Introduction

Traumatic anterior glenohumeral dislocation is a commonly encountered injury, particularly in young, active patients. The degree of injury to the glenoid resulting from the dislocation may range from soft tissue injury to the anterior labrum (Bankart lesions) to bone involvement along the glenoid rim. Depending on the severity of the injury, the resultant glenoid based lesion may be treated via soft tissue Bankart repair or a procedure to address bone loss. Herein we discuss indications for performing a reconstruction using autogenous tricortical iliac crest bone graft (ICBG), the Eden-Hybinette procedure. Operative planning, technique, and post-operative care are described. With proper technique, this methodology can address sizable glenoid defects. In the subset of instability patients in which the Latarjet fails, the Eden-Hybinette procedure has been shown in the literature to be a reliable option for restoring stability.

Keywords: Eden-Hybinette; glenohumeral instability; failed Latarjet

When it all fails—use the iliac crest


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Abstract: Traumatic anterior glenohumeral dislocation is a common injury, particular in young and active patients. Depending on the severity of the injury and patient-specific factors, a soft tissue Bankart repair or a procedure to address bone loss may be elected. Herein we discuss indications for performing a reconstruction using autogenous tricortical iliac crest bone graft (ICBG), the Eden-Hybinette procedure. Operative planning, technique, and post-operative care are described. With proper technique, this methodology can address sizable glenoid defects. In the subset of instability patients in which the Latarjet fails, the Eden-Hybinette procedure has been shown in the literature to be a reliable option for restoring stability.

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glenoid rim defect. Jankauskas et al. defined the loss of the sclerotic glenoid line on anteroposterior radiographs, a pathognomonic finding with very high specificity for anterior glenoid rim defects (15). Patients with this radiographic finding are often best served with a procedure to address the bone defect, or at a minimum require cross-sectional imaging to calculate the extent of the critical glenoid bone loss.

In many situations with engaging lesions or critical bone loss, the Latarjet procedure is an excellent surgical option. With long-term follow-up, recurrent instability following Latarjet is reported at a rate of 5–6% (16-18). Failures are most often the result of technical errors, which include excessively inferior or medial graft malposition, failure to obtain secure graft fixation with bicortical screws, and reliance on single screw fixation (16,19). Additionally, patients with large glenoid defects or narrow coracoid morphology may be prone to failure of a Latarjet procedure (18).

As discussed herein, the Eden-Hybinette procedure, which utilizes autogenous structural iliac crest bone graft (ICBG) is an excellent option to restore shoulder stability in the setting of a failed Latarjet procedure.

**Indications**

Patients who have failed a Latarjet procedure present unique challenges. With failed union and resorption of the coracoid graft, glenoid bone defects may range from small to quite large without the availability of local bone graft, such as the coracoid (Figure 1). Similarly, a sub-category of patients undergoing their index stabilization procedure may have a significant degree of glenoid bone loss that may be too large to reconstruct with a coracoid graft. The size of glenoid defect over which a Latarjet procedure may not restore stability has not been clearly defined in the literature. In such cases where the degree of glenoid bone loss is large or the coracoid morphology prevents its use for reconstruction, the Eden-Hybinette procedure may be a better option.

With careful technique, the iliac crest graft size available for reconstruction is large, enabling the surgeon to address sizeable defects. Graft availability comes at the cost of donor site morbidity, which may include prolonged pain or injury to the lateral femoral cutaneous nerve if the graft is harvested in close proximity to the anterior superior iliac

![Figure 1](image-url) Failed Latarjet procedure. CT axial (A) sagittal (B) and 3D reconstruction (C) imaging demonstrating graft nonunion 4 months after a Latarjet procedure. This patient ultimately underwent revision using ICBG. ICBG, iliac crest bone graft.
spine (ASIS). After harvesting the tricortical ICBG, it can be contoured to match the site of the glenoid deficiency. The concavity of the inner table may also be a closer match to that of the glenoid, providing a more congruent reconstruction (20). Furthermore, use of autogenous structural ICBG is a cost effective alternative to use of allograft, with lower risk of disease transmission.

We prefer the Eden-Hybinette procedure in patients who have failed a Latarjet procedure, or as an index procedure in patients with glenoid bone loss exceeding 40% (Figure 2), abnormal coracoid morphology, or an unreconstructable glenoid fracture with instability. Patients with uncontrolled seizures, active infections, and those who are unable to follow post-operative precautions are not recommended for this procedure.

**Operative planning, technique, and post-operative care**

In patients with suspected bone loss, we routinely get computed tomography (CT) with three-dimensional (3D) reconstructions. We use this imaging modality to accurately determine the shape of the glenoid and the extent of bone loss. In cases of substantial bone loss, provisional measurements of the length and width of the defect can be taken to determine the size of bone graft needed. CT scans can also be useful in identifying abnormal coracoid morphology.

For the Eden-Hybinette procedure, we prefer an open approach, though arthroscopic techniques have been described as well. The patient is placed in the beach chair position, sitting upright with only 30 degrees of elevation. Lower degrees of elevation may aid in keeping a particularly unstable shoulder in a more reduced position and also provide access to harvest the ICBG. We also do not sit obese patients as far upright as it may make accessing the iliac crest more challenging. The lateral support on the operative side often needs to be adjusted so that it supports the patient, but does not impede access to the iliac crest. A pneumatic arm positioner is used for the operative arm to aid in arm positioning throughout the procedure.

After prepping and draping both the operative shoulder and the iliac crest, a standard deltopectoral approach is made. As this procedure is often done in the setting of a failed Latarjet procedure, it is important to be cognizant of the altered surgical field. In addition to the scarring from previous procedures, the deltopectoral interval may not be readily identifiable, and the coracoid and conjoint tendon are not reliable landmarks. The axillary nerve is then carefully identified and protected.

The subscapularis is managed with either a split in line with its fibers at its superoinferior midpoint or a tenotomy. A subscapularis split may be a better option, particularly if a tenotomy was used previously such as at the time of a Latarjet. If instead a tenotomy is used during the exposure, the subscapularis should be dissected from the underlying capsule from lateral to medial using needle-tip electrocautery. In the setting of a failed Latarjet procedure, the conjoint tendon will

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**Figure 2** Significant glenoid bone loss. CT 3D reconstruction (A) and intraoperative imaging (B) of a very large glenoid defect (>40%) for which a primary Eden-Hybinette might be recommended.
likely be scarred into the subscapularis and does not need to be disturbed. The capsule is then released along the neck of the humerus. A Fukuda retractor is used to posteriorly displace the humeral head and a cobra retractor is placed over the anterior glenoid. The glenoid is then prepared by removing any screws and un-united coracoid graft (Figure 3). A burr or curved Lambotte osteotome is used to remove any prominent bone and abrade the surface to create a flat surface of bleeding bone for placement of the graft. After preparing the glenoid surface, measurements of the defect are taken to verify the size of graft needed. Once the glenoid has been prepared, we proceed with harvesting the iliac crest graft.

In order to facilitate the ICBG harvest the patient can be placed in a more supine position. The incision should be well posterior to the ASIS so as to avoid injury to the lateral femoral cutaneous nerve. An oblique incision is made two centimeters lateral to the ASIS extending approximately 5 centimeters laterally. The inner and outer tables are exposed with the aid of blunt retractors (Figure 4). An oscillating saw and osteotome are used to remove a tricortical wedge of bone that is appropriate in size for the patient’s glenoid.

Figure 3 Intra-operative findings of failed Latarjet. Intraoperative findings after hardware removal from a failed Latarjet procedure.

Figure 4 Exposure and harvesting of tricortical graft. (A) Illustration of the steps to harvest and prepare the tricortical ICBG; (B) intraoperative photographs showing exposure and measurement of the planned iliac crest graft, and (C) the harvested tricortical graft. Figure 4A used with permission from Warner JJ, Gill TJ, O’Hollerhan JD, et al. Anatomical Glenoid Reconstruction for Recurrent Anterior Glenohumeral Instability with Glenoid Deficiency Using an Autogenous Tricortical ICBG. Am J Sports Med 2006;34:205-12. ICBG, iliac crest bone graft.
defect. The graft is then prepared, with the concavity of the inner table aligning with the glenoid articular surface. This requires some planning and fitting of the graft so as to restore proper glenoid concavity. All soft tissue must be meticulously removed and the graft is carefully contoured to match the defect on the bony interface.

The graft is then positioned along the anterior glenoid, congruent with or slightly medial to the articular surface. If the graft is positioned too laterally, the patient will be at risk of developing rapidly progressive arthritis. The graft is then secured with at least two 3.5 mm cortical screws with washers oriented parallel to the articular surface. Before fully seating each screw, a #2 fiberwire suture is placed around the screw heads for capsular repair. An illustration of the capsular repair is shown in (B). Figure 5B used with permission from Warner JJ, Gill TJ, O'Hollerhan JD, et al. Anatomical Glenoid Reconstruction for Recurrent Anterior Glenohumeral Instability with Glenoid Deficiency Using an Autogenous Tricortical ICBG. Am J Sports Med 2006;34:205-12.

![Figure 5 Secured graft with sutures for capsular repair. The glenoid reconstruction is shown in (A) with the large iliac crest graft secured slightly medial to the glenoid articular surface with cortical screws and washers. Sutures are placed around the screw heads for capsular repair. An illustration of the capsular repair is shown in (B). Figure 5B used with permission from Warner JJ, Gill TJ, O'Hollerhan JD, et al. Anatomical Glenoid Reconstruction for Recurrent Anterior Glenohumeral Instability with Glenoid Deficiency Using an Autogenous Tricortical ICBG. Am J Sports Med 2006;34:205-12.](image)

Postoperative protocol is dictated based on how the subscapularis was managed during the exposure. In the case of a subscapularis split, the patient is kept in a sling for 4 weeks, though pendulums are allowed immediately. After 2 weeks, formal physical therapy begins with passive range of motion followed by active range of motion with assisted stretching at week 4. Strengthening is initiated after 2 months. Physical therapy is delayed for 4–6 weeks if a subscapularis tenotomy was performed. Pendulum exercises are allowed after the first week. After the 4 to 6 weeks period of immobilization, the patient may begin supervised physical therapy for active and passive range of motion and they may begin using the arm of activities of daily living. Strengthening is delayed until 3 months. A CT scan may be ordered after 6 months to confirm graft union (Figure 6). Contact sports are typically delayed until at least 8 months from surgery.

**Outcomes**

The Eden-Hybinette procedure has proven to be effective at restoring stability following failed Latarjet procedures. Warner *et al.* reported improvement in all recorded functional outcome scores (ASES, UCLA, and Rowe scores) in a series of 11 patients. All patients in this series returned to pre-injury levels of sport without recurrence of instability (7). Lunn *et al.* reported good to excellent results in 79% of 46 patients who underwent a modified Eden-Hybinette after a failed Latarjet (21). Successful long-term results have also been reported in a series of 48 patients, 28 of which...
Figure 6 Postoperative imaging. Post-operative imaging of a 54-year-old female who underwent an Eden Hybinette procedure following a failed Bankart and a failed Latarjet. (A) Anteroposterior and axillary images; (B) axial and sagittal CT images; and (C) 3D reconstruction images demonstrate union of the graft.
were revision cases. At a mean of 9 years follow-up, 7% of patients reported subjective instability and only 1 patient had sustained a redislocation. Twenty percent of patients had radiographic progression of arthritis by one stage in the Samilson and Prieto classification. One patient developed Goutallier stage 3 or 4 subscapularis atrophy (22). Early results of an arthroscopic technique have also shown some success in a series of 18 patients (23). Sixty-seven percent of the patients had good or excellent results, though 42% had a positive apprehension test postoperatively. Regardless of technique, restoration of stability and a successful outcome of the Eden-Hybinette are dependent on bony union of the iliac crest graft to the glenoid.

**Conclusions**

Arthroscopic Bankart repairs and Latarjet procedures have a high rate of success when performed in the appropriate patient. Consideration of patient-specific factors and goals, along with imaging to determine the presence of significant bony defects is critical for indicating the proper procedure. In the subset of patients in which the Latarjet procedure fails with recurrent instability, the Eden-Hybinette procedure using autologous structural ICBG is an excellent option. With proper technique, the available iliac crest graft size can be quite substantial, enabling treatment of very large glenoid defects. The surgeon should be prepared to approach this complicated procedure with caution as the surgical field can be disorienting from the altered anatomy. “When it all fails”, the Eden-Hybinette procedure has proven to be very successful in restoring stability.

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None.

**Footnote**

*Conflicts of Interest*: The authors have no conflicts of interest to declare.

**References**

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