Learning Curve for Arthroscopic Shoulder Latarjet Procedure Shows Shorter Operating Time and Fewer Complications with Experience

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Purpose: To evaluate the learning curve of the arthroscopic Latarjet procedure in a consecutive series of 103 shoulders in 102 patients by comparing the early clinical and radiologic outcomes and complications of the first 25 patients with the latter 25 patients. Our hypothesis was that the studied parameters would be enhanced over time. **Methods:** A consecutive cohort of 103 shoulders in 102 patients treated with arthroscopic Latarjet procedure was prospectively registered from December 2014 until November 2019. Patients in this cohort represent the first cases of arthroscopic Latarjet for the 2 shoulder surgeons. All patients had a double screw fixation technique. The Western Ontario Shoulder Instability Index (WOSI) score preoperatively and at 1-year follow-up and 3-dimensional computed tomography scans preoperatively, postoperatively, and at 1-year follow-up were prospectively registered. Patient demographics, intra-operative data, complications, and reoperations were all recorded. In total, 85 of 103 shoulders (83%) had complete data sets. Patient demographics, WOSI scores, operating time, complications, satisfaction rate, and radiology scores in the first and last 25 patients were compared to evaluate learning curve. **Results:** There was longer operating time in the early group compared with the latter (130 vs 105 minutes, $P = .001$) and number of complications was reduced with experience (16 vs 4, $P = .0005$). Serious complications requiring a reoperation were 4 (16%) in the early group compared to 1 (4%) in the latter group ($P = .157$). Clinical results were good with major improvement in WOSI scores and 84 % satisfaction rates in both groups. **Conclusions:** Arthroscopic Latarjet was associated with a learning curve where the early group had longer operating time and greater rates of complications. This is a procedure with few serious complications, acceptable surgery time and learning curve. **Level of Evidence:** Level III, retrospective comparative observation trial.

The Latarjet procedure is widely accepted as a treatment option for anterior shoulder instability; however, there is a wide variation in indications for this surgery.[1,2] Some surgeons perform a Latarjet as a standard procedure for anterior shoulder instability, whereas others limit the indications to presence of significant glenoid bone loss or as a secondary procedure after failed previous instability surgery.[3] Opponents of a Latarjet as a primary procedure for instability cite that it is nonanatomic and has high complication rates, considering the relatively low failure rates of a Bankart procedure.[4] Good functional outcomes, high rates of return to sports, and low recurrence rate have been reported after a Latarjet

procedure; however, it is technically challenging and has been associated with high complication rates of up to 30%, the most serious being neurovascular injuries.[5]

Historically, the Latarjet procedure has been performed as open surgery; however, in recent years, there has been increasing interest in performing the procedure arthroscopically. The arthroscopic Latarjet procedure was first described by Lafosse et al. in 2007.[6] The possible advantages of an arthroscopic procedure include concurrent diagnosis and treatment of concomitant intraarticular pathology, less pain, a shorter recovery time and potentially fewer wound problems.[7] The arthroscopic procedure is more technically challenging compared with the traditional open procedure; therefore, there has been some reluctance in some circles to adopt this technique. Historically, there has been a lag in adopting arthroscopic procedures when open procedures are established and have good outcomes and acceptable complication rates.[8] Both the Bankart procedure and rotator cuff repair were historically performed as open procedures but are currently predominantly performed arthroscopically.

After introduction of an arthroscopic technique for the Latarjet procedure,[6] the variation in published outcomes and complications has increased.[9,10] Some authors suggest that the arthroscopic technique may be associated with greater complication rates. When changing from a standard open procedure to a novel and technically demanding arthroscopic technique, a learning curve is to be expected. It is important that the outcomes and complication rates when introducing a new technique be acceptable and comparable with the standard of care. The purpose of this study was to evaluate the learning curve of the arthroscopic Latarjet procedure in a consecutive series of 103 shoulders in 102 patients by comparing the early clinical and radiologic outcomes and complications of the first 25 patients with the latter 25 patients. Our hypothesis was that the studied parameters could be enhanced over time.

Methods

This prospective study was approved by the Norwegian Regional Committee for Medical and Health Research Ethics. Patients who underwent an arthroscopic Latarjet procedure at our institution were prospectively registered from December 2014 until November 2019. Patients in this cohort represent the first cases for the 2 shoulder surgeons (B.B. and T.C.L.). No conversion to open surgery and no standard open Latarjet procedures were done in this period. At Oslo University Hospital, the standard treatment of choice for anterior shoulder instability is an arthroscopic Bankart repair, with or without a remplissage, depending on the size and shape of a concomitant

Hills–Sachs lesion. In cases with 1 or more of the following, glenoid bone loss, hyperlaxity, elite contact sports, a high number of previous dislocations and young age at first dislocation as well as in revision surgery, a Latarjet procedure is considered. Patients with incomplete data set and follow-up (FU) were excluded. The standard open Latarjet approach was practiced until November 2014, when we decided to convert to an arthroscopic double screw fixation technique as described by Lafosse et al.[6] Two experienced shoulder surgeons (B.B. and T.C.L.) gained experience on the technique by visiting fellow surgeons and trained in a wet laboratory before changing to the arthroscopic procedure.

Patient demographics were recorded, including age, sex, age at first dislocation, number of dislocations, type of sport, presence of hypermobility, and history of seizures. All patients underwent a preoperative computed tomography (CT) scan to evaluate the degree of bone loss using the "best fit circle" method.

Surgical Technique

The surgical technique as described by L. Lafosse was used in all patients.[6] The patient was placed in a modified beach-chair position with arm in slight dynamic traction (1.5-2 kg), under general anesthesia and hypotensive (<90 mm Hg systolic pressure) while monitoring cerebral oxygenation. A shoulder diagnostic arthroscopy was first performed with a 30° arthroscope. A careful arthroscopic dissection was then performed to release the pectoralis minor insertion and coracoacromial ligament from the bone to visualize the coracoid process (Fig 1). Careful visualization of both musculocutaneous and axillary nerves was done and all dissection and splitting of the subscapularis muscle was performed with these neural structures visualized to minimize the risk of iatrogenic injury (Fig 2). To minimize bleeding, the main working tool for the soft tissues was a radiofrequency probe, and tranexamic acid (1 g) was administered intravenously when starting the procedure. An osteotomy close to the base of the coracoid process was performed ensuring that the coracoclavicular ligaments were intact. The coracoid process was then mobilized to the anterior glenoid through the subscapularis split and fixated with two 3.5-mm bicortical screws (DePuy Mitek, Raynham, MA). Avoiding spike formation on the inferior part of the coracoid could be achieved by chiseling from inferior before completing the osteotomy from superior.

Patient Follow-up

A physiotherapist (I.B.) prospectively recorded Western Ontario Shoulder Instability Index (WOSI) score preoperatively and at 1-year FU.[11] After the operation, patients were advised to wear a sling for 4
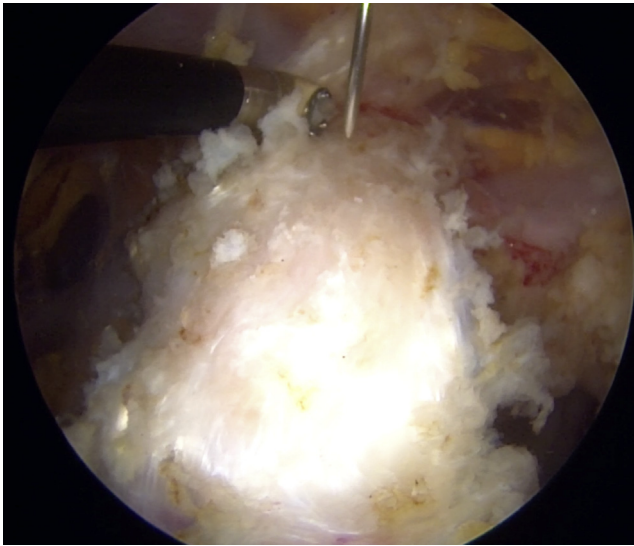
Fig 1. Anterior view of the coracoid in a right shoulder. The coracoacroimial ligament and the minor pectoral muscle is removed. A needle is used to estimate the direction before making a portal to drill the holes for the screws. The electrocautery probe is placed at the base of the coracoid anterior to the coracoclavicular ligaments.

weeks and at the same time start movements within pain free limits and restrictions of 60° of flexion and abduction and 20° of rotation 4 to 6 times per day. After 4 weeks, gentle stretching exercises were introduced and after achieving full flexion, strengthening exercises were allowed, no sooner than 12 weeks after surgery. Contact sports were allowed no sooner than 4 months after surgery. Five years after introducing arthroscopic technique, we founded a local shoulder instability registry to follow these patients. The project is approved by the national ethic committee and the institutional ethical board. From patient charts we also recorded operating time, sex, age at operation and at the first dislocation, number of dislocations, previous surgery, participation in sports, hyperlaxity, history of seizures, and satisfaction and range of motion at 1-year FU.

A 3-dimensional CT scan was done preoperatively, postoperatively, and at 1-year FU. Glenoid bone loss was calculated as a percentage by the "best fit circle" method (Fig 3). A radiology score was developed to analyze graft and screw positions, graft fixation, bony contact, and screw prominence Figs 4 and 5.

At 1 year, graft resorption of more than 50% of the original graft size was recorded as well as bony healing of the graft to the scapular neck. Reoperations and complications were recorded, complications were rated according to severity from 1 to 3, where 1 is adverse events requiring no additional treatment, 2 is adverse events with extended nonoperative observation or treatment, and 3 is adverse events that require additional operative treatment.

Statistical Analyses

Statistical analyses were performed using the R software (The R Foundation for Statistical Computing, Vienna, Austria). The Shapiro–Wilk test for normality was performed to check for normal distribution. Medians and interquartile ranges are reported, and Mann–Whitney U test was used for statistical significance. The comparisons between the 2 groups were performed using the χ^2 test for categorical variables. For radiology score, a Wilcox test was performed for comparison of the 2 groups. All tests were 2-sided, and $P < .05$ was considered statistically significant.

Results

Patient Demographics

Eighty-five of 103 (83%) shoulders had complete sets of data available for analysis. In total, 18 patients were not included due to the following: 11 had incomplete WOSI scores, and 5 were lost to FU due to drug abuse (3), death (1) and emigration (1). Two patients never turned up for planned FU. The patients were predominantly male (90%). The median age at surgery was 26 years in the first group and 32 years in the latter group, with time from first dislocation to surgery 65 months and 90 months, respectively. Average glenoid bone loss was 19% in the first group, 20% in the latter. The number of patients active in sports was greater in group 2 (16) than in group 1 (11), but with a greater percentage in competitive and contact sports in group 1. Nineteen of the fifty cases were reoperations after former instability surgery, 11 in the first group, 8 in the latter. We found no significant differences in other patient demographics between the groups (Table 1).
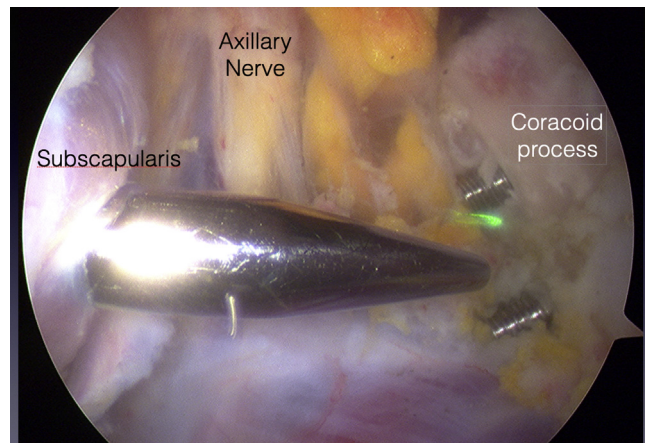
Fig 2. A switching stick is placed through the glenohumeral joint and the subscapularis muscle from a posterior portal in a right shoulder. Medial to the switching stick is the axillary nerve. The coracoid is osteotomized and fixated to a plastic guide with 2 metal cannulas (DePuy Mitek, Raynham, MA).
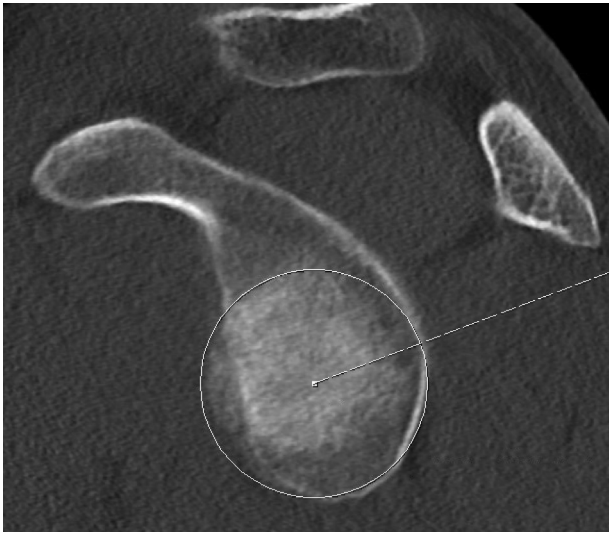
Fig 3. Best fit circle. The circle is considered to be close to the original shape of the glenoid. Computed tomography of the glenoid in a left shoulder, sagittal view, is shown.

Complication Rates

Minor Complications

In the first group a total of 17 grade 1 and 7 grade 2 adverse events were recorded, 12 of the 17 being graft resorption >50%. The corresponding figures for group 2 was 11 and 3, all 11 being graft resorption. In summary, excluding bone resorption, there were 4 grade 3, 7 grade 2, and 5 grade 1 events in the first group and 1 grade 3 and 3 grade 2 events in the latter group (Table 2).

Serious Complications; Required Additional Surgery or Long-Term (>6 Months) Nonoperative Treatment

Four patients in the first group had adverse events leading to reoperations. One patient had a *Cutibacterium acnes* infection successfully treated with arthroscopic lavage 13 days postoperatively and thereafter intravenous and per oral antibiotics, 2 patients developed stiffness and underwent reoperation with arthroscopic arthrolysis and mobilization, one of them after 4 months and the other after 9 months, both with uneventful recovery. One patient was diagnosed with extensive graft resorption and local symptoms from prominent screws and was reoperated with removal of screws. In the latter group, 1 patient was diagnosed with graft breakage and screws cutting out at the postoperative CT scan. He underwent an open procedure 5 days later with screw removal and graft fixation with double suture anchors and button technique, uneventful.

There were no re-dislocations in any of the groups. In the first group, 3 patients reported symptoms that could be interpreted as subluxations, and none in the latter. Two patients in the first group complained of possibly nerve related symptoms, 1 numbness in 2 ulnar digits that occurred 3 months after surgery with negative neurophysiological investigations, and 1 with transient and partial sensory loss in the C6 innervated area anterolateral on the upper arm. One patient in the latter group complained of symptoms from the brachial plexus, and further investigations including electromyography and neurography confirmed a partial axonal lesion of the proximal brachial plexus probably due to traction. FU at 14 months showed major improvement, both clinically and neurophysiologically, with no need for further actions.

Median surgical time spent was reduced with growing experience and dropped from 130 minutes in the first group to 105 minutes in the latter. Preoperative WOSI score was similar; 45% in the 2 groups, and they had both significant improvement in scores at 1 year FU. WOSI results after 1 year were 71% in the first group and 81% in the latter, meaning the difference (preoperative − FU) was 26% in the first group and 36% in the latter. A similar high satisfaction rate, 21 of 25 patients (84 %), was reported at 1 year FU in both groups.

Fig 4. Postoperative computed tomography of the first patient operated with arthroscopic technique. (A) Left shoulder, axial view. (B) Left shoulder, sagittal view.
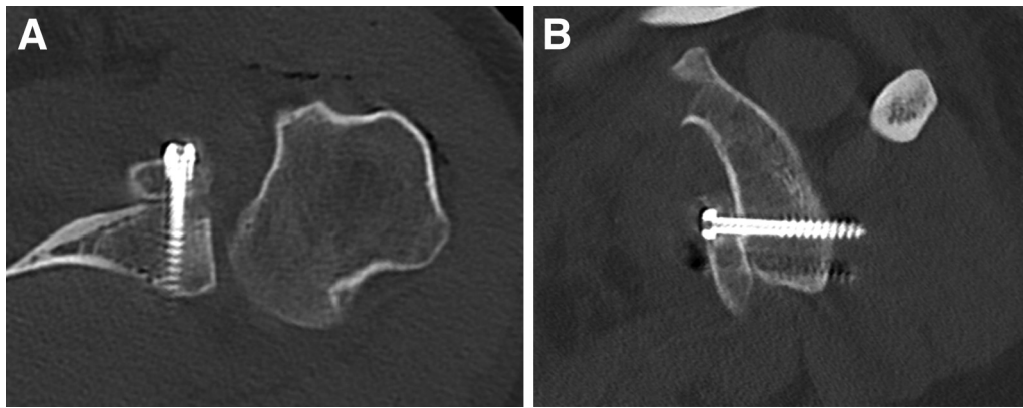
Fig 5. Postoperative computed tomography of a patient in group 2. (A) Left shoulder, axial view. (B) Left shoulder, sagittal view.

The radiology score improved significantly ($P = .002$) from 9/12 in the first group to 11/12 in the latter.

Radiologic signs of bone healed to bone was found in 17 patients in the first group and in 22 patients in the latter. Outcome in both groups were satisfactory and without any serious complications. We found marked improvement in both groups, but with superiority in all parameters in the latter (Fig 6).

Discussion

The most important finding in the present study was that surgical experience reduced the rate of complications and surgical time. The complications requiring surgical intervention decreased from 4 out of 25 (16%) to 1 of 25 (4%) during the study period. The majority of registered complications were related to bone resorption at 1-year FU and did not require surgical revision. Operating time was as expected high in the first cases and decreased to a lower plateau over time.

When changing from a standard open procedure to a novel and technically demanding arthroscopic technique, a learning curve is to be expected. In the present study, complications were classified according to severity. Previous studies have reported high complication rates associated with the Latarjet procedure, with Griesser et al.[5] reporting as high as 30% in a systematic review including 1904 shoulders. In the review, Griesser et al. reported that 7% of patients required reoperation. The complications reported in the literature include recurrent shoulder instability, infection, stiffness, hematoma formation, symptomatic hardware, fracture or nonunion of the coracoid graft, neurologic complications, residual pain, and arthritis. In the present study, there were greater rates of serious complications (16%) early in the study period compared with 4% in the latter period of the study, demonstrating improvement. Because of the small sample size, small numbers make a big difference in the percentage. Considering the close proximity of adjacent neurovascular structures during the transfer of the coracoid process, the brachial plexus, axillary, musculocutaneous, and suprascapular nerves are at risk during the surgery. The rate of nerve injuries was reported in the literature up to 1.4%; most of the reported nerve injuries were transient neurapraxias, which is comparable with 4% (2 of 50 patients) in the present study. The nerve injuries in the present series occurred in the axillary and musculocutaneous nerves. The nerve injuries in our series

Table 1. Patient Demographics in the Two Groups

Demographics	Group 1	Group 2	*P* Value
Sex, male:female	22:3	23:2	.637
Dominant hand, n (%)	16 (64)	15 (60)	.771
Hyperlaxity	4 (16)	6 (24)	.480
Median age at first dislocation, y (IQR)	19 (7)	20 (11)	.280
Median age at surgery, y (IQR)	26 (8)	32 (5)	.09
Months from first dislocation to surgery, (IQR)	65 (81)	90 (139)	.312
Median number of dislocations before surgery (IQR)	10 (10)	10 (15)	.841
Primary surgery, n (%)	14 (56)	17 (68)	.382
Glenoid bone loss, n (%)	19 (26)	20 (14)	
Competitive sports, n (%)	7 (28)	0	.020
Epilepsy	3 (12)	2 (8)	.637

NOTE. Group 1 is the early patient population group. Group 2 is the latter patient population group.

IQR, interquartile range.

Table 2. Complication Rates Classified by Severity Between the Early Group and the Latter Group

| Complications	First 25 Patients	Last 25 Patients	P Value
Grade 1	5	0	.018
Grade 2	7	3	.157
Grade 3	4	1	.157
Total	16	4	.0005
Bone resorption >50%	12	11	.777

were neuropraxia and resolved without long-term sequelae. We did not record any brachial plexus injuries.

Most of the complications reported in this cohort were minor, and the majority were related to bone block resorption. We chose to report non-union and osteolysis as complications because the aim of a bony procedure such as a Latarjet is to have a bone block extend the arc of curvature of the glenoid. The literature on bone block resorption is lacking and there is controversy on its clinical implications. Most studies published on the arthroscopic Latarjet learning curve does not report osteolysis as a complication[12-14] while other report osteolysis apart from clinical complication and measured on conventional radiographs, not CT.[15] Placement of the graft and osteolysis have been recognized as reasons for revision after open Latarjet[16] and analyses of arthroscopic cohorts are needed.

In the review from Griesser et al.,[5] a 9.1% nonunion or fibrous union rate were reported. However, the fibrous union of the coracoid does not have a significant impact on the clinical outcome and is often diagnosed as an incidental finding. Boileau et al.[17] reported a fibrous union in 9% of the patients 6 months after arthroscopic Latarjet surgery on a CT scan evaluation that was slightly greater than the rates of 1.5 to 1.7 previously reported by Mizuno et al.[18] and Dumont et al.,[19] respectively. Several factors have been proposed to increase the risk of fibrous union, including fixing the graft in an overly inferior position, which will cause insufficient purchase of the inferior screw in the bone, therefore leading to fibrous union because of the rotational instability.

Our indication for a Latarjet procedure is patients with high risk of recurrence and revision cases after an arthroscopic Bankart procedure. Nineteen of fifty were reoperations after former surgery. This patient group is more challenging and prone to complications than our Bankart patients. With the knowledge of traditions and differences in indications between France and the rest of the world, the risk of complications will be greater for those using a Latarjet for selected and challenging patients compared with those performing a Latarjet for most of their primary instability patients. In an internet questionnaire sent to members of the European, American, and South African Arthroscopic Societies, the members answered what was their preferred technique for chronic anterior shoulder instability. Among 171 surgeons responding, it appeared that Latarjet was the preferred technique in France, where 72% of surgeons preferred the Latarjet procedure over Bankart irrespective of the types of patients or lesions. Surgeons from English-speaking countries preferred Bankart in 90% of their cases. No surgeon from an English-speaking country preferred Latarjet as a first-line
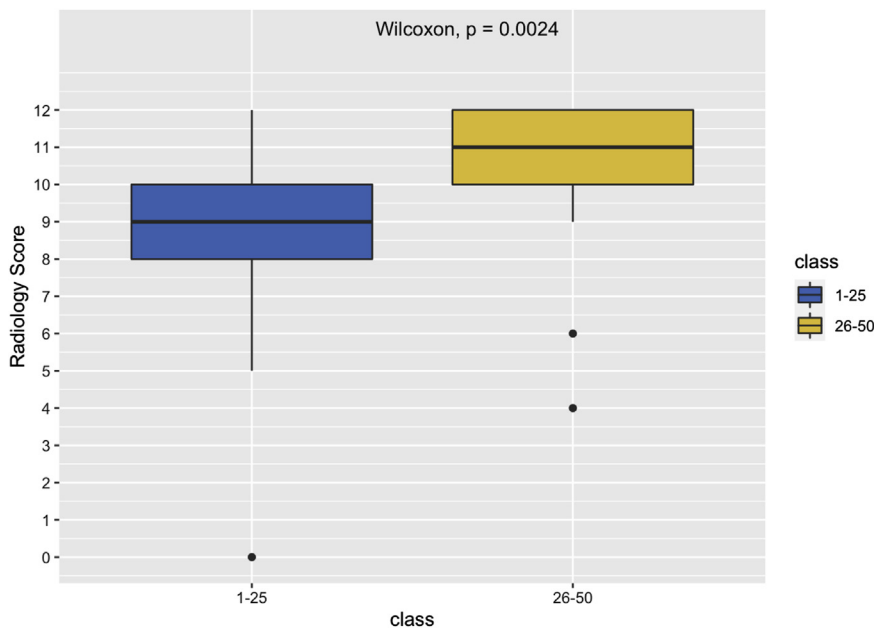
Fig 6. Radiology score for the early group 1 (1-25) versus the latter group 2 (26-50).

option.[3] The indication for a Latarjet procedure also reflects the total number of patients operated by the same surgeon. In countries where the surgeons prefer Bankart for 90% of the patients, the number of Latarjet will be low and the learning curve affected.

Are the benefits of an arthroscopic Latarjet sufficient to encourage orthopaedic surgeons to change from a well-established open procedure? We have seen the same development for the Bankart procedure and rotator cuff repair.[20,21] The benefit of diagnosing and treating concomitant injuries is obvious. Arthroscopy gives the opportunity to simultaneously address concurrent lesions like extensive Hill−Sachs fractures, rotator cuff, and SLAP tears. One can thus argue that slightly extended operating time, as seen at least in the early phase, is acceptable. Smaller incisions probably lead to less pain for the patient, further resulting in shorter hospital stay and faster recovery and rehabilitation. Infection rates also would be expected to be lower for an arthroscopic procedure compared with open surgery.

Open Latarjet has been the gold standard procedure for chronic shoulder instability associated with bone loss and in case of former unsuccessful instability procedures. Despite the reported success when it comes to recurrence after this procedure surgeons should be well aware of the risk of complications also exists for the open procedure. Shah et al.[22] reported an early complication rate of 25% in a series of 48 patients (12 patients) where 2 of them had residual neurologic symptoms.

Patients who underwent operation in the early phase had a longer surgery time compared with those who underwent operation in the latter phase. Developing new techniques is time-consuming but necessary. What is acceptable for an individual surgeon or hospital will depend on the individual expectations.[23,24] In university hospitals, there is an expectation of education of the staff, including the surgeons, both residents and consultants. The focus on general learning and teaching is obvious in some places while in other places the main focus is efficiency. For arthroscopic Latarjet, Valsamis et al.[12] presented the learning curve for 12 experienced shoulder surgeons and concluded that between 30 and 50 procedures were necessary to reach a plateau in operating time. The positioning of the bone block also tended to improve with number of procedures, but they found no evidence that indicated improvement in PROMs or complication rates with increased experience. It is worth noting that when learning a procedure like arthroscopic Latarjet new technical skills will be transferable to other arthroscopic procedures. Short-term FU in the present study demonstrated satisfactory patient-reported outcomes (preoperative − FU), WOSI scores improving with 26% in the first group and 36% in the latter, and low recurrence rates. The minimal clinically important difference for WOSI in instability patients is reported to be 152 and 220 points or 7.2% to 10.4%.[25,26] Previous studies have reported comparable clinical outcomes between the arthroscopic Latarjet procedure and the open procedure.[7,13,27,28]

The arthroscopic Latarjet is indeed a complex procedure that requires advanced surgical skills. Nerve safety is a concern during both open and arthroscopic procedures. We find it mandatory to explore both axillary nerve and musculocutaneous nerve before making the subscapularis split during the arthroscopic procedure. This is not the routine for an open Latarjet. These steps in the procedure were in some patients time-consuming, but we avoided severe nerve complications, which would be a disaster to the patient.

Limitations

The main limitation is that duration of FU is short. One year is not enough for conclusions on clinical outcome and recurrence rate after instability surgery.

Conclusions

Arthroscopic Latarjet was associated with a learning curve where the early group had longer operation times and greater rates of complications. This is a procedure with few serious complications and an acceptable surgery time and learning curve.

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