

## Technical Note With Video Illustration

# All-Arthroscopic Implant-Free Iliac Crest Bone Grafting: New Technique and Case Report

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**Abstract:** Glenoid bone loss is a recognized risk for recurrent instability. Open J-graft augmentation has been reported as a well-established procedure for anterior shoulder instability. Few data are available on arthroscopic techniques for the repair of bony Bankart lesions. We describe an all-arthroscopic implant-free iliac crest bone grafting technique and present the case of a 32-year-old hockey player who underwent glenoid reconstruction using this novel arthroscopic repair technique after 2 failed soft-tissue procedures. After 13 months, the patient reached nearly full range of motion with a slight loss of external rotation. The computed tomography scan showed a restoration of the glenoid cavity and complete healing of the graft.

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Various surgical techniques for the treatment of post-traumatic recurrent anterior shoulder instability have been previously described. Arthroscopic or open soft-tissue repairs are commonly performed to reattach the torn labrum of the Bankart lesion to the socket of the shoulder. However, recurrence rates after soft-tissue procedures of up to 20% were still reported.<sup>1-3</sup> Currently, a bony glenoid defect is considered one of the main causes of recurrent shoulder instability.<sup>4</sup> According to the literature, bony Bankart lesions are prevalent in 5.4% to 67.0% of cases.<sup>5-7</sup> Previous studies showed a relation between the amount of glenoid bone loss and

joint instability.<sup>5,8</sup> Subsequently, further clinical and biomechanical studies have shown that restoration of the glenoid surface is a crucial point in shoulder stability.<sup>9,10</sup> Several techniques have been described to restore the anatomy of the glenoid. Currently, the most popular methods used to address this pathology are modifications of the Eden-Hybbinette<sup>11</sup> or Bristow-Latarjet<sup>12</sup> procedure, either open or, more recently, arthroscopically. However, these nonanatomic procedures are not without risks, including graft nonunion or resorption, complications due to screw malposition, secondary osteoarthritic changes, and difficult revision surgery.<sup>13,14</sup>

Thus our intention was to further develop a well-established technique, the so-called J-bone graft described by Resch and colleagues,<sup>3,15,16</sup> to provide a minimally invasive, implant-free anatomic glenoid restoration. We present the technique for the all-arthroscopic implant-free iliac crest bone grafting procedure and report a case with glenoid bone loss undergoing reconstruction with this new all-arthroscopic procedure.

## CASE REPORT

A 32-year-old right-handed man initially presented with a dislocated left shoulder after a hockey accident

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16 years previously. At that time, he underwent an arthroscopic shoulder capsulorrhaphy. Nine years later, he had a work-related accident and his left shoulder dislocated again. Despite another arthroscopic shoulder capsulorrhaphy, the patient had recurrent dislocations due to instability of the left shoulder. The frequency of dislocations increased with time. He presented to our orthopaedic department 6 years after the second dislocation and 4 to 5 further episodes of dislocation of the left shoulder, even occurring during sleep. At the time of presentation, he showed apprehension at 90° of abduction and the Jobe relocation test and anterior drawer test were positive. He did not present signs of hyperlaxity and was only in slight pain.

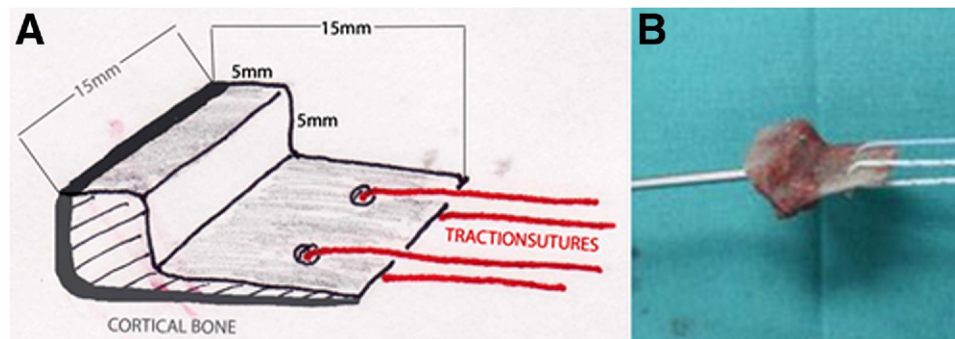
A computed tomography (CT) scan was obtained before operative planning and showed glenoid bone loss of 21.7%. The CT scans were measured in a 2-dimensional multiplanar reconstruction mode on the en face view, similar to published techniques.<sup>17</sup> The patient subsequently underwent an all-arthroscopic implant-free J-graft augmentation procedure for the glenoid bone defect of his left shoulder (Video 1, available at [www.arthroscopyjournal.org](http://www.arthroscopyjournal.org)).

### SURGICAL TECHNIQUE AND INTRAOPERATIVE FINDINGS

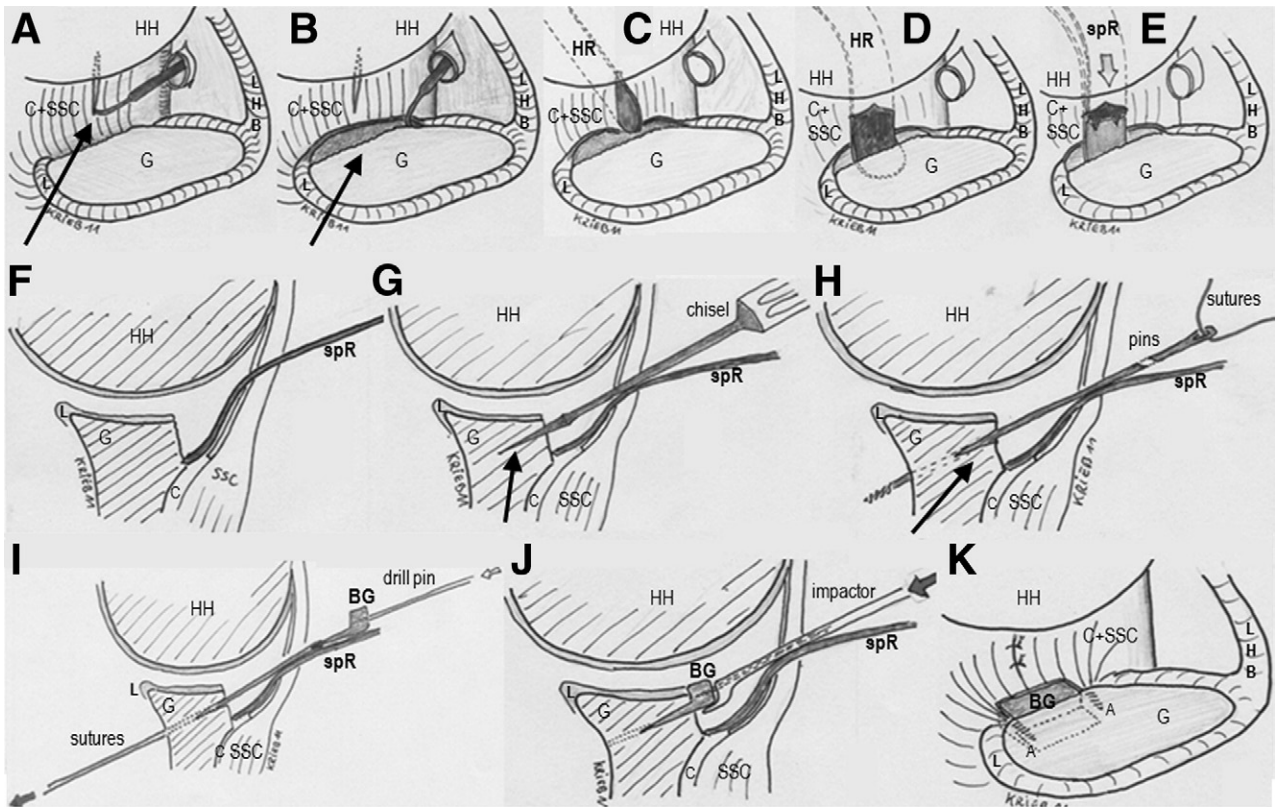
Under interscalene block and general anesthesia with an intravenous antibiotic regimen, the patient was placed in a lateral decubitus position with the possibility of double extension. First, an iliac crest bicortical bone graft, including crest and outer cortex, was harvested as described by Auffarth et al.<sup>16</sup> With a small oscillating saw, the graft was molded like a J, leaving cortical bone only on the keel of the graft (Fig 1A). The whole graft was 15 mm long and 15 mm wide, with the graft's keel measuring 5 mm in height and 5 mm in width. Then, 2 holes were drilled into the

long limb of the J to introduce 2 sutures (FiberWire; Arthrex, Naples, FL), and on the top end of the short limb, a drill pin was placed (Fig 1B).

After placement of a posterior portal, diagnostic arthroscopy was performed. The anterior labroligamentous complex was reruptured and medialized; the glenoid defect was identified; a grade II Hill-Sachs defect was present; the rotator cuff, biceps anchor, and superior and posterior labrum were intact; and no humeral avulsion of the glenohumeral ligaments (HAGL) or reverse humeral avulsion of the glenohumeral ligaments (RHAGL) could be found. After detection of the glenoid pathology, 1 anteroinferior portal in the rotator interval just above the subscapularis tendon and 1 anterosuperior portal in front of the biceps tendon were placed. The arthroscope was switched to the anterosuperior portal, and an inverted pear shape<sup>5</sup> of the glenoid was observed. From an intra-articular position, the capsule and the muscle belly of the subscapularis were split from medial to lateral along the fibers with a diathermic hook (Fig 2A). The labrum and capsuloligamentous complex were detached from the 2- to 6-o'clock position (Fig 2B), and then the glenoid rim was freshened with a bur. Thereafter a deep medial anteroinferior portal as described by Resch et al.<sup>18</sup> was created. After widening the anteroinferior 5-o'clock incision to 2 cm, the surgeon performed a blunt dissection of the soft tissue using the forefinger, leaving the conjoined tendons and musculocutaneous nerve medially. Afterward, a curved blunt Hohmann retractor was introduced parallel to the subscapularis fibers and then twisted 90° to spread the muscle fibers apart (Figs 2C and 2D). Over the Hohmann retractor, a 2-spiked glenoid retractor (Fig 3) was inserted to create a kind of a "waterslide" construct (Figs 2E and 2F). The following procedures were performed over this waterslide. According to Resch et al.,<sup>18</sup> a 15-mm-wide chisel (Lambotte; Limbeck, Vienna, Austria) was introduced to perform an osteotomy 5 mm medially to the glenoid rim



**FIGURE 1.** (A) Drawing of bone molded like a J (thick black line). (B) Picture of iliac crest bicortical bone graft with traction sutures (long limb of J) and drill pin (keel).



**FIGURE 2.** Drawings of surgical steps of all-arthroscopic insertion of implant-free iliac crest bone graft. (A) First, the capsule (C) and the muscle belly of the subscapularis (SSC) are split (arrow) from medial to lateral along the fibers with a diathermic hook. (G, glenoid; HH, humeral head; LHB, long head of biceps.) (B) The labrum (L) and capsuloligamentous complex are detached (arrow) from the 2- to 6-o'clock position. A curved blunt Hohmann retractor (HR) is (C) introduced parallel to the subscapularis fibers and (D) then twisted 90° to spread the muscle fibers apart. (E and F) Over the Hohmann retractor, a 2-spiked glenoid retractor (spR) is inserted to create a kind of a "waterslide" construct. (G) A 15-mm-wide chisel is introduced to perform an osteotomy (arrow) 5 mm medially to the glenoid rim and angled at 30° to the glenoid plane (chisel in place). (H) Two pins loaded with 2 FiberWire sutures are drilled through the crevice (arrow), FiberWire sutures are connected with the sutures of the bone graft, and then sutures are shuttled through (side view of 2 pins drilled through the crevice). (I and J) In the next step, the bone graft (BG) is pulled over the waterslide on 1 hand, and on the other hand, it is pushed over the drilled pin using an impactor into the crevice (sutures and drill pin shuttling the bone graft to the crevice and an impactor pushing the bone graft into place). (K) In a last step, the capsuloligamentous complex is reattached in a standard manner by use of 2 anchors (A), 1 superior and 1 inferior to the bone graft (final construct with reattached capsuloligamentous complex). Skin incisions are closed.

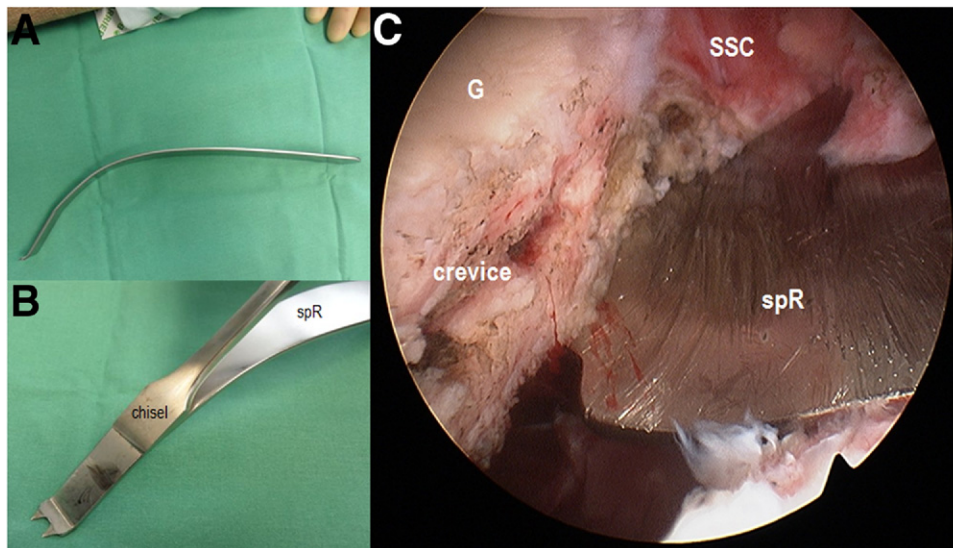
and angled at 30° to the glenoid plane (Figs 2G and 4). The crevice produced was 15 mm deep and 15 mm wide; otherwise, problems with sliding the graft in can occur. With a bur, the entrance of the crevice was slightly widened. Then, 2 pins were drilled through the crevice and loaded with 2 No. 2 FiberWire sutures. After the pins were passed through, the FiberWire sutures were connected with the sutures of the bone graft, and then sutures were shuttled through (Fig 2H). Attention had to be paid that the correct suture limbs were connected, which means the superior FiberWire of the graft and the superior FiberWire of the shuttle suture (and likewise for the inferior FiberWires), to avoid twisting. Slowly, the J-bone graft was pulled over the waterslide on 1 hand, and on the other hand, it was pushed over the drilled pin by

use of an impactor into the crevice (Figs 2I and 2J). As previously described by Auffarth et al.,<sup>16</sup> additional fixation was not needed. The correct position of the graft was controlled under vision from the anterosuperior portal (Fig 5), and with a high oscillating bur, the graft could then be contoured to re-establish the glenoid cavity. In a last step, the capsuloligamentous complex was reattached in a standard manner by use of 2 anchors (Push-Lock; Arthrex), 1 superior and 1 inferior to the bone graft (Fig 2K). Skin incisions were closed.

## REHABILITATION PROTOCOL

After surgery, the shoulder was immobilized in a sling for 5 weeks. During the first 5 weeks, only





**FIGURE 3.** (A) Picture of 2-spiked glenoid retractor from lateral view. (B) Picture from frontal view with chisel (C) over spiked retractor (spR). (C) Arthroscopic view from anterosuperior portal of left shoulder showing retractor in place. (G, glenoid; SSC, subscapularis.)

scapulothoracic closed-chain exercises were allowed. From the sixth week onward, the patient started passive, assisted, and active motion exercises mainly in the scapular plane to strengthen the rotator cuff and the deltoid muscle. No stretching was allowed for up to 12 weeks postoperatively, and no contact sports participation was allowed for up to 6 months.

### CLINICAL FOLLOW-UP

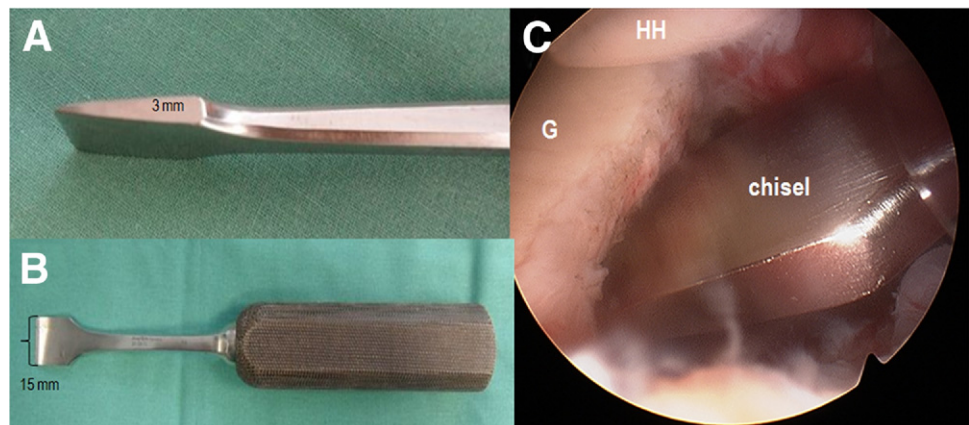
The most recent clinical examination, 13 months after the procedure, showed that the Constant score increased from 83 points before surgery to 92 points postoperatively, the Rowe score increased from 55 to 85 points, and the Walch-Duplay score reached 100 points. Preoperative glenoid bone loss decreased from 21.7% (Fig 6A) to 5.5% (Fig 6C) after the reconstruc-

tion of the glenoid at the first annual follow-up. The CT scan on the first postoperative day (Fig 7A), as well as at the most recent follow-up (Figs 7B and 7C), showed a stable iliac crest bone graft, no overhanging or impingement, and no signs of osteolysis or gap between the graft and glenoid. The graft was aligned with the glenoid surface.

### DISCUSSION

For reconstruction to treat glenoid bone loss of anteroinferior shoulder instability, several surgical approaches have been described to restore the shape of the glenoid, comprising open and arthroscopic procedures, with anatomic and nonanatomic techniques, using autograft or allograft. Although nonanatomic techniques, including the Latarjet and Bristow proce-

**FIGURE 4.** (A) Picture of chisel from lateral view. (B) Picture of chisel from frontal view. (C) Arthroscopic view from anterosuperior portal of left shoulder showing chisel in place. (G, glenoid; HH, humeral head.)



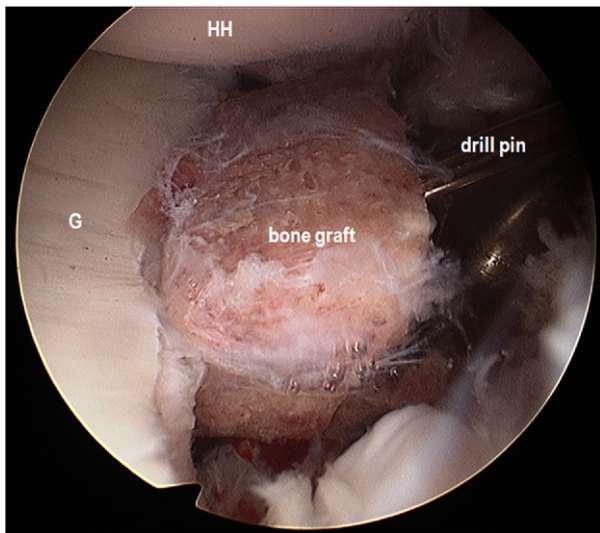


FIGURE 5. Arthroscopic view from anterosuperior portal of left shoulder showing J-shaped iliac crest bone graft in place. (G, glenoid; HH, humeral head.)

dures and their modifications, have been shown to restore the anterior stability, these coracoid transfer procedures fail to restore normal glenohumeral anatomy, including the concavity of the glenoid fossa and the buttress effect of the anterior glenoid rim and labrum. In addition, these procedures have been associated with significant complications, including hardware migration, recurrent instability, difficult revision surgery, and osteoarthritis.<sup>19</sup> Therefore techniques have been developed allowing an anatomic reconstruction of the glenoid fossa using allograft<sup>20-22</sup> or autograft tissue.<sup>16,23</sup>

As the arthroscopic treatment of anterior glenohumeral instability has continued to evolve and improve, all-arthroscopic techniques have been developed for

coracoid transfer, as well as for anatomic bone grafting.<sup>24-27</sup> An arthroscopic procedure, though technically demanding, has the advantage of better cosmesis, lower risk of infection, less scar formation, and faster rehabilitation.<sup>28</sup> Another benefit of an all-arthroscopic procedure is that the subscapularis muscle remains fairly intact without the risk of compromised function and loss of structural integrity of the musculotendinous unit.<sup>29,30</sup> We decided to use an autograft bone block primarily because it showed good results in open surgery without complications at the donor site (W.A., unpublished data, July 2011), it is easily available, it is cost-effective, and autografting still remains the gold standard.<sup>31</sup>

Few results have been published on an all-arthroscopic technique for anatomic glenoid reconstruction. To our knowledge, we are the first authors to describe an all-arthroscopic technique without the use of any implants. In our clinic we have been performed this novel technique for the past few years in several patients. No recurrent instability has occurred in any of the cases to date (W.A., unpublished data, July 2011). Other authors report recurrence rates after bone block procedures ranging from 0% to 18%.<sup>23,32</sup>

A summary of tips and helpful technical pearls for performing an all-arthroscopic implant-free iliac crest bone grafting technique is shown in Table 1. A serious concern with this technique is that there are no biomechanical data on the implant-free graft's reaction to early shear force; however, in open surgery, this technique has been used since the mid 1980s, and no severe complications due to graft migration have been observed in our experience. However, possible complications of the all-arthroscopic implant-free iliac crest bone grafting technique may include nerve injuries if the inferior 5-o'clock portal is placed improv-

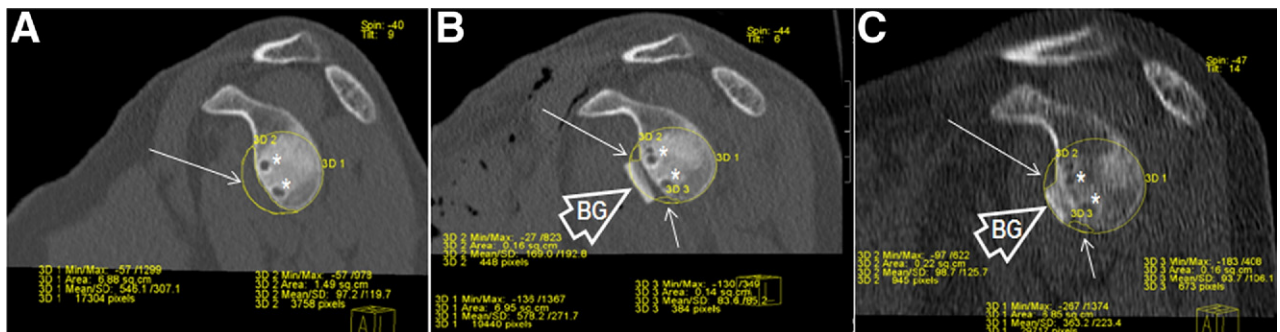


FIGURE 6. CT scans with 2-dimensional multiplanar reconstructions on en face view of left shoulder showing (A) preoperative glenoid defects (bone defect, 21.7%), (B) fresh bone graft (BG) (bone defect, 4.3%), and (C) incorporated remodeled bone graft (bone defect, 5.5%). Bone defect was considered as the missing part of the circle (arrows). Anchor holes from previous surgery are marked with asterisks.



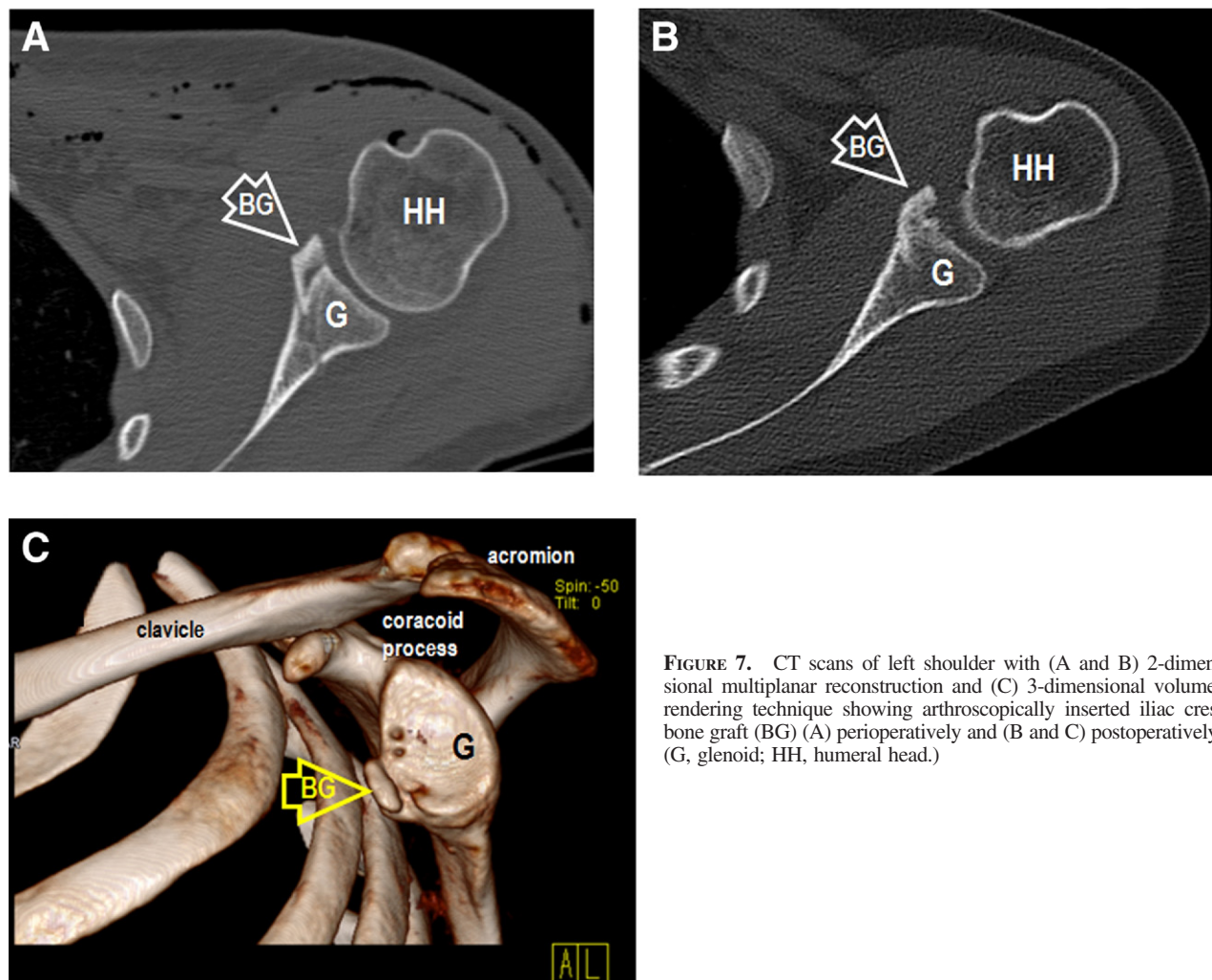


FIGURE 7. CT scans of left shoulder with (A and B) 2-dimensional multiplanar reconstruction and (C) 3-dimensional volume-rendering technique showing arthroscopically inserted iliac crest bone graft (BG) (A) perioperatively and (B and C) postoperatively. (G, glenoid; HH, humeral head.)

erly, intraoperative glenoid fractures, and hematoma at the shoulder or at the iliac crest. Nevertheless, further studies to evaluate graft stability and reaction to early motion as well as investigation of the remodeling process are necessary.

**TABLE 1.** *Tips and Helpful Technical Pearls for Performing All-Arthroscopic Implant-Free Iliac Crest Bone Grafting Technique*

Use CT scans to measure glenoid defect before procedure.
Use iliac crest bicortical bone and leave cortical bone only on keel of J-shaped graft.
Use anteroinferior 5-o'clock incision for technique.
Use proper-sized chisel to perform osteotomy to avoid problems with sliding bone block into crevice.
Use transglenoid traction sutures together with impaction for easy and proper insertion of iliac crest bone graft.

In conclusion, the all-arthroscopic implant-free glenoid reconstruction technique with tricortical J-shaped iliac crest bone grafting allows an anatomic restoration of the glenoid as well as a capsulolabral repair while preserving the function of the subscapularis muscle and avoiding complications due to implants, along with a much easier situation in case of revision surgery.

## REFERENCES

1. Castagna A, Markopoulos N, Conti M, Rose GD, Papadakou E, Garofalo R. Arthroscopic Bankart suture-anchor repair: Radiological and clinical outcome at minimum 10 years of follow-up. *Am J Sports Med* 2010;38:2012-2016.
2. Porcellini G, Campi F, Pegreffi F, Castagna A, Paladini P. Predisposing factors for recurrent shoulder dislocation after arthroscopic treatment. *J Bone Joint Surg Am* 2009;91:2537-2542.
3. Tauber M, Resch H, Forstner R, Raffl M, Schauer J. Reasons

- for failure after surgical repair of anterior shoulder instability. *J Shoulder Elbow Surg* 2004;13:279-285.
4. Bigliani LU, Newton PM, Steinmann SP, Connor PM, McLlveen SJ. Glenoid rim lesions associated with recurrent anterior dislocation of the shoulder. *Am J Sports Med* 1998;26:41-45.
  5. Burkhart SS, De Beer JF. Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs: Significance of the inverted-pear glenoid and the humeral engaging Hill-Sachs lesion. *Arthroscopy* 2000;16:677-694.
  6. Kim DS, Yoon YS, Yi CH. Prevalence comparison of accompanying lesions between primary and recurrent anterior dislocation in the shoulder. *Am J Sports Med* 2010;38:2071-2076.
  7. DePalma AF. *Surgery of the shoulder*. 3rd ed. Philadelphia: Lippincott; 1983.
  8. Gerber C, Nyffeler RW. Classification of glenohumeral joint instability. *Clin Orthop Relat Res* 2002;65-76.
  9. Itoi E, Lee SB, Berglund LJ, Berge LL, An KN. The effect of a glenoid defect on antero-inferior stability of the shoulder after Bankart repair: A cadaveric study. *J Bone Joint Surg Am* 2000;82:35-46.
  10. Yamamoto N, Muraki T, Sperling JW, et al. Stabilizing mechanism in bone-grafting of a large glenoid defect. *J Bone Joint Surg Am* 2010;92:2059-2066.
  11. Hybbinette S. Transplantation of a bone fragment to address recurrent dislocation of the shoulder: findings and operative results. *Acta Chir Scand* 1932;71:411-445 (in French).
  12. Latarjet M. Surgical technics in the treatment of recurrent dislocation of the shoulder (antero-internal). *Lyon Chir* 1965; 61:313-318 (in French).
  13. Wildner M, Wimmer B, Reichelt A. Osteoarthritis after the Eden-Hybbinette-Lange procedure for anterior dislocation of the shoulder. A 15 year follow up. *Int Orthop* 1994;18:280-283.
  14. Hovelius L, Sandström B, Saebö M. One hundred eighteen Bristow-Latarjet repairs for recurrent anterior dislocation of the shoulder prospectively followed for fifteen years: Study II—The evolution of dislocation arthropathy. *J Shoulder Elbow Surg* 2006;15:279-289.
  15. Resch H. J-Span Plastik. Stuttgart: Thieme, 1995.
  16. Auffarth A, Schauer J, Matis N, Kofler B, Hitzl W, Resch H. The J-bone graft for anatomical glenoid reconstruction in recurrent posttraumatic anterior shoulder dislocation. *Am J Sports Med* 2008;36:638-647.
  17. Magarelli N, Milano G, Sergio P, Santagada DA, Fabbriciani C, Bonomo L. Intra-observer and interobserver reliability of the 'Pico' computed tomography method for quantification of glenoid bone defect in anterior shoulder instability. *Skeletal Radiol* 2009;38:1071-1075.
  18. Resch H, Wykypiel HF, Maurer H, Wambacher M. The antero-inferior (transmuscular) approach for arthroscopic repair of the Bankart lesion: An anatomic and clinical study. *Arthroscopy* 1996;12:309-319, discussion 20-22.
  19. Young DC, Rockwood CA Jr. Complications of a failed Bristow procedure and their management. *J Bone Joint Surg Am* 1991;73:969-981.
  20. Provencher MT, Ghodadra N, LeClere L, Solomon DJ, Romeo AA. Anatomic osteochondral glenoid reconstruction for recurrent glenohumeral instability with glenoid deficiency using a distal tibia allograft. *Arthroscopy* 2009;25:446-452.
  21. Weng PW, Shen HC, Lee HH, Wu SS, Lee CH. Open reconstruction of large bony glenoid erosion with allogeneic bone graft for recurrent anterior shoulder dislocation. *Am J Sports Med* 2009;37:1792-1797.
  22. Skendzel JG, Sekiya JK. Arthroscopic glenoid osteochondral allograft reconstruction without subscapularis takedown: Technique and literature review. *Arthroscopy* 2011;27:129-135.
  23. Warner JJ, Gill TJ, O'Hollerhan JD, Pathare N, Millett PJ. Anatomical glenoid reconstruction for recurrent anterior glenohumeral instability with glenoid deficiency using an autogenous tricortical iliac crest bone graft. *Am J Sports Med* 2006;34:205-212.
  24. Lafosse L, Boyle S. Arthroscopic Latarjet procedure. *J Shoulder Elbow Surg* 2010;19:2-12.
  25. Boileau P, Mercier N, Roussanne Y, Thélou CÉ, Old J. Arthroscopic Bankart-Bristow-Latarjet procedure: The development and early results of a safe and reproducible technique. *Arthroscopy* 2010;26:1434-1450.
  26. Taverna E, Golanò P, Pascale V, Battistella F. An arthroscopic bone graft procedure for treating anterior-inferior glenohumeral instability. *Knee Surg Sports Traumatol Arthrosc* 2008; 16:872-875.
  27. Scheibel M, Kraus N, Diederichs G, Haas NP. Arthroscopic reconstruction of chronic antero-inferior glenoid defect using an autologous tricortical iliac crest bone grafting technique. *Arch Orthop Trauma Surg* 2008;128:1295-1300.
  28. Rhee YG, Lim CT, Cho NS. Muscle strength after anterior shoulder stabilization: Arthroscopic versus open Bankart repair. *Am J Sports Med* 2007;35:1859-1864.
  29. Scheibel M, Tsynman A, Magosch P, Schroeder RJ, Habermeyer P. Postoperative subscapularis muscle insufficiency after primary and revision open shoulder stabilization. *Am J Sports Med* 2006;34:1586-1593.
  30. Sachs RA, Williams B, Stone ML, Paxton L, Kuney M. Open Bankart repair: Correlation of results with postoperative subscapularis function. *Am J Sports Med* 2005;33:1458-1462.
  31. Giannoudis PV, Dinopoulos H, Tsiridis E. Bone substitutes: An update. *Injury* 2005;36:S20-S27 (Suppl 3).
  32. Allain J, Goutallier D, Glorion C. Long-term results of the Latarjet procedure for the treatment of anterior instability of the shoulder. *J Bone Joint Surg Am* 1998;80:841-852.