

One-Stage Osteochondral Fracture Repair Technique With Knotless Anchors and Interconnected Crossing Suture Sliding Loops for the Knee



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Abstract: Osteochondral fractures of the knee represent a challenging entity to manage since there are many different surgical techniques for cartilage repair or other salvage procedures. In terms of cartilage repair, several hardware devices can be used, and many of them could imply a second-stage surgery for hardware removal. The purpose of this article is to describe in detail a one-stage osteochondral fracture repair technique with knotless anchors and interconnected crossing suture sliding loops for the knee. This technique is a one-stage open or arthroscopic procedure with an unlimited number of loops configurations with no particular need for a second surgery for hardware removal, no knot damage, and without the use of bone tunnels. It can be used in different cartilage anatomic locations, such as femoral condyles, trochlea, patella, or other joints.

Osteochondral fracture (OCF) is an injury of the lateral femoral condyle/trochlea or patella that usually occurs in adolescents or young adults after trauma or patellar dislocation.¹⁻⁴ This entity is not always easy to differentiate from osteochondritis dissecans, a disorder of one or more ossification centers, usually in the lateral aspect of the medial femoral condyle.⁵ The patient with an acute OCF has a trauma/dislocation history either by a direct blow to the patella or by a twisting mechanism. Clinical presentation is usually pain, swelling, and functional limitation. Imaging usually includes radiography (X-ray), computer tomography scan, and/or magnetic

resonance imaging to identify the osteochondral defect and the fragment or loose body.^{2,3}

To avoid the early degenerative phenomena, high-grade of suspicion and early diagnosis are required, so that the surgical treatment can take place as soon as possible.

Classically, the treatment of OCFs include osteosynthesis of the fragment with different devices described in the literature, such as standard compression screws, headless compression screws, Herbert screws, bioabsorbable screws and pins, meniscus arrows, or sutures passed through complete bone tunnels.⁶⁻¹⁸

Occasionally, when the subchondral bone or the fragment is too small for fixation or chronic, it has to be removed and managed with cartilage restorative techniques, such as debridement and/or micro/nanofractures, autologous chondrocyte implantation/matrix-induced chondrocyte implantation, mosaicplasty, bone grafts and scaffolds, biomaterials or fresh osteochondral allograft, depending on the size and depth of injury.¹⁹⁻²³

The purpose of this Technical Note is to describe the one-stage osteochondral fracture repair technique with knotless anchors and interconnected crossing suture sliding loops, with no complete bone tunnels, no need for a second-stage surgery hardware removal, and suitable in certain cases (Table 1) and for different anatomic locations, such as patella, condyle, or trochlea defects.

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Table 1. Indications and Contraindications for One-Stage Osteochondral Fracture Repair Technique With Knotless Anchors and Interconnected Crossing Suture Sliding Loops for the Knee

Indications	Contraindications
<ul style="list-style-type: none"> • Adolescents (open physis) or young adults • Acute injury • Osteochondral fractures or chondral defects • After trauma, patellar dislocation or unstable “in situ” osteochondritis dissecans (OCD) • Femoral condyles, trochlear and patellar cartilage defects • Middle size defects (technically fixable) 	<ul style="list-style-type: none"> • Degenerative joint disease (osteoarthritis) • Chronic cartilage fragments/injury • Small and comminuted defects (if not feasible for fixation) • Completely detached non viable OCD cartilage fragments

Surgical Technique

The patient is positioned supine with a tourniquet applied. After skin preparation and draping, diagnostic arthroscopy is usually performed to assess the cartilage injury. The skin is then marked with a marking pen for the following anatomical landmarks and skin incision. A longitudinal lateral or medial parapatellar incision is made as needed for injury exposure (Video 1). Subcutaneous tissue is dissected, and a lateral or medial parapatellar arthrotomy is then performed.

The chondral or osteochondral fragment is then located, removed, prepared, and cleaned at the back table (Fig 1). Close attention should be taken to regularize the edges of the fragment, avoiding excessive bone or cartilage debridement. The defect is also cleaned and deepened with a curette, creating a bleeding bed, and irregular and unstable cartilage edges are removed. The fragment and the defect are then evaluated and sized to avoid size mismatches. Later on, the fragment is placed in the correct position. Other

pearls and pitfalls should be taken into account in the surgical osteochondral fracture repair with knotless anchors and interconnected crossing suture sliding loops for obtaining an optimal result (Table 2).

Next, the drill guide for the first anchor should be positioned correctly in the desired position, such that the drilling takes place in the edges of the defect, in the vicinity of healthy cartilage. The knotless sliding anchors (Knotless BioComposite SutureTak 3 mm; Arthrex, Naples, FL) should then be placed after each drilling. Once all the anchors are in place, the main suture of each anchor should be interconnected with a different opposite anchor. These knotless anchors are provided with a primary high-strength suture and a shuttling thread, so that a loop is created in between the primary suture from one suture and the shuttling thread from a distant anchor. Multiple crossing loops configurations are possible with this technique (Fig 2). For tightening, the free ends of different compression sutures already shuttled into the anchors should be pulled, so that the sliding mechanism and the loop generate compression over the fragment. The ends of the sutures are cut with a blade at the edges of the fragment.

At the end of the procedure (Fig 3), the knee should be cycled to check the stability of the fragment and the quality of the repair. The retinaculum is sutured to close the arthrotomy, the following layers are then closed, and proper dressing is applied.

Postoperative Rehabilitation

Postoperatively, the patient is placed in a straight knee brace in extension for 1 month with non-weight-bearing for 3 to 4 weeks, and then progressive partial weight-bearing is allowed with crutches. Isometric exercises should begin in the first week. After 1 week, the brace should be taken once per day for 0 to 90° passive flexion exercises.

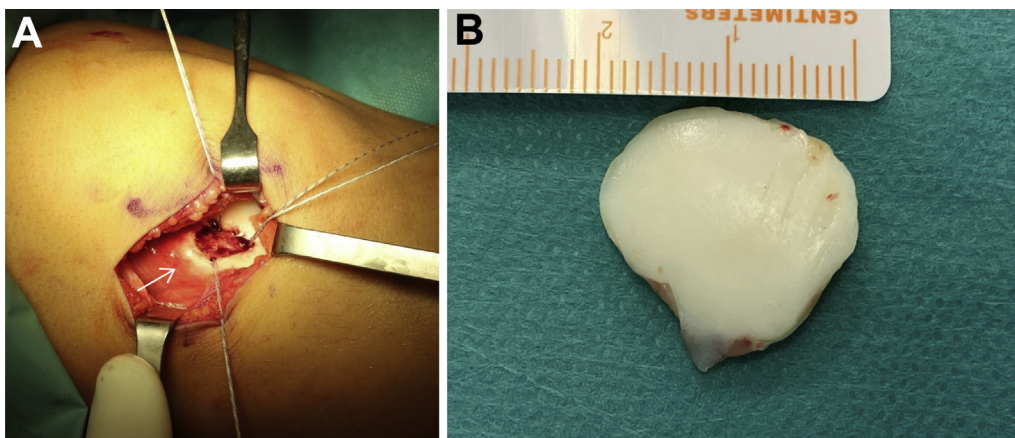


Fig 1. Osteochondral defect on the lateral trochlea of a right knee in a patient with decubitus supine position (A) and a chondral fragment (B). The defect (A) and the fragment (B) should be sized for proper fit between them.

Table 2. Pearls and Pitfalls of the One-Stage Osteochondral Fracture Repair Technique with Knotless Anchors and Interconnected Crossing Suture Sliding Loops for the Knee**Pearls**

- First, before the skin incision, perform a diagnostic arthroscopy to check the extent of the chondral or osteochondral injury, locate and retrieve the loose fragment/s (if possible).
- Reshape and regularize the fragment so it can fit properly in the defect, taking into account that it typically increases its size in the synovial fluid environment in chronic scenarios.
- Debride the subchondral bone bed defect to remove unstable or necrotic tissue and to have a bleeding bone bed environment to favor healing.
- Before drilling, plan your repair, in terms of number and position of knotless anchors to have a reliable and equidistant stable construct repair.
- When drilling, ask the assistant to grab the spear with a perpendicular orientation to the defect surface in order to correctly position the anchors in the edges of the defect; the sutures will exit vertically between the fragment and the remaining healthy cartilage.
- Interconnect the repair sutures of each anchor with opposite anchors so that effective loops are created over the fragment/s.
- When tightening the sutures, ensure sound reduction and adequate compression.
- At the end of the procedure and before closing, cycle the knee to check the stability and the fixation quality of the osteochondral fracture repair.

Pitfalls

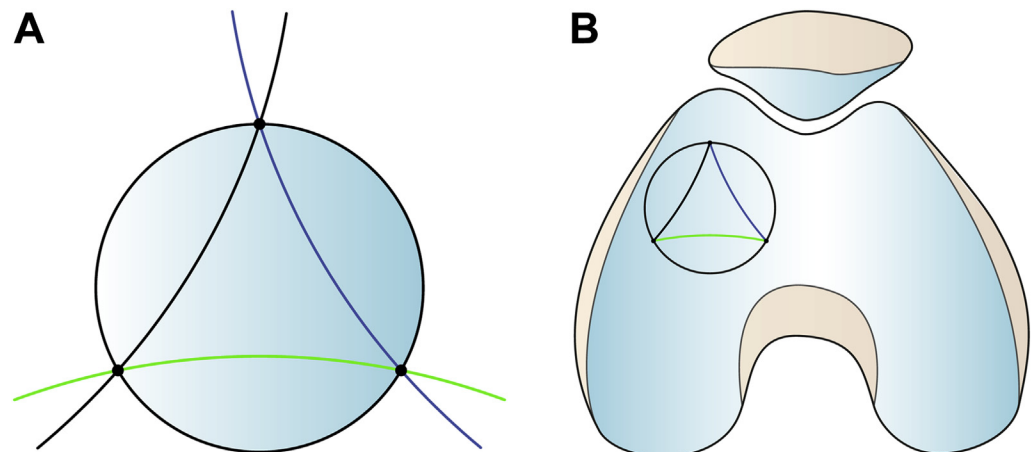
- Avoid malposition and size mismatching of the fragment in the defect by evaluating and sizing both with a ruler.
- Be cautious about not damaging the cartilage fragment and drill before placing the fragment into the defect.
- Avoid suture trapping and tangling by creating large loops separated from each other before placing the fragment into the defect.
- Avoid fragment movement by applying finger pressure to the fragment when sliding the sutures for tightening.
- Avoid leaving suturing material into the joint by cutting the pulling ends of the sutures with a blade at the edges, without damaging the cartilage.
- In cases of comminuted or irregular non-contained fragments, provisional fixation with K-wires could be used to facilitate the procedure and allow the crossing sutures knotless fixation.

Discussion

There are different techniques described in the literature for the repair of osteochondral fractures and to avoid future chondral damage and subsequent osteoarthritis.⁶⁻¹⁶ The more classic techniques use metallic devices, such as screws and pins, and more recently, there is new available materials and biomaterials with new mechanisms of fixation. Some of these materials are resorbable, which are thought to be less harmful to the cartilage and the surrounding soft tissues. They can protrude, move, and fail to fix the fragment due to the degree and

capacity of fixation and compression, remaining in situ while healing and before the possible enzymatic reabsorption or hardware biochemical reactions. Hardware protrusion, movement, migration, and failure can lead to collateral damage to healthy soft tissues, such as cartilage, bone, or meniscus (Table 3).²⁴ Hardware biochemical reactions can lead to foreign body reactions, osteolysis, inflammation, infection, nonunion, malunion, pseudotumor, and clinical symptoms such as stiffness, pain, and functional limitations. These complications can justify a second surgery for hardware removal, which has an

Fig 2. Crossing sutures loops configuration. (A) Three knotless anchors are equally distanced between each other; each repair suture is interconnected to a distant anchor using the shuttling mechanism, so that the loops stay and generate compression forces over the fragment. (B) Three loops connect to each other in the knotless sliding anchors without the need for bone tunneling.



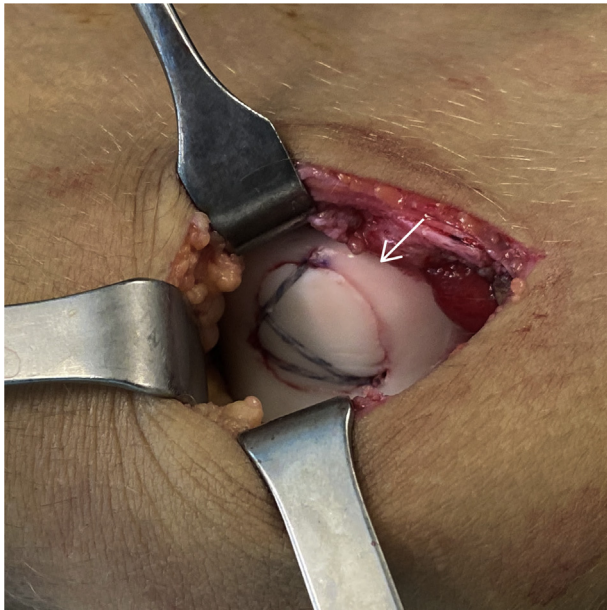


Fig 3. Final crossing sutures knotless loop configuration for osteochondral fracture repair on the lateral trochlea. White arrow marks the lesion.

impact on the patient's recovery, satisfaction, and economic implications. Moreover, implant hardware removal does not guarantee avoidance of hardware complications, relief, or improvement and may be associated with further complications.²⁵ The real impact and prevalence of these complications, as well as the rate of a second hardware removal surgery, are not found explicitly in the literature for cartilage surgery repair. There are no general guidelines for hardware removal, although some surgeons prefer to remove some of these devices and avoid future complications.

There are different indications and contraindications for one-stage osteochondral fracture repair technique

with knotless anchors and interconnected crossing suture sliding loops for the knee that should be respected to maximize surgical outcomes (Table 1).

One of the advantages of this technique is that this implant uses high-strength braided non-absorbable sutures (No. 2 FiberWire; Arthrex), which has shown resistance to bending abrasion compared with other sutures.²⁶ Unlike other types of devices, this type of suture is not known to cause complications that would require a second surgery for its removal.

The peculiarity of knotless anchors minimizes the risk of iatrogenic surrounding cartilage or tissue damage.²⁷ Suture fixation can give a uniform compression of the fragment(s) without penetrating to the cartilage tissue, and an unlimited number of loops configurations can be used. This characteristic potentially allows for earlier rehabilitation and return-to-play, as we have seen clinically in the presented cases.

This technique can be performed with open or mini-open surgery or by arthroscopy, depending on the injury and surgeon's preference and skills. In cases of comminuted or irregular non-contained fragments, provisional fixation with K-wires could be used to allow the osteochondral fracture fixation with crossing sutures knotless (Fig 4).

Comparing our technique with other suture techniques for cartilage repair, such as the one described by Ng et al.⁸ for patella or by Bowers and Huffman¹¹ for femoral condyle defects, our technique does not use bone tunnels, which simplifies the technique and reduces the risk of fractures. Another advantage is that it can be used in different anatomic locations, such as patella, femoral condyles, trochlea, or in other joints, unlike mentioned techniques described in the literature.

However, some potential disadvantages and risks of this technique could be less potential fixation strength (no complete fragment passage of the sutures);

Table 3. Advantages and Disadvantages of One-Stage Osteochondral Fracture Repair Technique With Knotless Anchors and Interconnected Crossing Suture Sliding Loops for the Knee

Advantages	Disadvantages
<ul style="list-style-type: none"> • No need for second surgery revision for hardware removal. • No metallic hardware and less risk of iatrogenic healthy soft-tissue harm by protrusion, movement, migration, and hardware failure. • Less chondral fragment risk of injury. • No bone tunnels required—less risk of fractures. • The sliding loops with high-strength braided non-absorbable sutures and knotless anchors generate a uniform compression in over the fragment. • Can be performed with open or mini-open surgery or by arthroscopy, especially in cases of stable OCD lesions. • Multiple loop configurations option. • Application in other different anatomic locations. 	<ul style="list-style-type: none"> • No complete sutures fragment passage and less potential fixation strength. • Possible loosening of the sliding loop mechanism and failure. • Nonabsorbable braided sutures can potentially cause inflammatory responses, synovitis²⁴ and cartilage abrasion (load-bearing surfaces).

OCD, osteochondritis dissecans.

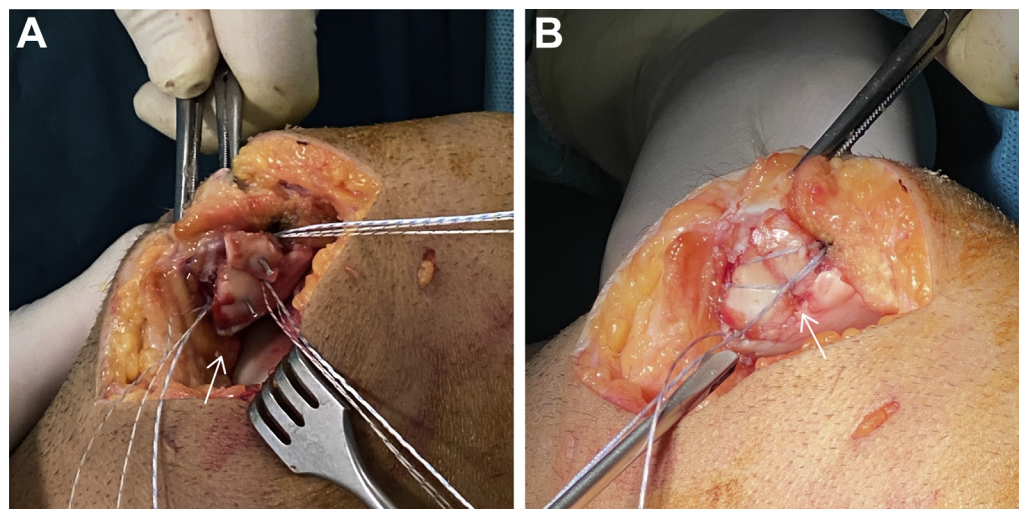


Fig 4. (A) Provisional K-wire fixation in a comminuted medial facet patellar osteochondral fracture. White arrow marks the lesion. (B) Final crossing sutures knotless fixation.

potential loosening of the sliding loop mechanism and failure; and potentially inflammatory responses, synovitis,²⁴ and cartilage abrasion (load-bearing surfaces) (Table 2).

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