Technical Note

Arthroscopic Single-Layer Hyaluronate-Based Scaffold for Osteochondritis Dissecans of the Glenoid

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Abstract: Osteochondritis dissecans (OCD) of the glenoid is a rare condition occurring primarily in overhead athletes. Symptoms are not specific and consist of pain, worsening range of motion, and decreased sport performance. Radiologic evaluation is crucial for diagnosis and, in particular magnetic resonance imaging, to grade this condition according to the International Cartilage Research Society OCD grading system. International Cartilage Research Society OCD stages II, III, and IV generally require surgical treatment. There's still no consensus on the best procedure, and various techniques have been described, mostly inspired by experience in other joints. This Technical Note describes an arthroscopic technique with a single-layer hyaluronate-based scaffold added to microfractures and fixed with fibrin glue for the treatment of osteochondritis dissecans of the glenoid.

Osteochondritis dissecans (OCD) is a rare acquired joint condition characterized by damage of the subchondral bone from a suspected ischemic cause with a secondary possible focal disruption with osteonecrotic evolution. It occurs primarily in young overhead athletes (e.g., those who participate in tennis, badminton, cricket, baseball, volleyball, weightlifting, gymnastics) between 6 and 20 years of age after a joint injury or a long period of sport activity, usually after repetitive overuse.[1]

Because of a lack of cartilage innervation and vascularization, symptoms are nonspecific and characterized by pain and crepitus and appear only when the innervated subchondral bone is damaged. Spontaneous healing is absent or very slow, with possible evolution toward a degenerative condition.

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Convex articular surfaces are generally involved, such as femoral condyles (especially the posterolateral part of the medial condyle), talar dome, and humeral head. Therefore, the most typically affected joints are the knee (75% of cases), the ankle, and the elbow: the shoulder represents approximately 1.6% cases of OCD. The humeral head is more involved than the glenoid, which conversely presents a concave, non–weight-bearing articular surface.[2]

The etiology of OCD is poorly understood and plausibly multifactorial. Reduced blood flow attributable to vascular disruption from repetitive trauma is probably the main cause. Another important factor is represented by the particular relationship between the humerus and the glenoid in the overhead arm position: this implies an increased mechanical load from compressive forces across the glenohumeral joint accentuated by repetitive microtrauma.[2] In particular, it has been hypothesized, at least in baseball players, that the humeral head is pushed posteriorly by the anterior band of the inferior glenohumeral ligament; this determines, over time, a compressive force on the glenoid that may lead to the onset of OCD.[2] Moreover, a genetic component could be present, predisposing certain individuals to a greater possibility of developing the disease.

Recent studies have evaluated the progressive joint damage stages (from I to IV) according to the International Cartilage Research Society (ICRS) OCD grading on the basis of magnetic resonance imaging (MRI).[3] It was demonstrated that, despite the different concave

shape of the glenoid, its OCD follows the same progression over the time of the convex weight-bearing articular surfaces and needs, likewise, the same grade-specific management.

Patients with IRCS OCD stage I and some with OCD stage II present with a stable shoulder and can undergo conservative treatment. Unstable or advanced glenoid OCD stages, characterized by disruption of the articular cartilage and the presence of separated fragments as loose bodies, require surgical treatment. Moreover, this is indicated when the conservative approaches fail, especially because of long-standing pain and joint range of motion worsening.

Proposed surgical treatments include arthroscopic drilling, microfractures, debridement of the unstable osteochondral fragments, and fixation with suture anchor or autogenous osteochondral plugs, platelet-rich plasma, and gel-like sodium hyaluronate.[2,4] There is not yet consensus regarding the ideal technique. In this Technical Note, we describe an arthroscopic procedure with a single-layer hyaluronate-based scaffold for the treatment of OCD of the glenoid.

Patient Evaluation

Patient evaluation must comprise anamnesis investigation for age, sport activity, appearance, span, and eventual worsening of the symptoms. Clinical evaluation must consider the passive and active range of motion, the strength of the rotator cuff muscles, and the presence of shoulder instability (both anterior and posterior). Pain and grade of disability are investigated with dedicated patient-reported outcome measures (e.g., Numeric Rating Scale, Constant-Murley score, American Shoulder and Elbow Surgeons score, etc.).

Imaging

Standard radiographs are usually unhelpful for the diagnosis of OCD and may just show signs of associated conditions such as Hill-Sachs and bony Bankart lesion in case of anterior instability or osteophytes for arthritis development. In contrast, MRI is crucial for the diagnosis and planning management of glenoid OCD: all axial, coronal, and sagittal axes are important to evaluate the width and the depth of the lesion. Both T1- and T2-weighted images are useful. The lesion appears as an intensity alteration or complete absence of articular chondral layer (Fig 1 A-C).

Indications

The following factors and conditions may lead to a surgical indication: unstable shoulder, advanced glenoid OCD (IRCS stages II, III, and IV), failed conservative approach/worsening of the OCD, and long-standing pain and joint range of motion worsening.

Surgical Technique

Patient Positioning and Surgical Preparation

After receiving an interscalene block with ropivacaine 0.375%, the patient is transported to the operating room. The patient is then placed in the lateral decubitus position on the operating table. After a meticulous clearance assessment of the shoulder and axilla, general anesthesia is administered. The operative extremity is then suspended, with usually 7 to 10 kg of traction applied, between 7% and 10% of the whole-body weight. The shoulder is slightly flexed forward and abducted to approximately 60° to 70°. To ensure aseptic conditions, the arm is prepared with chlorhexidine solution and draped according to standard practices. Anatomical landmarks such as the acromion, coracoid, acromioclavicular joint, coracoacromial ligament, and the primary posterior viewing portal are distinctly marked using a surgical pen. A single dose of antibiotic prophylaxis is administered.

Diagnostic Arthroscopy

A standard posterior viewing portal is established 2 cm inferior and 1 cm medial to the posterolateral border of the acromion. After a careful introduction of the arthroscope into the glenohumeral joint, a comprehensive diagnostic arthroscopy is conducted. By using an "inside-out technique" with a Wissinger rod through the camera-coat, a standard anterior portal is created within the rotator interval, just lateral to the tip of the coracoid. Eventual loose bodies are removed.

When the glenoid chondral lesion is identified, depending on its position, the working portal is established switching from the anterior to posterior portal and/or creating midglenoid portals as necessary. First, nonviable tissue is removed, and the margins are cleaned using a tissue biter and a standard shaver to regularize the cartilage rim and better define the real dimension of the lesion.When the area of the OCD is completely exposed, separately proceed to size a hyaluronate-based scaffold (HYALOFAST; Anika Therapeutics, Inc., Bedford, MA) of the same shape of the lesion.

OCD Treatment

A deep debridement of the lesion with a sharp spoon or curette is then performed, exposing subchondral bone. Some degenerated chondral samples are collected for histologic examination. Microperforations are then applied by drilling the lesion with a 1.26-mm K-wire or using a small dedicated microfracture awl (usually L-shaped), from the articular side to the subchondral bone until it starts bleeding, to enhance growth factors and progenitor cells homing.

The fluid inflow is then stopped and the dry single-layer scaffold previously prepared is inserted in the joint and positioned with a grasper to cover all the area,

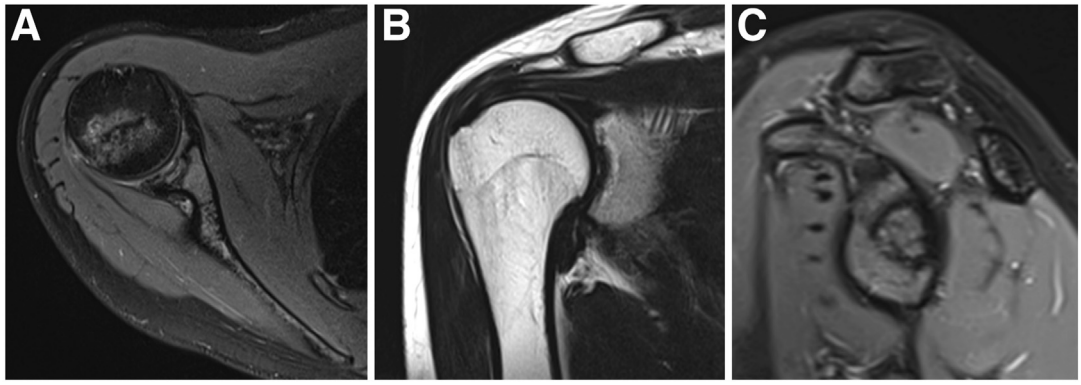

Fig 1. Preoperative magnetic resonance imaging: axial PD-TSE-FS (A), coronal T2-TSE (B), and sagittal PD-TSE-FS (C) plane of the right shoulder. The glenoid OCD lesion appears as a well-defined area of altered intensity in the chondral and subchondral bone. In this young female patient, 22 years old, professional volleyballer, the OCD lesion is an area of 1.1 × 1.3 cm in the posterosuperior surface of the glenoid. (FS, fat-suppressed; OCD, osteochondrosis dissecans; PD, proton density; TSE, turbo spin echo.)

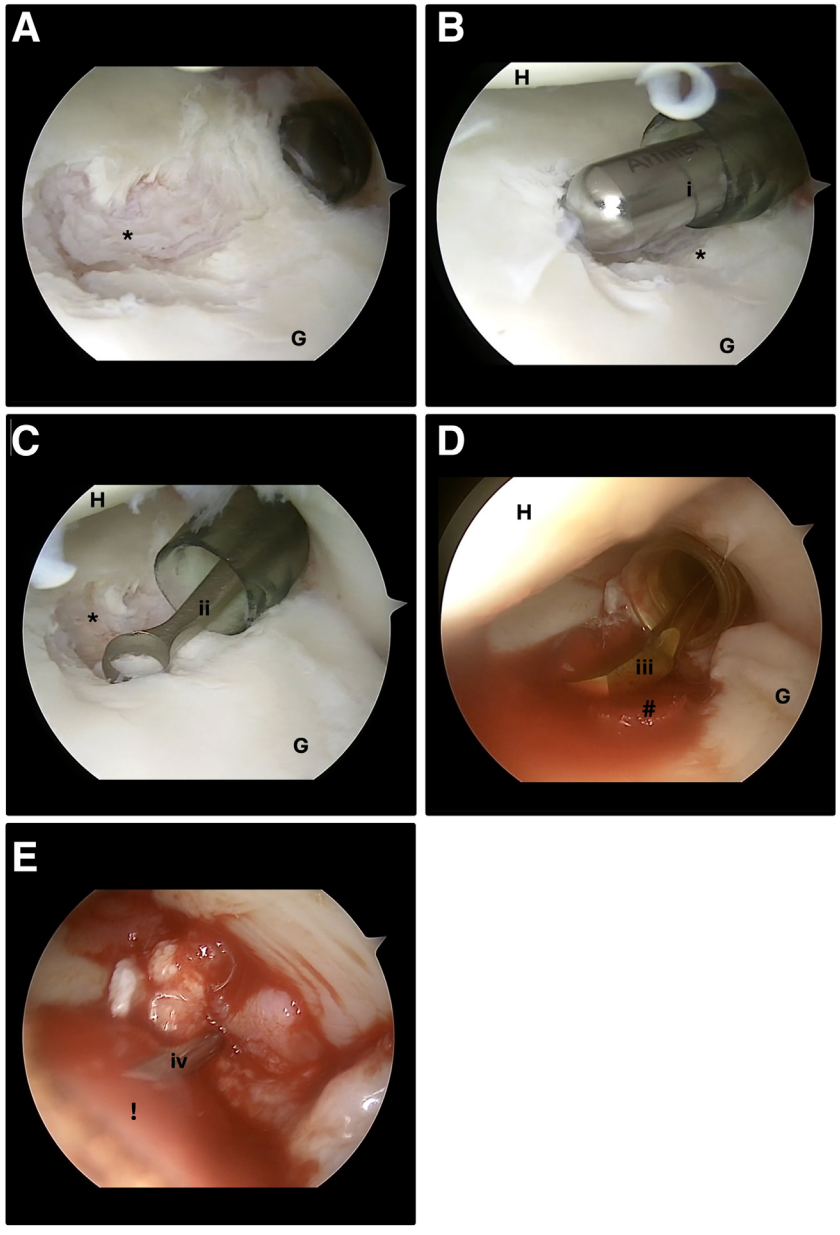

Fig 2. The patient is shown in lateral decubitus, right shoulder, view from posterior portal, 30° scope, midglenoid posterior working portal, intra-articular view. (A) Chondral lesion of the anterosuperior glenoid. (B) Debridement of the lesion to better define dimensions and deepness. Shaver from posterosuperior cannula. (C) Curettage and bleeding of the subchondral bone. Curette from posterosuperior cannula. (D) Introduction and positioning of the hyaline matrix in the chondral defect. Elevator from posterosuperior dry cannula. Dry joint. (E) Hyaline matrix and fibrin glue to cover the chondral defect. Glue-syringe from posterosuperior cannula. Dry joint. * indicates chondral lesion, (i) indicates shaver, (ii) indicates curette, (iii) indicates elevator, (iv) indicates syringe, (#) indicates single-layer hyaluronate-based scaffold, and (!) indicates hyaline matrix and fibrin glue. (G, glenoid; H, humeral head.)

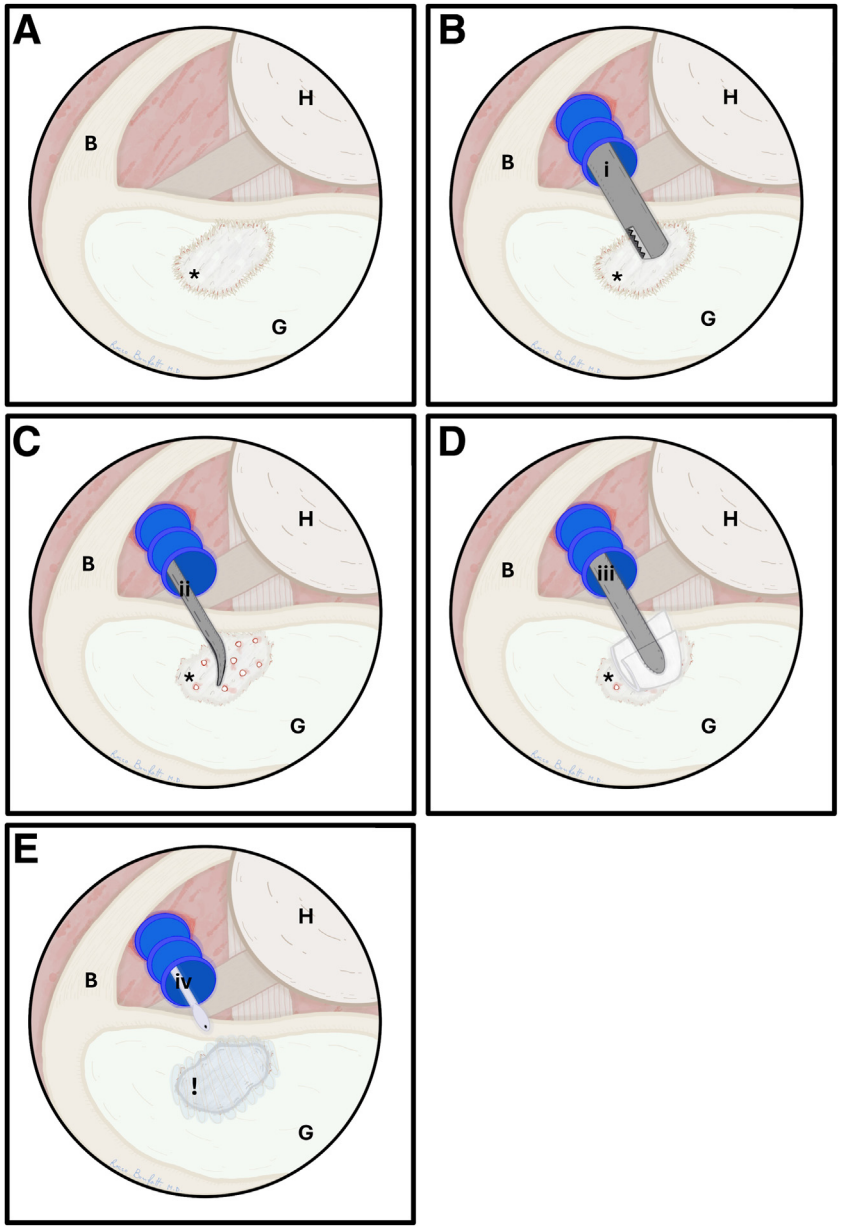

Fig 3. The patient is shown in lateral decubitus, right shoulder, view from posterior portal, 30° scope, anterosuperior working portal, intra-articular view. (A) Chondral lesion of the anterosuperior glenoid. (B) Debridement of the lesion to better define dimensions and deepness. Shaver from anterosuperior cannula. (C) Microperforations and bleeding of the subchondral bone. Microfracture awl from anterosuperior cannula. (D) Introduction and positioning of the hyaline matrix in the chondral defect. Grasper from antero-superior cannula. Dry joint. (E) Hyaline matrix and fibrin glue to cover the chondral defect. Glue-syringe from anterosuperior cannula. Dry joint. * indicates chondral lesion, (i) indicates shaver, (ii) microperforator, (iii) grasper, (iv) indicates glue-syringe, and (!) indicates hyaline matrix and fibrin glue. (G, glenoid; H, humeral head.)

adjusting it with the probe so that it results in being smoothly applied to the bone surface. For the intra-articular passage of the scaffold, a yellow 80 × 85-mm cannula (Dry-DOC; ConMed Corporation, Utica, NY) previously modified by eliminating the antifluid leak membrane is positioned through the working portal: this allows an easy gliding of the scaffold.

To complete the procedure, the scaffold is fixed with fibrin glue (Tissucol/Tisseel; Baxter International, Deerfield, IL) with attention paid mostly to the edges where it is in contact with the healthy chondral remnants. A final dry investigation allows to verify the correct positioning of the construct and, using a surgical probe, the stability and the good adhesion of the membrane to the margins previously delimited.

The different surgical steps are resumed with intraoperative photos and anatomical drawings in Figures 2 and 3, and the full technique is also described in Video 1. Table 1 presents insights and potential challenges associated with the arthroscopic single-layer hyaluronate-based scaffold.

Rehabilitation Program

The postoperative rehabilitation consists of 3 weeks of immobilization in a Desault-like brace followed by a dedicated program. This is based on obtaining a complete recovery of range of motion through subsequent

Table 1. Insights (Pearls) and Potential Challenges (Pitfalls) Associated With the Arthroscopic Single-Layer Hyaluronate-Based Scaffold Technique for Osteochondritis Dissecans of the Glenoid

Pearls	Pitfalls
Be aware of the incidence of chondral lesions in the glenoid and be prepared to treat them surgically.	An incomplete debridement of the osteochondral fragments may lead to underestimating the dimensions of the lesion.
Optimal workflow is achieved by using the midglenoid portal as working portal on the same side of the lesion.	Incorrect exposure of the subchondral bone may lead to ineffective bleeding and mesenchymal cells homing.
If previous experience on instability surgery and dry arthroscopy has been limited, a learning curve may be encountered.	During the dry phase of arthroscopy, bleeding may complicate the visualization of the joint: it's essential to control blood pressure.
The debridement of the chondral fragments is essential to define the rim of the lesion and its real dimensions.	Incorrect sizing of the scaffold may generate incorrect or incomplete coverage of the lesion.
Dry the joint and use a new dry cannula to avoid vicious bending of the scaffold and to allow its easier intra-articular manipulation.	A too-fast injection may lead to a messy effusion and inefficacy of the fibrin glue.
Pay attention to the correct sizing of the scaffold to have the right housing in the lesion.	
Fibrin glue allows good mechanical stability of the scaffold and better housing in the lesion.	
Take care not to create labral lesions, which may lead to glenohumeral instability.	

passive and active mobilization steps, after the removal of the brace.

Then, at 3 months postoperatively, if active range of motion is completely regained, the patient is allowed to gradually start muscle strengthening and sports activities such as ball exercises on the court without contact and trauma.

In case of athletes, from the fourth month sport activity is progressively resumed, but before reintroducing trauma and competitions, we suggest evaluating the patient in terms of pain and strength. For the "return to play," the Numerical Rating Scale score must be almost 0, and the isokinetic strength testing of the rotator cuff has to be not less than 80% of the contralateral side.

In our experience, recovery of the full strength occurs after 12 months from the surgical procedure, so it's important to inform the athletes, mostly professional players, and define the difference between "being ready to play" and "being ready to perform" at the maximum potential.

Radiologic Follow-Up

We suggest performing an MRI control after 6 months from the procedure to evaluate the maintenance of scaffold stability and the absence of OCD's progression in terms of deepness and width (Fig 4 A and B).

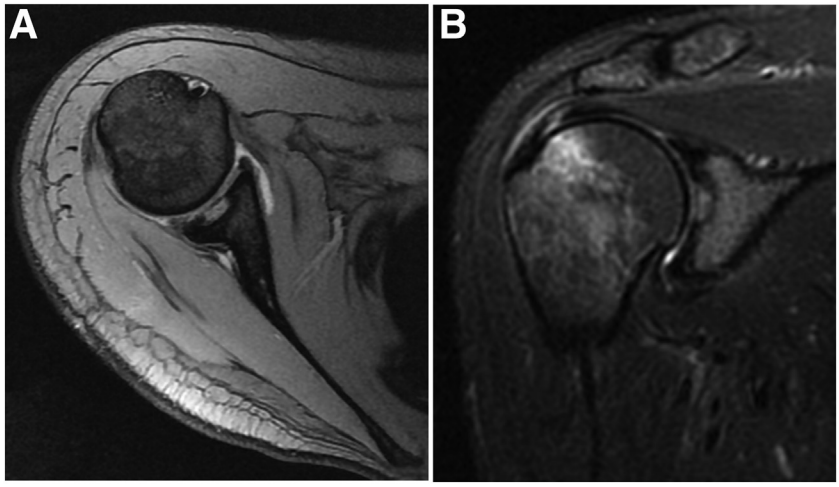

Fig 4. Postoperative magnetic resonance imaging: axial T2_me2d (A) and coronal short tau inversion recovery (B) plane of the right shoulder. This is a 6-month postoperative control scan of the previously described patient, showing the debridement of the borders of the osteochondrosis dissecans lesion that does not present any signs of progression, with a stable hyaluronate-based scaffold. (me2d, 2-dimensional multi echo data.)

Discussion

The management of OCD of the glenoid can be challenging and, despite the different procedure that have been proposed, there's still no consensus on the best option for this rare condition. Looking at other joints, where literature presents more studies, some points result better defined.

For a III-IV IRCS OCD grade, surgical indication must be considered: in lower limbs (knee, ankle) and elbow OCD case series, progressively, all operated athletes noticeably recovered their joint function.[2] Similarly, among competitive overhead athletes affected by glenoid OCD, those who undergo surgery present a faster recovery than those who have been subjected to a conservative treatment.[4,5]

Technically, microfractures of the subchondral bone are an important surgical step: bleeding promotes, by bone marrow factors stimulation, the revascularization of the subchondral bone and the provision of the mesenchymal stem cells into the chondral damage, for glenoid cartilage repair.[2,4,6-8] Furthermore, techniques have been described exploiting the use of a hyaluronate-based scaffold developed to drive the cartilage regeneration in the lesion site.[2,4,6-8] Among the currently available scaffolds, those based on hyaluronic acid are easy to apply and highly adherent, so they are usually preferred for these conditions.[2,4,6-8]

Our arthroscopic technique exploits the benefic effects of the microperforations joined to the regenerative potential of a single-layer hyaluronate-based scaffold. The use of fibrin glue adds more mechanical stability to the final construction. Because its minimal invasiveness and relatively simple execution, this technique results as an interesting surgical option for a such challenging condition like the OCD of the glenoid.

This arthroscopic technique, which comprises a single-layer hyaluronate-based scaffold, added to microfractures and fixed with fibrin glue, may be a good option for the surgical treatment of the OCD of the glenoid.

Disclosures

All authors (R.B., C.M., E.D.S.P., A.D., G.M.M., A.G., G.P.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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