Arthroscopic Latarjet—learning curve, results, and complications

David Saliken, Pascal Boileau

Department of Orthopaedic Surgery and Sports Traumatology, iULS (Institut Universitaire Locomoteur & Sport), Hôpital Pasteur 2, University Côte d'Azur, Nice, France

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Correspondence to: Pascal Boileau, MD. Department of Orthopaedic Surgery and Sports Traumatology, iULS (Institut Universitaire Locomoteur & Sport), Hôpital Pasteur 2, University Côte d'Azur, 30 Voie Romaine, 06001 Nice Cedex 1, France. Email: Boileau.P@chu-nice.fr.

Abstract: The Latarjet procedure was developed by the French surgeon Michel Latarjet in 1954 to treat recurrent glenohumeral instability and provides enhanced stability through a triple-blocking mechanism: reconstruction of glenoid bone loss through the coracoid bone block, a "sling-effect" of a lowered subscapularis, and a bumper mechanism through a labral repair. It is typically indicated in cases of significant glenoid bone loss and can also be used effectively in other high-risk patients (young, hyper-lax, contact or competitive sports) or in the revision setting. It has classically been performed through an open approach but since 2007 has also been performed arthroscopically. Multiple grafts can be used (autograft coracoid, autograft iliac crest, allograft) with many modes of fixation (one or two bicortical screws, cortical button, suture anchor, or implant-less). While the arthroscopic procedure is technically demanding and a learning curve has been demonstrated, it can be completed successfully with good union rates and minimal complications in these complex patients. Benefits of the arthroscopic technique generally include decreased bleeding, less post-operative pain, ability to treat concomitant pathology, and better cosmesis. However, the most important benefit to the arthroscopic Latarjet may be the improved intra- and extra-articular visualization, which allows excellent bone graft positioning and protection of neurovascular structures. In this review article, we discuss findings associated with the learning curve, results, and complications of the arthroscopic Latarjet procedure.

Keywords: Arthroscopic Latarjet; glenohumeral instability; shoulder dislocation; glenoid bone loss

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Learning curve

Nourissat *et al.* described an arthroscopically assisted, mini-open Latarjet technique in 2006 (1). The following year, Boileau *et al.* described the first clinical application performing an arthroscopic Bristow in 40 high-risk patients with recurrent glenohumeral instability (2). Lafosse *et al.* then described an all-arthroscopic Latarjet technique performed in the beach chair position using two screws (3). In the time since these first clinical applications of the arthroscopic Latarjet, a learning curve has been described in achieving efficient and effective completion (3-5).

While different versions have been published, in general the arthroscopic Latarjet is performed through five major steps: coracoid preparation, drilling, and osteotomy; glenoid preparation; subscapularis splitting with axillary nerve protection; coracoid transfer and fixation; and at our institution a Bankart repair. In a survey by the French Arthroscopy Society, the most difficult steps involved subscapularis splitting, coracoid transfer, and hardware placement (6). They evaluated the learning experience of five surgeons' first 25 cases each and noted recurrent instability in 6%, neurologic injury in 0.8%, need for revision in 0.8%, and 8% hematoma; showing that even in

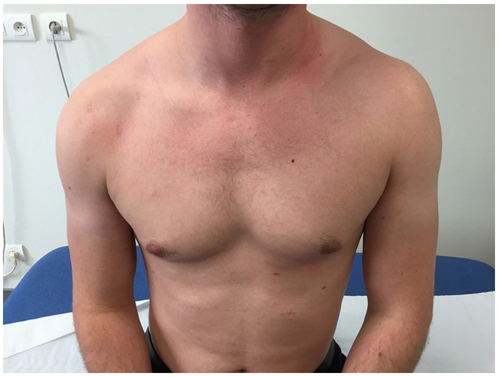

Figure 1 Post-operative clinical image at 6 months demonstrating excellent cosmesis following arthroscopic Latarjet.

the early performance of the arthroscopic Latarjet, it could be safely completed.

Further learning curve analysis has been performed by Kany *et al.*, who prospectively evaluated 104 patients and compared their first 30 patients to their last 30 (with 44 procedures in between) (4). They noted three complications during their initial phase (two bone block fractures and one malpositioned screw) and none in their second phase. Their accuracy of positioning the bone block significantly improved in their second cohort of patients and their surgical duration decreased from 103 minutes to 76 minutes. Many studies have similarly found a decrease in operative time when analyzing their learning curves (4,5,7,8). Cunningham *et al.* reduced their operative time from 183 to 150 minutes after ten cases, then to 95 minutes after another ten cases which matched their open Latarjet duration (5). Although we have seen a learning curve with the arthroscopic Latarjet, this has also been shown with the open Latarjet by Dauzère *et al.* (9). The authors evaluated their first 69 open Latarjet procedures and found that with experience, their surgical duration decreased along with early complications. It is important to further contextualize these learning curves by noting that there have been learning curves demonstrated for other arthroscopic procedures including hip arthroscopy and arthroscopic rotator cuff repairs (10,11).

As surgeons have a learning curve, so to do procedures. With increasing knowledge and experience, the arthroscopic technique has been refined and guided systems developed to increase reproducibility and potentially reduce complications (12,13). That being said, there is a learning curve for an individual surgeon to anticipate in the form of comfort of the operation, surgical duration and potentially in accurate graft positioning. Therefore, when a surgeon is first performing the procedure they should keep in the mind the option to convert intra-operatively to the open technique; Cunningham *et al.* converted from arthroscopic to open during 3 of their first 10 cases but none of their remaining 18 cases required intra-operative conversion (5).

In general, we recommend a step-wise learning approach including a surgical observership and cadaver training prior to performance on patients. With proper preparation, the arthroscopic Latarjet can be performed safely and reproducibly. For the procedure to become widespread, it must be safe, but should also reliably produce good results. Indeed, evidence is growing that supports the efficacy of the arthroscopic performance.

Results

The Latarjet procedure, whether open or arthroscopic, is typically performed in high-risk instability patients (significant bone loss, revision surgery, high-level contact and young athletes) which can increase failure rates (14). Still, overall it performs well and in most cases superiorly when compared to an arthroscopic Bankart repair: Bankart recurrence rates between 0–37.5% (15,16) *vs.* open Latarjet recurrence rates between 0.3–11.6% (17-19). In fact, many comparative studies conclude that the open Latarjet procedure outperforms a Bankart repair, particularly in the long-term for stability (18,20,21). In this section, we evaluate the arthroscopic Latarjet keeping these baseline comparisons to the open procedure and to the arthroscopic Bankart, while being mindful that the Latarjet is typically reserved for complex patients. In general, benefits of the arthroscopic technique include decreased bleeding, less post-operative pain, ability to treat concomitant pathology, and better cosmesis (*Figures 1,2*). A summary of specific surgical results in the literature following arthroscopic Latarjet are outlined in *Table 1* and presented below in detail. Surgical tips and pearls to improve results are listed in *Table 2*.

Recurrence rates

Post-operative recurrence was noted between 0–8.3% of patients with the majority reporting recurrence rates <4% (*Table 1*) (2,5,7,8,12,22-24). These results compare well with the open Latarjet published in literature, especially given that between 10–49% of these cases are performed in the revision setting (7,8,12,22-24).

Figure 2 Post-operative range of motion following arthroscopic Latarjet at 6 months. (A) Active forward elevation; (B) internal rotation; (C) external rotation behind the head; (D) external rotation.

Union rates

Union was noted in 83–100% of patients. Smoking was a factor significantly associated with non-union (12,24) and we strictly counsel our Latarjet patients on smoking cessation prior to proceeding with bone block fixation. While most patients achieve union within 2–6 months, we have noted many patients diagnosed with partial or non-union progress to complete union up to 1 year after surgery.

Bone block positioning

Computed tomography (CT) evaluation of bone block positioning is more accurate than plain films and we only included those studies that used CT for accuracy. The goal of the Latarjet is to recreate the anteroinferior glenoid which is the location typically eroded or fractured in recurrent instability patients (25,26). The optimal position is flush to the glenoid rim (within −5 and +3 mm) and sub-equatorial (4,12) (*Figure 3A,B*). Accurate positioning was obtained in both axial and sagittal planes in 76–96% of patients (4,5,7,12,22,24). This is an improvement on the open technique as malpositioning of the bone block has been reported in the open Latarjet of 20.6% (27), 53% (28), and up to 67% (29). Positioning is an important factor as an excessively medially placed graft can result in recurrent instability (30) and osteolysis, while a laterally placed graft can accelerate arthritis (27-29).

Return to sport/activity, functional scores, and range of motion (Figure 2)

Return to sport was noted in 91–100% of patients (2,7,12,23). Excellent functional scores were obtained with

Table 1 Clinical results following arthroscopic Latarjet procedure

Authors	Journal	Years	Patient number	Fixation methods	Follow-up (months)	Recurrence rate	Non-union	Return to sport	Functional score	Accurate bone block position
Athwal *et al.* (8)	Arthroscopy	2016	83	2 screws	17	3 (3.6%)	1 (1.2%)	NR	NR	NR
Boileau *et al.* (2)	Arthroscopy	2007	36	Interference screw	19	3 (8.3%)	1 (2.8%)	91%	WD, 87	NR
Boileau *et al.* (22)	Arthroscopy	2010	47	1 screw	16	0	8 (17.0%)	NR	Rowe, 88; WD, 87.6; SSV, 87.5%	92% axial; 98% sagittal
Boileau *et al.* (12)	JSES	2016	76	Cortical button	14	1 (1.3%)	7 (9.2%)*	93% to pre-injury level	Rowe, 95; WD, 96	96% axial; 93% sagittal
Castricini *et al.* (7)	Musculoskelet Surg	2013	30	2 screws	13	0	NR	100%	Rowe, 90	76% axial
Cunningham *et al.* (5)	KSSTA	2016	28	2 screws	6.6	1 (3.6%)	2 (7.1%)	NR	WD, 88	93% "correct position"
Dumont *et al.* (23)	AJSM	2014	62	2 screws	76.4	1 (1.6%)	NR	93.50%	WOSI, 90.6%	NR
Gendre *et al.* (24)	OTSR	2016	70	Cortical button	12	2 (2.9%)	12 (17.1%)*	NR	NR	94% axial; 93% sagittal
Kany *et al.* (4)	JSES	2016	105	2 screws	NR	NR	NR	NR	NR	91% axial; 81% sagittal

*, smoking was a risk factor. NR, not reported; WOSI, Western Ontario Shoulder Instability Index; WD, Walch-Duplay; SSV, subjective shoulder value.

consistent values of the Rowe and Walch-Duplay scores >90 (2,5,7,12,22) and Western Ontario Shoulder Instability Index (WOSI) of 90.6 (23). A concern with any instability surgery is loss of external rotation post-operatively, particularly in patients who perform overhead sports. The results demonstrate that some degree of loss of external rotation can be expected, between 9–17° (2,7,22). We believe this can be improved by placing patients in neutral rotation slings post-operatively to prevent the conjoint tendon from healing within the tendinous portion of the subscapularis, which can restrict motion.

Studies directly comparing arthroscopic with open Latarjet

Nourissat and the French Arthroscopic Society performed a multicentre analysis of 99 arthroscopic Latarjet patients compared with 85 open Latarjet patients (31). They found that the arthroscopic group had significantly less pain within the first post-operative week. While the arthroscopic group had better WOSI scores at 3 months, by 6 months the open group had better WOSI scores. The same society also compared three groups of patients receiving either open or arthroscopic Latarjet in 390 cases (open Latarjet with two screws, arthroscopic Latarjet with two screws, and arthroscopic Latarjet with suture button) (32). They noted similar recurrence rates and Rowe scores for all techniques: 4.5 % and 92.8 for arthroscopic screw fixation, 3% and 95.3 for arthroscopic suture button fixation, and 1% and 83.9 for open Latarjet. There was a significant difference in external rotation at last follow-up: 68.4° for arthroscopic screw, 70.4° for arthroscopic suture button, and 61.1° for open, favoring arthroscopic performance.

Marion *et al.* prospectively followed 22 open and 36 arthroscopic patients to a mean follow-up of 29.8 months (33). While surgical duration was 15 minutes longer in the arthroscopic group, they noted significantly less pain during the first post-operative week, similar to Nourissat *et al.* Three patients required revision in the arthroscopic group [8.3%; all involving hardware-related complications (twisted screw with recurrence, prominent screw, and bone-block fracture)] while none in the open group had reoperation.

Table 2 Surgical tips and pearls for arthroscopic Latarjet procedure

Pre-operative
Planning should include 3D CT to fully assess glenohumeral bone loss
Smoking cessation is important to reduce risk of non-union
Step-wise learning approach including training in a cadaver lab and observership recommended prior to performing first arthroscopic Latarjet
Operative
70-degree scope helps with appropriate viewing angles
Different arm positions help at various points in the case: 30-degree internal rotation helps while working in sub-coracoid space; elbow flexion relaxes conjoint tendon; 60-degree shoulder flexion helps while working in anterior sub-deltoid space; shoulder abduction is contra-indicated as it brings the neurovascular structures in front of the glenoid neck
Perform appropriate bone removal of coracoid and glenoid neck to allow flat opposable surfaces while not creating excess iatrogenic bone loss
Follow the “3 sisters” (anterior humeral circumflex vasculature) to identify the “2 brothers” (axillary and musculocutaneous nerves). You must see the nerves to protect the nerves
Post-operative
Neutral rotation sling allows conjoint tendon to heal in muscular portion of subscapularis rather than the tendinous portion thereby reducing risk of loss of external rotation

3D, three-dimensional; CT, computed tomography.

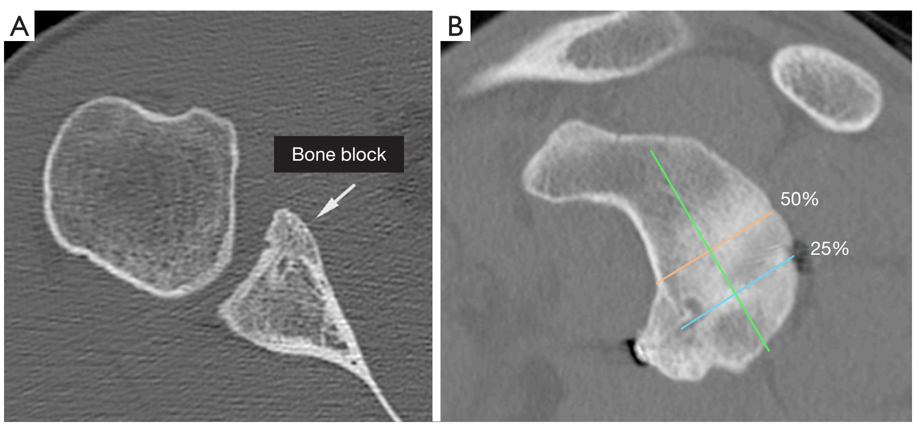

Figure 3 CT scan at 1-year follow-up. Excellent bone block position is obtained as a result of intra-articular visualization: (A) axial view showing bone block flush to the glenoid surface; (B) sagittal view showing sub-equatorial placement. CT, computed tomography.

The WOSI scores were similar between the arthroscopic and open groups (82.3 *vs.* 78.5). On CT evaluation, 59.1% of the arthroscopic grafts were subequatorial compared to 50% of the open grafts.

Randelli *et al.* performed a systematic review of 23 Latarjet studies (17 open Latarjet with 1,058 shoulders total *vs.* 6 arthroscopic Latarjet with 259 shoulders total) to identify clinical results and a cost analysis (19). They found a significantly better rate of healing in the open compared to the arthroscopic group (88.6% *vs.* 77.6%), a non-significant trend towards lower revision surgery in the open group (3.9% *vs.* 7.8%), and a lower rate of recurrence in the open group (0.3% *vs.* 3.3%). In contrast, they noted better accuracy of graft positioning in the arthroscopic group (87% *vs.* 78%). While making some assumptions based on operating time and instrument costs, they determined the

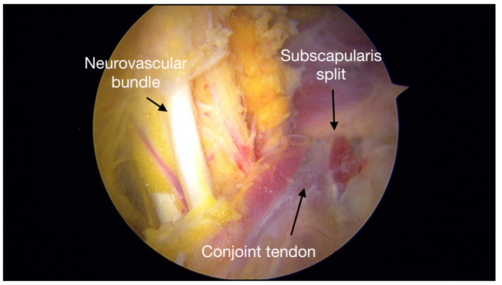

Figure 4 Arthroscopic view from an anterolateral portal. The anterior neurovascular bundle is in close proximity to the transfer demonstrating the importance of direct visual control of these structures. Excellent visualization allows the surgeon to protect the neurovascular bundle safely.

arthroscopic Latarjet cost on average 1,295 euros, or twice more than the open technique. They stated that because both techniques produced excellent clinical results (optimal-excellent in 85–100% of arthroscopic and 73–100% of open cases), the higher direct instrument costs of the arthroscopic procedure resulted in it being less cost efficient.

Kordasiewicz *et al.* compared 62 arthroscopic Latarjet patients with 47 open Latarjet patients each fixed with two screws (34). Their arthroscopic surgical duration was faster (110 *vs.* 120 minutes) and the arthroscopic group had lower rates of non-union (1.7% *vs.* 11.9%). They noted similar rates of recurrence for the arthroscopic and open groups (4.8% *vs.* 6.2%) while revision surgery was required in 9.7% of the arthroscopic group *vs.* 9.3% of the open group. However, the functional scores for the open group had a higher trend (Rowe 87.8, Walch Duplay 83.9 *vs.* Rowe 78.9, Walch Duplay 76.7) and there was less loss of external rotation in the open group (7° *vs.* 14°).

According to current literature, arthroscopic Latarjet performs well regarding stability, functional outcomes, safety, and union rates while allowing more accurate positioning of the bone block. More studies, with higher number of patients and longer outcomes will allow for more definitive conclusions to be drawn.

Complications

Neurologic injury

The open and arthroscopic Latarjet technique should be approached carefully because there are risks to neurologic structures both anteriorly and posteriorly. This was highlighted by Delaney *et al.* in a neuro-monitoring study of the open Latarjet procedure where they noted that 76.5% of their 34 patients had nerve alert episodes during the procedure, most commonly affecting the musculocutaneous and axillary nerves (35). The most common occurrences were during glenoid exposure and graft placement; it is possible that the amount of retraction necessary to expose the glenoid during an open performance could result in traction injuries. In fact, 20.6% of the patients in that series had axillary nerve deficits post-operatively (fortunately all resolved at a mean 86 days). Using an open Latarjet technique, neurologic injuries have been reported in up to 10% of patients (17,36,37).

We feel arthroscopic performance can reduce the risk of both direct and traction-related neurologic injuries. First, the surgeon has excellent direct visualization of the axillary and musculocutaneous nerves to facilitate protection of the nerves (*Figure 4*). Second, less retraction is required for exposure and the coracoid graft does not need to be exteriorized during preparation, both of which reduces risks of traction injuries. In our two published series evaluating 76 and 70 patients respectively, we have not identified any post-operative neurologic deficits (12,24). In a 5-year follow-up study from Lafosse's group, 1 out of 64 (1.6%) patients was noted to have some wasting of the anterior deltoid (23). Some may argue that these rates are low because they were performed by pioneers of the arthroscopic Latarjet, however, in three studies evaluating learning curve experience, the rate of neurologic injuries were still very low (4,7,9). Dauzère *et al.* noted one case (1.5%) of axillary nerve palsy which resolved by 3 months (9), Kany *et al.* similarly found only one transient axillary nerve palsy (0.9%) (4), while Castricini *et al.* did not encounter any neurologic injuries (7). No injuries to the suprascapular nerve have been described in the arthroscopic Latarjet technique, however, the risk is present if fixation is made >2 cm medial to the posterior glenoid rim (38).

Hardware related

Athwal *et al.* presented their "North American" experience with the arthroscopic Latarjet and reported similar adverse event rates as in previous open Latarjet reports (8). In a series of 83 patients involving five surgeons, they found a 28% adverse event rate (18% "problem" rate and 10% complication rate). It is interesting to note that 14% of their 28% adverse events appeared to be hardware related (screw backout/bending/failure, graft fracture, hardware removal surgery). Similarly, Dumont *et al.* found a 12.5%

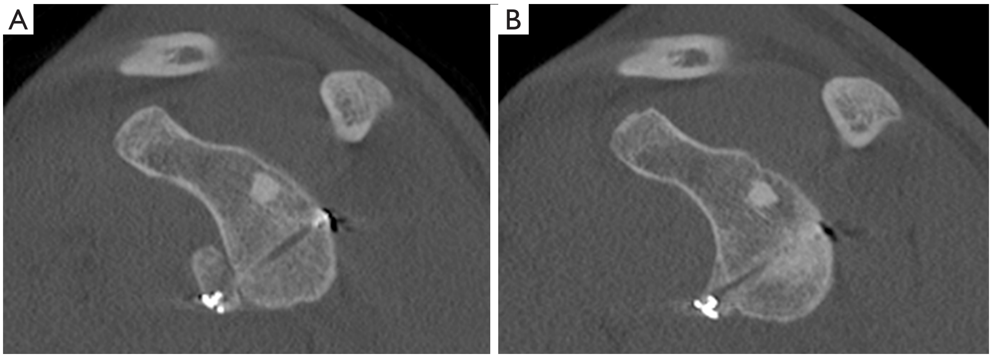

Figure 5 CT scan at 2 weeks and 6 months demonstrating typical remodeling of coracoid bone graft. (A) 2-week post-operative CT with cortical-button fixation; (B) 6-month post-operative CT demonstrating complete osseous union and proximal pole re-modelling but unexposed hardware due to positioning of the button. CT, computed tomography.

rate of hardware removal for prominent screws (23). This phenomenon of hardware related complications is not unique to the arthroscopic performance as shown by Butt *et al.* in a systematic review of open Latarjet (all performed using screws) (17). They found hardware-related problems in 6.5% and these were the most common cause for revision surgery. Griesser *et al.* noted a similar finding in a systematic review of predominantly open Latarjet procedures (90%) (39). Although the rate of re-operation was low (7%), 35% of these were related to symptomatic hardware.

A potential solution to reduce hardware-related complications is the use of non-rigid fixation such as cortical buttons (*Figure 5A,B*), suture-anchor constructs, or implant-less (12,40,41). Boileau *et al.* and Gendre *et al.* used cortical button fixation in 76 and 70 patients respectively and found union rates of 91% and 83% (12,24). No hardware related complications were reported in either of these series. Three reasons may explain this: (I) the button is low profile; (II) the labrum was repaired making the hardware extra-articular, and (III) because re-modelling most commonly affects the proximal pole of the graft (42-44), using a button construct nearer to the distal pole reduces the likelihood of exposed hardware (*Figure 5A,B*). Zhao *et al.* reported on 52 patients with a mean follow-up of 39 months using suture anchor fixation of iliac crest allograft (40). They obtained 100% union with no hardware related problems.

Non-union or osteolysis

Remodeling and/or osteolysis has been described after a Latarjet typically affecting the proximal aspect of the coracoid graft (42-44). Following open Latarjet, Di Giacomo *et al.* found on average 59.5% of total osteolysis on CT at a mean follow-up of 17.5 months (42) while Zhu *et al.* found an overall incidence of resorption at 1 year of 90.5%, with 49.2% being major-complete using their classification system (43). Kordasiewicz *et al.* noted partial osteolysis occurring around the proximal screw in 53.3% of their arthroscopic Latarjet patients (34). Haeni *et al.* evaluated resorption following arthroscopic Latarjet using three-dimensional (3D) CT volume measurements and also noted that the superior half of the graft underwent significant osteolysis by 6 months post-operatively (44). It appears whether the Latarjet procedure is performed open or arthroscopically, the surgeon should expect some degree of graft resorption, particularly proximally. As mentioned above, this may be a source of hardware-related complications if screw heads become prominent and is a reason to consider alternative modes of fixation, such as cortical-buttons.

Conclusions

The arthroscopic Latarjet is an effective procedure for dealing with high-risk glenohumeral instability patients. While it is complex and has an associated learning curve, it can be performed safely and efficiently as demonstrated by surgeons in different practice settings. It allows excellent intra-articular and extra-articular visualization giving the potential to lower neurovascular complications and improve the accuracy of graft placement and fixation. The benefits of arthroscopy are also apparent including better cosmesis, lower post-operative pain, and the flexibility to treat concomitant lesions. Functional results, return to sport, and union rates compare favourably with the open technique. Multiple graft options are available with many modes of fixation options. Detailed systematic and guided techniques are now available increasing the feasibility of the arthroscopic technique. For these reasons, we believe the frequency of the arthroscopic Latarjet will continue to increase with time.

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