T E C H N I Q U E

Posterior Bone Block for Posterior Instability

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■ ABSTRACT

Posterior bone block is one of the surgical procedures proposed in the literature for posterior instability of the shoulder. Prognosis is better in traumatic than in atraumatic instability. Voluntary subluxations with true intentional episodes are a contraindication for surgery. To have an accurate and reproducible technique, we recommend 7 surgical steps: (1) Vertical deltoid approach, (2) Horizontal infraspinatus splitting approach, (3) Medial T-shaped arthrotomy, (4) Joint exploration and treatment of labral lesions, (5) Abrasion of posterior glenoid cortex, (6) Harvesting and preparation of an accurately sized and shaped iliac graft, and (7) Cautious fixation of the graft with 2 low compression screws. Association with capsulorrhaphy and/or glenoid osteotomy may be necessary, respectively, in cases of hyperlaxity and/or excessive glenoid retroversion. The best treatment of patients who have recurrent posterior instability of the shoulder remains controversial. Precise, specific, and durable rehabilitation prior to surgical treatment has been universally recommended.[1–7] If this program fails to relieve the patient's symptoms, a great variety of surgical procedures have been proposed: soft-tissue procedures (posterior capsulorrhaphy, reverse Putti-Platt, biceps tendon transfer), osteotomy of the glenoid, rotational osteotomy of the humerus, and posterior bone block. Various combinations of these procedures have also been proposed. Posterior bone block is not the most popular procedure that has been recommended in this pathology but it is our preferred method, alone or in combination with posterior capsulorrhaphy and/or glenoid osteotomy.

■ HISTORICAL PERSPECTIVE

In 1949, Fried was the first author to report on a series of 5 patients with recurrent posterior instability, treated by posterior bone block, with only 1 recurrence due to resorption of the graft.[8] Jones in 1952 reported on 1 case successfully treated by posterior bone block after the failure of the soft-tissue procedure.[1] Mac Laughlin recommended in 1962 a combination of capsular plication

and posterior bone block in recurrent posterior dislocations.[2] De Palma and others have suggested that the graft extend 6 mm beyond the glenoid.[3] Gosset proposed a larger, U-shaped graft projecting beyond the whole height of the glenoid.[9] Mowery reported about 5 cases of posterior recurrent dislocation successfully treated by intracapsular posterior bone block.[10] Fronek proposed that the choice of bone block or soft tissue procedure should be based on the etiology and depends if the instability was traumatic or not.[5]

■ INDICATIONS AND CONTRAINDICATIONS

Indications for posterior bone block are persistent pain and subluxation or dislocation in association with posterior instability episodes, after failure of specific and durable rehabilitation. In our experience, there are 2 clinical presentations[11]:

- Recurrent posterior dislocations following an initial traumatic posterior dislocation. There is usually a significant traumatism, such as a convulsion, traffic accident, or contact sport. In our experience, less than 10% of acute traumatic dislocations become recurrent, and the patients usually have associated radiographic abnormalities (posterior glenoid fracture, reversed Hill–Sachs lesion).[12,13]

- Involuntary recurrent posterior subluxations. There is no initial dislocation in this group. There are 3 different scenarios. Some patients report a trauma after which they developed symptoms of pain, subluxation, or dead arm sensation, all occurring in the same position (flexion, adduction, internal rotation). X rays may show posterior glenoid rim fracture or erosion. A second group of patients present constitutional hyperlaxity or only a hyperlax shoulder. A history of voluntary instability as a child may be related, followed by a period during which they became involuntary. These patients may be able to demonstrate posterior subluxations. In an otherwise emotionally stable patient, the ability to voluntarily demonstrate posterior subluxation is not a contraindication to surgery. A third group of patients may have constitutional hyperlaxity and decompensate in adulthood after

a minor traumatic event. When hyperlaxity is present, posterior glenoid bony lesion is rare.

Associated techniques may be optimum for different patterns. A T-shaped capsulorrhaphy may be added when ligamentous hyperlaxity is present,[5] while posterior opening glenoid osteotomy may be indicated when there is excessive glenoid retroversion.

Contraindications include true, intentional, voluntary instability. This category includes intentional subluxations accompanying transient emotional disturbances of childhood or adolescence, and may include adults with such psychiatric problems as conversion hysteria. In patients involved in medico-legal, compensation, or secondary gain situations, we recommend being extremely cautious before proceeding with surgery.

■ PREOPERATIVE PLANNING

Our preoperative planning includes history, clinical examination, radiographic examination, and computed tomographic arthrography.

Patient history may include voluntary subluxations in childhood or adolescence, type of onset (traumatic or atraumatic), and type of symptoms. The diagnosis of subluxations may be subtle and may be associated with a history of pain or dead-arm sensation.

Clinical examination includes 2 general types of tests: hyperlaxity tests and instability tests. Hyperlaxity tests include drawer test, sulcus sign, and hyperexternal rotation test; these are generally bilateral and symmetric, and they reflect constitutional features that predispose to posterior instability. The posterior instability test is done in lying or sitting position by the examiner, who pushes posteriorly the humerus placed in flexion, adduction, and internal rotation; the test is positive if it reproduces the subluxation or the unpleasant sensation recognized by the patient as the major symptom. The patient may be able to voluntarily produce the subluxation. Observation of the patient's attitude as he subluxates is very important to differentiate what we identify as only "reproducible" subluxation with a true intentional "voluntary" instability.

Radiographic examination should include a standard roentgenographic series (anteroposterior views in neutral, internal, and external rotation and axillary view) to rule in or out any associated abnormalities and to detect a reverse Hill–Sachs lesion (in case of recurrent dislocation) or osteophytes. It also includes a comparative lateral view according to Bernageau to detect posterior glenoid bone fracture or erosion, especially in traumatic forms (Fig. 1).[14]

CT arthrography is also helpful, and may be better than MRI to detect the rare posterior capsulo-labral detachment.[11,15] Posterior capsular distension and posterior glenoid bony erosion or fracture may be seen with this
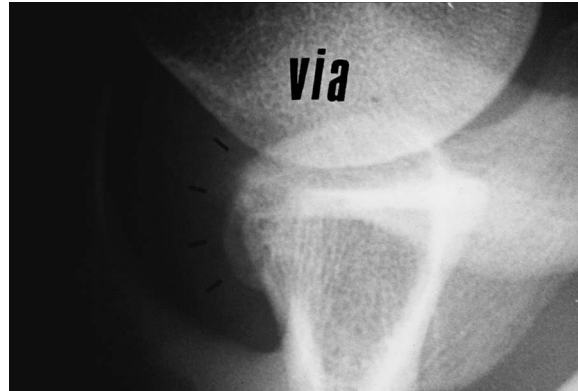

FIGURE 1. Posterior glenoid rim lesion on x-ray lateral view according to Bernageau.

study (Fig. 2). Finally, it is possible to measure glenoid retroversion by the angle between the line joining the anterior and posterior glenoid rim and the perpendicular to the line connecting the midpoint of the glenoid to the medial margin of the scapula. The optimal cut passes through the center of the glenoid (Fig. 3). Normal retroversion angle is 5° to 10°, and we consider glenoid dysplasia when it is greater than 15°.

This precise and standardized preoperative planning helps us to classify the patient into 1 of the following 4 categories of recurrent posterior instability, which have different surgical prognoses:

1. Recurrent posterior dislocations: traumatic onset with initial dislocation, no hyperlaxity, constant bony lesion, very good surgical prognosis;
2. Recurrent posterior traumatic involuntary subluxation: traumatic onset, rare associated hyperlaxity, frequent bony lesion, good surgical prognosis;
3. Recurrent posterior atraumatic involuntary subluxation: atraumatic onset or following minor trauma, possible history of voluntary subluxations in childhood, hyperlaxity, rare bony lesion, moderate surgical prognosis; and
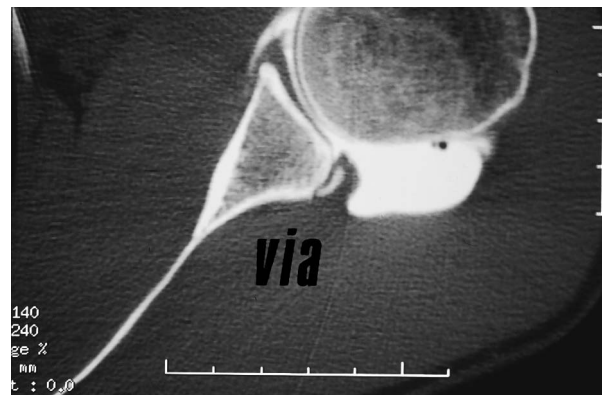

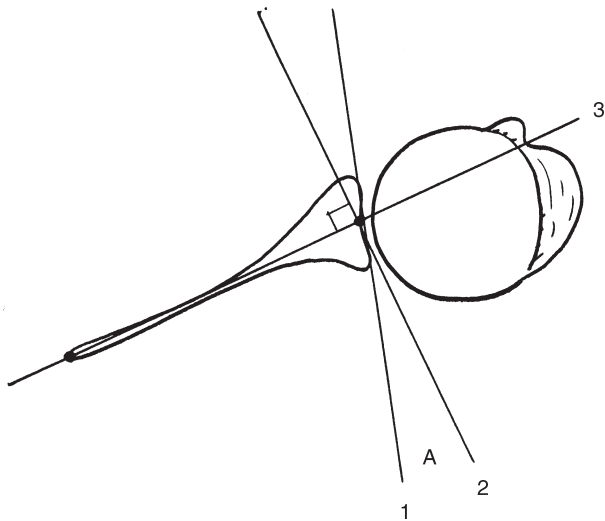**FIGURE 2.** Posterior glenoid rim fracture on CT-arthrography.

FIGURE 3. Glenoid version as measured on CT-scan; the optimal cut is at the level of the glenoid equator. Glenoid version (A) is the angle between the line of the articular surface (1) and the perpendicular to the line connecting the midpoint of the glenoid to the medial margin of the scapula (3).

4. Recurrent posterior voluntary subluxations: atraumatic onset (or trauma with medico-legal involvement), hyperlaxity, repetitive subluxation during examination, no bony lesion, poor surgical prognosis.

■ SURGICAL TECHNIQUE

The posterior bone block should not contact the humeral head directly, and, if required, capsulorrhaphy should always be carried out before the graft is secured. The graft should extend approximately 10 mm over the posterior aspect of the glenoid.[10] Thus, the articular surface is increased posteriorly, because of the orientation of the posterior aspect and rim of the glenoid (Fig. 4). The graft should be placed low on the glenoid, as translation of the humeral head in the presence of posterior instability is observed mainly in a downward and backward direction.

Patient Positioning/Set-Up

After general anesthesia, the patient is placed in a lateral decubitus position on the uninvolved side. The shoulder and iliac crest are prepared under sterile conditions. A U-shaped support is placed anteriorly to the patient to position the shoulder either in anterior elevation with the arm on the support, or in neutral rotation with the forearm resting on the support (Fig. 5).

Incision/Approach

We no longer use the horizontal approach parallel to the scapular spine, as it entails reflection of the deltoid
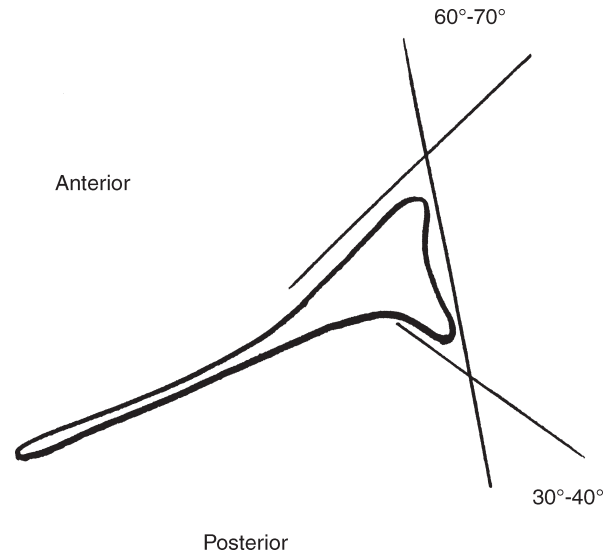

FIGURE 4. The angle between the articular surface and posterior cortex is sharper (30°–40°) than the angle between the articular surface and anterior cortex (60°–70°).

muscle from the spine,[16] which in our opinion is not mandatory and may lead to loss of residual strength. We use a posterior approach, with a vertical incision starting 2 cm medial to the posterolateral acromial tip extending inferiorly for 8 cm toward the axillary fold. This protects the deltoid origin.[17] This skin incision is made deliberately more vertical than the fibers of the underlying deltoid, to be in line with the joint line and to give maximal exposure of the posterior aspect of the glenoid (Fig. 6).

The approach is carried out without muscle or tendon sectioning. The deltoid is split in line with the fibers at the virtual junction between the posterior and middle sections, starting at the scapular spine and extending 5 cm distally. The axillary nerve may be injured if the dissection is extended too inferiorly. The deltoid is retracted. The infraspinatus fascia is easily detected by internal rotation of the humerus, which tenses the muscle. The infraspinatus is split horizontally at the lower third/middle third junction in line with the fibers. This zone is normally marked by a layer of fat (Fig. 7). The posterior part of the capsule and the posterior aspect of the glenoid can, thus, be exposed. Two angled retractors are placed gently on the upper and lower borders of the joint line. An angled retractor is placed laterally in the subacromial bursa. Medially, the suprascapular nerve is identified at a point where the nerve is located lateral to the base of the scapular spine (Fig. 8).

T-Shaped Arthrotomy

The arthrotomy is then performed in such a way that a capsulorrhaphy may be added. A number of techniques
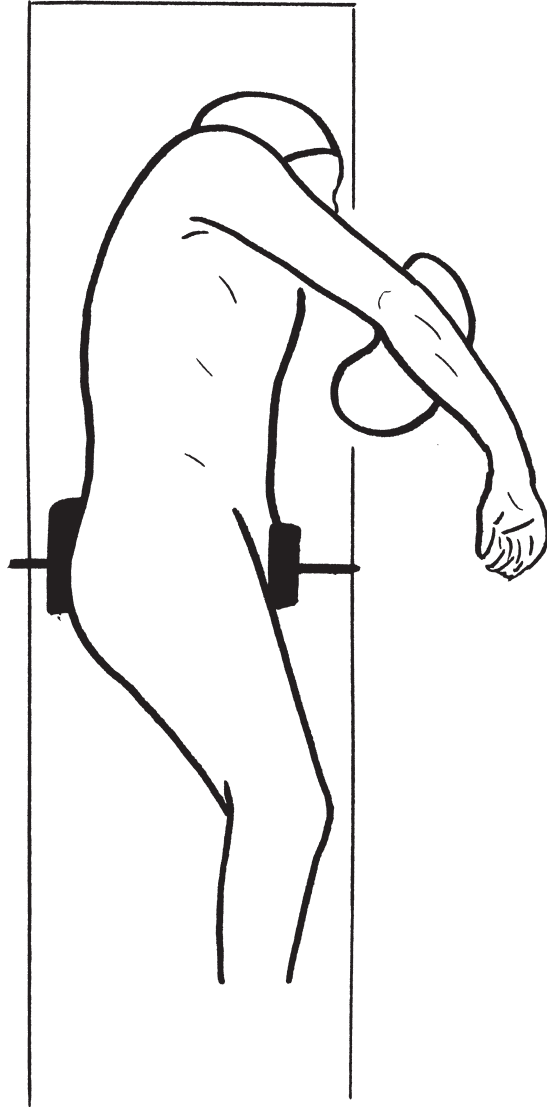
FIGURE 5. The patient is in the lateral decubitus position with access to the shoulder and the iliac crest. The forearm rests on a U-shaped support.

FIGURE 6. The incision begins 2cm medial to the postero-lateral corner of the acromion and extends toward the axillary fold.

have been described, but we routinely use the "T-plasty" procedure.[5] A T-shaped arthrotomy is made with its horizontal limb at the level of the glenoid equator and extending laterally, and its vertical limb on the edge of the posterior labrum (Fig. 9). The corners of the 2 capsular flaps are secured by 2 sutures.

Joint Exploration and Treatment of Labral Lesions

A specifically designed intra-articular retractor is placed onto the anterior rim of the glenoid to retract the humeral head laterally, and the joint is explored. Lesions of the posterior labrum are excised. When a labral detachment is present, it may be reattached with transosseous sutures or anchors. When the labrum lesion is associated with
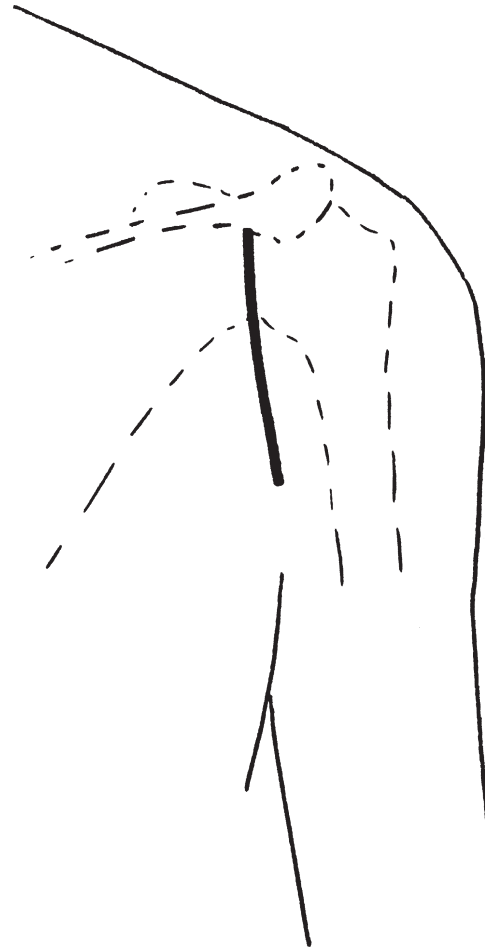
fracture of the posterior aspect of the glenoid with pseu-darthrosis, the bone fragment is excised and the labrum is directly reinserted into the bony bed.

Preparation of Posterior Glenoid Cortex

Abrasion of the posterior cortex of the glenoid is performed with a thin and curved osteotome or with a burr. The lateral posterior labrum is preserved. Medially and superiorly, it is limited by the presence of the suprascapular nerve. The completed abrasion should reveal a totally smooth and bleeding surface (Fig. 10).

Graft Harvesting and Preparation

Graft sampling and preparation may be performed prior to the shoulder approach or at this stage of the procedure. It is essential that the graft be voluminous (at least 3 cm long), which is why we do not take it from the scapular spine. The graft is harvested from the ipsilateral iliac crest at the level of the gluteus medius tubercle. It is bicortical and measures 2–3 cm wide from the upper
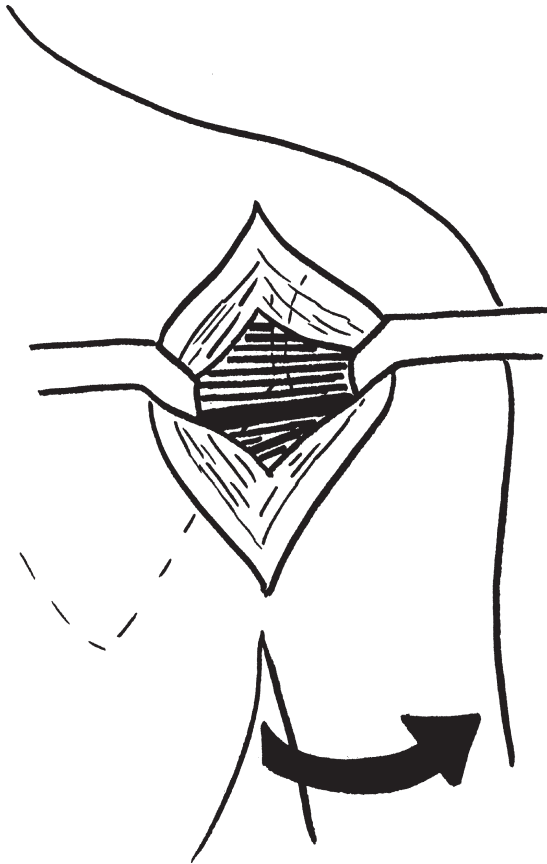
FIGURE 7. Internal rotation of the humerus tenses the infraspinatus. It is split in line at the junction of the middle third with the inferior third.

cortex (the lateral edge of the bone block) and 3–4 cm long from the external cortex. The cancellous bone with the cortex should be as thick as possible (Fig. 11). The graft is prepared and adapted to the posterior aspect of the glenoid (cancellous face anteriorly) to extend approximately 10 mm over the posterior glenoid rim. The lateral edge of the graft is trimmed and beveled to increase the posterior articulating surface of the glenoid, without impingement on the humeral head. The bone block may be secured transiently by a pin positioned at the location later occupied by a screw and directed parallel with the articular surface (Fig. 12). This trick may permit checking that the position of the graft is correct before definitive fixation. The pin and the bone block are then removed and a 3.2 mm hole is drilled in the glenoid pin hole, with great care being taken to keep the same orientation, followed by drilling of the bone block.

Capsulorrhaphy (if required)

If necessary (in cases of hyperlaxity), capsulorrhaphy is carried out at this step of the procedure. As previously described by Fronek, the inferior flap is shifted superiorly
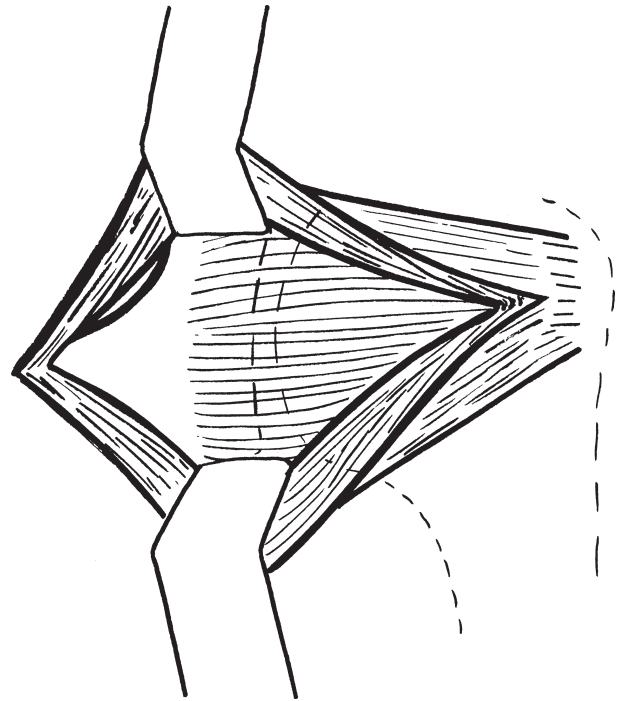
FIGURE 8. The posterior capsule and glenoid cortex are exposed. Care must be taken to avoid injuring the suprascapular nerve, supero-medially.

and medially and secured to the posterior glenoid labrum with no. 2 nonabsorbable sutures.[5] The superior flap is then shifted inferiorly and medially and secured in the same way onto the posterior glenoid labrum (Fig. 13).
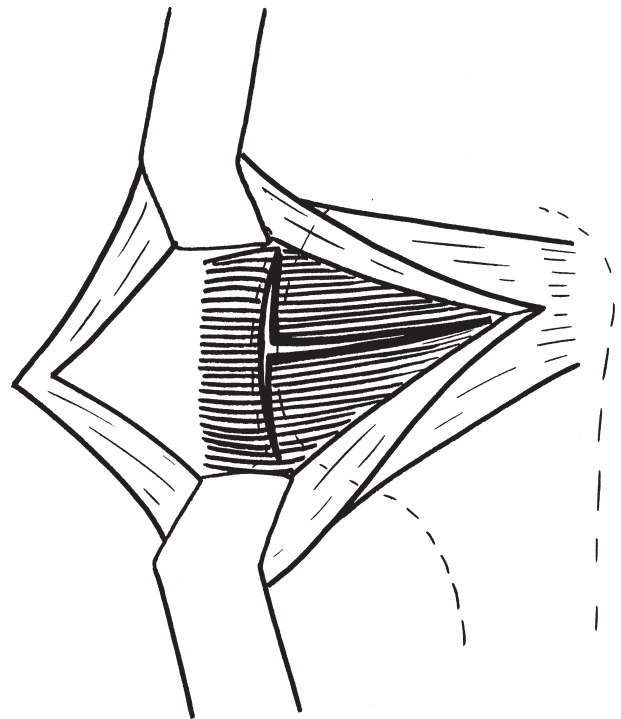
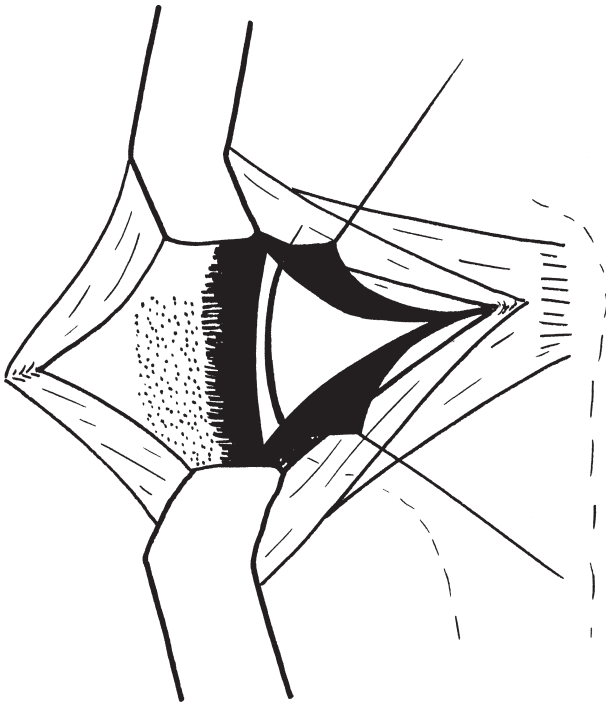**FIGURE 9.** Medial T-shaped arthrotomy.

FIGURE 10. The corners of the 2 capsular flaps are secured by 2 sutures. Posterior glenoid cortex is abraded.

Fixation of the Bone Block

Osteosynthesis for fixation of the bone block is performed with the use of 4.5 mm malleolar screws that provide adequate compression. The first screw is inserted into the predrilled inferior hole; the second screw is placed 1 cm higher, in the same direction as the first screw. Each screw is tightened alternately, without excess, to avoid fracturing of the graft (Fig. 14).It is essential that the screws reach the anterior cortex to obtain strong fixation (Fig. 15).
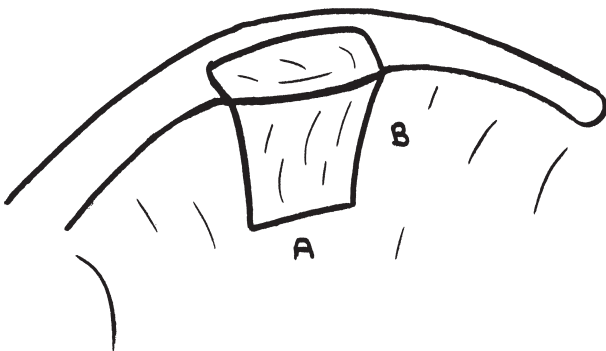
The wound is closed in layers over a drain.

FIGURE 11. The iliac graft is 2–3 cm large (A) and 3–4 cm long (B), harvested from the superior and lateral cortex at the level of the gluteus medius tubercle.
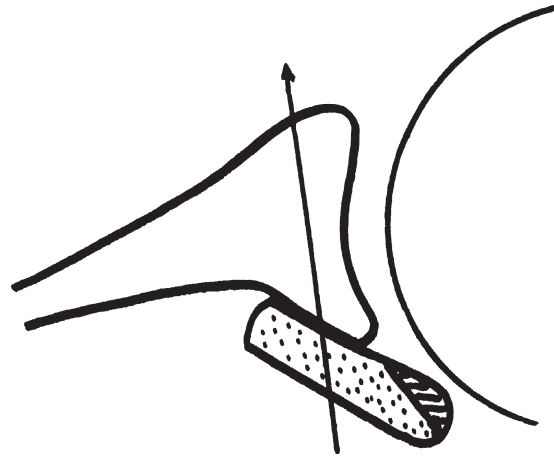

FIGURE 12. Bone block may be secured transiently by a pin at the exact point of the future lower screw and directed parallel with the articular surface. The graft is then shaped to avoid any impingement with the humeral head.

Surgical Variation: Posterior Bone Block With Osteotomy of the Glenoid

A posteriorly opening wedge osteotomy according to Scott[18] may be added, with posterior/inferior base, as the dysplasia exists generally both posteriorly and inferiorly. We suggest adding osteotomy when glenoid retroversion is more than 15°.[19] The suprascapular nerve must be clearly identified and protected throughout the
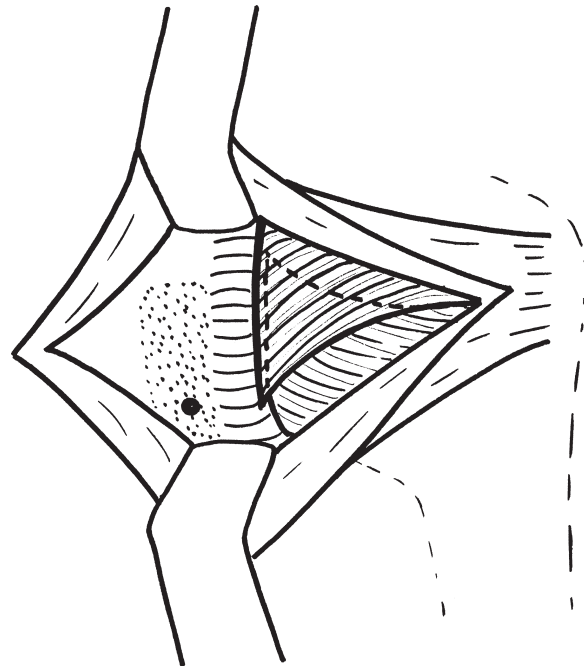

FIGURE 13. Capsulorrhaphy is performed by shifting the inferior flap superiorly and medially, securing it to the posterior labrum by no. 2 nonabsorbable sutures, and then shifting the superior flap inferiorly and medially secured in the same way.
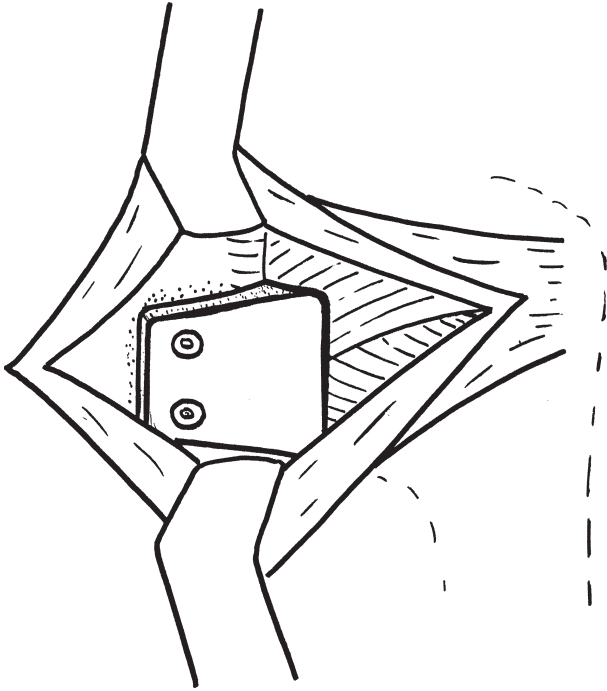
FIGURE 14. Posterior bone block is repositioned identically by drilling and screwing the lower screw in the same hole as the previous and transient pin. Adjusting the graft in rotation is even possible before preparing the upper screw. Preparation of the upper screw must be absolutely in the same direction as the lower screw to avoid any articular penetration.

procedure, as it is very close to the osteotomy at the superior glenoid.

Osteotomy is performed vertically, 8 mm medial to the posterior rim of the glenoid. If the site is more lateral, the risk of intra-articular penetration and of necrosis is
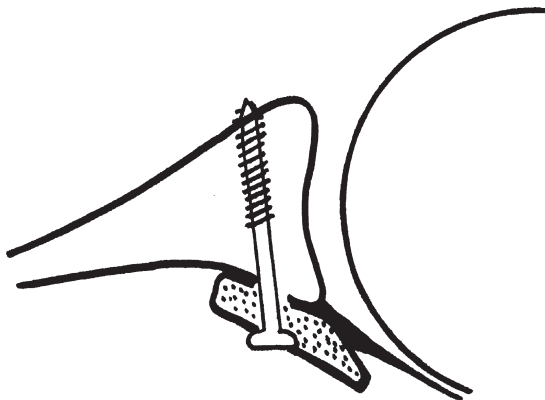
high. If it is more medial, the suprascapular nerve may be injured. Two-thirds of the osteotomy procedure is performed with the use of an oscillating saw. It must be kept strictly parallel to the articular surface. The orientation is oblique, from back to front and bottom to top, so as to obtain an anterosuperior hinge below the base of the coracoid process. Osteotomy is completed by 2 osteotomes that are introduced alternately until the entire articular surface is raised laterally, without breakage of the anterosuperior hinge.

The size of the opening depends on the preoperative CT scan estimation of the glenoid retroversion, to reduce it to 5°. The opening is then filled with triangular corticospongial grafts harvested from the ipsilateral iliac crest. Excellent primary stability is generally obtained by these grafts.

Gerber has described the occurrence of a secondary coracoid impingement following osteotomy.[7] We agree that resection of a portion of the coracoid should be included when the coracoid process is long, as is often encountered in cases of severe glenoid dysplasia. Resection is performed before the posterior approach, through a small anterior deltopectoral approach that may be realized in the same operative position.

When including glenoid osteotomy with posterior bone block, 3 technical steps are of importance. First, abrasion of the posterior aspect of the glenoid must be performed prior to the osteotomy. Second, the iliac graft must be longer as it bridges the osteotomy. Finally, the 2 osteosynthesis screws are placed medially to the osteotomy site (Fig. 16).

■ POSTOPERATIVE MANAGEMENT

A splint in neutral rotation is worn for 3 weeks (6 weeks in cases of capsulorrhaphy). However, physical therapy

FIGURE 15. Screws are parallel with the articular surface and reach the anterior cortex for an adequate fixation. Lateral extension of the graft is 10 mm, but its orientation and shape explain the smooth continuity of the joint line posteriorly. Posterior labrum and capsule separate the graft from the joint.
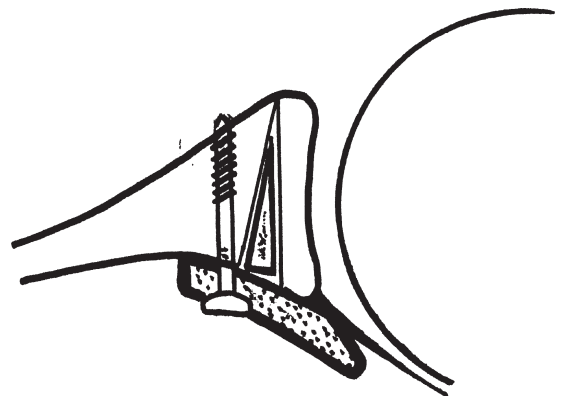

FIGURE 16. Posterior bone block may be associated with posterior glenoid opening osteotomy. Iliac graft must be longer; abrasion of glenoid cortex must be carried out before the osteotomy and screws are medial to the osteotomy site.

may be initiated on the day after surgery by 2 daily sessions of passive motion in forward elevation in the scapular plane with the arm kept in neutral rotation. Once the splint is removed, a passive rehabilitation program is pursued, with no specific internal rotation exercises. An active rehabilitation protocol is initiated once symmetrical passive anterior elevation is reached. It entails static, then dynamic resistance exercising of the external and internal rotators. Resuming of sports activities is allowed generally by the fifth postoperative month.

■ RESULTS

We have reported 2 personal series. The first is a series of 29 patients (31 shoulders) operated on for recurrent posterior shoulder subluxations and dislocations, with traumatic onset, without any history of childhood voluntary subluxations.[20] The age of the 25 males and 4 females averaged 26 years (range 17–65). Hyperlaxity was associated with traumatic onset in 68%. Posterior bone block was the procedure in all cases, associated with capsulorraphy in 80%. Patients were evaluated clinically and radiographically with a follow up of 33 months on average (12–167 months). Subjectively, no patient was disappointed, 26% were satisfied, 74% very satisfied. Objectively, 65% ware rated excellent results, 35% good results. Regarding stability, 13% complained of a persistent apprehension in critical position but no recurrent subluxation or dislocation occurred. The mobility was symmetric in 61%, slightly limited in internal rotation in 29%, slightly limited in internal and external rotation in 10%. Persistent pain was present, mostly during sports, in 39%. However, 84% returned to the same level of sport. Radiographic evaluation showed partial lysis of the bone block in 23%. No glenohumeral arthritis was seen. Three patients required removal of the screws. No neurologic complication occurred. One patient required revision the day after surgery to change 1 screw because of articular penetration without any adverse impact on the final result. The percentage of excellent results was significantly lower in 3 situations: hyperlaxity, ''reproducible'' subluxation, and absence of bone fracture.

In a second series, we reported on the combination of posterior bone block and capsulorrhaphy in 12 adult cases with childhood history of voluntary posterior subluxations and recurrent instability in adulthood on involuntary pattern.[11] Hyperlaxity was present in all cases. Subluxations were involuntary at the time of operation, but 11 out of 12 were still able to demonstrate subluxation. Results were different according to the cause of secondary recurrence. They were rated good or excellent in a group of patients whose recurrence was created by intensive practice of sport. Results were poor in the group of patients with medico-legal association and if there was a prior surgical procedure.

■ COMPLICATIONS

(1) The axillary nerve is at risk during 2 steps. During the surgical approach, fibers of deltoid must be split with great care downward, less than 8 cm, to avoid injuring the nerve. In addition, during capsule exposure, an inferior angled retractor or any blunt retractor must be placed gently and very close along the inferior capsule below the glenoid to protect the nerve.

(2) The suprascapular nerve may be injured during glenoid exposure and preparation, as it courses around the base of the spine of the scapula. To avoid injury, we recommend placing a thin blunt retractor or even an awl in the scapula, retracting together suprascapular nerve and superomedial part of infraspinatus muscle.

(3) Malposition of graft fixation screws may occur, because of the orientation of the posterior aspect of the glenoid. Actually, the angle between the articular surface and posterior cortex is very acute (30–40°), and the natural tendency is to drill in a too lateral direction with the risk of articular penetration. Knowledge of this anatomic feature and control by an intra-articular humeral head retractor are essential.

(4) Fracture of the graft is a frequent complication but is not always identified during the procedure. Diagnosis is mostly identified during routine postoperative or follow-up X-rays. Fracture may be confused with graft resorption. The most important precaution against graft fracture is to tighten the 2 screws alternately, only between thumb and index, to avoid any excess of pressure.

(5) Hardware related pain. The screws may be too long and painful anteriorly, or may migrate posteriorly. Hardware malposition or pain mandates removal of the screws.

(6) Widened and inflammatory scars are frequent, especially in cases of hyperlaxity.

■ DISCUSSION

Numerous aspects of the technique have been discussed in the literature, but we would like to focus on 5 points:

1. Deltoid approach: A horizontal incision with detachment of the deltoid insertion from the scapular spine has been recommended by several authors.[2,9,10,12,21,22] In our view, this approach may have some morbidity, and we prefer a vertical incision with the deltoid-splitting approach, as others advocate.[17,23]
2. Infraspinatus approach: Cutting the infraspinatus tendon enlarges the exposition,[4,9,21,22] but we advocate a muscle split to avoid any risk of loss of postoperative strength. Moreover, the splitting approach facilitates
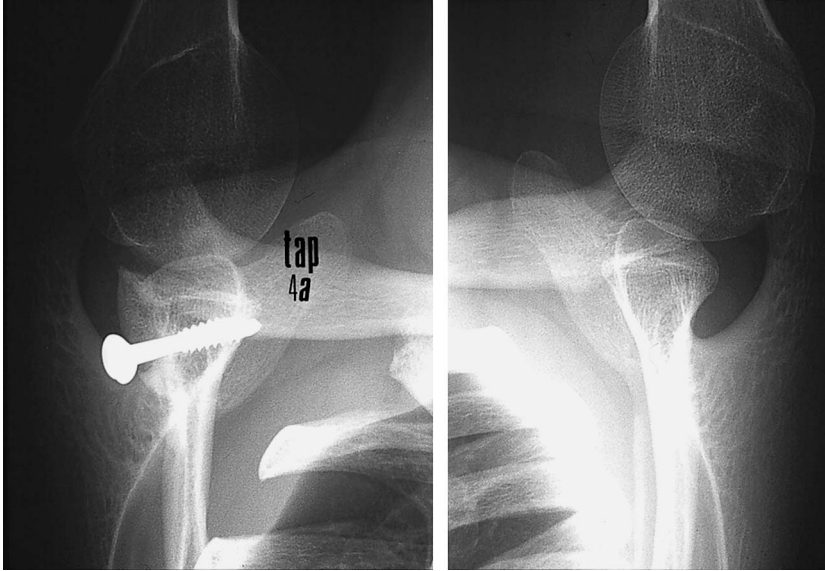
FIGURE 17. X-ray view of a posterior bone block with a follow-up of 4 years (left) compared with the controlateral shoulder (right). The lateral extension of the graft enlarges smoothly the glenoid articular surface posteriorly. Humeral head appears to be quite recentered compared to the other side.

postoperative rehabilitation. Finally, we prefer to preserve as well as possible the active posterior strap in this pathology. Concerning the height level of the approach, our preference is just below the middle third of the infraspinatus muscle, as others advocate.[7,14] Above this level, exposition is not adequate to place the bone block in proper anatomic location, low on the glenoid. Below this level, it is difficult to control the suprascapular nerve superiorly, and the axillary nerve is at risk inferiorly.

3. Graft harvesting site: The scapular spine has been proposed,[5,15,21] but we found that the graft was not always large enough to prevent posterior instability. An acromion graft has also been described with a deltoid flap, assuring an active stabilization effect.[24] We prefer, as do others, the iliac graft[10,25,26] for size flexibility.

4. Position of the graft: Many authors place the graft in an extracapsular position.[8] A lateral extension of the graft is universally recommended; as the angle between the posterior cortex and the articular surface is relatively sharp (30°–40°), a moderate lateral extension (10 mm) enlarges posteriorly the articular surface and doesn't create impingement with the humeral head (Fig. 17). The optimal height level of the graft is postero-inferior, just at the level of the frequent lesions of the glenoid rim and the posterior labrum; these are generally situated at the equator of the glenoid or below, but never above.

5. Associated procedures: We agree that associated procedures are required in some situations. If hyperlaxity is present, and particularly if there is no posterior labrum or bony lesions, we add a medial T-shaped capsulorrhaphy.[5] If glenoid retroversion is more than 15°,

we add an opening posterior glenoid osteotomy.[18,19] In our experience, these procedures in isolation do not reproducibly control instability.

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