SUBSPECIALTY PROCEDURES

ARTHROSCOPIC GLENOID RECONSTRUCTION
FOR CHRONIC ANTEROINFERIOR SHOULDER
INSTABILITY USING A TRICORTICAL ILIAC
CREST BONE GRAFT

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Introduction

Arthroscopic glenoid reconstruction using a tricortical iliac crest bone graft is performed to anatomically reconstruct the glenoid and reestablish glenohumeral stability in patients with chronic antero-inferior shoulder instability and substantial osseous defects¹⁻³.

Present bone-grafting techniques are based on the initial descriptions by Eden in 1918⁴ and Hybinette in 1932⁵. At that time, as the aim was to create a mechanical dislocation barrier, the bone block was placed intra-articularly but extra-anatomically between the scapular neck and the capsule without additional fixation. In 1983, DePalma introduced an open anatomic and intra-articular technique for extensive erosion-type defects and began to attach the graft to the anterior glenoid rim using screws⁶. Open bone-grafting techniques have been applied for a long time⁷. With the progression of arthroscopic techniques and the development of sophisticated instruments and implants, the insertion of the bone block can now be performed with an all-arthroscopic approach⁸⁻¹⁰. In addition to potential cosmetic benefits, the preservation of the integrity of the subscapularis tendon insertion constitutes the main advantage¹¹. A fatty degeneration and atrophy of the subscapularis muscle can therefore be prevented¹¹. The following technique represents an arthroscopic anatomic and intra-articular reconstruction of the glenoid^{9,12,13}.

For this procedure, the patient is placed in the lateral decubitus position with horizontal and vertical traction applied to the arm. The affected extremity as well as the ipsilateral iliac crest for the later graft-harvesting are prepared and draped in a sterile fashion. Four portals, including a standard posterior portal and anterosuperior, antero-inferior, and deep antero-inferior portals, are required. Diagnostic arthroscopy is performed to identify concomitant glenohumeral lesions and to evaluate the extent of the glenoid defect. The capsulolabral complex is mobilized from the scapular neck, and the glenoid rim is prepared with a motorized burr. The autologous tricortical iliac crest

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bone block is harvested from the ipsilateral side and is contoured appropriately. After its insertion into the glenohumeral joint and anatomic placement at the scapular neck, a specifically designed drill-guide is utilized to first achieve temporary graft stabilization using Kirschner wires, followed by permanent fixation by means of 2 Bio-Compression screws (Arthrex). Finally, the capsulolabral complex is reattached to complete the anatomic reconstruction.

The anatomic pear-shaped configuration of the glenoid can be successfully reconstructed with this reproducible technique. Clinically, good to excellent results were achieved. Radiographically, a complete osseous consolidation of the bone graft as well as a remodeling process toward the anatomic glenoid configuration became evident¹².

Indications & Contraindications

Indications

The following indications are based on the classification system of glenoid defects in Table I¹⁴ in consideration of biomechanical principles, failure analysis of soft-tissue procedures, and results achieved after open bone-block procedures. Additionally, the clinical status, age, activity level, and functional demand of the patient as well as concomitant lesions should be taken into account.

- In the rare patient with an acute glenoid injury, if a nonreconstructible multifragmentary situation is present (type Ic).
- Chronic fragment-type defects with a fragment size that is insufficient for an anatomic reconstruction of the glenoid in relation to the dimensions of the osseous defect (type II) (Video 1).
- Erosion-type defects with a size of <25% (type IIIa) after prior failed arthroscopic stabilization.
- Erosion-type defects in the absence of a fragment, if the size of the glenoid defect is $\geq 25\%$ (type IIIb).

Contraindications

- Large Hill-Sachs lesions without a substantial glenoid defect.
- Capsular insufficiency following multiple failed soft-tissue stabilization procedures without a large glenoid defect.

TABLE I Classification of Anterior Glenoid Defects as Described by Scheibel et al. *

Type	Description
I	Acute fragment-type lesion
a	Osteochondral avulsion lesion
b	Solitary glenoid rim fracture
c	Multifragmented glenoid rim fracture
II	Chronic fragment-type lesion
	Malunited (extra-anatomically consolidated) or nonunited bone fragment lesion
III	Chronic glenoid bone loss without fragment
a	<25% bone loss of the glenoid surface
b	$\geq 25\%$ bone loss of the glenoid surface

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Video 1 Case example showing a 3-D CT reconstruction of a chronic fragment-type defect (type II) with an extra-anatomically consolidated fragment after a failed arthroscopic Bankart repair.

Step 1: Patient Positioning

Place the patient in the lateral decubitus position and prepare the arm and ipsilateral iliac crest.

- After the induction of general anesthesia and administration of perioperative antibiotics, place the patient in the lateral decubitus position. The advantages of this position, in comparison with the beach-chair position, include joint distension, better visualization, more ergonomic conditions for the surgeon, and a better accessibility of the ipsilateral iliac crest.
- Prepare and drape the arm and the ipsilateral iliac crest in a sterile fashion.
- Position the arm in a traction device (STaR Sleeve; Arthrex) in 30° of abduction and 20° of external rotation with traction of 5 kg applied horizontally and 3 kg applied vertically (Fig. 1, Video 2).

A
Fig. 1

Figs. 1-A and 1-B Drawing (**Fig. 1-A**) and photograph (**Fig. 1-B**) showing the patient placed in the lateral decubitus position with the affected extremity as well as the ipsilateral iliac crest prepared and draped and with the arm fixed in a traction device. (Reproduced from: Scheibel M, Kraus N. [Arthroscopic reconstruction of the glenoid concavity with an autologous bone block procedure]. German. Orthopade. 2011 Jan;40[1]:52-60. Copyright 2010. Reproduced with permission of Springer.)

Video 2 Positioning of the patient in the lateral decubitus position and preparation of the arm and ipsilateral iliac crest. Diagnostic arthroscopy via the posterior portal. The concomitant lesions in this example are an osseous ALPSA (anterior labral periosteal sleeve avulsion) lesion, synovitis due to a previous surgery, and a lateral Hill-Sachs lesion.

Step 2: Diagnostic Arthroscopy and Portal Placement

Perform a diagnostic arthroscopy via the posterior portal and establish an anteroinferior, an anterosuperior, and a deep anteroinferior portal.

- Perform a diagnostic arthroscopy through the standard posterior portal in order to evaluate the pathology and to identify concomitant glenohumeral lesions, including rotator cuff tears, biceps tendon pathologies, and capsulolabral lesions. These should be addressed after completion of the graft fixation to avoid additional soft-tissue swelling (Video 2).
- Create an anteroinferior working portal superior to the subscapularis tendon using an outside-in technique and insert a transparent Twist-In Cannula (8.25 mm × 7 cm; Arthrex) (Figs. 2-A and 2-B, Video 3).
- Establish an anterosuperior viewing portal and place the camera anterosuperiorly using a switching stick (Figs. 2-A and 2-B, Video 3).
- Insert a second transparent Twist-In Cannula into the posterior portal under direct visualization (Figs. 2-A and 2-B, Video 3).
- Examine the anterior and anteroinferior glenoid rim as well as the capsuloligamentous complex via the anterosuperior portal to evaluate the glenoid defect more thoroughly (Video 3). An “inverted-pear glenoid” or “banana-shaped glenoid” can be observed in patients with substantial osseous defects¹⁵. If the procedure constitutes revision surgery, remove any remaining sutures from prior surgeries as well as suture anchors that are protruding into the intra-articular space and send them for culture.
- Establish the deep anteroinferior portal through the flat tendinous parts of the subscapularis muscle. To achieve the correct orientation of this portal, insert a spinal needle 6 to 7 cm below the anteroinferior portal aiming toward the 4 o'clock position. Introduce a switching stick parallel to the needle through the subscapularis muscle under direct visualization. Insert a transparent Twist-In Cannula (8.25 mm × 9 cm) (Figs. 2-C and 2-D, Video 3).

Fig. 2-A

Fig. 2-B

Fig. 2-C

Fig. 2-D

Figs. 2-A through 2-D Portal placement. (Reproduced from: Scheibel M, Kraus N. [Arthroscopic reconstruction of the glenoid concavity with an autologous bone block procedure]. *Orthopade*. 2011 Jan;40[1]:52-60. Reproduced with permission of Springer.) **Figs. 2-A and 2-B** Drawing (Fig. 2-A) and photograph (Fig. 2-B) showing the osseous landmarks of the 4 required portals including a standard posterior portal and anterosuperior, anteroinferior, and deep anteroinferior portals.

Figs. 2-C and 2-D Drawing (Fig. 2-C) and arthroscopic view (Fig. 2-D) showing placement of the deep anteroinferior portal through the inferior part of the subscapularis tendon.

Video 3 Location of the anteroinferior, the anterosuperior, and the standard posterior portal. Evaluation of the anterior and anteroinferior glenoid as well as the capsuloligamentous complex via the anterosuperior portal. Placement of the deep anteroinferior portal under direct visualization.

Step 3: Capsulolabral Complex Release and Scapular Neck Preparation

Depending on the pathology and morphology of the defect, release the capsulolabral complex from the scapular neck and prepare the glenoid rim and scapular neck with a motorized burr to ensure adequate osseous healing.

- In patients with an anterior labral periosteal sleeve avulsion in combination with an erosion-type glenoid defect (type III), mobilize the labrum from the glenoid neck up to the 6 o'clock position using either a rasp or an electrothermic instrument under visualization via the anterosuperior portal (Figs. 3-A and 3-B).
- In patients with a chronic fragment-type defect (type II) with a small fragment, resect the fragment to create a flat surface at the scapular neck for the bone graft. Alternatively, mobilize the fragment and later reattach it together with the capsuloligamentous complex.
- In patients with a chronic fragment-type defect (type II) with a large fragment that is healed in a medial position (>1 cm), solely mobilize the labrum, leaving the fragment in place. The fragment may provide further support against a medial dislocation of the graft and facilitate its temporary Kirschner wire stabilization, as well as definitive screw fixation (Video 4).
- In the rare patient with a nonreconstructible multifragmentary glenoid fracture (type Ic), resect loose osteochondral fragments. Leave fragments that are attached to the labrum in place and later reattach them against the bone block.
- Prepare the glenoid rim and the scapular neck with a motorized burr to create a flat surface and to facilitate the osseous consolidation of the graft (Figs. 3-C and 3-D, Video 4). In patients with a banana-shaped glenoid, particularly dissect the caudal part of the scapular neck to straighten the articular surface for the attachment of the bone graft.
- Debride adjacent chondral defects with a shaver and, if necessary, perform an additional microfracture at the end of the procedure.

Fig. 3-A

Fig. 3-B

Fig. 3-C

Fig. 3-D

Figs. 3-A through 3-D The capsulolabral complex release and preparation of the scapular neck. (Reproduced from: Scheibel M, Kraus N. [Arthroscopic reconstruction of the glenoid concavity with an autologous bone block procedure]. *Orthopade*. 2011 Jan;40[1]:52-60. Copyright 2010. Reproduced with permission of Springer.) **Figs. 3-A and 3-B** Drawing (**Fig. 3-A**) and arthroscopic view (**Fig. 3-B**) showing the release of the capsulolabral complex from the scapular neck using a rasp or electrothermic instrument.

Figs. 3-C and 3-D Drawing (**Fig. 3-C**) and arthroscopic view (**Fig. 3-D**) showing preparation of the scapular neck using a motorized burr.

Video 4 Capsulolabral complex release and preparation of the glenoid rim and scapular neck.

Step 4: Harvesting and Preparation of the Iliac Crest Bone Block

Harvest an autologous tricortical iliac crest bone block from the ipsilateral side and contour it appropriately for an anatomic reconstruction of the glenoid.

- Harvest a tricortical iliac crest bone graft from the ipsilateral side. The size and length of the graft depend on the superoinferior and anteroposterior dimensions of the glenoid defect. Large osseous defects usually require a graft measuring 2 to 3 cm $\times$ 1 to 1.5 cm $\times$ 1 to 1.5 cm (Fig. 4-A, Video 5).
- Close the wound at the iliac crest in a standard fashion after hemostasis and insertion of a drain.
- Simultaneously clean the graft of soft tissue and contour it appropriately (Fig. 4-B, Video 5).

Fig. 4-A

Fig. 4-B

Figs. 4-A and 4-B Harvesting and preparation of the graft. (Reproduced from: Scheibel M, Kraus N. [Arthroscopic reconstruction of the glenoid concavity with an autologous bone block procedure]. *Orthopade*. 2011 Jan;40[1]:52-60. Copyright 2010. Reproduced with permission of Springer.)

Fig. 4-A Drawing showing the harvesting of the tricortical iliac crest bone block from the ipsilateral side. **Fig. 4-B** Preparation of the tricortical iliac crest bone block.

Video 5 Measurement of the glenoid defect and preparation of the autologous tricortical iliac crest bone graft. Dilation of the graft passage through the rotator interval followed by the insertion and anatomic positioning of the bone block.

Step 5: Graft Insertion and Positioning

Enlarge the passage for the graft through the rotator interval, insert the bone block, and position it anatomically at the scapular neck.

- To assist the implementation and anatomic placement of the graft, drill a hole through the center of the bone block. Then place a single-loaded all-suture anchor at the corresponding site of the scapular neck via the deep anteroinferior portal (Video 5).
- Before inserting the graft, dilate its passage through the anteroinferior portal. Temporarily remove the Twist-In Cannula and enlarge the skin incision approximately 1 cm. Further dilate the passage under direct visualization using expanding scissors or bluntly with one's index finger (Video 5).
- Extract 1 of the sutures from the anchor at the scapular neck, thread it through the bone block, and secure it with knots. Insert the graft via the anteroinferior portal using a straight clamp and simultaneously pulling on the distal suture of the anchor. Place the bone block between the scapular neck and the subscapularis muscle and capsuloligamentous complex (Video 5).
- Introduce the scope back into the anterosuperior portal and reinsert the Twist-In Cannula (8.25 mm × 7 cm) into the anteroinferior portal using a switching stick. Close the incision near the cannula to prevent loosening during further instrumentation (Video 5).
- Position the graft anatomically at the scapular neck. Introduce a switching stick via the posterior portal to adjust the surface of the bone block to the glenoid level (Figs. 5-A and 5-B, Video 5).

Fig. 5-A

Fig. 5-B

Figs. 5-A and 5-B Drawing (**Fig. 5-A**) and arthroscopic view (**Fig. 5-B**) showing the anatomic positioning of the bone graft. (Reproduced from: Scheibel M, Kraus N. [Arthroscopic reconstruction of the glenoid concavity with an autologous bone block procedure]. *Orthopade*. 2011 Jan;40[1]:52-60. Copyright 2010. Reproduced with permission of Springer.)

Step 6: Graft Fixation

With the aid of a drill sleeve, temporarily stabilize the graft using Kirschner wires and then definitively attach it to the scapular neck using 2 Bio-Compression screws.

- To establish temporary and later definitive graft fixation, utilize a special drill sleeve (Twist-Drill Guide; Arthrex) consisting of a Kirschner wire placement sleeve and a drill sleeve. Insert this instrument via the deep anteroinferior portal and place it at the caudal end of the bone block with the integrated Kirschner wire placement sleeve positioned at the transition of the distal to the middle third of the bone block (Video 6).
- Establish temporary graft fixation by pressing the Twist-Drill Guide onto the graft and introduce a first 1.0-mm Kirschner wire through the Kirschner wire placement sleeve up to the posterior cortical wall of the scapular neck (Video 6).
- To further guarantee rotational stability prior to the definitive graft fixation, insert a 1.6-mm Kirschner wire percutaneously at the cranial end of the graft (Video 6).
- Place a second 1.0-mm Kirschner wire through the actual drill sleeve within the cannulated drill to ensure its parallel placement. Overdrill this inferior Kirschner wire using a cannulated drill under direct visualization (Figs. 6-A and 6-B). Manually insert a thread cutter over the Kirschner wire and tap the drill-hole (Video 6).
- Remove the inferior Kirschner wire and insert the first Bio-Compression screw (3.0 to 3.7 mm × 26 mm; Arthrex) to obtain definitive fixation of the graft. Place this screw 2 mm below the level of the bone block (Figs. 6-C and 6-D, Video 6).

Fig. 6-A

Fig. 6-B

Fig. 6-C

Fig. 6-D

Video 6 Temporary stabilization of the bone block using Kirschner wires. Drilling, tapping, and insertion of the first inferior Bio-Compression screw for the definitive graft fixation. Rotation of the Twist-Drill Guide about 180° counterclockwise and parallel insertion of the second, superior Bio-Compression screw. Correction of a lateral overhang of the bone graft.

Figs. 6-A through 6-H Graft fixation. (Figs. 6-A through 6-F and Fig. 6-H reproduced, with permission of Springer, from: Scheibel M, Kraus N. [Arthroscopic reconstruction of the glenoid concavity with an autologous bone block procedure]. *Orthopade*. 2011 Jan;40[1]:52-60. Copyright 2010; and Fig. 6-G reproduced, with permission of Elsevier, from: Kraus N, Amphansap T, Gerhardt C, Scheibel M. Arthroscopic anatomic glenoid reconstruction using an autologous iliac crest bone grafting technique. *J Shoulder Elbow Surg*. 2014 Nov;23[11]:1700-8. Copyright 2014.)

Figs. 6-A and 6-B Drawing (Fig. 6-A) and arthroscopic view (Fig. 6-B) showing overdrilling of the Kirschner wire drill sleeve using a cannulated drill under direct visualization.

Figs. 6-C and 6-D Drawing (Fig. 6-C) and arthroscopic view (Fig. 6-D) showing definitive graft fixation with the first Bio-Compression screw (3.9 to 3.7 mm x 26 mm).

- After completion of the screw fixation, rotate the Twist-Drill Guide 180° clockwise (right shoulder) or counterclockwise (left shoulder) so that the drill sleeve comes to rest parallel and superior to the first inferior screw. The first Kirschner wire, which had been retained in the placement sleeve, is thereby functioning as the rotational center (Figs 6-E and 6-F, Video 6).
- Place the second drill-hole parallel and superior to the first drill-hole, with the aid of a Kirschner wire and insert the second Bio-Compression screw (3.0 to 3.7 mm × 26 mm) (Figs. 6-G and 6-H, Video 6).
- After achieving definitive screw fixation, correct a lateral overhang of the bone block, if present, using a burr (Video 6).

Fig. 6-E

Fig. 6-F

Fig. 6-G

Fig. 6-H

Figs. 6-E and 6-F Drawing (**Fig. 6-E**) and arthroscopic view (**Fig. 6-F**) showing the Twist-Drill Guide rotation of 180°, drilling, and tapping for the second screw.

Figs. 6-G and 6-H Drawing (**Fig. 6-G**) and arthroscopic view (**Fig. 6-H**) showing insertion of the second Bio-Compression screw parallel and superior to the first screw.

Step 7: Capsulolabral Repair

Reattach the capsulolabral complex to the original glenoid, inferior and superior to the bone block, using 2 knotless suture anchors to complete the anatomic reconstruction of the glenoid.

- Penetrate the capsuloligamentous complex inferior to the graft with a 25° SutureLasso (Arthrex) and bring a number-2 FiberWire (Arthrex) in as a loop. Use this suture as a pulling suture in order to place a second one slightly more inferior. Then reattach both sutures to the original anteroinferior glenoid rim using a knotless PushLock anchor (2.9 or 3.5 × 15.5 mm; Arthrex) (Figs. 7-A and 7-B, Video 7).
- Extract the superior 1.6-mm Kirschner wire and insert a first suture through the anterosuperior aspect of the labrum (Video 7).
- Remove the 1.0-mm Kirschner wire and the suture used for the initial graft insertion. Place a final suture superiorly to achieve sufficient tension of the labrum and to raise it up to the required level of the bone graft. Attach the 2 sutures superior to the bone block using a second knotless PushLock anchor (2.9 or 3.5 × 15.5 mm) (Figs. 7-A and 7-B, Video 7).
- Smooth the surface of the bone graft with a shaver in order to facilitate the formation of fibrous cartilage and to adjust it to the level of the glenoid (Video 7).
- After completion of the glenoid rim reconstruction (Video 8), address any accompanying lesions such as chondral defects, rotator cuff tears, biceps tendon pathologies, or humeral avulsion of the glenohumeral ligament lesions. Finally, close the arthroscopic portals in a standard fashion.

Fig. 7-A

Fig. 7-B

Drawing (**Fig. 7-A**) and arthroscopic view (**Fig. 7-B**) showing the anatomic reconstruction of the intra-articular glenoid configuration after arthroscopic capsulolabral repair. (Reproduced from: Scheibel M, Kraus N. [Arthroscopic reconstruction of the glenoid concavity with an autologous bone block procedure]. *Orthopade*. 2011 Jan;40[1]:52-60. Copyright 2010. Reproduced with permission of Springer.)

Video 7 Refixation of the capsulolabral complex to the glenoid.

Video 8 Postoperative 3-dimensional CT of the reconstructed glenoid.

Step 8: Rehabilitation and Postoperative Treatment

Immobilize the arm for 6 weeks postoperatively and limit flexion and external rotation during this time period.

- Immobilize the arm postoperatively in a brace in 15° of external rotation for 6 weeks and only allow passive mobilization of the arm. Restrict flexion in internal rotation to 90° and external rotation in adduction to 20°. Passive range-of-motion exercises should be conducted during physical therapy.
- Initiate active range-of-motion exercises 7 weeks postoperatively.
- At 12 weeks postoperatively, have the patient begin an intensive strengthening program of the deltoid, rotator cuff, and scapulothoracic muscles.

Results

Fifteen patients with a mean age of 31.4 years (range, 17 to 49 years) with anteroinferior glenohumeral instability and substantial glenoid defects underwent arthroscopic iliac crest bone-grafting and were prospectively evaluated for an average period of 20.6 months (range, 12 to 65 months)¹². These included 5 type-II as well as 10 type-III glenoid defects, and 8 of 15 patients had an average of 1.5 previous arthroscopic or open procedures (range, 0 to 4 procedures). At the time of the final follow-up, no recurrent subluxations or dislocations were observed and the apprehension sign tested negative in all patients. The comparison of the range of motion on the affected side and the contralateral side showed no significant difference. The Constant score, Rowe score, Subjective Shoulder Value, and Western Ontario Shoulder Instability Index were assessed. Consistently good to excellent results were achieved postoperatively in the objective and subjective scores used for the clinical evaluation, especially when considering that this intervention represented a revision surgery in the majority of the patients. Radiographically, the axial 2-dimensional computed tomography (CT) images displayed a complete osseous consolidation of the iliac crest bone grafts in all patients. Furthermore, a partial extra-articular graft resorption was observed in the 3-dimensional CT reconstructions in terms of a remodeling process. The glenoid was initially reconstructed too large, but remodeled over the course toward an anatomic pear-shaped configuration (Wolff's law) (Fig. 8, Video 9). Eight patients showed no signs of glenohumeral osteoarthritis. Two patients had grade-I osteoarthritis, 1 patient had grade-II osteoarthritis, and the remaining 4 patients, who had preexisting arthritis (grade I), showed no evidence of progression over the course of follow-up. Complications occurred in 2 patients. One patient experienced a temporary hypoesthesia at the harvesting site of the iliac crest. A second patient reported a persistent feeling of a loose shoulder. The bone graft was observed to almost be completely covered by fibrous cartilage during the consecutively conducted inferior capsular shift procedure.

Arthroscopic reconstruction of anteroinferior glenoid defects using an autologous tricortical iliac crest bone graft represents a reproducible and reliable technique. The anatomy of the anteroinferior aspect of the glenoid is successfully reestablished, and good to excellent clinical results are achieved while preserving the integrity of the insertion of the subscapularis tendon.

Fig. 8

Fig. 8 Three-dimensional CT reconstruction displaying an erosion-type defect (type III) before surgery (**Fig. 8-A**), immediately after glenoid reconstruction (**Fig. 8-B**), and one year postoperatively (**Fig. 8-C**) after partial resorption and remodeling toward the anatomic glenoid configuration. (Reproduced from: Scheibel M, Kraus N. [Arthroscopic reconstruction of the glenoid concavity with an autologous bone block procedure]. *Orthopade*. 2011 Jan;40[1]:52-60. Copyright 2010. Reproduced with permission of Springer.)

Video 9 A case example of the remodeling process showing a reconstructed glenoid that was initially too large and the resulting anatomic pear-shaped configuration that was observed at the latest follow-up.

Pitfalls & Challenges

- Insertion of the graft
 - In order to facilitate a smooth passage of the graft, the anteroinferior portal is dilated. A guided suture passage is helpful to assist the insertion and positioning of the graft at the scapular neck. A hole is thereby drilled medially to avoid a conflict during the later screw fixation. The suture is extracted, threaded through the bone block, and secured with knots. The bone block can then be inserted and positioned using a straight clamp and simultaneously pulling on the distal suture.
- Temporary stabilization of the graft
 - The use of the Twist-Drill Guide is helpful to establish temporary graft fixation. The first 1.0-mm Kirschner wire is inserted through the Kirschner wire placement sleeve of the Twist-Drill Guide up to the posterior cortical wall of the scapular neck. To further guarantee rotational stability prior to the definitive graft fixation, a 1.6-mm Kirschner wire is introduced percutaneously at the cranial end of the graft. Then, a second 1.0-mm Kirschner wire can be placed through the actual drill sleeve within the cannulated drill to ensure its parallel placement.

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