Technical Note

Suture-Based Technique for Patellar Osteochondral Fractures Fixation Using an All-Absorbable Implant

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Abstract: The osteochondral fractures (OCFs) of the patella are most common injuries of adolescence, usually associated with acute dislocation of patella. Although the acute cases are managed with a variety of options ranging from either conservative or removal or refixation, the latter seems to be the best option. While fixation using screws or bioabsorbable pins has been a standard practice, complications remain a concern. The use of suture fixation for treatment of such low-profile OCFs has gained popularity in recent times. However, each author has used the sutures in a random manner without a predefined methodology and guidelines. This Technical Note presents a step-by-step, standardized surgical technique using an implant, which offers a secure and bioresorbable fixation of acute patellar OCFs.

Chondral and osteochondral fractures (OCFs) of the patella are most common injuries of adolescence, usually associated with acute dislocation of the patella (APD). OCFs are managed in several ways, ranging from either conservative treatment or removal or refixation,[1] with refixation being the best option.[2] The use of metallic screws assures more compression and rotational stability and is recommended when the osseous part in OCF is larger. Bioabsorbable pins don't provide compressive strength but provide rotational stability and the ability to be assessed on magnetic resonance imaging. However, as the complications like chondral erosion, loosening, chemical reaction, synovitis, and bone resorption have been increasingly being reported[1,3] with the use of metallic screws or the bioabsorbable pins, the suture-based fixation has gained popularity.[4,5] But, suture-based fixations are being used in a random manner without a predefined methodology or guidelines.[6-11] In this Technical Note, a step-by-step, standardized surgical technique is described for achieveing a secure fixation of acute patellar OCFs that uses an all-suture, bioresorbable implant.

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Surgical Technique

Implant Description

The DG-Lock (TM) (Healthium Medtech Ltd, Bengaluru, India) is an all-suture, fully absorbable implant that is designed to fix an acute OCF fragment against its native bed. The various components of the implant include a central pilot needle (a in Fig 1) with 4 lead sutures (b in Fig 1), 4 peripheral needles (f in Fig 1) with 4 fixation sutures (e in Fig 1), a central fixation node (c in Fig 1), and a protection ring (known as a DG ring) (d in Fig 1). All the components of the implants are composed of polyglactin-910 except the needles. The following surgical steps are described to standardize the fixation of acute small- to mid-sized loose OCF of the patella.

Patient Positioning and Preparation

A supine position is preferred for the patient, with a high-thigh tourniquet applied. Surgical instrumentation preparation should also consider the need to correct concomitant pathologies while fixing the patellar OCF.

Step-by-Step Procedure

The complete procedure is shown in Video 1.

Step 1

An arthroscopy procedure is performed to ascertain the source of acute OCF from the patella. The loose OCF fragment is retrieved arthroscopically and secured either

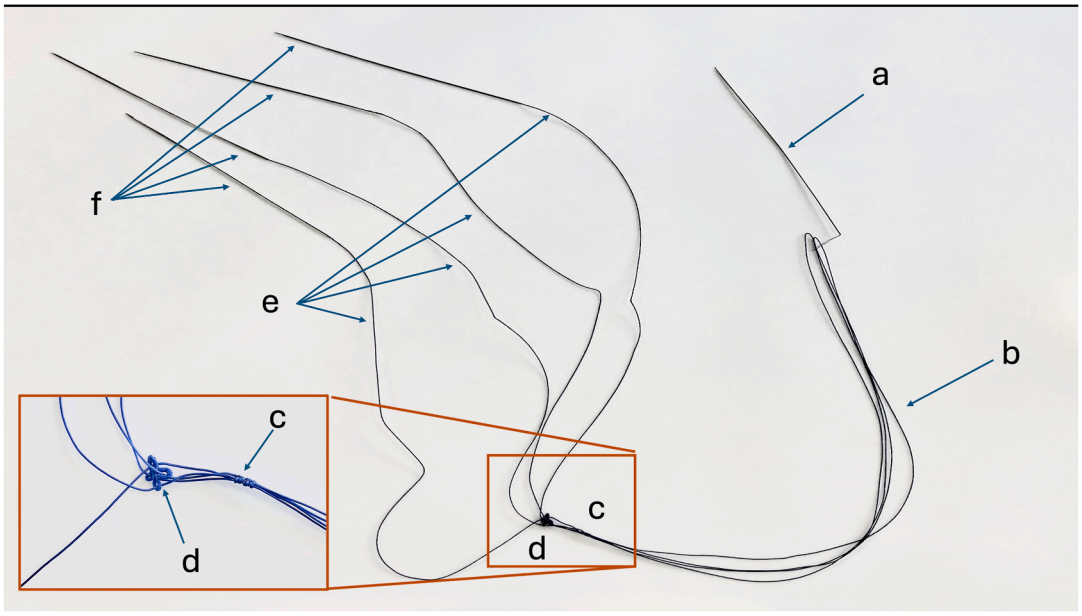

Fig 1. The DG-Lock (TM) implant (Healthium Medtech Ltd, Bengaluru, India) for fixation of acute osteochondral/chondral fractures of patella has several components. a: the central pilot needle. b: the lead sutures (4 in number). c: the fixation node (see inset for larger image). d: the protection ring (see inset for larger image). e: the peripheral fixation sutures (4 in number). f: The peripheral fixation needles (4 in number).

in a saline bowl (Fig 2) or in a saline-soaked gauze wrap. The defect size is measured and documented.

Step 2

A minimedial parapatellar arthrotomy is performed and the patella is everted. The OCF base is cleaned of all the blood clots and debris (Fig 3). The final defect size is measured. The previously isolated loose OCF fragment is reduced over its native fracture site and held in position using a single towel clip or a fragment holding device (Fig 4).

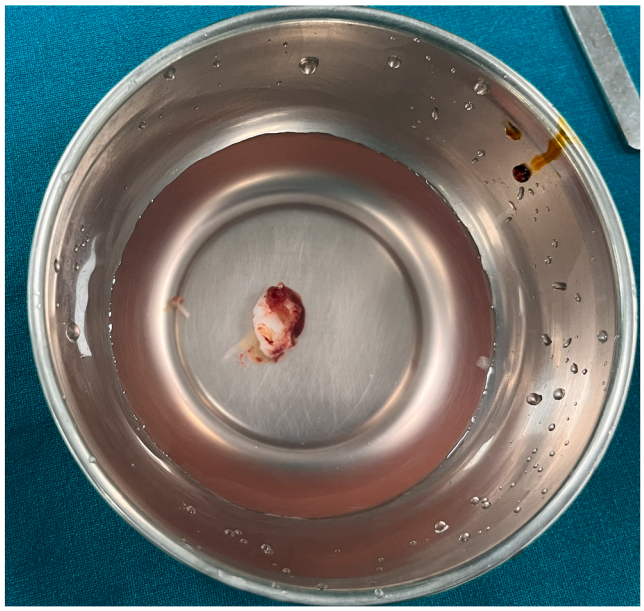

Fig 2. A separated osteochondral fracture that was lying loose in lateral gutter after an acute episode of patella dislocation in a 21-years-old female patient. The fractured fragment was retrieved thru medial portal.

Step 3

A central pilot hole is made using a 1.9-mm drill bit in the center of the OCF. Precautions are taken to ensure that the placement of the pilot hole is in the center of the loose OCF fragment when assessed from all the directions. The pilot hole drill should come out on the anterior surface of the patella.

Step 4

Four peripheral fixation holes are created using 1.2-mm drill bit in 4 different corners of the loose OC fragment outside its edge. These fixation holes should not traverse the loose OC fragment but should pass through the edges of the crater on the patella. All 4 fixation holes should also exit on the anterior surface of the patella.

Step 5

The pilot needle (a in Fig 1) is passed through the central hole from the articular surface side toward the anterior surface. The needle is pulled out from the anterior surface of the patella along with 4 lead sutures (b in Fig 1), all the way out till the fixation node (c in Fig 1) rests on the articular surface (Fig 5). The protection ring (d in Fig 1) is now reduced over the OCF (Fig 6).

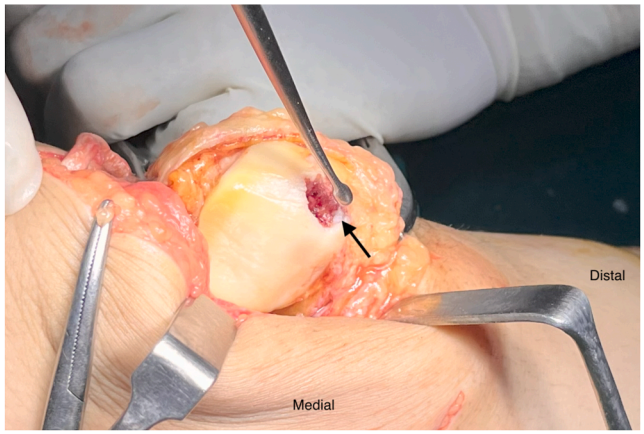

Fig 3. The osteochondral defect (black arrow) in the inferior part of medial patellar facet of the left knee after an acute episode of patella dislocation in a 21-year-old female patient. A minimedial parapatellar arthrotomy is carried out and patella is everted, view is from the medial side of the knee when patient is in supine position. The distal and medial sides are marked as in figure.

Step 6

First, a peripheral fixation needle (f in Fig 1) along with peripheral fixation suture (e in Fig 1) is passed through one of the peripheral fixation holes from the articular surface toward the anterior surface of the patella. One of the 4 lead sutures is cut from the pilot needle and is used to tie the knot with the peripheral fixation suture (Fig 7).

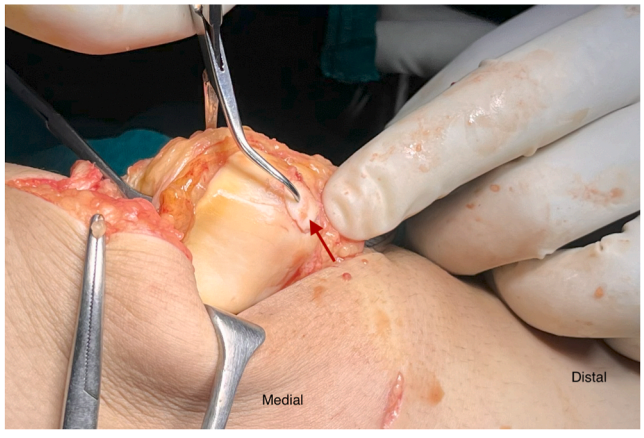

Fig 4. The osteochondral fractured fragment (red arrow) is reduced over the osteochondral defect on the inferior part of medial patellar facet of the left knee. The osteochondral fragment got fractured and became separated after an acute episode of patella dislocation in a 21-year-old female patient. A minimedial parapatellar arthrotomy is carried out and patella is everted, view from medial side of the knee in a supine patient. The distal and medial sides are marked as in figure. A single towel clip is holding the fragment in its reduced position.

Step 7

At this stage. it is important to ensure that the protection ring (d in Fig 1) is placed over the center of the OC fragment. If after tying the first knot, the protection ring is displaced on one side, gently push it back to the central location using toothless forceps.

Step 8

The second fixation needle (f in Fig 1) along with the second peripheral fixation suture (e in Fig 1) is now passed through the diagonally opposite peripheral fixation hole and pulled out on the anterior surface of the patella. One more lead suture from the pilot needle is tied with the fixation suture on the anterior surface of the patella. The reduction of the OFC fragment over its base is rechecked and position of protection ring is secured over the central location on the OCF fragment (Fig 8). In a similar manner, the third and fourth peripheral sutures are passed in a diagonal manner and tied on the anterior surface with the remaining 2 lead sutures.

Step 9

A good solid reduction is achieved with a strong fixation, keeping the articular congruency in mind (Fig 9). A range of movements is done to check the secure fixation and stability of OCF.

Step 10

The parapatellar arthrotomy closure is performed in layers. The concomitant procedures are simultaneoulsy executed as necessary for the case as per the diagnosis and the surgical plan.

Postoperative Protocol

The postoperative protocol is largely dictated by the associated concomitant surgeries, if carried out simultaneously. In case of isolated OCF fixation, the knee is put in long knee immobilizer immediately after surgery. From day 0 in the postoperative period, gradual active and active assisted range-of-movements exercises are started, with an aim of getting full knee flexion in 7 to 10 days. Full weight-bearing is allowed from day 1 with the knee immobilizer. The knee immobilizer is discontinued at 3 to 4 weeks, depending on the patient's comfort, quadriceps buildup, and clinicoradiologic evidence of healing. Static quadriceps exercises are also started from day 0, which progress to dynamic quadriceps building exercises at 4 to 6 weeks after surgery.

Discussion

The DG-Lock (TM) (patent applied) is an all-suture compression device to secure acute, low-demand, small- to mid-size OCF fractures of patella to its native bed. The polyglactin-910 material of implant

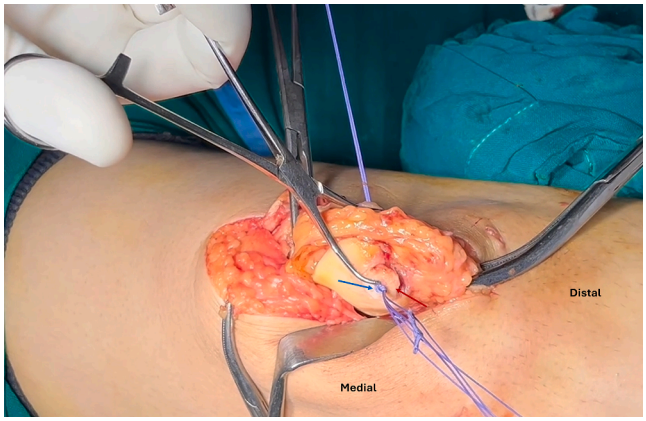

Fig 5. A 21-year-old female patient is in a supine position and a minimedial parapatellar arthrotomy is carried out to fix the osteochondral fracture fragment with suture based implant, viewing the surgical field from the anterior side of the left knee. The osteochondral fractured fragment is reduced (red arrow) over the osteochondral defect on the inferior part of medial patellar facet in a 21-year-old female. A pilot hole (blue arrow) is created using 1.9-mm drill through the center of the osteochondral fractured fragment and then the central pilot needle (a from Fig 1) of the implant is passed along with the 4 lead sutures (b from Fig 1) until the fixation node (c from Fig 1) reaches the articular surface and holds the fragment. The distal and medial sides are marked as in figure.

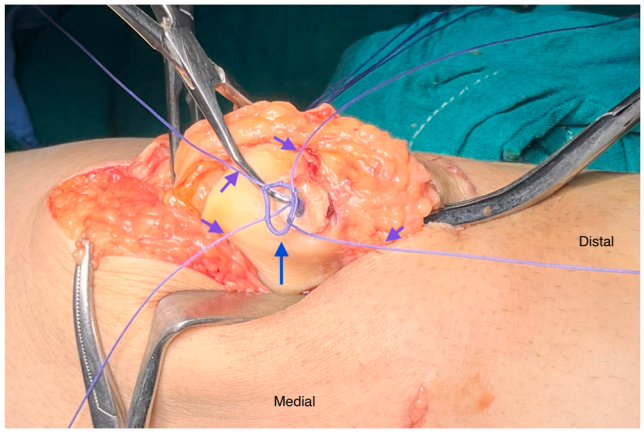

Fig 6. A 21-year-old female patient is in a supine position and a minimedial parapatellar arthrotomy is carried out to fix the osteochondral fracture fragment with suture based implant, viewing the surgical field from the anteromedial side of the left knee. The fixation node (c from Fig 1) is resting on the central hole of the reduced osteochondral fracture of the patella, whereas 4 peripheral fixation sutures (e from Fig 1) (small violet arrows) are spread in 4 directions and protection ring (patent applied) (d from Fig 1) (blue arrow) is covering the fractured osteochondral fragment. The distal and medial sides are marked as in figure.

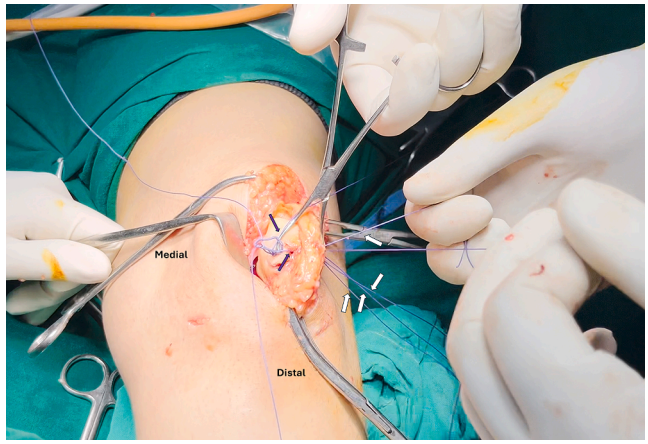

Fig 7. A 21-year-old female patient is in a supine position and a minimedial parapatellar arthrotomy is carried out to fix the osteochondral fracture fragment with a suture-based implant, viewing the surgical field from the anterior side of the left knee. The fixation node (c from Fig 1) is being pulled anteriorly with the help of the 4 lead sutures (b from Fig 1) (small white arrows) The 2 peripheral fixation sutures (e from Fig 1) (small violet arrows) are passed through 2 peripheral fixation holes and are also pulled out on the anterior surface of the patella. The distal and medial sides are marked as in figure.

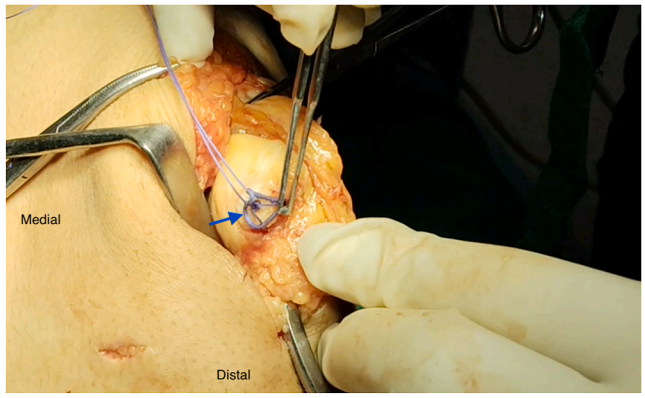

Fig 8. A 21-year-old female patient is in a supine position and a minimedial parapatellar arthrotomy is carried out to fix the osteochondral fracture fragment with suture based implant, viewing the surgical field from the medial side of the left knee. The fixation node (c from Fig 1) and the protection ring (d from Fig 1) (blue arrow) is seen holding the osteochondral fragment in situ. Two lead sutures (b from Fig 1) and 2 peripheral sutures (e from Fig 1) have been tied on the anterior surface of the patella (not seen in the view) that has stabilized the osteochondral fragment in its native bed. The distal and medial sides are marked as in figure.

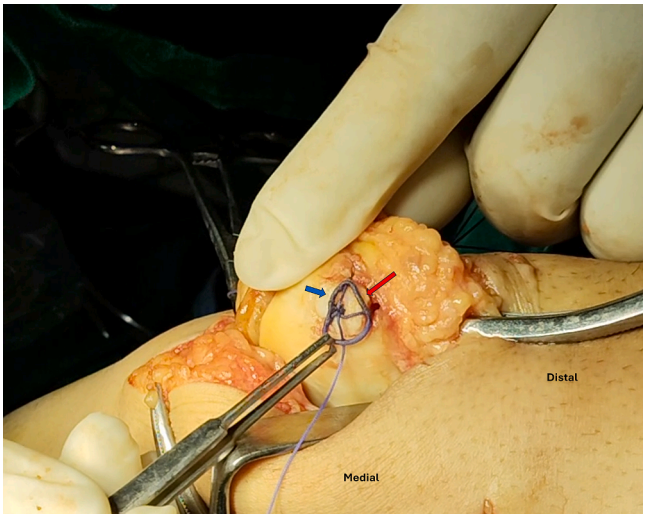

Fig 9. A 21-year-old female patient is in a supine position and a minimedial parapatellar arthrotomy is carried out to fix the osteochondral fracture fragment with suture based implant, viewing the surgical field from the medial side of the left knee. The fixation node (c from Fig 1) and the protection ring (d from Fig 1) (blue arrow) have reduced and securely fixed the osteochondral fragment (red arrow) on its native bed. Before passing the last peripheral fixation suture (e from Fig 1), the final adjustments of the protection ring (e from Fig 1) are made so as to improve its uniform distribution and compression on the osteochondral fractured fragment. The distal and medial sides are marked as in figure.

provides reasonable compression and strength to the fracture fixation until natural healing takes place in 3 to 4 weeks while eliminating the need for implant removal at the later stage. The half-life of polyglactin 910 with size 5-0 has been reported to be 64 to 70 days in nasal cavity,[12] whereas polyglactin 910 with size 6-0 has been reported to become fully absorbed in 56 to 70 days,[13] irrespective of anatomical location of its use. The implant in this technique uses 1-0 size polyglactin 910 material, which should have a greater half-life and a timeline to complete resorption.

Patellar OCFs frequently result from APD, particularly in the pediatric and adolescent populations. The biomechanical forces after APD in adolescent-age group result in small- to mid-sized, either osteochondral or pure chondral loose fracture fragment, which generally originates either from the medial patellar facet or the apex or as a large piece from both the locations. Qiu et al.[14] did a systemic analysis of English literature from 2000 to 2021 and found that out of the reported 2,446 first time dislocated cases, 38.3% of patients had OCF. In another systemic review and meta-analysis by Yi et al.[15] in 2024, the incidence was 48.8% in APD involving 39 studies and 3,354 patients. Puddu et al.[1] in their series reported an incidence of 54% of OCF in APD cases. Apart from the incidence, the common location and size of the OCF fragment after APD also have been reported. In a systemic review of literature by Migliorini et al.,[16] patellar apex and medial patellar facet were the most commonly affected locations. In another series involving a prospective analysis of patients with APD, a majority (61%) of patellar chondral lesions were at their inferomedial aspect.[17] In another study by Uimonen et al.,[18] the mean size of the patellar defect was 146 mm^2.

The adolescent age group, with its high healing potential, is an advantage that allows early healing after fixation, giving superior mid- to long-term results in preserving joint integrity and function.[2] However, these small- to mid-sized OCF fragments, which are sometimes flake-like, are a challenge to be fixed using metal screws or bioabsorbable pins. In addition, complications like erosion of opposite chondral surface, bone resorption, chemical reaction, synovitis, and loosening from metal or bioabsorbable implants remain a concern.[1,3] Recent interest has shifted toward suture-based techniques for low-profile OCFs.[7-11] Despite this, a standardized protocol and predefined methodology has not been widely established. The DG-Lock (TM) implant design described here offers a standardized approach for a secure fixation of patellar OCF while eliminating the usual complications due to its bioresorbable material.

The suture-based protection ring (patent applied), which is also fully absorbable, offers several advantages (Table 1). The protection ring with the help of fixation node keeps the sutures away from the edges of OCF, near the central pilot hole and peripheral fixation holes. This helps in reducing the chances of cutting-through of the sharp suture material in flake like OCF or at pure chondral edge. In addition, protection ring redistributes the compression forces and provides a uniform compression over a wider area, aiding early healing (Table 2). As the entire construct comprises of polyglactin, it is expected to be fully absorbed within 10 weeks, leaving no traces of implant and need for its removal.

Even though the design of the implant helps in filling the missing gap in treatment of acute patellar OCF, it still has certain drawbacks (Table 2). The polyglactin implant can start losing its strength and grip as early as 4 to 6 weeks and hence the OCF must heal before then. For the same reason, this implant and technique cannot be used in conditions in which the OCF fragment has a sclerotic or an ischemic base, e.g., osteochondritis dissecans, chronic OCF fracture, or an osteonecrotic piece. The protection ring, which remains slightly prominent, can potentially rub against the trochlear surface before it dissolves. However, in early postoperative phase, active loading of the patellofemoral joint is not allowed for 4 to 8 weeks, which

Table 1. Advantages and Disadvantages of the Technique

Advantages	Disadvantages
1. The implant design sets a methodology to fix the small- to mid-size OCFs in a predefined manner, removing the need of customization in every case while doing suture-based fixation. 2. It is an all-absorbable implant that leaves no traces of implant in 8 to 10 weeks. There is no need for future implant removal as needed with the use of metal screws or bioabsorbable pins. 3. The suture-based protection ring (patent applied) keeps the sutures away from the edges of the OCF near the central pilot hole and peripheral fixation holes. Thus, it reduces the chances of a cutting-through of the suture material in a very thin OCF or in pure chondral fragments. 4. The protection ring also redistributes the compression forces and provides a uniform compression over the 4 corners of the fragment, aiding early healing. 5. The side effects associated with metal devices and bioabsorbable pins, such as erosion of chondral surface, loosening, chemical reaction, synovitis, bone resorption, are nullified.[1,3]	1. The fear of an implant composed of polyglactin-910 losing its strength earlier than expected is a legitimate concern. However, the OCFs in adolescents heal faster than expected, and there are multiple reports in literature to support the use of polyglactin.[9] 2. The protection ring remains prominent on the OCF, which potentially can erode the opposite chondral surface. However, the ring is absorbed in 6 to 10 weeks, during which active and active assisted range of movement exercises are encouraged but no loading activities are allowed. Hence, the chances of the protection ring rubbing against the opposite chondral surface are minimal. In addition, most (61%) of patellar osteochondral fractures after acute dislocation of patella are found at its inferomedial aspect, which doesn't fully articulate with the trochlea.[15] 3. It is an open procedure and presently doesn't allow fixation using arthroscopy. 4. This technique and implant cannot be used in chronic OCF fractures, in ischemic conditions, or in osteochondritis dissecans, etc.

OCF, osteochondral/chondral fracture.

Table 2. Tips and Pitfalls of the Technique

Tips	Pitfalls
1. Sometimes the OCF fragment seems larger than the defect. This happens due to concave OCF piece becoming compressed between the tibiofemoral joint surface while loose, making it flat and thereby increasing it in size. In such cases, minor trimming of uneven borders can be helpful. 2. In an irregular OCF fragment, an absolute central location may not always be possible for drilling the central hole. In such cases, the best attempt should be made to obtain the maximum hold of the fragment either in the most central location of the fragment or at the stronger location of the fragment, so that the fragment doesn't split. 3. In case of a large OCF fragment, 2 implants can be used side by side. 4. Of the 4 lead sutures coming out of the central pilot hole, any one lead suture can be used with any of the peripheral fixation sutures. There is no need to match corresponding sutures while tying the knot.	1. The protection ring requires adjustments while the knots are being tied on the anterior surface of the patella so that it remains in the center and provides uniform compression. 2. The protection ring helps in elevating the sutures away from the chondral surface, thereby reducing the chances of a cut through. This works well as long as the distance between the outer diameter of protection ring and peripheral fixation hole is 4 mm or less. This safe distance can easily be managed with OCF fragment that are 15 mm or less in diameter. Any OCF fragment that is larger than 15 mm will require 2 such implants, side by side.

OCF, osteochondral/chondral fracture.

reduces the chances of the protection ring rubbing against the opposite chondral surface. A failure to address and correct associated comorbidities may jeopardize the outcome of any fixation procedure done for the patellar OCF defect.[4,19]

The DG-Lock (TM) provides an easily reproducible, standardized fixation technique for low-profile acute patellar OCFs. Its all-suture, fully absorbable design avoids complications associated with traditional fixation methods while offering sufficient strength for biological healing over 3 to 4 weeks.

Disclosures

The author declares the following financial interests/personal relationships which may be considered as potential competing interests: consulting or advisory and speaking and lecture fees from Healthium Medtech Limited; and patent application number 202421002096 pending to Licensee.

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