Musculoskelet Med*. 2013;6(1):88-94.
- Jacobson A, Gilot GJ, Hamilton MA, et al. Glenohumeral anatomic study: a comparison of male and female shoulders with similar average age and BMI. *Bull Hosp Jt Dis (2013)*. 2015;73(suppl 1):S68-S78.
- Kraeutler MJ, McCarty EC, Belk JW, et al. Descriptive epidemiology of the MOON shoulder instability cohort. *Am J Sports Med*. 2018;46(5):1064-1069.
- Ljungquist KL, Butler RB, Griesser MJ, Bishop JY. Prediction of coracoid thickness using a glenoid width-based model: implications for bone reconstruction procedures in chronic anterior shoulder instability. *J Shoulder Elbow Surg*. 2012;21(6):815-821.
- Lo IK, Parten PM, Burkhart SS. The inverted pear glenoid: an indicator of significant glenoid bone loss. *Arthroscopy*. 2004;20(2):169-174.
- Mathews S, Burkhard M, Serrano N, et al. Glenoid morphology in light of anatomical and reverse total shoulder arthroplasty: a dissection- and 3D-CT-based study in male and female body donors. *BMC Musculoskelet Disord*. 2017;18(1):9.
- Piasecki DP, Verma NN, Romeo AA, Levine WN, Bach BR Jr, Provencher MT. Glenoid bone deficiency in recurrent anterior shoulder instability: diagnosis and management. *J Am Acad Orthop Surg*. 2009;17(8):482-493.
- Provencher MT, Bhatia S, Ghodadra NS, et al. Recurrent shoulder instability: current concepts for evaluation and management of glenoid bone loss. *J Bone Joint Surg Am*. 2010;92(suppl 2):133-151.
- Provencher MT, Ghodadra N, LeClere L, Solomon DJ, Romeo AA. Anatomic osteochondral glenoid reconstruction for recurrent glenohumeral instability with glenoid deficiency using a distal tibia allograft. *Arthroscopy*. 2009;25(4):446-452.
- Provencher MT, LeClere LE, Ghodadra N, Solomon DJ. Postsurgical glenohumeral anchor arthropathy treated with a fresh distal tibia allograft to the glenoid and a fresh allograft to the humeral head. *J Shoulder Elbow Surg*. 2010;19(6):e6-e11.
- Riff AJ, Frank RM, Sumner S, et al. Trends in shoulder stabilization techniques used in the United States based on a large private-payer database. *Orthop J Sports Med*. 2017;5(12):2325967117745511.
- Rugg CM, Hettrich CM, Ortiz S, Wolf BR, Zhang AL. Surgical stabilization for first-time shoulder dislocators: a multicenter analysis. *J Shoulder Elbow Surg*. 2018;27(4):674-685.
- Shah AA, Butler RB, Romanowski J, Goel D, Karadagli D, Warner JJP. Short-term complications of the Latarjet procedure. *J Bone Joint Surg Am*. 2012;94(6):495-501.
- Sugaya H, Moriishi J, Dohi M, Kon Y, Tsuchiya A. Glenoid rim morphology in recurrent anterior glenohumeral instability. *J Bone Joint Surg Am*. 2003;85(5):878-884.
- Werthel JD, Sabatier V, Schoch B, et al. Outcomes of the Latarjet procedure for the treatment of chronic anterior shoulder instability: patients with prior arthroscopic Bankart repair versus primary cases. *Am J Sports Med*. 2020;48(1):27-32.
- Yamamoto N, Muraki T, An KN, et al. The stabilizing mechanism of the Latarjet procedure: a cadaveric study. *J Bone Joint Surg Am*. 2013;95(15):1390-1397.
- Zacchilli MA, Owens BD. Epidemiology of shoulder dislocations presenting to emergency departments in the United States. *J Bone Joint Surg Am*. 2010;92(3):542-549.