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Acromial J-bone graft on the acromion for surgical treatment of glenohumeral instability: an anatomical study

Matthieu Sanchez[1], Shahnaz Klouche[1], Bruno Faivre[1], Thomas Bauer[1] and Philippe Hardy[1,2]

Abstract

Background: Anterior glenohumeral instability is frequently associated with anteroinferior glenoid bone defects. One original technique has been described in the literature that incorporates a J-shaped graft from the iliac crest into the anterior glenoid rim. The main goal of the present study was to evaluate the feasibility of harvesting a J-shaped graft from the acromion that corresponds to previously described dimensions. The secondary goal was to determine the ideal harvesting site.

Methods: Forty shoulders from 20 cadavers were included. Twenty grafts were harvested from the posterior acromion and 20 from the lateral acromion. The length, width and thickness of the grafts were measured. The incision was then enlarged to confirm the absence of an acromial fracture by fluoroscopic control.

Results: Harvesting a graft whose size was similar to a J-graft was successfully performed in all cases (100%) with a mean (SD) incision of 4.2 (0.3) cm. Mean (SD) harvesting time was 4.5 (0.5) minutes. Two acromial fractures were identified during lateral harvesting (10%) and none during posterior harvesting ($p = 0.49$).

Conclusions: It is always possible to harvest a J-graft on the acromion. The posterior side of the acromion is the best site to harvest a graft that has the necessary size to treat glenoid bone defects.

Keywords

glenoid bone loss, iliac graft, J bone graft, Latarjet, shoulder instability

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Introduction

Anterior glenohumeral instability is frequently associated with anterior glenoid bone defects.[1–5] Arthroscopic Bankart procedures have a high rate of failure in the treatment of these cases of instability.[2,6–8] A classic response to this problem is to perform a Latarjet or Bristow coracoid transfer.[9] This stabilization technique by coracoid transfer was recently criticized for its non-anatomical results and the risk of long-term secondary osteoarthritis.[10–13] Certain studies have proposed anatomical grafts of the anterior glenoid with the iliac crest[14–16] or allografts.[17–20] Auffarth et al.[14] described an original technique of reconstruction of the anterior glenoid using a J-shaped iliac graft that resulted in stable fixation without a screw in most cases. The series by Auffarth et al.[14] is the largest in the literature for this indication and has shown excellent results. This technique also makes it possible to restore glenoid bone defects and obtain anatomic remodelling. Scheibel et al.[15] reported the results of an arthroscopic iliac graft associated with capsulolabral Bankart type repair.[15,21–23] However, harvesting of an iliac graft is limited by a high rate of morbidity.[24–29] Although allografts may seem to be an attractive

[1]Hôpitaux Universitaires Paris Ile de France Ouest, Assistance Publique-Hôpitaux de Paris, Boulogne Billancourt, France
[2]Université de Versailles Saint-Quentin-en-Yvelines, UFR des Sciences de la Santé, Versailles, France

Corresponding author:
Matthieu Sanchez, Hôpital Ambroise Paré 9, avenue Charles De Gaulle, 92104 Boulogne-Billancourt, France.
E-mail: matthieu.bs@hotmail.fr

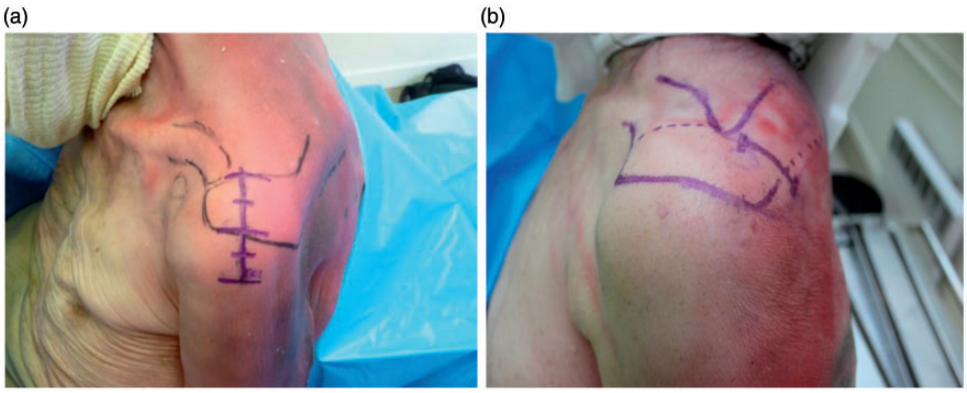

Figure 1. Drawing of the (a) lateral and (b) posterior surgical approaches.

alternative for this indication, this option is limited by cost and availability.

Harvesting a graft from the acromion makes it possible to have a single surgical field for the operation and avoids the morbidity associated with iliac harvesting. Once the graft is harvested, it could be arthroscopically implanted.[15] The main goal of the present study was to evaluate the feasibility of harvesting a J-graft from the acromion similar to the graft described by Auffarth et al.[14] The secondary goal was to determine the optimal harvesting site.

Materials and methods

Right and left shoulders were dissected. These were fresh unembalmed anatomical subjects, preserved at +4°C and returned to room temperature the evening before dissection. Shoulders that had signs of prior surgery or obvious clinical deformities were excluded.

Surgical technique

The surgical protocol was standardized and validated by the scientific committee of the surgical school. All dissections were performed by the same junior orthopedic surgeon and validated by a senior orthopedic surgeon. The graft was harvested according to the description of the J-graft provided by Auffarth et al.[14] Dissections were performed with the subject in the beach chair position.

Lateral approach. Inspired by the description by Neviaser[30] used for glenohumeral arthroplasties, this approach takes the superior part of the anterosuperior approach to the shoulder (Fig. 1a). A 4 cm to 5 cm incision was made descending vertically along the axis of the arm. The upper 2 cm of the incision was located on the superior part of the acromion then the incision descended 2 cm below the lateral surface of the acromion. After cutting the subcutaneous tissue, the deltotrapezoid fascia was approached. An incision was made with a cold scalpel to separate approximately 2 cm of the fibres of the anterior and middle deltoids (Fig. 2a). The acromion was approached subperiostally with a cold scalpel. The subacromial bursa of the inferior surface of the acromion was then detached with a rasp (Fig. 3a).

Posterior approach. The approach was vertical, 2 cm from the posterolateral angle of the acromion (Fig. 1b). The incision measured 4 cm to 5 cm and descended vertically along the axis of the arm. The upper 2 cm of the incision was located on the superior surface of the acromion then the incision descended 2 cm below the posterior surface of the acromion. After cutting the subcutaneous tissue, an incision was made down to the deltotrapezoid fascia. The deltoid was then cut with a cold scalpel to separate 2 cm of the fibres of the middle deltoid from those of the posterior deltoid (Fig. 2b). The acromion was approached subperiostally with a cold scalpel. The subacromial bursa of the inferior acromion was then detached with a rasp (Fig. 3b).

Harvesting the graft. Once the acromion was sufficiently exposed, the graft was marked with a dermographic pen (Fig. 4). The graft was harvested in exactly the same way with both approaches.

Harvesting by lateral approach was centered on the middle of the anteroposterior part of the acromion. A series of osteotomies was performed with a 10-mm osteome along the lines drawn by the dermographic pen. An osteotomy on the inferior surface of the graft and facing upwards made it possible to harvest the graft.

Posterior harvesting of the graft was centered on the middle of the distance between the posterolateral corner of the acromion and the spine of the scapula. The sequence of the osteotomies was the same as that

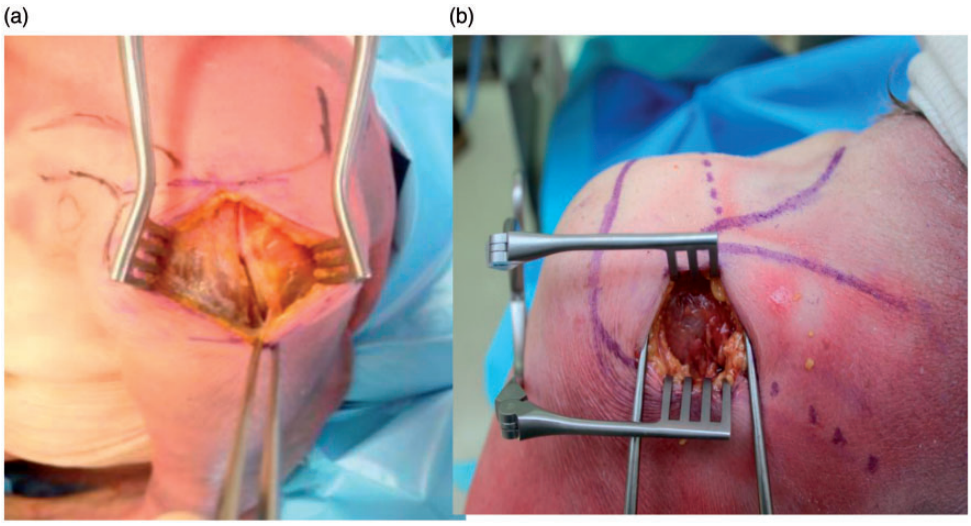

Figure 2. Exposure of the (a) lateral and (b) posterior deltotrapezoid fascia.

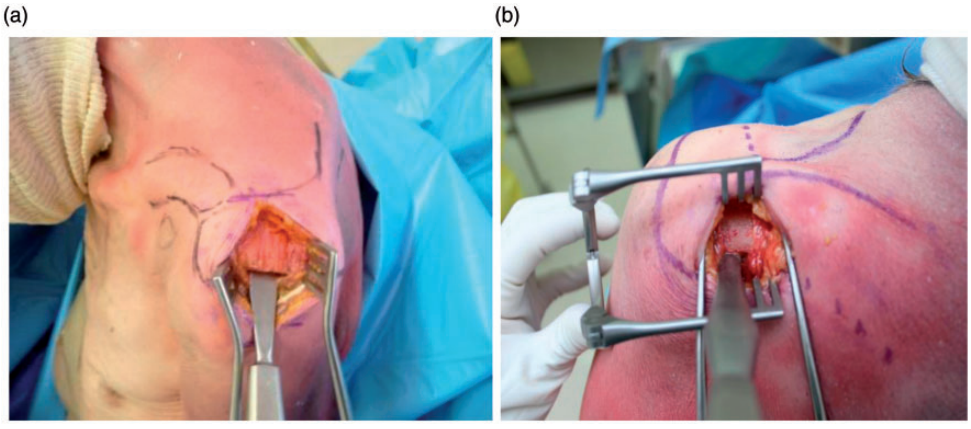

Figure 3. The inferior surface of the acromion is scraped with a rasp to detach the subacromial bursa by a (a) lateral and (b) posterior approach.

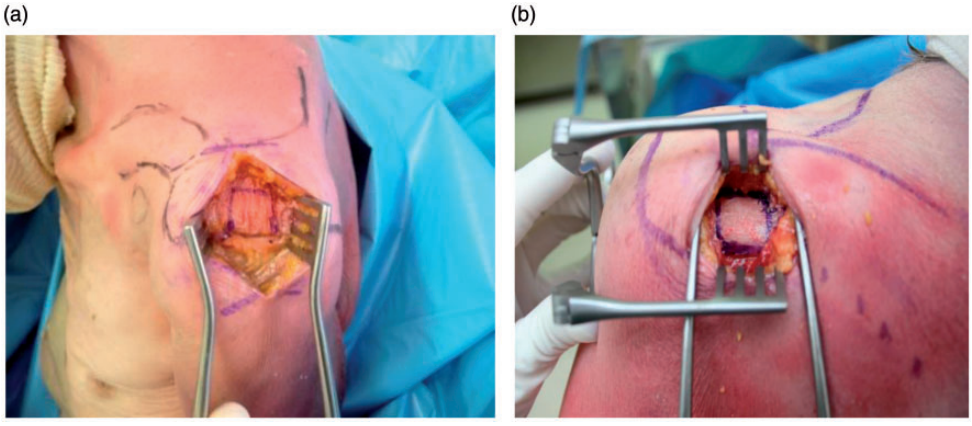

Figure 4. Drawing of the 15 mm long and 15 mm wide graft with a dermographic pen by a (a) lateral and (b) posterior approach.

for lateral harvesting, beginning with superior osteotomies and ending with the inferior osteotomy (Fig. 5).

The deltotrapezoid fascia was then reinserted transosseously. The incision was closed with an absorbable running intradermal suture.

The bicortical graft was then modelled into a J-shape using a motorized drill so that the final dimensions of the graft were 15 mm long, 15 mm wide (Fig. 6) and approximately 6 mm high. The distal part of the graft needed to be thin and included only cortical bone, whereas the proximal bent section needed to be approximately 6 mm thick and include both cortical and cancellous bone.

Evaluation criteria

The main evaluation criterion was the feasibility of acromial harvesting of a J-graft that was at least 15 mm long, 15 mm wide and 6 mm high, similar to the graft described by Auffarth et al.[14]

Secondary evaluation criteria were an acromial fracture that was first searched for macroscopically by enlarging the surgical incision after closing (Fig. 7a), and then by performing an osteotomy of the scapular spine under fluroscopic control and harvesting the entire acromion (Fig. 7b, c).

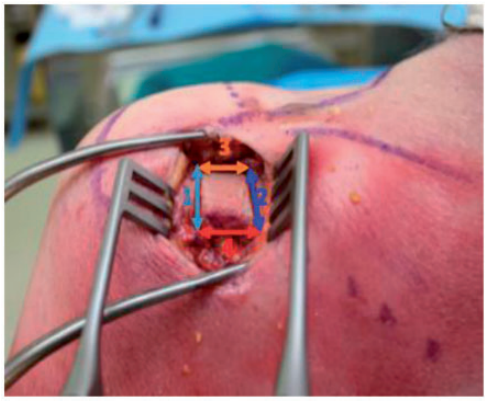

Figure 5. Order of osteotomy cuts.

Statistical analysis

Nonparametric tests were used depending on the sample size. Quantitative variables were tested by the Mann–Whitney test for independent groups and qualitative variables by Fisher's exact test. $p > 0.05$ was considered statistically significant.

Results

Forty shoulders were included from 20 cadavers. Harvesting was lateral (lateral surface of the acromion) in 20 shoulders in 10 different subjects (five men and five women). Harvesting was posterior (posterior surface of the acromion) in 20 shoulders from 10 other subjects (five men and five women). Subjects were conserved for a mean (SD) of 28 (8.7) days (range 12 days to 44 days). Subjects mean (SD) age at death was 71.1 (8.7) years (range 42 years to 88 years).

A graft that was morphologically similar to the J-graft was successfully harvested in all of the 40 shoulders (100% of the cases). Grafts measured at least 15 mm long (15 mm to 17 mm) and 15 mm wide (15 mm to 17 mm). Height varied from 5 mm to 7 mm. The mean (SD) length of the incision once it was closed was 4.2 (0.3) cm (range 4 cm to 5 cm) with the lateral approach and 4.1 (0.3) cm with the posterior approach (range 4 cm to 5 cm) ($p = 0.64$). Harvesting from the incision to closing took a mean (SD) 4.6 (0.6) minutes (range 4 minutes to 6 minutes) by the lateral approach and 4.4 (0.5) minutes (range 4 minutes to 5.5 minutes) by the posterior approach ($p = 0.39$).

The macroscopic assessment, completed by a fluoroscopically controlled assessment of the entire acromion identified two acromial fractures in the lateral

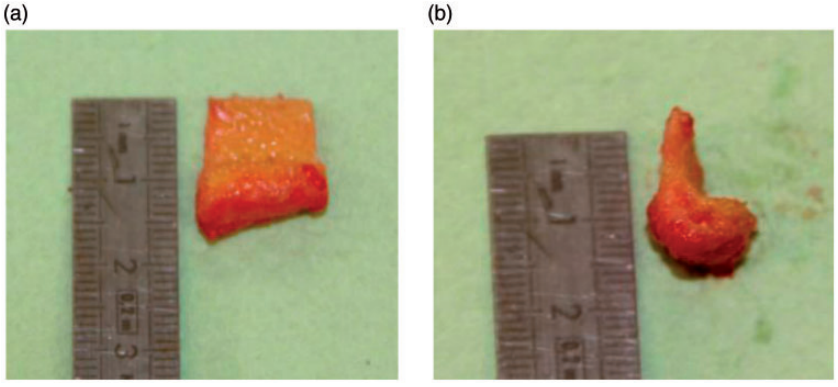

Figure 6. Example of the (a) 15 mm long and 15 mm wide graft frontal and (b) profile with a J-shape.

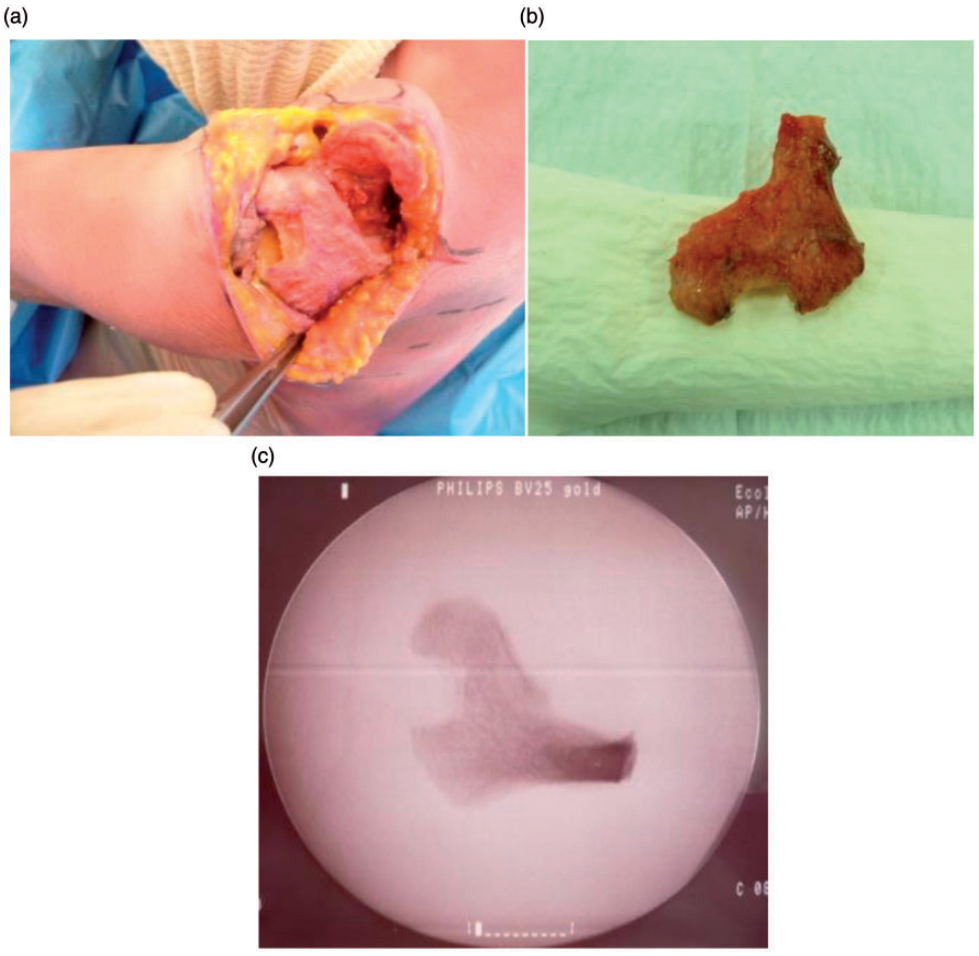

Figure 7. Macroscopic search for an acromial fracture after (a) enlarging the surgical incision (a) and then (b) removing the entire acromion and (c) under fluoroscopic control.

harvesting group (10%). The two acromial fractures were longitudinal extending from lateral (harvesting site) to medial side (acromio-clavicular joint). These fractures occurred in one male specimen and one female, which had normal sizes. There were no fractures found in the posterior harvesting group (0%). There was no statistically significant difference for this parameter ($p = 0.49$).

Discussion

In this cadaveric study, a graft with characteristics similar to that of the J-bone graft described by Auffarth et al.[14] was successfully harvested in 100% of the cases from either the lateral or posterior surface of the acromion.

According to Auffarth et al.,[14] treatment of recurrent anterior glenohumeral instability by J-bone graft is reproducible and effective, showing no recurrent dislocation after 90 months of follow-up and very good functional results, with a constant score of 93.5/100 for the operated shoulder and 95% for the contralateral shoulder. This option can be used for primary or revision surgery. Glenoid reconstruction by J-bone graft provides nearly anatomical reconstruction of glenoid bone defects after 1 year of follow-up.[31] The main disadvantage of the technique is that harvesting of the iliac graft is associated with significant morbidity and the Auffarth et al.[14] reported one case of revision surgery for haematoma and five cases of nerve injury.

A recent review of the literature was published by Dimitriou et al.[27] on the morbidity of harvesting the iliac graft. The mean rate of complications during harvesting of the iliac graft was 19.37%. Chronic pain was frequent (7.75% to 39%),[24–29] as were sensory disorders at the harvesting site (4.81%), and can influence the patient's activities.[11] Severe complications (hematoma 1.5%, infection 1.4%, gluteal artery injury 0.06%, fractures 0.2% or wound dehiscence 0.28%) are more rare and often require surgical revision.[27]

There is no statistically significant difference in the incidence of complications between anterior iliac and posterior iliac harvesting.[27]

Because of the significant morbidity, another simpler and safer harvesting site is needed to obtain a graft that corresponds to the characteristics of the J-bone graft described by Auffarth et al.[14] Most importantly, harvesting from the acromion should make it possible to avoid the many complications associated with iliac harvesting at the same time as providing all of the necessary characteristics of the graft. This harvesting option makes it possible to have a single surgical field. The approach is rapid and simple, no matter how heavy the patient is, which is not the case when harvesting an iliac graft in obese subjects in the beach chair position. Harvesting of the anterior surface of the acromion might appear to be an attractive approach because it could be included in the deltopectoral approach that is necessary to expose the anterior glenoid. However, the proximity of the acromioclavicular joint presents too great a risk to recommend this procedure. In the present study, two acromial fractures occurred involving the acromioclavicular joint using a lateral harvesting site. The risk of acromial fracture apppears to be higher with lateral harvesting (10% versus 0%), which suggests that the posterior surface of the acromion is the most reliable harvesting site.

The present study has several limitations. It is an anatomical study and an additional clinical study is needed to validate this harvesting technique and evaluate its morbidity. The choice of the J-graft is not common and has only been evaluated for the moment by Auffarth et al.[14] An additional study evaluating the feasibility of this technique by arthroscopy would also be interesting. Because arthroscopic stabilization surgery is completely intra-articular, the risk of leaking should be low because there is no subacromial phase.[15,21–23,32,33]

Conclusions

A J-graft can always be harvested from the acromion. The posterior surface of the acromion is the first choice site to harvest a graft with the appropriate dimensions to treat anterior glenoid bone defects according to the technique described by Auffarth et al.[14] The difficulties associated with harvesting the iliac crest in the beach chair position and the associated comorbidities can be avoided by employing this technique.

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Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: T. Bauer is consultant for Arthrex. P. Hardy is consultant for Arthrex and Zimmer. The other authors declare that they have no conflicts of interest regarding the present study.

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Ethical review and patient consent

The study was validated by the ethical committee of the surgical school.

Level of Evidence

Level 4. Basic science; surgical technique using cadaver specimens.

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