Technical Note

Osteoarticular Open Flake Fracture Refixation: The "Parachute" Technique

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Abstract: Osteochondral fractures of the patella, also known as "flake fractures," frequently occur after patellar dislocation. In such fractures, a piece of patellar cartilage with subchondral bone breaks off due to patellar dislocation or subsequent reposition. Various surgical techniques have evolved for surgical therapy with the goal of realigning the patellar cartilage. This article presents a cost-effective surgical technique for achieving stable refixation of large osteochondral fragments in patellar flake fractures. The proposed technique entails creating transosseous tunnels in a confluent fashion at the margins, exactly between the fragment and the natural cartilage. Sutures are passed through the established tunnels for flake refixation. This refixation method ensures evenly distributed pressure without penetration of the fragment itself, resulting in the formation of a characteristic parachute configuration composed of confluent bone tunnels and absorbable sutures. The suitability of flake refixation is assessed through an algorithm, allowing for appropriate patient selection. The described technique offers several advantages, including its simplicity and cost-effectiveness, a flexible configuration of the sutures, and the ability to provide stable refixation for large osteochondral fragments.

Orthopaedic surgeons are frequently faced with patellar dislocations in their clinical practice. Published incidence numbers range from 13.5 to 53.6 per 100,000 person-years, with primary dislocation usually occurring in adolescence.[1,2] Concomitant lesions of the cartilage are reported in up to 95% of patellar dislocations, and osteochondral fractures of the patella, referred to as "flake fractures," are reported in up to 58%.[1,3]

Because progressive patellofemoral osteoarthritis may result, proper management of the osteochondral defect is crucial.[4,5] Depending on the size, shape, and constitution of the defect, various surgical options have evolved. Chondral debridement, microfracturing, or micro-drilling is recommended for small lesions.[5] Satisfactory results have been published after autologous chondrocyte implantation in cases of large defects.[6,7] For smaller defects with substantial bone loss, autologous osteochondral transplantation may be a reasonable treatment option.[5,6]

Osteochondral fractures of the patella, also known as "flake fractures," occur when a piece of patellar cartilage with subchondral bone breaks off due to patellar dislocation or subsequent reposition. Surgical refixation of these flakes is a promising option to preserve the native cartilage, provided that both the fragment itself and the surrounding patellar cartilage are intact.[6] For this purpose, various techniques using bioabsorbable screws, pins, or trans-fragmental sutures have been described in the literature.[8,9] This article introduces an easy and cost-effective surgical technique that allows stable refixation of large osteochondral fragments at the patella by using resorbable transpatellar sutures.

Surgical Technique

Indication and Diagnosis

The indication for surgery is based on the combination of clinical examination findings, radiography, and magnetic resonance imaging. If loose osteochondral fragments are present, they can be identified on the

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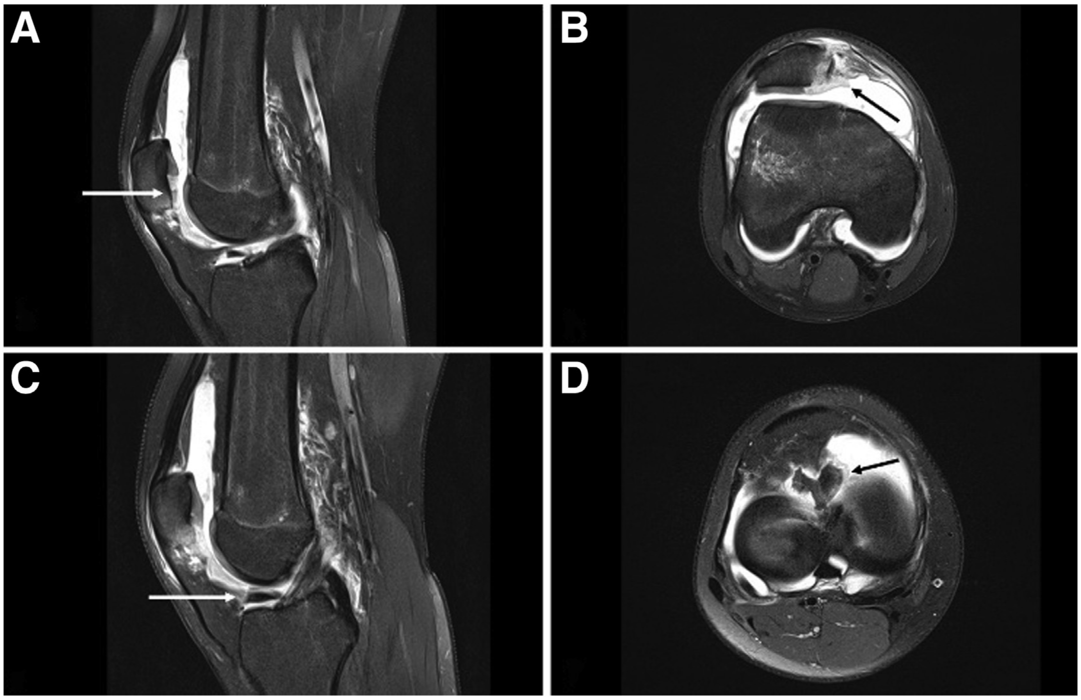

Fig 1. Magnetic resonance imaging of right knee of 16-year-old female patient with flake fracture after traumatic patellar dislocation. Sagittal (A) and axial (B) T2-weighted sequences allow good estimation of the size of the defect (arrows). The osteochondral fragment (arrows) is visible on sagittal (C) and axial (D) sequences ventral to the tibial insertion of the anterior cruciate ligament.

magnetic resonance imaging scan, which additionally provides a good estimation of the defect size and the integrity of the fragment (Fig 1).

It is recommended that the surgical approach starts with a standard diagnostic arthroscopy to evaluate the defect area and to remove the osteochondral fragment. Depending on the size of the defect and the integrity of the fragment, the final indication for refixation is set (Fig 2).

Diagnostic Arthroscopy

The patient is placed supine, and a lateral thigh holder and a leg holder are installed to position the knee joint at 90° of flexion (Fig 3A). All the following steps are shown in Video 1. A standard anterolateral portal is used to access the joint arthroscopically, and careful lavage is performed to cautiously remove abundant hematoma (Fig 3B), without washing out the fragment (Table 1). Diagnostic arthroscopy is

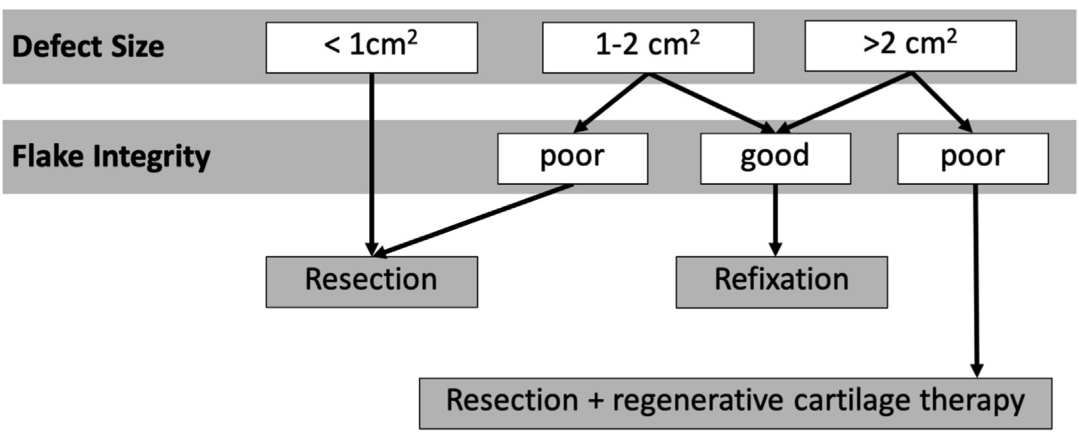

Fig 2. Treatment algorithm for osteochondral flake fractures depending on defect size and flake integrity.

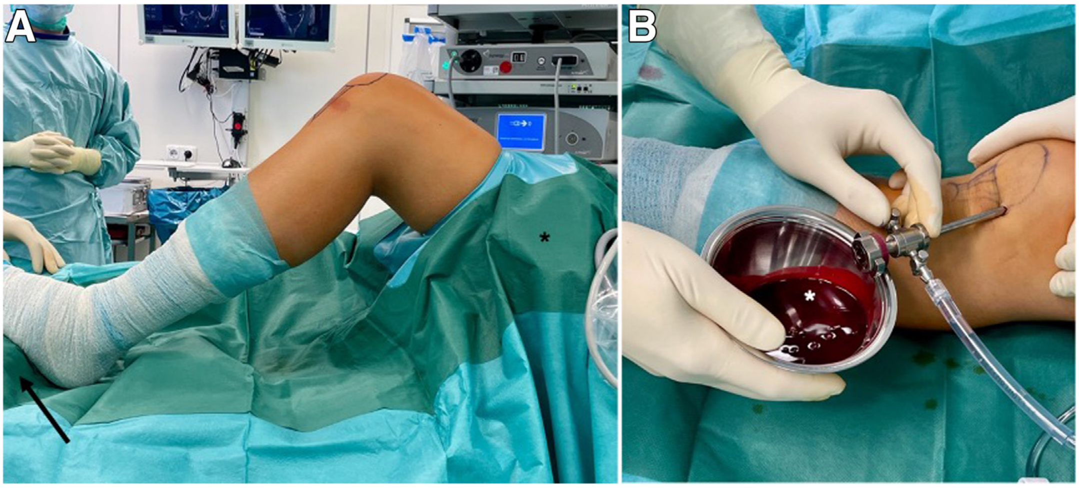

Fig 3. Left knee of 17-year-old patient with flake fracture after acute patellar dislocation. (A) The patient is placed in a standard supine position with a foot support (arrow) and a lateral thigh support (asterisk) to stabilize the knee in 90° of flexion. (B) The procedure starts with a diagnostic arthroscopy. The intra-articular hematoma (asterisk) can be drained through the standard anterolateral arthroscopic portal.

then performed to assess the osteochondral defect area.

By use of an arthroscopic grasper, the loose fragment may be removed (Fig 4). However, if the size of the fragment does not allow retrieval through the arthroscopic portal, the fragment may be retrieved later, after the paramedian arthrotomy.

Refixation of Osteochondral Fragment

To access the medial patellar facet, a central or centromedial skin incision (about 8 cm) is performed. After subcutaneous preparation, the medial capsule is exposed and longitudinally incised. It is recommended to place the incision about 5 mm from the medial patellar rim for easier closure of the capsule. Lateral eversion of the patella can be facilitated by inserting a 2.0-mm Kirschner wire (K-wire) at the medial edge of the patella (Fig 5). After removal of the hematoma, thorough debridement of the defect area is necessary to create stable surroundings and a vital subchondral base for the healing of the fragment.

Depending on the time since injury, the loose fragment may have swollen due to osmosis. In these cases, it may be necessary to trim the fragment with a scalpel to ensure perfect fitting in the defect zone (Table 1). The fragment is then fixed temporarily with a thin K-wire (Fig 6).

Table 1. Pearls and Pitfalls of Parachute Technique for Open Flake Refixation at Patella

Pearls
Use of Kirschner wire as joystick for better patellar visualization
Trimming of fragment and preparation of defect bed for better fit
Use of multiple suture threads (×3) to prevent cutting of fragment and to optimize contact pressure
Pitfalls
Loss of osteochondral fragment by washing out during arthroscopy
Breakage of fragment during refixation
Bone tunnel conflict with patellar tunnels for MPFL graft
Poor management of sutures on ventral side of patella

MPFL, medial patellofemoral ligament.

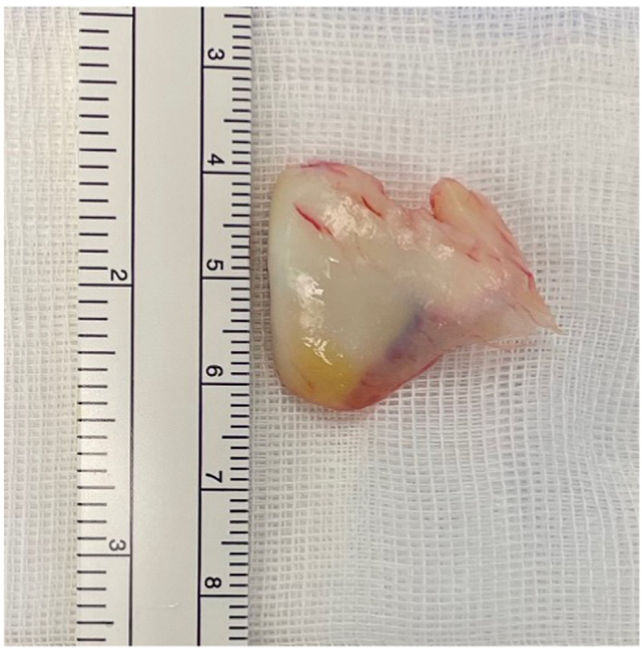

Fig 4. Osteochondral fragment of medial patellar facet after traumatic patellar dislocation (maximum diameter, 22 × 30 mm).

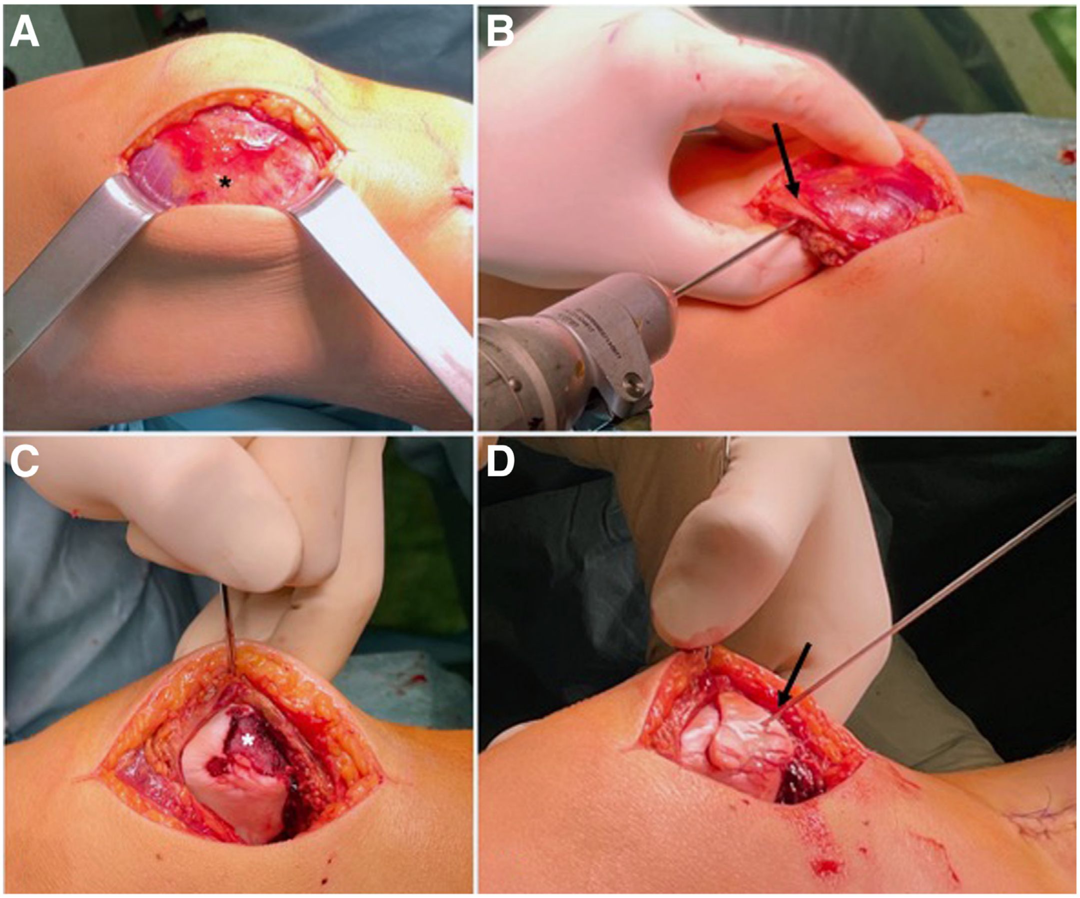

Fig 5. Medial view of left knee. (A) Standard paramedian approach to access medial capsule (asterisk). (B) A 2.0-mm Kirschner wire (arrow) is drilled into the medial patellar border and used as a "joystick" for better visualization of the articular surface of the patella. (C) Thorough debridement of defect zone (asterisk). (D) Temporary fixation of osteochondral fragment with 1.2-mm Kirschner wire (arrow).

Next, small transosseous tunnels are drilled exactly at the margins between the fragment and the native cartilage using a 1.4-mm K-wire (Fig 6A). All tunnels are drilled transpatellar to the anterior side of the patella, leaving a sufficient bony bridge between tunnels. Subsequently, the characteristic parachute configuration is formed (Fig 7). Triple-loaded resorbable suture material (e.g., No. 1-0 Vicryl; Ethicon, Bridgewater, NJ) is then shuttled through the created tunnels using a flexible loop wire (Nitinol Suture Passing Wire; Arthrex, Naples, FL). The placement of the tunnels and the sutures can be individually selected depending on the size or shape of the fragments, as well as the location of the defect (Table 2). To gain maximum stability and a congruent realignment of the chondral surface, it is recommended to position the sutures in a crossed configuration (Fig 6). Subsequently, the corresponding pairs of resorbable sutures are knotted on the ventral side of the patella (Fig 7). After successful osteochondral fragment refixation, the joint capsule is closed with resorbable sutures and subsequent reconstruction of the medial patellofemoral ligament is performed.

Postoperative Rehabilitation

The postoperative protocol includes partial weight bearing with a maximum of 20 kg for 6 weeks in full knee extension only, while no weight bearing is allowed in knee flexion. In addition, knee flexion range of motion (ROM) is limited to 30° and is increased by 30° every 2 weeks: weeks 1 and 2, ROM in extension-flexion of 0°/0°/30°; weeks 3 and 4, ROM in extension-flexion of 0°/0°/60°; and weeks 5 and 6, ROM in extension-flexion of 0°/0°/90°. This period is followed by a cautious increase in weight bearing up to full body weight and full ROM.

Discussion

Osteochondral fractures of the patella frequently occur as a result of patellar dislocation.[1] If possible, the loose fragment should be saved and refixed in the defect zone. For this purpose, different techniques have been described previously using screws, pins, or transfragmental sutures. However, punctual refixation may cause an uneven pressure distribution on the osteochondral fragment.[9] Additionally, if no resorbable

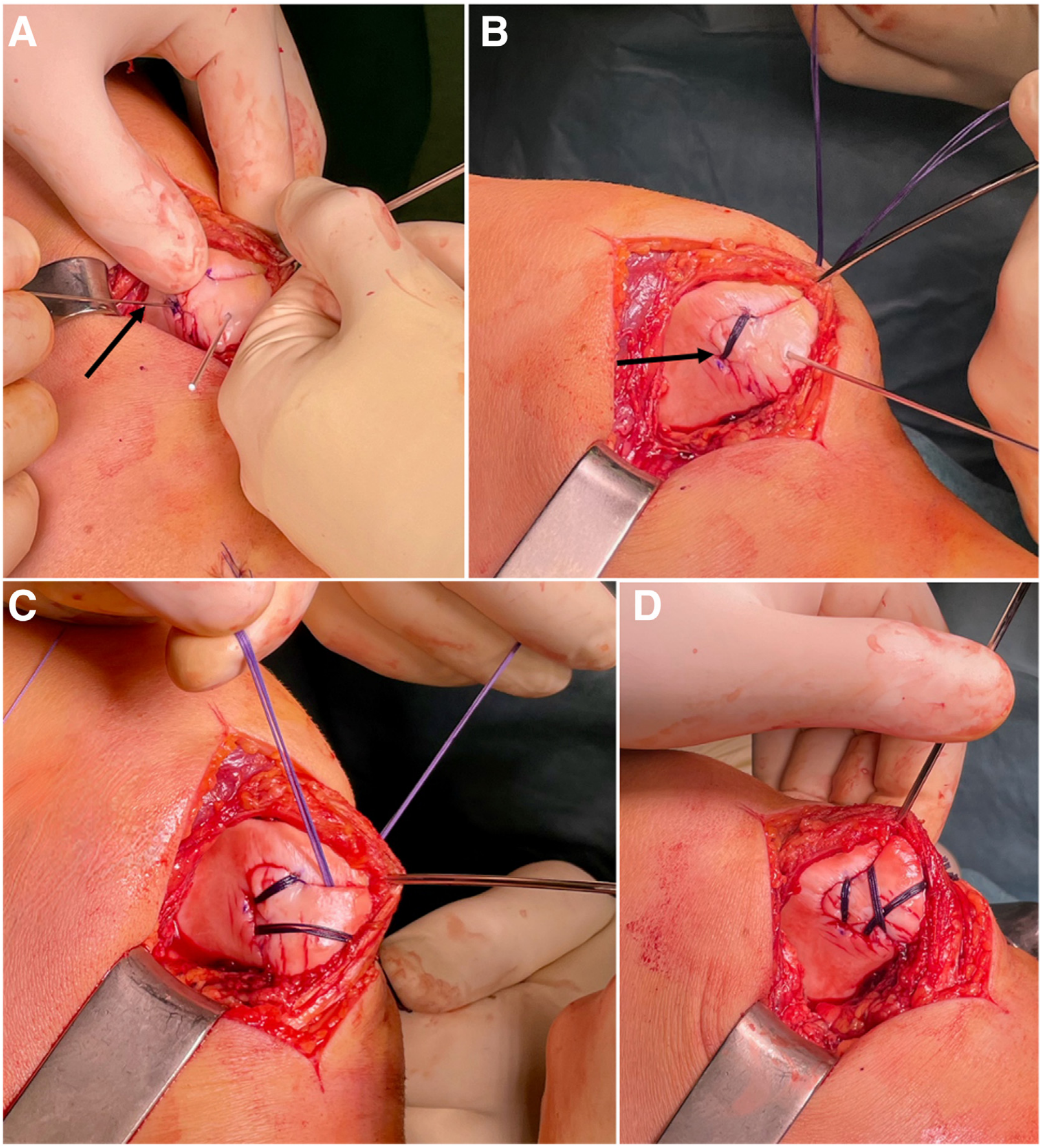

Fig 6. (A) By use of a 1.4-mm Kirschner wire, drill holes (arrow) are placed exactly at the border between the fragment and the native cartilage. (B) Triple-loaded resorbable sutures (No. 1-0 Vicryl) (arrow) are shuttled through the created drill holes using a flexible loop wire (Nitinol Suture Passing Wire). (C) Placement of the drill holes can be chosen individually to guarantee stable refixation. In this case, an X-shaped suture configuration was used to gain maximal stability of the fragment. (D) Chondral realignment between the defect and the fragment could be achieved.

material is used, a second intervention may be necessary to remove implants. Other techniques such as suturing or re-adhering the fragment with fibrin have been described but stability may be lacking.

Our technique offers a fragment-preserving and stable option for patellar osteochondral fractures. The parachute configuration of absorbable suture material leads to evenly distributed pressure on the osteochondral fragment, which is crucial for healing and re-establishing osteochondral integrity. In addition, this technique requires only a few special instruments beyond the standard orthopaedic equipment (Table 3). The possibility to freely choose the tunnel positioning between the fragment and the defect margin allows individual configurations, independent of the fragment's size or shape.

In summary, the parachute technique provides several advantages in comparison to alternative treatment procedures such as fixation with bioabsorbable screws and pins, which may not even be available in every clinical setting. However, this technique still needs to be further investigated by means of clinical studies with larger numbers of cases to support the good results achieved so far.

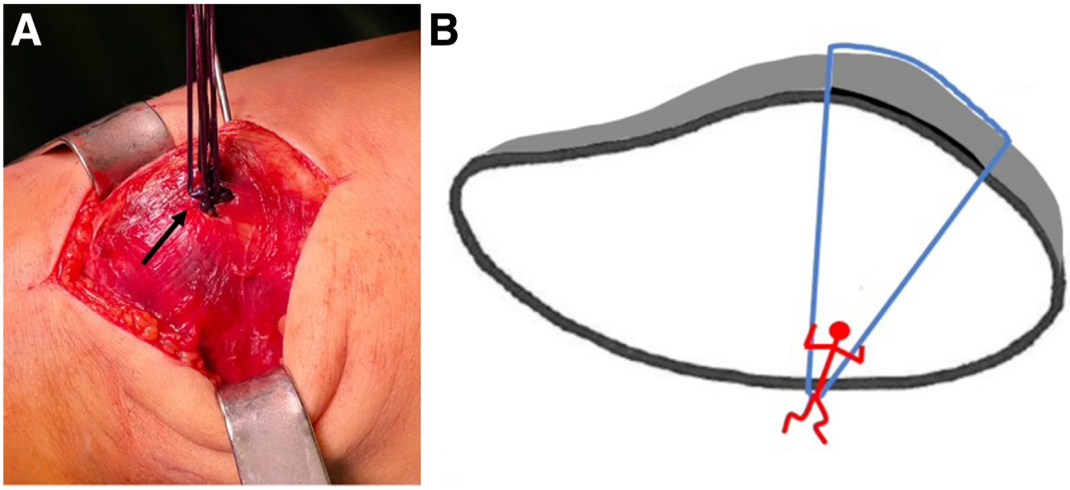

Fig 7. (A) Osteochondral refixation is completed by tensioning and knotting the corresponding ends of the sutures on the ventral side of the patella (arrow). (B) Namesake parachute configuration.

Table 2. Advantages and Disadvantages of Parachute Technique for Patellar Flake Fractures

Advantages
There is a possibility of restoring the native cartilage.
The technique is independent of the fragment's shape owing to the freely selectable configuration of drill holes and sutures.
There is uniform pressure on the fragment, allowing for an optimal healing response.
Only a few special instruments are required.
Regenerative chondral procedures may still be an option if refixation is not successful.
Disadvantages
The technique is not suitable for every type of flake fracture (e.g., with fragmented flake).
An open approach is necessary.
There is a risk of tunnel conflict in combination with MPFL reconstruction techniques that require patellar bone tunnels.
In the early postoperative stage, retropatellar crepitations may occur because of the suture material.

MPFL, medial patellofemoral ligament.

Table 3. Required Instruments and Implants for Parachute Technique for Open Flake Refixation at Patella

Special Instruments and Implants	Recommended Use
K-wires	• 1.2-mm K-wire for temporary flake fixation • 1.4-mm K-wire for trans-patellar drill holes • 2.0-mm K-wire used as joystick for lateral eversion of patella
Flexible suture passing wire (Arthrex)	Transpatellar shuttling of suture material
Resorbable suture material (No. 1-0 Vicryl)	Transosseous flake refixation

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