

Osteochondral Fracture Fixation With Fragment Preserving Suture Technique



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Abstract: Osteochondral fractures are relatively uncommon injuries that typically present after an acute or subacute traumatic injury. Osteochondral fracture fixation is traditionally performed in the acute setting with internal fixation procedures using pins or compression screws through the fragment. Outcomes have generally been good, but cartilage thinning, subchondral remodeling, and tissue reactions can occur after internal fixation through the fragment. This article describes osteochondral fracture fragment fixation with a fragment-preserving technique that does not violate the articular cartilage of the fragment. This technique minimizes risk to articular cartilage that has already sustained injury and also provides superior fixation.

Osteochondral fractures are relatively uncommon injuries that typically present after an acute or subacute traumatic injury. The most common mechanisms described are direct shear impaction during patellar dislocation or indirect shear stress by the tibial plateau during a twisting motion of the knee.^{1,2} Adolescents are particularly susceptible to osteochondral fractures caused by generalized ligamentous laxity³ and decreased biomechanical strength at the osteochondral junction.^{4,5} Osteochondral fracture fixation is traditionally performed in the acute setting (less than 2 weeks preferably) with internal fixation procedures using metal or bioabsorbable pins or compression screws through the fragment. Metal devices are typically removed and require a second staged surgery. Bioabsorbable devices do not need to be removed, but they can result in tissue reactions,⁶ slow degradation,⁷ and bone cyst formation.⁸ Fixation techniques using

fibrin glue have also been described.⁹ Late presentation of osteochondral fractures may not have a viable fragment suitable for fixation¹⁰ and may require fragment excision and surgical treatment with a chondral or osteochondral resurfacing. Outcomes have generally been favorable after fixation of osteochondral fractures,¹¹ and some authors assert that it is superior to debridement.¹² However, cartilage thinning and extensive subchondral remodeling can occur after internal fixation of an osteochondral fragment with bioabsorbable compression screws,⁶ potentially as a result of violating the vulnerable fragment. Furthermore, despite a lack of biomechanical data, it is commonly observed that screws, even variable pitch screws, and pins often do not yield superior compression of an often largely cartilaginous piece.

This article describes osteochondral fracture fragment fixation with a fragment-preserving technique that does not violate the articular cartilage of the fragment. This technique minimizes further articular cartilage violation that has already sustained injury, can minimize the need for secondary procedures, and provides superior reduction and compression of these fractures.

Diagnostic Evaluation and Surgical Indications for Osteochondral Fracture of the Knee

Physical examination may be somewhat limited in the setting of an acutely inflamed knee with a large hematoma. A subacute to chronic presentation will allow for a more thorough examination, but the osteochondral fragment may be less suitable for repair

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as time goes on. Ligamentous stability should be assessed to rule out other concomitant injuries. Neurovascular status should be assessed and documented as well.

An imaging workup includes anterior to posterior, 45° degree posterior to anterior notch, and lateral and 15° to 20° axial Merchant radiographs. Depending on the size and amount of bone present on the osteochondral fragment, it may or may not be easily seen on radiographs.⁶ Magnetic resonance imaging (MRI) is necessary to fully characterize the size, shape, and location of the osteochondral fracture fragment and to help the surgeon predict suitability for fixation (Figs 1 and 2). The most common clinical setting for these injuries will be an acute patellar dislocation, and most injuries will be from the medial patellar facet or the lateral femoral condyle.

Surgical Technique

The patient undergoes general anesthesia in the supine position, and a thigh-high tourniquet is placed. The affected extremity is prepped and draped in the usual sterile fashion. Diagnostic arthroscopy can be performed initially to evaluate whether the osteochondral fracture fragment and donor site are suitable for fragment fixation.

For an open technique as demonstrated in Video 1, the leg is exsanguinated with an Esmarch, and the tourniquet is inflated. Diagnostic arthroscopy may need to be performed to identify and secure or remove the fracture fragment, but it has been our experience that most fragments that are large enough to be fixed can often be removed through arthrotomy, provided the preoperative

MRI scan shows the fragment to be anywhere other than in the posterior compartments. The leg can be placed over a tibial triangle to keep the knee flexed approximately 45° to aid in initial exposure. Appropriate exposure is performed according to the location of the osteochondral fracture fragment. For example, a small lateral arthrotomy is used in the case shown in Video 1 for an osteochondral fracture on the lateral femoral condyle. For patellar lesions, a medial arthrotomy may be preferred, but it is our experience that a lateral arthrotomy can also work quite well for medial patellar lesions. After the lesion is approached with an appropriate arthrotomy, the fracture fragment should be removed, cleaned of any debris with freshening of any irregular edges, and safely set aside. The donor site should be evaluated and cleaned of any hematoma or debris. The fracture bed can be microfractured with a 0.45 K-wire, but it is uncertain whether this additional step needs to be taken. The fractured piece is placed into the donor bed with a provisional reduction to ensure that articular congruity can be achieved. If the piece has swollen, this is the time to trim it down to fit.

For femoral lesions, fixation of the fragment is achieved using knotless suture anchors and several strands of no. 1 Vicryl suture. The authors prefer 2.9-mm bio-composite PushLock anchors (Arthrex, Naples, FL). The exact number of suture anchors and Vicryl sutures depends on the size, shape, and location of the osteochondral fracture fragment. In the lateral femoral condyle osteochondral fracture case in Video 1, 4 strands of Vicryl suture are used. These sutures are loaded through the eyelet of the suture anchor and evened out so that the midpoint of the sutures is

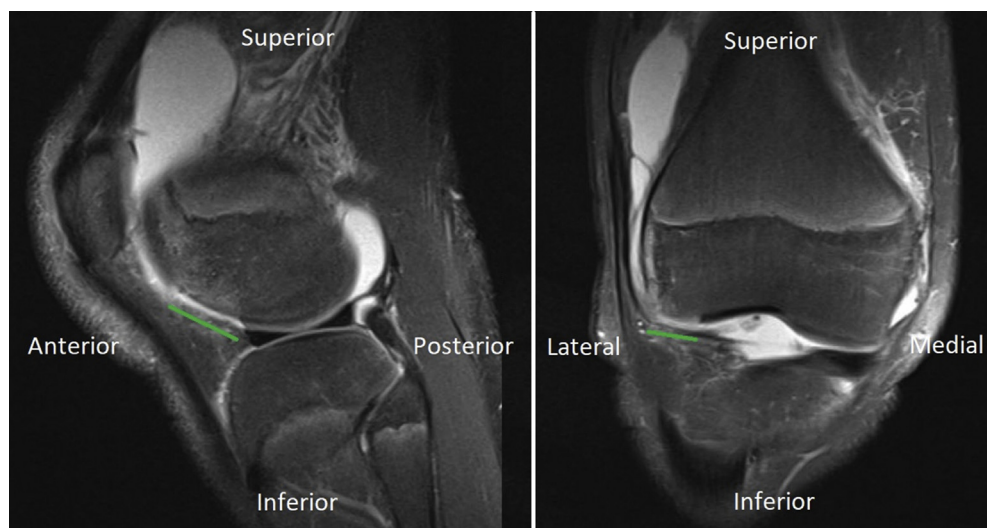
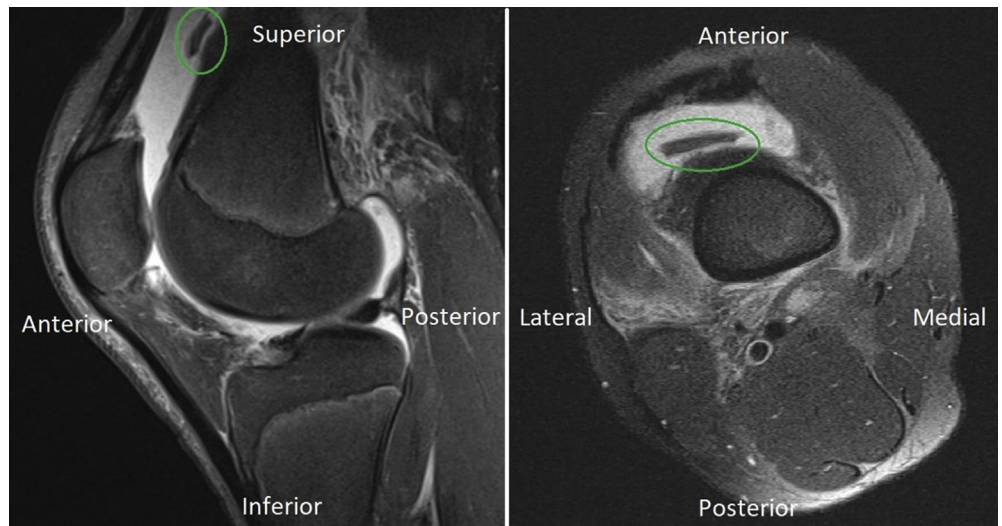


Fig 1. Preoperative magnetic resonance imaging (MRI) slices of a right knee showing an osteochondral fracture donor site in the lateral femoral condyle (marked by a green line).

Fig 2. Preoperative magnetic resonance imaging (MRI) slices of a right knee showing the corresponding osteochondral fracture fragment (marked by a green circle) to the lateral femoral condyle lesion seen in Fig 1.



through the eyelet with equal lengths of suture on either side, thus creating 8 effective free ends of suture



Fig 3. To prepare for fixation of the osteochondral fracture fragment, Vicryl suture strands are loaded into a bioabsorbable suture anchor and pulled to their midpoint. This initial anchor is typically the midpoint between 2 additional anchors that will be loaded with the free ends of the suture (final construct seen in Fig 4).

(Fig 3). The first anchor is typically placed off the articular surface in the intercondylar notch (Fig 4), but it can also be placed in the articular cartilage adjacent to the fracture. To minimize dissection, the drill guide and PushLock can be placed through an arthroscopic portal (Fig 5). Next, each cluster of 4 suture strands are placed through a second and third anchor and placed laterally off the articular surface with appropriate spread to maximize compression of the fracture fragment in a

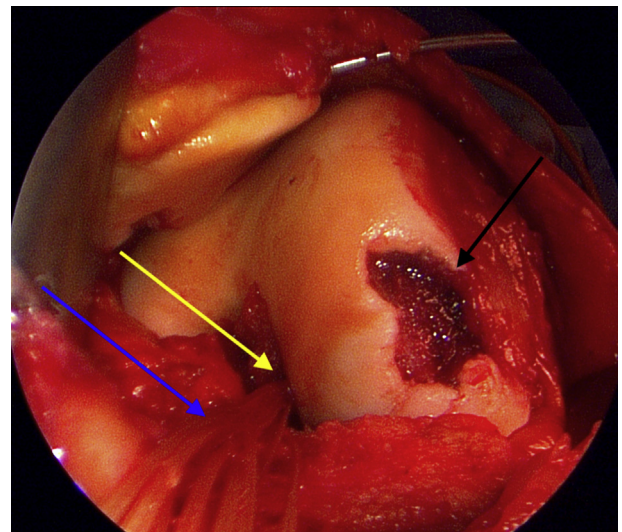


Fig 4. Left knee. The yellow arrow points into the intercondylar notch. The PushLock anchor has been placed on the lateral aspect of the notch. The blue arrow points to the multiple strands of no. 1 Vicryl suture that have been secured with the PushLock anchor. These will ultimately be taken laterally and secured on the lateral femur with additional anchors to hold the osteochondral fragment in place.

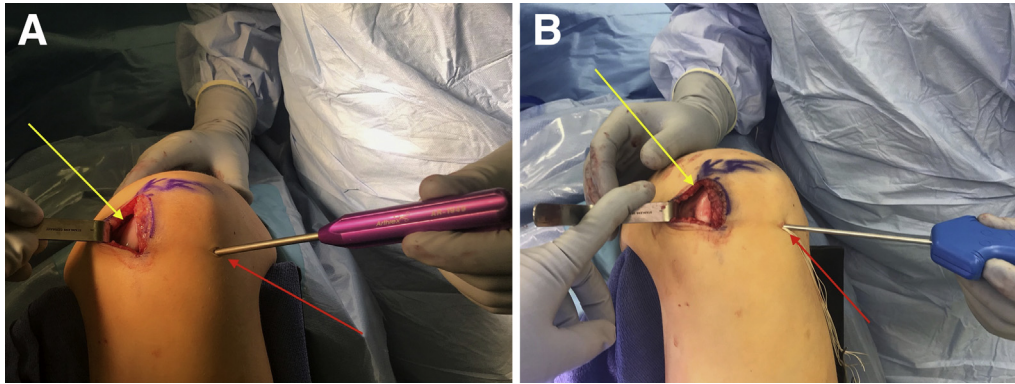


Fig 5. Technique for less invasive placement of central PushLock anchor. (A) A medial parapatellar tendon arthroscopic portal is used to place a drill guide (red arrow). This is directly into the lateral wall of the intercondylar notch. The surgeon can visualize placement of the drill guide on the lateral wall of the notch through the lateral arthrotomy (yellow arrow). (B) Placement of the PushLock anchor loaded with Vicryl suture through the anteromedial portal incision (red arrow). Confirmation that the PushLock is placed in the predrilled socket on the lateral wall of the notch is confirmed by viewing through the lateral arthrotomy (yellow arrow). The initial anchor from Fig 3 is the anchor in the intercondylar notch and the free suture ends were loaded into the 2 additional anchors on the lateral aspect of the lateral femoral condyle.

suture bridge manner (Fig 6). Second-look arthroscopy after arthroscopic-assisted techniques shows good integration of the loose fragment and complete resorption of the Vicryl suture with no overlying damage to the articular cartilage (Fig 7). The Vicryl sutures typically resorb in 6 to 8 weeks.

After fixation is complete, the knee is ranged to check stability of the osteochondral fracture fragment in the donor bed and ensure that articular cartilage congruity is maintained. The wound and joint are washed with

saline solution, and the wound is closed in a layered fashion. A sterile dressing is applied.

For patellar lesions, the sutures are placed in a transosseous fashion and tied over the anterior patella. Usually a 0.62 or a 2-mm K-wire creates a tunnel of sufficient size (Fig 8). A suture passing device such as a Chia Suture Passer (Depuy Mitek, Raynham, MA) can be used to shuttle the Vicryl sutures through the patella. These are often placed in a “cross” configuration, but this can be modified based on the shape of the fracture.

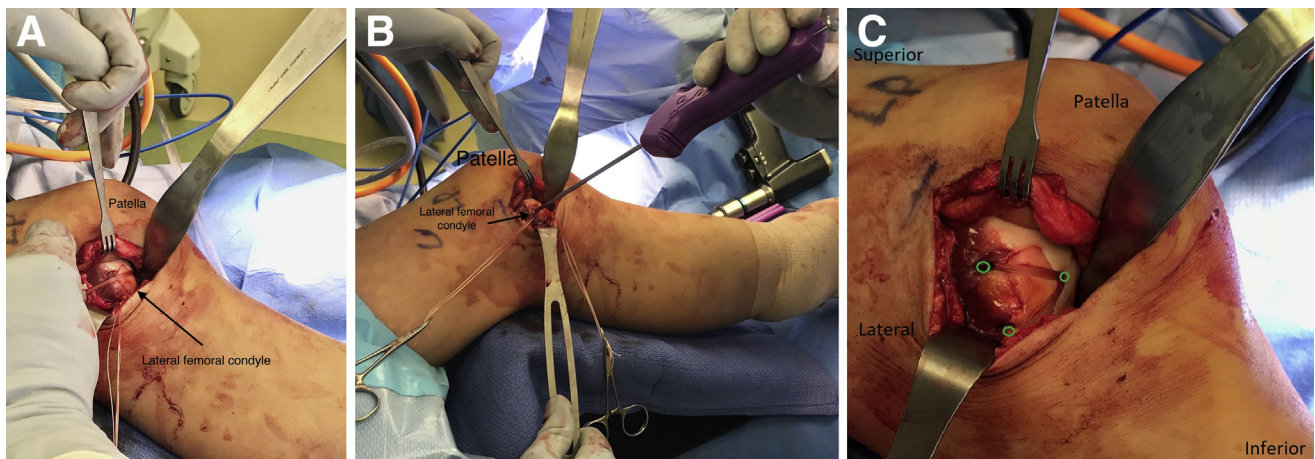


Fig 6. (A) after placement of a central PushLock, 4 strands of no. 1 Vicryl suture are draped laterally over the superior aspect of the osteochondral fracture to determine appropriate placement. (B) The strands of Vicryl suture are loaded on a PushLock and placed on the nonarticular portion of the lateral femoral condyle to secure the superior aspect of the osteochondral fracture. (C) Final suture bridge fixation construct for the lateral femoral condyle lesion seen in Figs 1 and 2. The suture anchors are marked by green circles and the Vicryl suture can be seen in a triangular fashion compressing the fracture fragment. In this specific situation, the central PushLock was placed through the articular cartilage medial to the fragment as opposed to the intercondylar notch.

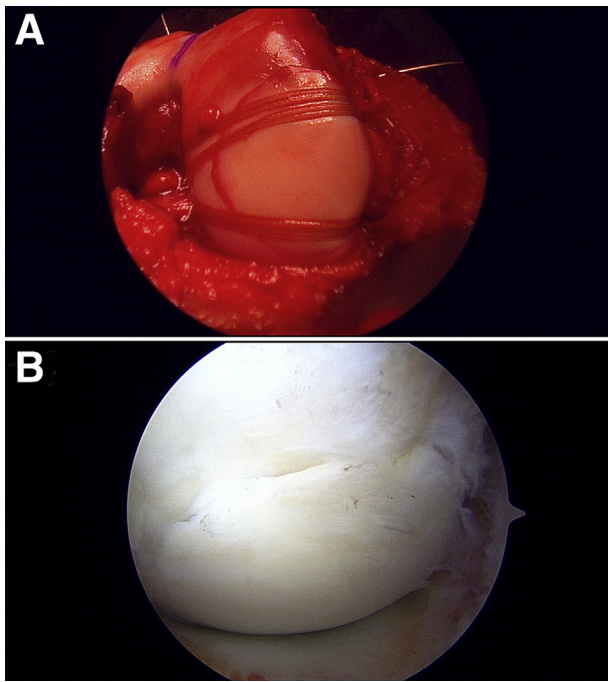


Fig 7. (A) Left knee weight bearing lateral femoral condyle osteochondral fracture that has been fixed in a V configuration with 3 knotless anchors and 4 strands of no. 1 Vicryl suture. (B) Second look arthroscopy of the same osteochondral fracture approximately 10 weeks after fixation. The fracture has completely healed and the Vicryl suture has completely resorbed with no signs of cartilage damage.

The surgeon will hold the piece reduced on the patella, and an assistant will independently tie each suture to achieve final fixation. Pearls and pitfalls of our technique are summarized in [Table 1](#).

Postoperative Management

The patient is discharged home as an outpatient. The patient's weight bearing status is dependent on the location of the lesion. For patellofemoral lesions, the patient can bear weight as tolerated with immediate full motion. A hinged knee brace is rarely to never used. For weight-bearing femoral condyle lesions, the patient is toe-touch weight bearing for 4 weeks, followed by 50% partial weight bearing for an additional 2 weeks. Full motion is allowed immediately. Physical therapy is commenced within a week of surgery to re-establish motion and work on early muscle activation and swelling reduction. If rehab proceeds appropriately and is not limited because of other potential associated procedures, the patient may begin a return to impact activities and sporting activities at 2 to 3 months after surgery. Based on the specific clinical scenario, an MRI scan can be obtained 2 to 3 months after surgery to ensure proper healing ([Fig 9](#)).

Discussion

To our knowledge, there are very few articles describing suture fixation of osteochondral fractures of

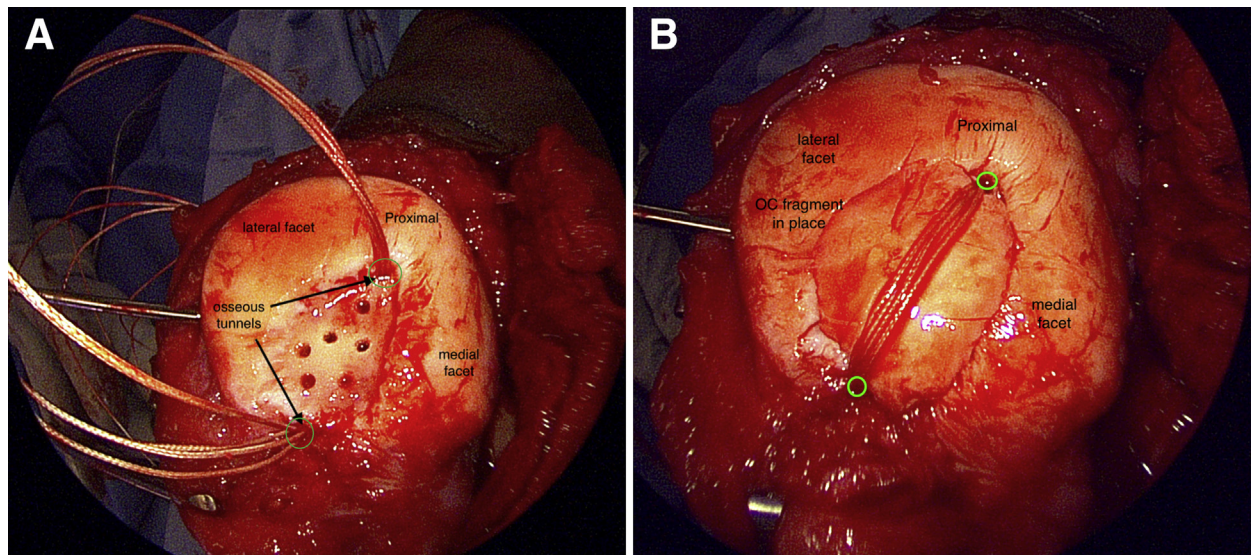


Fig 8. (A) the fracture bed for an osteochondral patellar fracture has been prepared with multiple perforations to enhance bleeding and egress of marrow elements. Two transosseous tunnels have been drilled from posterior to anterior through the patella (green circles). Both ends of a collection of Vicryl suture have been passed through each tunnel but left loose prior to reduction of the osteochondral fragment. (B) After the osteochondral fragment has been reduced into place, the Vicryl sutures are tensioned and tied on the anterior patella through the transosseous tunnels (green circles).

Table 1. Pearls and Pitfalls of Osteochondral Fracture Fixation With Fragment Preserving Suture Technique

Pearls	
Have 3-4 strands of Vicryl suture between each knotless anchor.	This creates a "tape" with a broader surface area to compress without cutting through the cartilage.
Plan suture configuration to optimize the surface area of compression on the fracture fragment.	
Take care to clean and prepare both the fracture fragment and donor bed to optimize anatomic reduction and healing.	
Pitfalls	
Loss of reduction of patellar lesions may occur during knot-tying.	Insufficient number of suture anchors or suture configuration may lead to loss of reduction.
Don't over-tension the Vicryl suture during anchor placement.	Although unlikely, it could cut through a thin fragment.

the knee.¹³⁻¹⁵ Only 1 other article by Bowers et al.¹³ describing suture bridge fixation of osteochondral fractures in the treatment of femoral condyle lesions. Their technique used Vicryl suture passed through bone tunnels and over the osteochondral fragment in a cruciate fashion. The benefits of the technique by Bowers et al.¹³ and the one described in this article are good fragment compression and stability that allows early range of motion in the absence of implants in the articular cartilage that can lead to abrasive wear. Our technique eliminates the small potential risk of fracture through bone tunnels that may occur with the technique by Bowers et al.¹³; it can be applied to any aspect of the distal femoral articular surface and achieves reliably robust and anatomic compression with the knotless suture anchors. Since this technique does use bioabsorbable suture anchors, there is a risk of tissue reaction. We feel that this risk has minimal to no clinical implication because the suture anchors are

generally off the articular cartilage, do not pass through the vulnerable osteochondral fracture fragment, and are buried in bone. Thus exposure to synovial fluid or synovial tissue is more theoretical than practical.

With regard to patellar fracture fixation, knot tying over the anterior patella can be bit tedious, but given the short depth of the patella, this technique avoids the risk of an implant violating the anterior cortex. The advantages and disadvantages of our technique are summarized in Table 2. As with all techniques used to fix osteochondral fracture fragments, the major limitation of this technique is whether the fragment is suitable for fixation. Our technique allows surgeons to broaden indications to more subacute or chronic cases because the vulnerable fracture fragment is not violated, but this should be done with careful clinical consideration. This technique also allows for treatment of pure articular cartilage fracture fragments, which other authors have shown have the capability to heal after fixation with traditional fixation through the fragment.¹⁶

Future studies are needed to determine the long-term clinical outcomes of this technique in comparison to traditional methods of treating osteochondral fractures, although early cases show good healing both on MRI (Fig 7) and during second-look arthroscopy (Fig 6). Other authors have similarly shown that suture fixation restores the surface of articular cartilage but that there may be thinning or narrowing of the cartilage layer on long-term follow-up with their technique that involved suture fixation through the fracture fragment.¹⁷ Histologic investigation of subchondral bone and articular cartilage quality would more precisely characterize healing after treatment of osteochondral fractures with this fragment-sparing technique.

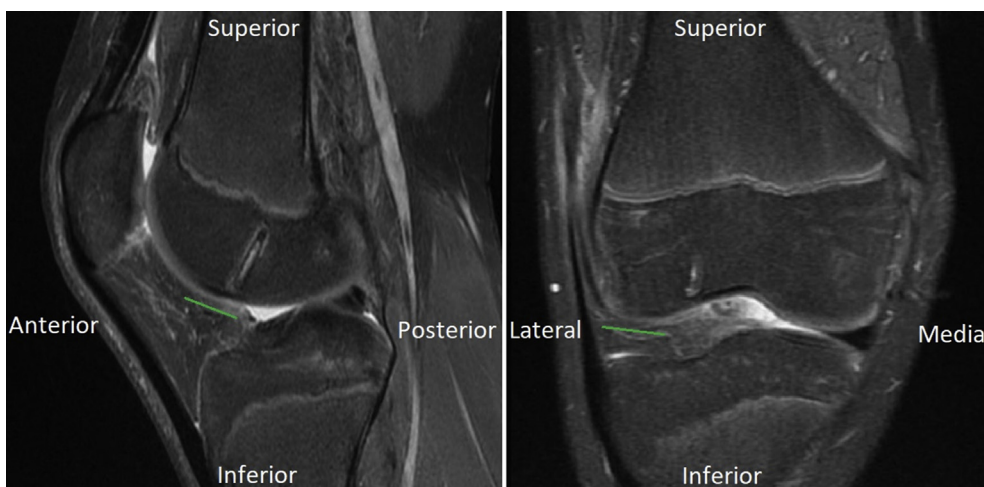


Fig 9. Three-month post-operative magnetic resonance imaging (MRI) slices of the case seen in Figs 1, 2, and 6. The osteochondral fragment has completely healed, and the only evidence of prior surgery is the epiphyseal PushLock anchor.

Table 2. Advantages and Disadvantages of Osteochondral Fracture Fixation With Fragment Preserving Suture Technique

Advantages
No violation of vulnerable osteochondral fracture fragment for fixation.
The procedure uses absorbable suture and no hardware that requires routine removal.
Superior fragment compression allows for early range of motion without articular implants that may cause abrasive wear.
No femoral bone tunnels that may result in iatrogenic fracture.
Use of small patellar bone tunnels minimizes risk of anterior cortex violation.
Disadvantages
Requires arthroscopy.
Use of patellar bone tunnels may result in iatrogenic fracture.
Patellar lesion fixation relies solely on knot security.

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