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Adolescent patellar osteochondral fracture following patellar dislocation

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Abstract
Purpose Patellar dislocations in adolescents may cause osteochondral fractures of the patella. The aim of this study was to review the outcomes of adolescent patients who underwent surgical intervention for patellar osteochondral fracture following patellar dislocation.
Methods Nine patients who underwent surgery for osteochondral fracture of the patella following dislocation were identified retrospectively. Following arthroscopic examination, if the fragment was large enough to support fixation, headless screws or bioabsorbable pins were used. Otherwise, the loose body was excised, and the donor site was managed with a microfracture. Postoperatively, patients were assessed using the International Knee Documentation Committee (IKDC) and Knee injury and Osteoarthritis Outcome Score (KOOS) outcome measures.
Results The average age of the patients was 14.6 with average follow-up 30.2 months. Four of the nine patients underwent fixation, while five patients underwent removal of loose body with microfracture. The average defect size in the nonfixation group was 1.2 cm^2 compared with 3.2 cm^2 in the fixation group. The IKDC scores for fixation and nonfixation groups were 63.9 (SD = 18) and 76.1 (SD = 11.7), respectively. The KOOS subscale scores for symptoms, function in sports and recreation, and knee-related quality of life were higher for the nonfixation group when compared to the fixation group.
Conclusions This is the first known series examining surgical outcomes of osteochondral fractures of the patella following patellar dislocations in the adolescent population. While patients without fixation were less symptomatic in this series, this may be attributable to more severe injuries in patients undergoing fracture fixation.
Level of evidence Retrospective case series, Level IV.

Keywords Paediatric osteochondral injury · Patellar dislocation · Patella · Osteochondral fracture

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Introduction

Patellar dislocation is a common injury to the knee in the adolescent population. The estimated annual incidence in children younger than age 16 is 43/100,000 [17]. Risk factors for this injury include family history of dislocation, female gender, and patellofemoral dysplasia [2]. Common sequelae of this injury include osteochondral fractures of the patella and/or lateral femoral condyle. The mechanism for osteochondral injury is believed to involve the shear stress produced as the patella dislocates and reduces, and the medial facet of the patella engages the lateral femoral condyle [13, 15].

Osteochondral injuries occur commonly in adolescents, with the most common magnetic resonance imaging (MRI) diagnosis after trauma being cartilaginous injury [19]. These injuries may be asymptomatic, and nonoperative care in these cases is appropriate. Injuries that may lead to long-term pain and disability should be treated, yet techniques are varied based on injury pattern and surgeon and patient preference. Reported management of these osteochondral fractures includes observation for stable nondisplaced fractures, surgical removal of loose bodies, marrow-

stimulating techniques such as microfracture, mosaicplasty, fixation of large osteochondral fragments, and acute chondrocyte implantation [4–6, 9, 12]. Previous investigations have studied management of osteochondral fractures of the lateral condyle associated with patellar dislocations [6, 14, 25].

To our knowledge, there is no known series examining the outcomes of paediatric patients undergoing surgical treatment for osteochondral fractures of the patella. The aim of this study was to review the clinical outcomes of paediatric patients at our institution who underwent surgical intervention for patellar osteochondral fracture following patellar dislocation. The hypothesis for this study was that paediatric patients undergoing surgical intervention for osteochondral fractures of the patella would have favourable clinical outcomes postoperatively.

Materials and methods

This investigation is a retrospective case series. Prior to investigation, institutional review board (IRB) approval was obtained. Paediatric patients (<18 years) who underwent surgical intervention for osteochondral fracture by a single surgeon were retrospectively identified. All patients had routine initial 3-view knee X-rays following patellar dislocation. If there was any concern for osteochondral fracture, such as evidence of patellar defect or loose body, MRI was subsequently obtained. Study inclusion criteria consisted of (1) a diagnosis of acute osteochondral fracture of the patella following patellar dislocation, (2) presentation less than 4 weeks from injury, (3) MRI scan of the knee documenting osteochondral injury and evidence of loose body, (4) surgical treatment of patellar pathology, and (5) age less than 18. Exclusion criteria included (1) age greater than 18, (2) prior ipsilateral knee surgery, and (3) follow-up less than 12 months.

All surgical cases were performed by a single, board-certified orthopaedic surgeon. In the operating room, lateral patellar stability was tested under anaesthesia prior to prep and draping. Following that, a diagnostic arthroscopy was performed. Patellar tracking and the integrity of medial patellar retinaculum were then assessed through the arthroscope. Loose bodies were identified, removed, and examined. The articular surfaces, particularly of the lateral femoral condyle and medial patellar facets, were also examined for evidence of fracture. The osteochondral loose body was inspected to determine whether it contained enough bone to support fixation. If this was the case, then a medial parapatellar arthrotomy was made such that the medial patellar facet could be accessed. The osteochondral fragment was reduced to the donor site and fixed with headless variable pitch screws (Acutrak Headless Compression Screw, Acumed, Hillsboro, OR), bioabsorbable pins (OrthoSorb Resorbable Pins, Depuy, Warsaw, IN), or bioabsorbable darts (Chondral Dart, Arthrex, Naples, FL). If the osteochondral fragment did not bear enough surface area for fixation, the loose surrounding cartilage was debrided and a microfracture technique was employed with an awl at the fracture site. If the patella demonstrated lateral instability, the insertion of the medial patellofemoral ligament (MPFL) was sutured to the adductor tubercle and the medial capsule was tightened in a pants-over-vest fashion.

Postoperatively, all patients received outpatient physical therapy. All patients were weightbearing as tolerated in extension for the first 6 weeks. Patients that had fixation of osteochondral fragments worked on range of motion and isometric quad exercises for the first 6 weeks. For the next 6 weeks, they progressed to open chain exercises and gentle strengthening with full strengthening beginning at 3 months. For the nonfixation group, patients began with 6 weeks of continuous passive motion (CPM), passive range of motion, and isometric quad exercises. No strengthening was started until the 3-month point.

At final follow-up, the patients were asked to complete validated measures of subjective knee function, including the Knee injury and Osteoarthritis Outcome Score (KOOS) and International Knee Documentation Committee (IKDC) forms.

Results

There were nine patients who met the inclusion criteria from 2007 to 2009. The average age of the patients was 14.6 years (SD = 1.2 years; range, 12–17). The average follow-up period was 30.2 months (SD = 13.4 months; range, 15–54). Eight patients were female, while one was a male. One patient had a previous history of patellar dislocation in the ipsilateral knee. One patient had a history of recurrent patellar dislocation in the contralateral knee. Preoperative MRI in all patients demonstrated loose bodies, patellar osteochondral fracture, and bony contusions to the medial patella and lateral femoral condyle suggestive of patellar dislocation/relocation injury (Fig. 1a–c). While 1/9 patellar osteochondral fractures was located centrally on the patella, 8/9 (88.9 %) osteochondral fractures were localized to the medial patellar facet.

Four out of the 9 patients were determined to have osteochondral fragments with enough bone to attempt fixation. Bioabsorbable pins (OrthoSorb Resorbable Pins, Depuy, Warsaw, IN) or darts (Chondral Darts, Arthrex, Naples, FL) were used for fixation in three patients, while headless variable pitch screws (Acutrak Headless Compression Screw, Acumed, Hillsboro, OR) were used in one

◀**Fig. 1** Imaging of left patellar osteochondral fracture of medial facet **a** coronal proton density fat saturation view with evidence of loose body adjacent to lateral femoral condyle. **b** Axial T2-weighted MRI image and **c** sunrise view of left patella demonstrating fracture of medial facet of patella. *Arrow* indicates fracture site of patella; *arrowhead* indicates loose fracture fragment adjacent to lateral femoral condyle

patient (Fig. 2a). These four fixation patients were also found to have lateral patellar instability such that a MPFL repair was also performed. The remaining five patients had osteochondral fracture fragments that were determined to be too small or had insufficient bone to support bony fixation (Fig. 2b). The average defect size in this group was 1.2 cm^2 (SD = 0.3 cm^2; range, 1–1.5) compared with 3.2 cm^2 (SD = 2.4 cm^2; range, 1–6.3) in the fixation group. All patients in the fixation group ($n = 4$) underwent MPFL repair, while only 2 out of the 5 patients in the nonfixation group required MPFL repair. Two patients from the fixation group and 2 patients from the nonfixation group suffered at least one repeat postoperative patella dislocation.

The average IKDC score for the nonfixation group (76.1, SD = 11.7) was higher than that for the fixation group (63.9, SD = 18). Differences in the KOOS subscale scores between the 2 groups are depicted in Fig. 3.

In addition to the 2 patients in the fixation group that sustained postoperative repeat dislocations, one additional patient in the fixation group required a second surgical procedure after developing significant postoperative stiffness. She subsequently underwent an arthroscopic release and removal of her hardware 5 months postoperatively. Nineteen months after her index procedure, this patient had full painless motion of her knee and had resumed her normal activity. The overall complication rate including repeat procedures and repeat patellar dislocation following surgical fixation was 75 % (3/4 patients).

Discussion

In this investigation, a series of 9 paediatric patients surgically treated for patellar osteochondral fracture following patellar dislocation were examined. While the sample size was small, the most important finding of this study was that suboptimal short- to mid-term outcomes occur following surgical management of this injury.

Osteochondral injuries to the patella are a relatively common occurrence following lateral patellar dislocations of the knee. As the dislocated patella is reduced from a lateral to medial direction by the pull of the vastus medialis, the medial facet of the patella impacts the lateral femoral condyle which may result in fracture. In Luhman et al's [11] series of 38 adolescents undergoing patellar

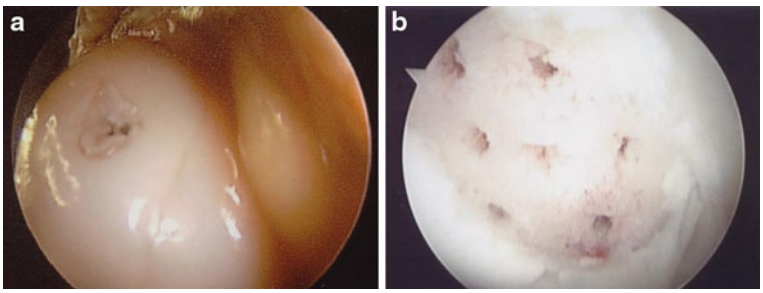

Fig. 2 Intraoperative arthroscopic pictures following **a** open reduction internal fixation of patellar osteochondral fracture with variable pitch headless screw and **b** microfracture of osteochondral fracture bed

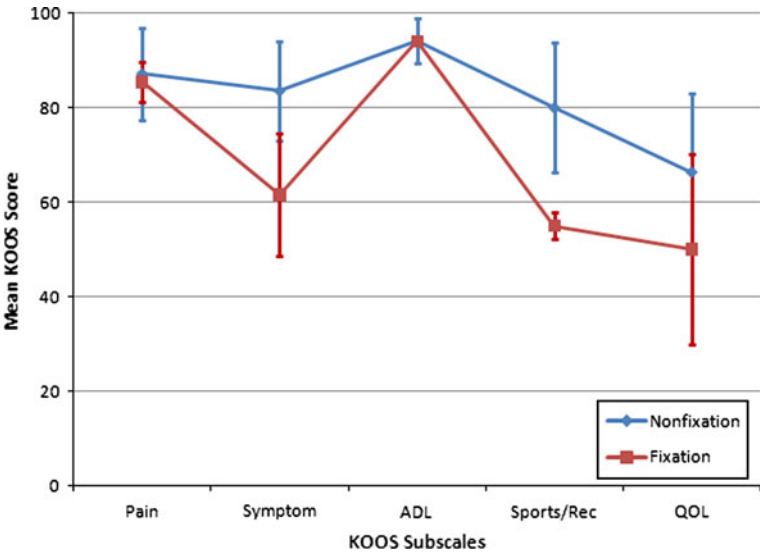

Fig. 3 KOOS profile. Mean KOOS subscale scores with standard deviations are depicted for the nonfixation and fixation groups. *Abbreviations*: *ADL* function in daily living, *Sports/Rec* function in sport and recreation, *QOL* knee-related quality of life

realignment surgery, 73 and 23 % of patients were found to have patellar and femoral osteochondral lesions, respectively. Nietosvaara et al. [17] found 15 of 72 patella dislocations result in femoral condyle or patellar osteochondral fractures of which three underwent fixation. Following acute patellar dislocation, Nomura et al. [18] diagnosed 54 % of patients with chondral or osteochondral fracture of the patella by arthroscopy. MRI studies of patellar dislocation have produced results consistent with these clinical studies [3, 8, 24].

Management of osteochondral fractures of the patella can be challenging but begins with accurate diagnosis. Given its prevalence, this injury should be suspected in any patient who suffers a patellar dislocation. Radiographs of the knee should be obtained. Evidence of fracture can often be seen on the sunrise view with the presence of a loose body or an irregularity in the subchondral bone of the patella. In addition, an MRI can be ordered to evaluate for evidence of osteochondral fracture and loose bodies, which are often not visualized on radiographs [21]. The MRI can also identify injury to the medial patellar stabilizers.

Once the osteochondral fracture is identified, a decision on the manner of treatment must be made. While early reports of this injury describe a complete patellectomy as definitive treatment [1], current treatment algorithms revolve around the decision of whether to excise the loose fragment or to fix it back to its donor site. Acute chondrocyte implantation may also be a potential treatment for this injury; however, this intervention was not examined in the current study [12]. The advantage of fixation is the potential restoration of the normal patellofemoral articulation. Simple excision of the fragment, particularly in the paediatric population, may have long-term consequences of arthrosis about the patellofemoral joint. However, technical considerations may preclude fixation of the fragment. Despite healing reports of purely chondral fragments [6, 16], it is generally accepted that osseous healing is required for successful fixation of osteochondral fragments. In our series, five patients had fracture fragments that either were too small or had insufficient bone to warrant fixation. In addition to excision of the fragment(s), the donor site was treated with the microfracture technique to stimulate a reparative fibrocartilaginous response [9, 22]. At final follow-up, these patients were all doing well but the adverse consequences of the altered patellofemoral articulation would require longer follow-up to manifest itself.

Fixation techniques of these fractures can include the use of suture [20], metal screws [7], bioabsorbable pins [10, 14, 25], and fibrin glue [23]. One of the challenges with treating this fracture as with corresponding osteochondral fractures of the lateral femoral condyle is that there is often only a sliver of bone attached to the larger chondral component [25]. This makes achieving rigid fixation more difficult. In this study, one patient underwent fixation with variable pitch headless screws and three underwent fixation with bioabsorbable pins/darts. One noncompliant patient (6) displaced her fragment, and another (7) required an arthroscopic release as well as removal of her hardware for arthrofibrosis. Another patient (9) remains symptomatic due to persistent patellar instability of both her operative and her contralateral nonoperative side and has declined any further surgical treatment. Overall, patients in our fixation group had a high complication rate of 75 %, which included repeat dislocations and repeat operative intervention. These results demonstrate the operative and rehabilitative obstacles in treating these injuries. It is challenging to manage the delicate balance between protecting tenuous fracture fixation from sheer stresses of the patellofemoral joint and early motion to prevent postoperative stiffness.

There were many limitations to this study. First, there were a high number of patients (4/9) who suffered redislocation. This may portend a worse prognosis and confound our results. Furthermore, the patient population for the present study consisted of 89 % females; while patellar dislocations are more common in the female population, these results may not be relatable to males who sustain this injury. This study was additionally limited by the small number of patients and its retrospective nature. Finally, the follow-up was relatively short-term, with an average follow-up of 30 months. This short-term study may not reflect mid- to long-term outcomes. Yet, we believe that our results are still of interest, and longer-term follow-up on this patient cohort is ongoing.

In summary, this is the first known series examining surgical outcomes of osteochondral fractures of the patella following lateral patellar dislocations in the paediatric population. Options for treatment include excision of smaller fragments with microfracture or fixation of fragments with a larger bony base. While our series demonstrates that fixation of larger fragments and excision with microfracture of smaller fragments may have acceptable clinical outcomes in the short term, it is important to note that there was a high complication rate and suboptimal outcome scores (KOOS/IKDC) were reported by patients in both treatment groups. Osteochondral fractures of the patella following patellar dislocation are challenging injuries to treat, and further studies are required to determine optimal treatment algorithms and long-term outcomes.

Conclusion

This is the first known series examining surgical outcomes of osteochondral fractures of the patella following patellar dislocations in the adolescent population. High complication rates were observed following surgical management; while patients without fixation were less symptomatic in this series, this may be attributable to more severe injuries in patients undergoing fracture fixation.

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