Technical Note

Patellar Sleeve Avulsion Fracture Repair: Suture Anchor Technique With Suture Cerclage Augmentation

Jared A. Nowell, M.D., and Emily L. Niu, M.D.

Abstract: Patella sleeve fractures are rare injuries that occur in pediatric patients. For minimally displaced fractures, nonoperative treatment with immobilization is possible. When fractures are displaced, surgical repair is indicated. Previously described operative techniques include transosseous sutures and tension band wiring. We describe a surgical technique to repair distal pole and patella sleeve avulsion fractures in pediatric patients using intraosseous suture anchors with suture cerclage augmentation.

Patella sleeve avulsion fractures are rare, comprising 1% of all fractures in pediatric patients.[1-3] However, these injuries represent approximately 50% of all patella fractures in this population.[1] The peak incidence occurs at 12.7 years of age, with the mechanism being a strong eccentric contraction of the quadriceps in knee flexion, resulting in separation of the inferior pole of the immature patella from the remainder of the patella. This area in the extensor mechanism of the pediatric knee is a weak point that is predisposed to injury.[2] The resulting distal fragment is composed primarily of cartilage with attached periosteum and minimal bone, precluding repair with standard patella fracture techniques.

Nonoperative treatment is limited to fractures with less than 2 mm of displacement on plain radiographs and consists of cast immobilization in extension.[1] Operative management is indicated for fractures with greater than 2 mm of displacement, articular incongruity, or presence of extensor lag.[2] Goals of surgery are to restore congruity of the articular surface and tension of the extensor mechanism. Published methods to achieve this consist of small case reports using transosseous nonabsorbable sutures or tension band wiring.[1-5] A recent 2022 case report consisted of 20 patients treated with transosseous fixation.[6]

Our Technical Note presents an easily reproducible method of achieving anatomic reduction, even in the presence of small fragments and comminution, and fixation method using absorbable intraosseous suture anchors with suture cerclage augmentation (Table 1).

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Use K wires as joysticks to achieve initial provisional reduction	Ensure that the K wires are appropriately centered within the fracture fragment(s) to avoid risk of fracture comminution or malreduction
Drive the K wires across the fracture site into the proximal segment of the patella to mark the correct placement of anchors and ensure anatomic reduction	Avoid the articular surface of the patella when drilling the tracts for the anchors
Use the double-loaded sutures in the anchor to perform cerclage technique around the fracture fragments and to perform retinacular repair, adding to overall construction stability	

From the Department of Orthopedic Surgery and Rehabilitation, Howard University Hospital (J.A.N.); and Orthopaedic Surgery and Sports Medicine, Children's National Hospital (E.L.N.), Washington, D.C., U.S.A.

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Address correspondence to Emily L. Niu, M.D., 111 Michigan Avenue Northwest, Washington, D.C. 20010. U.S.A. E-mail: eniu@childrensnational.org

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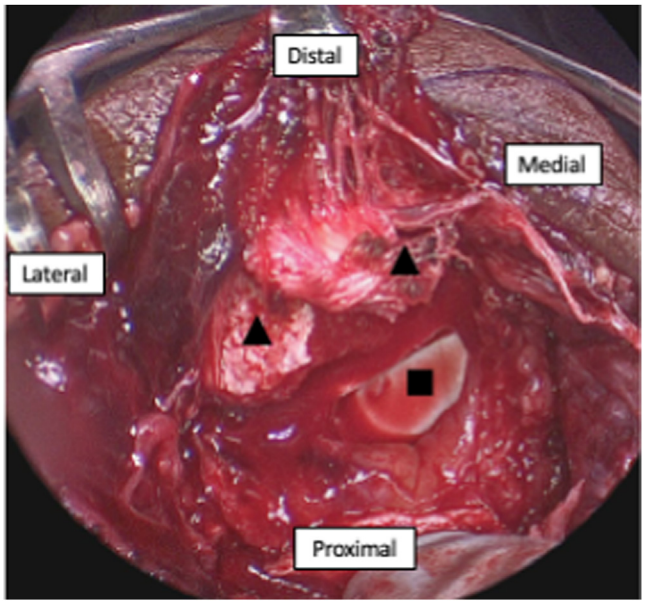

Fig 1. Direct inspection of the left knee distal patella avulsion fracture looking from proximal to distal showing comminution with 2 major distal fracture fragments. Black square marks the trochlea and black arrowheads mark distal fracture fragments.

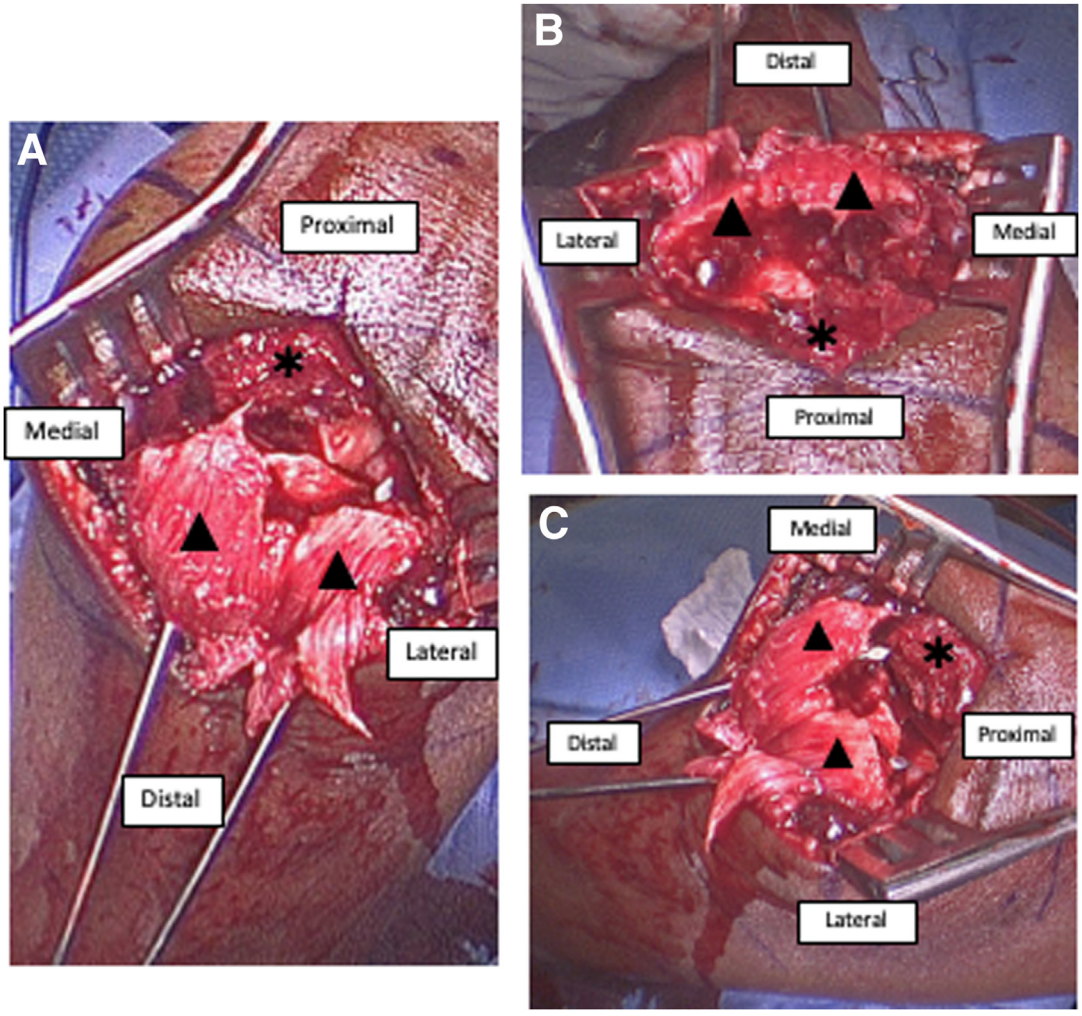

Fig 2. Three views of 2.0 K wires after being placed retrograde in the distal patella avulsion fragments. A is a direct anterior view, B is looking from proximal to distal, C is a view taken from the lateral aspect of the left knee. Black arrowheads mark distal fracture fragments, asterisk marks proximal fracture fragment.

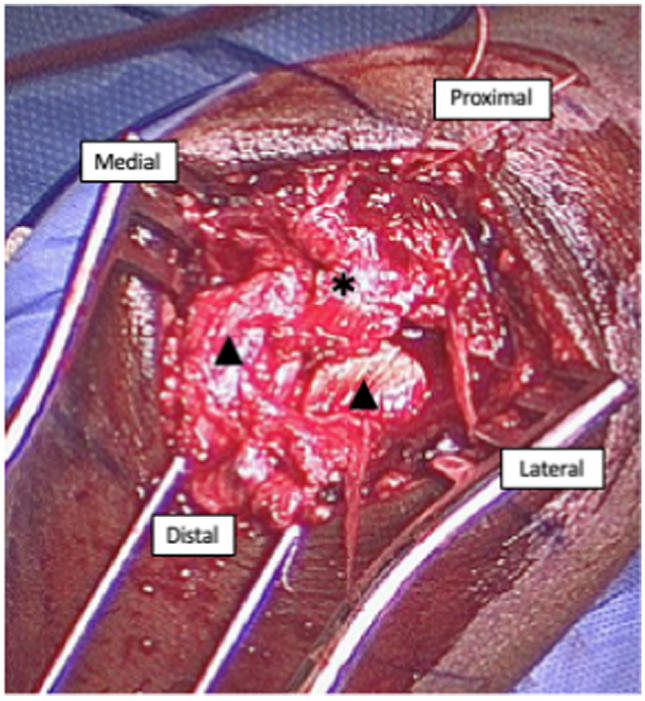

Fig 3. Reduction of the left knee patella following advancement of 2.0 K wires from the distal avulsion fragments into the proximal fragment of the patella. Black arrowheads mark the distal fracture fragments, asterisk marks proximal fracture fragment.

Surgical Technique (With Video Illustration)

The patient is placed supine, with optional upper-thigh tourniquet on the operative leg and bump under the ipsilateral hip. Before draping, contralateral lateral knee radiographs are obtained with the knee at 30° of flexion to determine the native station of the patella, for later comparison of repair tensioning. A midline incision is made from the midportion of the patella to the tibial tubercle. Full-thickness flaps are elevated above the retinaculum and paratenon. The patellar tendon is identified and inspected to ensure continuity. We identified 2 major fragments consisting of bone and cartilage (Fig 1, Video 1). Hematoma is cleared to improve visualization. The cartilage surfaces of the patella and trochlea can be assessed through the fracture gap to ensure no other chondral injuries. Soft-tissue adhesion release is performed as needed for full mobilization of the distal fragment and attached patella tendon.

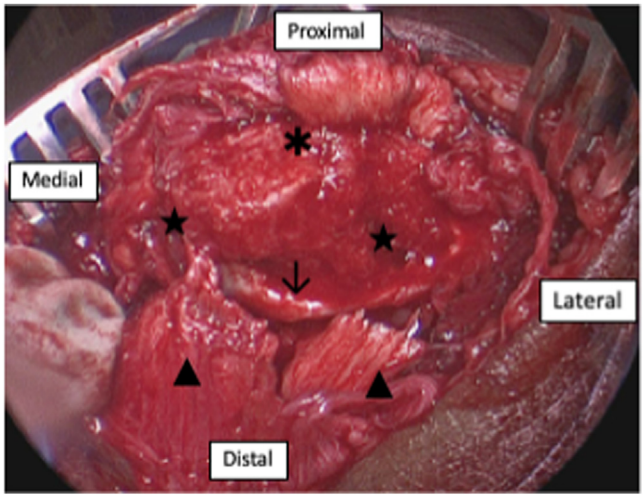

Fig 4. View of the proximal fracture fragment with the medial and lateral aspects marked with electrocautery in place of the retracted K wires for bioabsorbable suture anchor placement. Arrow points to articular cartilage of patella, bovie sites are marked with black stars, distal fracture fragments with black arrowheads, and proximal fracture fragment with an asterisk.

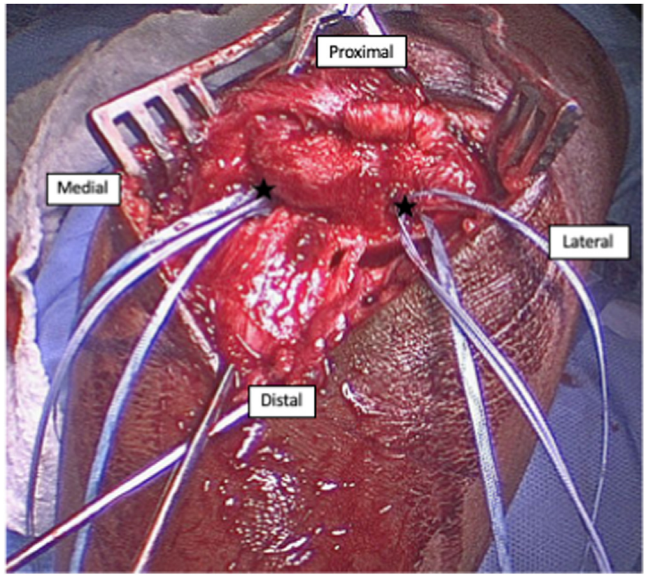

Fig 5. Anterior view of left knee after placement of both the medial and lateral suture anchors. In the image, 4 strands are noted coming from each anchor. Suture anchors marked with a star.

Two 2.0 K wires are inserted in retrograde fashion through the distal pole fracture fragment (Fig 2). These are spaced evenly along the avulsion fragment, and, in this case, due to comminution, a K wire was placed centrally into each main fracture fragment. The 2 K wires are used as joysticks to achieve reduction. In the reduced position the K wires are advanced into the distal aspect of the patella (Fig 3).

The K wires are retracted and their entry locations on the proximal segment of patella are marked with electrocautery, to mark the insertion sites of the bioabsorbable anchors (Fig 4). This ensures correct placement of the anchors to achieve an anatomic reduction and good spread across the fracture site. Next, two 4.75-mm bioabsorbable suture anchors (HELIACOIL; Smith & Nephew, Andover, MA) preloaded with 2-mm ULTRATAPE and #2 ULTRABRAID

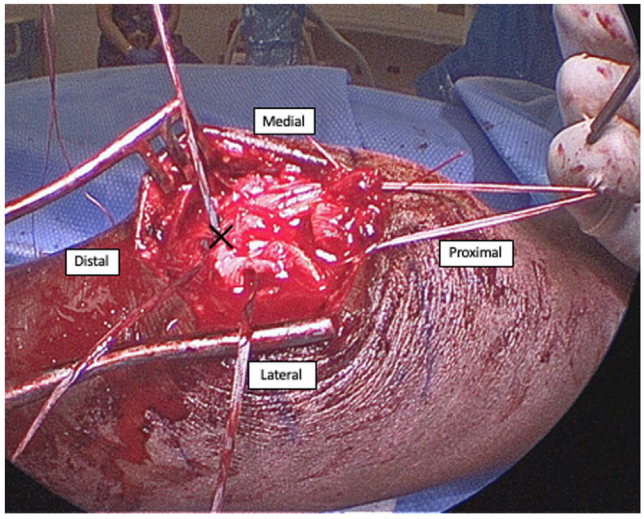

Fig 6. Lateral view of left knee. A horizontal mattress suture construct made of 2-mm ULTRATAPE is seen held up in the air while patella fracture reduction is maintained with the ULTRABRAID suture being pulled proximally. Horizontal mattress is marked with an X.

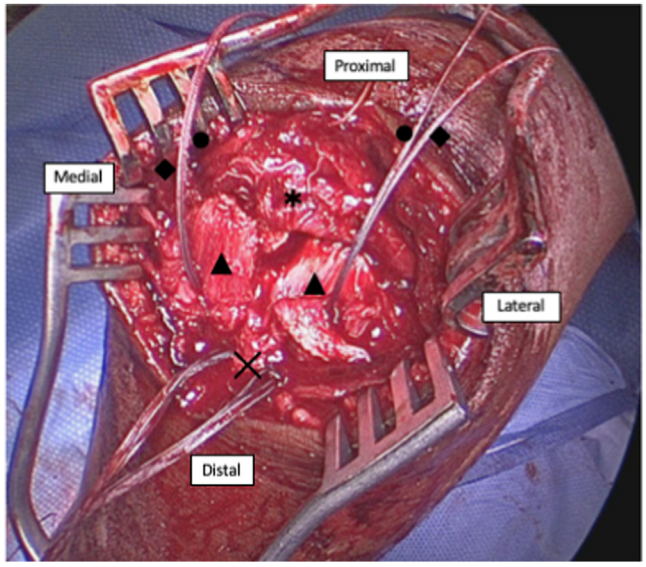

Fig 7. Anterior view of the left knee with reduction of patella fracture fragments shown after the horizontal mattress has been tied with strands from suture anchor. Remaining strands will be used for suture cerclage augmentation and retinacular repair. Horizontal mattress is marked with X, distal fracture fragments with black arrowheads, and proximal fracture fragment with asterisk. Diamond is adjacent to strands used for cerclage, whereas the circle is next to the retinacular repair strands,

suture are inserted into the patella at the previously marked locations. Each suture anchor consists of four total suture limbs, 2 from the tape and 2 from the suture (Fig 5).

The 4 suture limbs from a single anchor are passed through the distal bone fragments via the K wire tracts using a suture passer. Alternatively, a free needle can be used. All 4 lateral suture limbs are passed through the lateral K wire tract, then the medial suture limbs through the medial hole. The 4 limbs of tape are brought through the proximal insertion of the patella tendon using a free needle, spaced evenly. They are tied sequentially in a horizonal mattress fashion while reduction of the patella is maintained and tension is removed by pulling the four #2 ULTRABRAID suture limbs proximally (Fig 6). After tying, the distal fragments are reapproximated to the patella (Fig 7).

Using a free needle one #2 suture from the medial anchor is brought around the patella laterally, through the quadriceps to the medial border of the quad tendon in a cerclage fashion. This is repeated with a lateral limb around the medial patella (Fig 8). These limbs are tied at the proximal medial aspect of the patella, within the distal quadriceps' tendon insertion (Fig 9). Stable reduction is confirmed in 2 ways, first by directly examining the reduction as the knee is ranged from 0 to 30°. Second, intraoperative fluoroscopy is used to evaluate the fixation construct with 2 images of the knee, at 0 and 30° of flexion.

Lastly, the remaining #2 suture limbs are brought proximally to repair the retinacular rent with the medial limb used for the medial retinaculum and the lateral limb for the lateral retinaculum. Using fluoroscopy, the knee is ranged from 0 to 60° noting stable fixation through this range of motion.

The incision is closed in a layered fashion. Paratenon, which was preserved during initial dissection, is reapproximated over the patella tendon, followed by subcutaneous tissue and skin. Postoperatively, the patient is allowed to weight bear as tolerated with a hinged knee brace locked in extension for weight-bearing. Range of motion from 0 to 30° in the brace is allowed for the first 2 weeks and advanced sequentially by 30° every 2 weeks. Brace use is discontinued after 6 weeks.

Discussion

Patella sleeve fractures are considered the pediatric equivalent of patellar tendon rupture and inferior pole fractures more commonly seen in adults. Literature on patella tendon repair has shown that suture anchor construct has greater resistance to gap formation, greater peak force to failure, decreased operative time, and reduced incision size compared with transosseous techniques.[7-9] Similarly literature on inferior pole patella fractures treated with tendon advancement has biomechanically shown that suture anchors have less gapping during cyclic loading with similar load to failure when compared with transosseous suture fixation.[10] It is probable that the benefits of suture anchor repair also apply to pediatric patellar sleeve fracture.

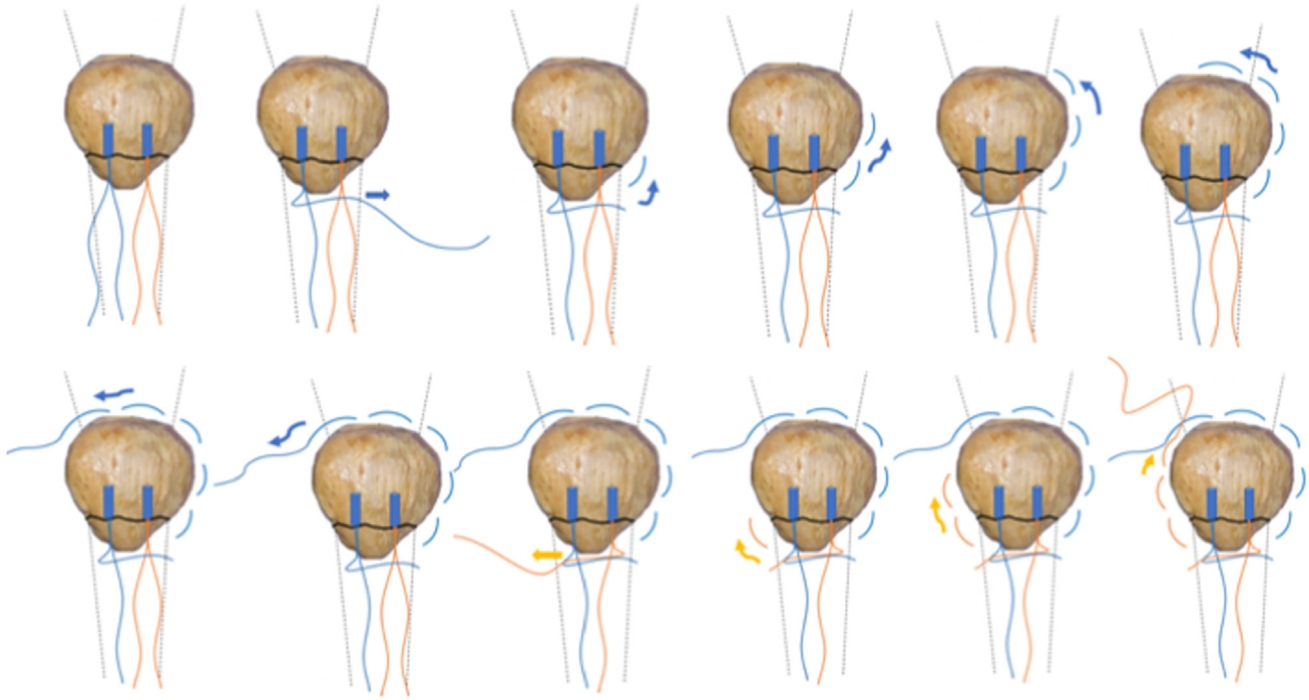

Fig 8. Illustration of suture cerclage technique, with blue limbs representing the medial anchor sutures and yellow limbs represent the lateral anchor sutures. The limbs are coming from the distal patella. The image is read from left to right in the top row, followed by the second row in the same manner. The medial anchor suture (blue) is brought around the patella laterally to the superomedial corner followed by the lateral anchor suture (orange) brought medially to the same location. The sutures are then tied at this location at the superomedial patella, adjacent to the quad tendon insertion.

In our construct, we also add a cerclage technique using suture, which potentially adds additional strength to resist displacement forces, allowing for early initiation of range of motion. A 2016 case report discussed cerclage fixation for patella sleeve fracture through the use of metal wire.[4] However, the implant was removed at 9 months postoperatively due to symptomatic hardware.

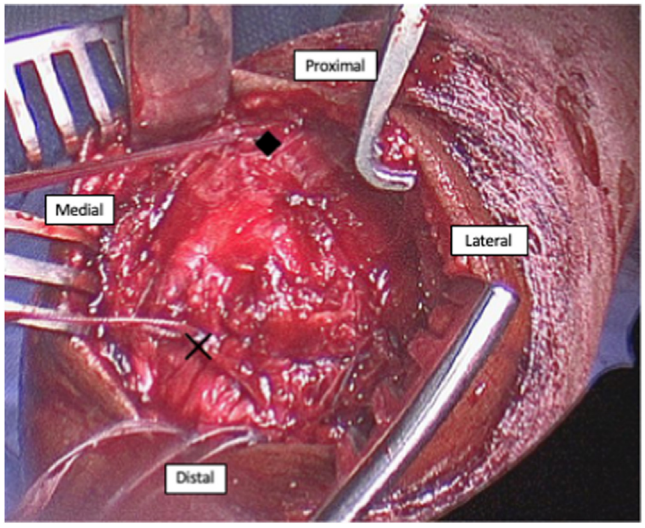

Fig 9. Anterior view of the left knee showing the final construct with suture anchor fixation and suture cerclage augmentation with reduction of the patella fracture fragments. The horizontal mattress tie is marked with X and tied cerclage knot with a diamond.

A 2021 study presented a technique for treating comminuted patella sleeve fragments using of a low-profile mini-plate.[11] Our construct is suitable for treatment of comminuted fractures, as shown in the case example, without need for special implants. An advantage of using suture anchors and suture cerclage compared with the plate and metal wire cerclage case report is a lower likelihood of hardware irritation or need for return to the operating room for hardware removal.

Published techniques using transosseous suture fixation keep patients strictly immobilized in extension ranging from 4 to 6 weeks with varying weight-bearing restrictions.[1,2,4,5] One series notes range of motion initiated at an average of 27.5 days.[6] Our protocol allows immediate range of motion and weight-bearing, allowing for more accelerated rehabilitation protocols. We hypothesize potential benefits of early mobilization include avoiding complications associated with casting such as skin irritation, heel ulcers, and need to return to clinic for wet casts or cast adjustments. Furthermore, early mobilization likely leads to decreased time out of

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Suture anchor construct decreases hardware irritation and hardware removal rates	Increased cost of suture anchors compared with drilling transosseous tunnels
Use of suture anchors may lead to less gapping, as seen in the adult literature	Smaller anchors may be needed in smaller pediatric patients
Decreased proximal exposure and increased ease of suture passage compared with transosseous tunnels	Cerclage suture knot may cause irritation along the quadriceps tendon
Cerclage augmentation strengthens overall construct strength which allows for early weight-bearing and range of motion	

school and time out from work for parents in order to care for their immobilized children.

The technique we discuss has similar disadvantages of surgical management, including risk of nonunion, malunion, patella alta, wound infection, and ischemic necrosis of the patella compared with other forms of fixation.[3] Technically, use of suture anchors is likely easier and more reliable, as the drilling of transpatella osseous tunnels can require increased exposure and can introduce error in the reduction if the tunnels are not perfectly placed (Table 2).

Our proposed technique aims to decrease currently reported disadvantages to commonly reported fixation methods for patella sleeve fractures in pediatric patient. With accelerated postoperative mobilization, cast-related complications are avoided and time out from school and work is likely decreased. Given an all-suture construct, we hypothesize the incidence of symptomatic implant and need for return to surgery for removal is reduced. Future studies performing biomechanical comparison of transosseous tunnel fixation versus intraosseous suture anchors for this injury are needed to confirm the advantages of our technique.

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