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ORIGINAL PAPER

Functional and Radiological Outcomes of Open *Versus* Arthroscopic Latarjet for Anterior Shoulder Instability

Christos KOUKOS[a, b], Georgia KANELLOPOULOU[c], Dimitrios GIOTIS[d], Christos YIANNAKOPOULOS[e], Stylianos KAPETANAKIS[f], Christos KONSTANTINIDIS[d], Saseendar SHANMUGASUNDARAM[g], Emilios E. PAKOS[h], Koray SAHIN[i], Fredy MONTOYA[j]

[a]Helios Klinikum Niederberg, Verbert, Germany

[b]Sports Trauma and Pain Institute, Thessaloniki, Greece

[c]Department of Orthopaedics, General Hospital of Athens "G. Gennimatas", Athens, Greece

[d]Department of Orthopaedics, General Hospital of Ioannina "G. Hatzikosta", Ioannina, Greece

[e]Department of Orthopaedic Surgery, National and Kapodistrian University of Athens, Athens, Greece

[f]Department of Orthopaedics, Aristotle University, Thessaloniki, Greece

[g]Department of Orthopaedics, Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry, India

[h]Department of Orthopaedic Surgery and Traumatology, University Hospital of Ioannina, Ioannina, Greece

[i]Department of Orthopaedics and Traumatology, Benmialem Vakif University, Istanbul, Turkey

[j]Sanatorio Aleman Clinic, Universidad de Concepcion, Concepcion, Chile

Address for correspondence:
Dimitrios Giotis, MD, MSc, PhD, Orthopaedic Surgeon / Consultant, Orthopaedic Department, General Hospital of Ioannina "G. Hatzikosta", Ioannina, Greece
Mailing address: 60 Stratigou Makrigianni Avenue, Ioannina, Greece (Postal code: 45445)
Tel.: 00 30 26510-80480 / 00 30 6946352613; email: dimitris.p.giotis@gmail.com

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ABSTRACT

Objectives: *The purpose of this study is to compare the clinical, functional and radiographic outcomes among 42 patients with anterior shoulder instability treated with either the open or arthroscopic Latarjet procedure.*

Materials and methods: *Between 2011 and 2018, we treated 42 patients with anterior shoulder instability, 19 underwent the open Latarjet procedure (OLP) and 23 underwent the arthroscopic Latarjet procedure (ALP). In the OLP group, 17 patients were males, with a mean age of 21.3 years (range: 16-37 years) and a mean follow-up of 6.2 years (range: 5.5-7.2 years). In the ALP group, 20 patients were males, with a mean age of 20.6 years (range: 17-31 years) and a mean follow-up of 2.5 years (range: 2-3.1 years). All procedures were performed by a single surgeon. Functional outcomes were assessed using the University of California-Los Angeles (UCLA) shoulder score and the constant score (CS). Radiographic evaluations included standard radiographs and computed tomography (CT) scans. The two groups were compared to analyze differences in outcomes.*

Results: *All patients returned to their pre-injury level of activity. The arthroscopic Latarjet procedure resulted in better graft integration and inferior screw positioning. No major complications were reported in either group.*

Conclusions: *Anterior shoulder instability remains a complex issue in orthopedics regarding the optimal management approach. However, this study suggests that the arthroscopic Latarjet procedure offers advantages, including superior visualization and effective restoration of damage.*

Keywords: arthroscopic Latarjet procedure, open Latarjet procedure, shoulder instability, functional outcome, graft integration.

INTRODUCTION

Traumatic anterior shoulder instability (TUBS) is the most common form of shoulder instability, occurring when an anterior force is applied to the glenohumeral joint while it is abducted and externally rotated. The literature reports an incidence rate of 1-2% in the general population, with a higher prevalence among young males, football and basketball players and military personnel (1-3).

The management of TUBS remains a challenge and there is no consensus on the parameters that favor one surgical technique over another, particularly in cases involving bone loss. Bone loss may occur on the humeral head (Hill-Sachs lesion) or the glenoid. The threshold of glenoid bone loss requiring a bone block procedure remains debated, although a recent systematic review and meta-analysis by Gowd *et al* suggest that critical bone loss ≥15% is a strong indication for reconstruction with the Latarjet procedure (4).

First described by Dr. Michel Latarjet in 1954, the open Latarjet procedure (OLP) involves a classic deltopectoral approach with coracoid process grafting, along with the conjoint tendon attached to the anteroinferior border of the glenoid rim. In contrast, the arthroscopic Latarjet procedure (ALP), introduced by Lafosse *et al* in 2007, offers the advantages of a minimally invasive approach (5).

The purpose of this study is to compare these two techniques concerning graft positioning in the axial and coronal planes, the divergence angle of the superior and inferior screws, the risk of nonunion between the graft and glenoid rim, the potential for osteolysis and postoperative osteoarthritis and standardized clinical outcome scores. We hypothesize that ALP provides superior outcomes compared to OLP due to its enhanced visualization and minimally invasive nature.

MATERIALS AND METHODS

Study design

This study was a cross-sectional, multicentric, retrospective analysis of quantitative variables.

Patient selection

Between 2011 and 2018, 42 patients with anterior shoulder instability were selected for management with either the OLP or the ALP based on convenience sampling. Only patients undergoing a primary (first-time) surgical procedure for shoulder instability with glenoid bone loss ≥15% and a concurrent on-track Hill-Sachs lesion were included. On the contrary, patients with prior surgical interventions for shoulder instability, glenoid bone loss <15%, or any other shoulder pathology, were excluded from the study.

Clinical and imaging assessment

Preoperative and postoperative clinical and imaging data was collected. All patients followed the same standardized postoperative rehabilitation protocol. Follow-up assessments included: functional shoulder tests, clinical examination and evaluation using the University of California-Los Angeles (UCLA) shoulder score and constant score (CS), measured using goniometers and an Isobex isometric dynamometer, anteroposterior and lateral radiographs to assess osteoarthritis (based on the Samilson-Prieto classification) and computed tomography (CT) scans to evaluate graft positioning relative to the glenoid rim, graft integration and screw positioning (6).

All patients underwent a standardized physical examination performed by a surgeon at a mean follow-up of 6.2 years (range: 5.5-7.2 years) for the OLP group and 4.5 years (range: 4-5.1 years) for the ALP group. Range of motion (ROM) was measured by physiotherapists using goniometers according to standardized measurement guidelines. Active ROM included external rotation and abduction of the shoulder.

The CS is a 100-point scale composed of four individual parameters: pain (15 points), activities of daily living (20 points), mobility (40 points, including forward elevation, external rotation, abduction and internal rotation of the shoulder) and strength (25 points). Higher scores indicate better shoulder function (7).

The UCLA shoulder score, first described by Romeo *et al* for evaluating shoulder instability, assesses five parameters: active forward flexion (maximum of five points), strength of forward flexion (maximum of five points), pain (maximum of 10 points), patient satisfaction (maximum of five points) and overall function (maximum of 10 points). Scores range from 0 to 35, with 0 indicating the worst shoulder function and 35 indicating the best shoulder function (8).

Postoperative imaging was assessed by a single radiologist specializing in musculoskeletal system analysis. Standard anteroposterior and lateral radiographs were performed to evaluate signs of OA based on osteophyte size, following the Samilson-Prieto classification. Mild OA was defined as an osteophyte in the humerus or glenoid measuring less than 3 mm, moderate OA as inferior osteophytes between 3-7 mm, and severe OA as inferior osteophytes greater than 7 mm.

All patients underwent CT scans to assess graft positioning in the axial and coronal planes, graft integration, possible osteolysis in the sagittal plane, and the divergence angle between the inferior and superior screws. In the coronal plane, graft positioning was classified as adequate if it was positioned below the glenoid equator and inadequate if it was at or above the glenoid equator (Figure 1). In the axial plane, coracoid graft positioning was considered adequate if the distance between the graft and the glenoid surface was 2-5 mm, whereas inadequate positioning was defined as >2 mm lateral or >5 mm medial to the glenoid surface (Figure 2). The divergence angle of the screws was measured as the angle between the screw and the articular surface (Figure 3). Ideally, screws should be inserted at an angle between 10-15 degrees, with no specific distance between them. An angle greater than 15 degrees is associated with a significantly higher rate of graft displacement. Additionally, bicortical double-screw fixation has been shown to be superior to unicortical double-screw fixation, whereas screw type (diameter, thread, and composition) does not significantly affect construct strength (9).

Graft integration was classified into three categories. Nonunion was defined as a persistent

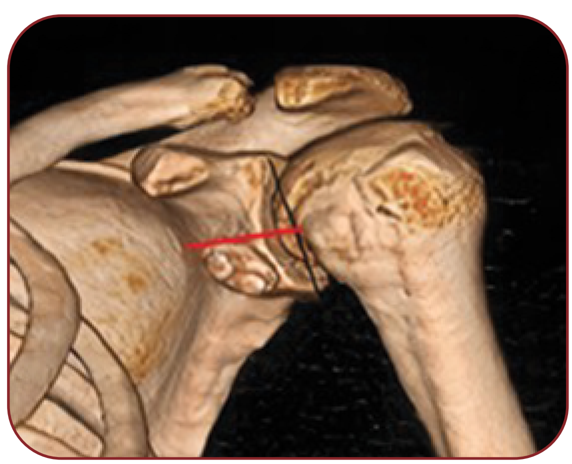

FIGURE 1. Graft position in coronal plane. In coronal computed tomography (CT) plane, 3D reconstruction of the glenoid, defining the glenoid superior-inferior length (black line) and the equator (red line). The graft, as shown inferior-anterior, is adequate when it is under the glenoid equator.

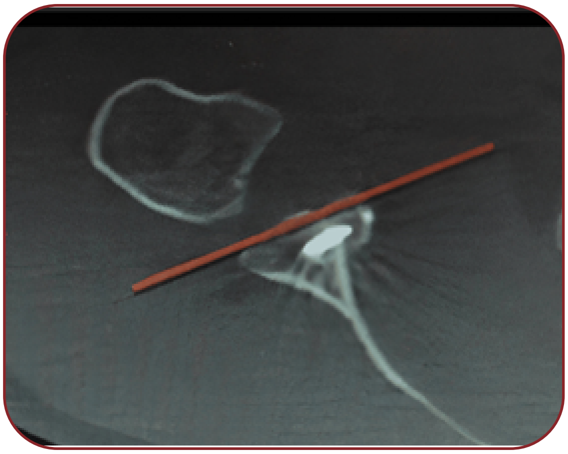

FIGURE 2. Graft position in axial plane. In axial computed tomography (CT) plane, measurement of the distance between graft and glenoid surface. Distance is characterized as adequate when it is 2-5 mm.

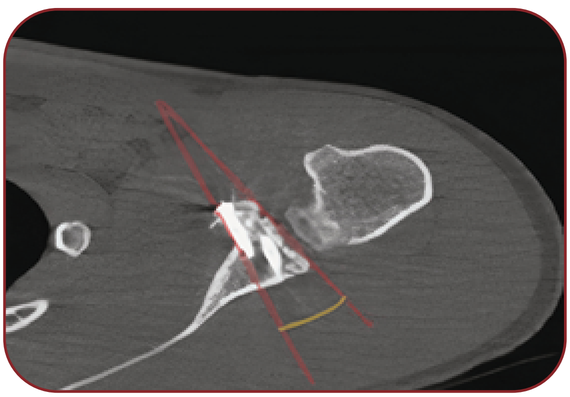

FIGURE 3. Divergence of the angle of both inferior and superior screws. In axial computed tomography (CT) plane, assessing the divergence of the inferior and superior screw (yellow arc). Divergence is defined as the angle between the screw and the articular surface (in this picture we measure the inferior screw's divergence).

gap between the graft and the glenoid, accompanied by a two-cortical profile or graft fragmentation. Partial integration was noted when 75% or less of the graft was in contact with the glenoid, whereas complete integration was defined as more than 75% contact between the graft and the glenoid. Osteolysis was evaluated based on its presence or absence in the sagittal plane.

Surgical technique

The OLP was performed using the standard technique described by Dr. Latarjet. For the ALP, Lafosse's technique was followed (5). All procedures (OLPs and ALPs) were performed by the same surgeon to ensure procedural consistency.

Data collection and statistical analysis

Data was collected in a computerized database and included physical examination findings, functional outcome scores, and imaging results. Statistical analyses were performed using SPSS software, with a significance level (α) set at 0.05. P-values were two-sided to account for differences in both directions. Patients were stratified into two groups (OLP and ALP). The Chi-squared test was used for categorical variables, while the Mann-Whitney test was applied for ordinal variables. Spearman's correlation was utilized to analyze relationships between variables and Fisher's exact test was employed to determine associations between two categorical variables. The Shapiro-Wilk test was conducted to assess the normality of data distribution. The null hypothesis (H_0) stated that OLP and ALP yielded equivalent outcomes. A P-value lower than the significance threshold (0.05) led to the rejection of H_0, indicating a statistically significant difference between OLP and ALP.

RESULTS

A total of 42 patients were included in this study and divided into two groups. The OLP group consisted of 19 patients (17 males and two females, with a mean age of 21.3 years [range: 16-37 years]), while the ALP group included 23 patients (20 males and three females, with a mean age of 20.6 years [range: 17-31 years]). The overall male-to-female (M:F) ratio was 37:5, with an M:F ratio of 17:2 in the OLP group and 20:3 in the ALP group.

It was found that there was no significant difference between OLP and ALP in terms of graft positioning relative to the glenoid equator and axial plane ($p = 0.732$). There was also no significant difference between the two procedures regarding the position of the superior screw ($p = 0.289$). However, concerning the position of the inferior screw, ALP demonstrated a significantly better inferior screw position compared to OLP ($p = 0.027$), with a relative risk (RR) of 2.96 (95% CI 0.99-8.87) and an odds ratio (OR) of 5.09 (95% CI 1.15-22.62) (Figure 4). In terms of graft integration, ALP showed superior graft integration compared to OLP ($p = 0.021$), with an RR of 1.5 (95% CI 0.95-2.52) and an OR of 4.0 (95% CI 0.95-16.92) (Figure 5). There was no significant difference between ALP and OLP in the

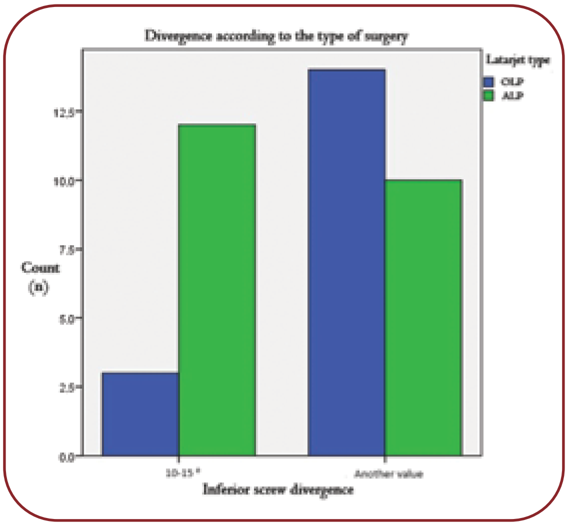

FIGURE 4. Bar chart displaying inferior screw divergence in the open Latarjet procedure (OLP) (blue bars) and arthroscopic Latarjet procedure (ALP) (green bars). The ALP group demonstrates a significantly higher proportion of screws positioned within the optimal 10-15° range compared to the OLP group.

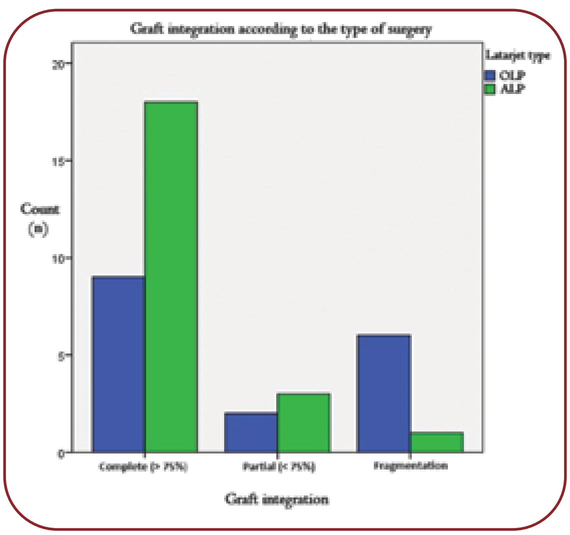

FIGURE 5. Bar chart exhibiting graft integration outcomes in the open Latarjet procedure (OLP) (blue bars) and arthroscopic Latarjet procedure (ALP) (green bars). The ALP group shows a higher rate of complete graft integration (>75%), while the OLP group has a greater incidence of graft fragmentation.

presence of osteolysis (p = 0.407), with an RR of 2.3 (95% CI 0.26-20.36) and an OR of 2.5 (95% CI 0.24-26.72). The majority of patients did not exhibit signs of osteoarthritis and there was no significant difference between the groups (p = 0.235).

Regarding the functional assessments, all patients returned to their pre-injury level of activity. The mean UCLA score was 32.94 ± 3.24 for OLP and 32.30 ± 4.13 for ALP, with no significant difference between the groups (p = 0.156). Similarly, the mean CS was 90.44 ± 10.09 for OLP and 92.00 ± 9.05 for ALP, showing no significant difference (p = 0.753). Postoperative findings also indicated no statistically significant differences between ALP and OLP groups in terms of pain (p = 0.249), function scores (p = 0.939), active ROM (p = 0.798) and muscle strength (p = 0.950). Furthermore, patient-reported satisfaction scores showed no significant difference between the two groups (p = 0.702).

DISCUSSION

The results of this study suggest that graft integration and screw positioning were superior in the ALP group compared to the OLP one. For all other parameters, no statistically significant differences were observed between the two groups.

In 2011, Young *et al* reported outcomes from more than 2,000 OLPs, finding that OLP had a recurrence rate of 1%, with 83% of patients returning to their preinjury level and 98% rating their outcome as excellent or good (10). Similarly, in a long-term study involving 319 shoulders, Hovelius *et al* found that OLP yielded good results, with a bony fusion rate of 83% for the coracoid. The addition of a horizontal capsular shift to the coracoid transfer further decreased recurrence rates and improved subjective outcomes (11).

Despite the widespread use of OLP, few studies have directly compared it to ALP. Horner *et al* found that both procedures were equally effective, with similar low complication rates, recurrent instability, and need for revision surgery. However, ALP was associated with less early postoperative pain but a longer operative time (12). In 2017, Zhu *et al* demonstrated that both techniques were equivalent, with OLP providing better positioning in the inferior-superior direction, while ALP resulted in less graft resorption (13). A systematic review and meta-analysis conducted in 2019 including 896 patients, described both procedures as effective, with comparable complication and instability rates. However, the open group had a lower rate of persistent apprehension (10.2% *vs.* 35.7%) and ALP was noted to have a long learning curve (14). Similarly, Randelli *et al* confirmed the equal effectiveness of both procedures, emphasizing that the higher cost of ALP (15).

The reported rate of intraoperative complications for both OLP and ALP ranges from 15-30%, including graft malposition, fracture, nerve or vascular injury. Immediate postoperative complications may include hematomas, swelling, neurapraxia, brachial plexopathy, osteolysis and infections (16). Recurrent instability after a first-time shoulder dislocation is influenced by a combination of modifiable and non-modifiable risk factors and may exceed 26% (17).

Biomechanically, traumatic dislocation or subluxation of the shoulder triggers a cascade of soft tissue and/or bony injuries. Preoperative magnetic resonance imaging (MRI) findings commonly include an anterior labral tear (Bankart lesion), which is the most frequent associated injury (80-90%). In parallel, an anterior labral periosteal sleeve avulsion (ALPSA) lesion is present in 97% of recurrent instability cases. Other associated findings include a Hill-Sachs defect of the humeral head (40-100%), a bony Bankart lesion (up to 49%) and rotator cuff tears (up to 30% in patients over 40 years old). Less common pathologies include humeral avulsion of the glenohumeral ligament (HAGL) and axillary nerve injury (2).

The advantages of ALP include improved graft positioning, reduced soft tissue dissection and identification of coexistent intra-articular pathologies, such as labral and rotator cuff tears. These benefits were also observed in our study, as arthroscopic visualization provided superior intraoperative assessment. On the other hand, Athwal *et al* reported an overall complication rate of 24% in a cohort of 83 patients treated with ALP, which they considered insignificant (18).

Our study can be objectively compared to that of Athwal *et al* for several reasons. First, their study involved five different surgeons, while all procedures in our study were performed by a single experienced surgeon. This is a key advantage of our study, as variations in surgical technique and skill between multiple surgeons may influence clinical outcomes and complication rates. Moreover, in that study, each surgeon performed an average of 16.6 arthroscopic procedures, with a mean surgical experience of 12.6 years, having started performing ALP after their first year of surgical practice. In contrast, in our study the single surgeon had performed over 1,000 complex shoulder arthroscopies, more than 200 OLPs, and over 200 ALPs, having been in practice since 2005. This extensive experience strengthens the validity of our findings.

This aligns with Lafosse and Boyle's assertion that a surgeon must have completed at least 1,000 arthroscopic surgeries before attempting ALP to avoid intraoperative and postoperative complications (19). Likewise, Valsamis *et al* suggest that 30-50 ALPs are necessary to achieve consistent operative efficiency (20). Furthermore, in a study of 75 cases Papalia *et al* have recently reported that OLP required a deep learning curve, with operative time decreasing after 15 procedures and efficiency plateauing after 30 cases (21). This underscores the fact that ALP is more technically demanding than OLP and an average of 16.6 procedures per surgeon, as seen in Athwal *et al*'s study, may account for their reported 24% complication rate.

One major strength of our study is the long-term follow-up period (mean FU: 6.2 years for OLP and 4.5 years for ALP), compared to Athwal *et al*'s study, which had a mean follow-up of only 17 months. Although our sample size is smaller, the longer follow-up period strengthens our findings by confirming the absence of immediate or long-term major complications. In addition, all patients in our study received double-screw fixation, whereas in Athwal *et al*'s study, five patients had single-screw fixation, which may have contributed to higher rates of hardware or graft failure. In our study, all grafts were properly osteotomized and prepared, preventing fractures. In contrast, Athwal *et al* reported a 7% graft fracture rate, possibly due to inadequate contouring of the coracoid. Most importantly, none of our patients required revision surgery, while Athwal *et al* reported seven revision cases, thus reinforcing the effectiveness of our approach.

Despite its strengths, our study has some limitations. First, the sample size is relatively small. Moreover, patient selection was based on convenience sampling and random treatment assignment to either OLP or ALP. This was necessary because the current literature does not provide clear guidelines on the ideal indications for each technique.

CONCLUSIONS

The arthroscopic Latarjet procedure presents a steep learning curve; however, with the increasing adoption of arthroscopic techniques, surgeons today are more proficient in minimally invasive procedures than in the past. Our study provides a unique analysis that clearly demonstrates the superiority of ALP over OLP. When performed by experienced arthroscopists, ALP is associated with fewer to no major complications and results in high patient satisfaction over the long term. Scientists should carefully consider the current literature and recognize arthroscopic Latarjet as a valuable addition to the surgical arsenal for treating anterior shoulder instability, alongside the open technique. ❑

Ethical statement: The study was approved by the Institutional Review Board (2018-1356).

Conflicts of interest: none declared.

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