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Outcomes of Simultaneous Medial Patellofemoral Ligament Reconstruction with Osteochondral Fracture Fixation Following Patellar Dislocation in Children

Çocuklarda Patellar Dislokasyon Sonrası Osteokondral Kırık Fiksasyonu ile Eşzamanlı Medial Patellofemoral Ligament Rekonstrüksiyonunun Sonuçları

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AMAÇ: Bu çalışmanın amacı çocuklarda ilk patellar dislokasyon sonrası osteokondral kırık fiksasyonu (OKF) fiksasyonu ve eş zamanlı medial patellofemoral ligaman (MPFL) rekonstrüksiyonu yapılan hastaların sonuçlarını değerlendirmektir.

GEREÇ VE YÖNTEM: 2018-2021 yılları arasında OKF fiksasyonu ve eş zamanlı MPFL rekonstrüksiyonu yapılan toplam 12 hasta retrospektif olarak değerlendirildi. Demografik bilgiler, cerrahi özellikler ve klinik takip verileri toplandı. Ameliyat sonrası klinik değerlendirmeler Kujala ve Lysholm skorları kullanılarak yapıldı.

BULGULAR: Ortalama ameliyat yaşı 10,4 yıldı (dağılım, 7-15 yıl). Ortalama takip süresi 36,5 aydı (dağılım, 24-58). Bir (%8) hastada ipsilateral diz için ikinci bir ameliyat gerekti. Parçaların ortalama yüzey alanı 2.5 cm^2 (SD: 1.4) idi. Ameliyat öncesi Kujala skoru 38.2 (SD: 13.3) ve Lysholm skoru 44.1 (SD: 10.4) idi. Bu skorlar ameliyat sonrasında belirgin iyileşme göstererek en son takipte 87.6 (SD: 11) ve 88.2'ye (SD: 10.3) ulaştı. Röntgen ve MR'lardaki radyolojik incelemelerde OKF'lerde olumlu iyileşme olduğunu gösterdi.

SONUÇ: Patellofemoral instabilitesi olan çocuklarda osteokondral kırık fiksasyonu, eş zamanlı medial patellofemoral ligament rekonstrüksiyonu ile birlikte fiksasyon yoluyla etkili bir şekilde yönetilebilir. Orta dönem sonuçlar tatmin edici sonuçlar göstermiştir.

Anahtar Kelimeler: Patellar çıkık, osteokondral kırık, medial patellofemoral bağ rekonstrüksiyonu, çocuklar

AIM: The aim of this study was to evaluate the outcomes of the patients who underwent osteochondral fracture (OCF) fixation and simultaneous medial patellofemoral ligament (MPFL) reconstruction after patellar dislocation in children.

MATERIAL AND METHOD: A total of 12 patients who underwent OCF fixation and simultaneous MPFL reconstruction between 2018 and 2021 were retrospectively evaluated. Demographic information, surgical specifics, and clinical follow-up data were gathered. Postoperative clinical assessments were conducted utilizing Kujala and Lysholm scores.

RESULTS: The mean age at surgery was 10.4 years (range, 7-15 years). The mean period of follow-up was 36.5 months(range, 24-58). One (8%) patient required a second surgery on the ipsilateral knee. The mean surface area of the fragments was 2.5 cm^2 (SD: 1.4). Preoperatively, the Kujala score and the Lysholm score were 38.2 (SD: 13.3) and 44.1 (SD: 10.4), respectively. These scores exhibited significant improvement postoperatively, reaching 87.6 (SD: 11) and 88.2 (SD: 10.3) at the latest follow-up ($p<0.05$). Radiological examinations, including X-ray and MRI, indicated favorable healing of the OCFs.

CONCLUSION: Osteochondral fracture fixation in children with patellofemoral instability can be effectively managed through fixation combined with simultaneous medial patellofemoral ligament reconstruction. The mid-term results have demonstrated satisfactory outcomes.

Keywords: Patellar dislocation, osteochondral fracture, medial patellofemoral ligament reconstruction, children

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INTRODUCTION

Patellar dislocation is a prevalent knee injury among adolescents, with an estimated annual incidence of 43 per 100,000 in children younger than 16 years old.[1] The primary etiological factors are predominantly traumatic in nature, encompassing instances of either direct knee trauma or twisting motions. Throughout the process of dislocation and reduction, the medial facet of the patella shears against the lateral femoral condyle, often resulting in osteochondral fractures (OCFs) either at the patella or the lateral femoral condyle. The incidence of OCFs following a patellar dislocation varies widely, ranging from 5% to 54%.[2] When an OCF is detected, prompt surgical intervention is advised to enhance healing, minimize articular cartilage loss, and reduce the risk of subsequent osteoarthritis.[3]

Numerous surgical methods have been outlined to address OCFs.[4–8] Historically, these lesions were perceived as loose fragments and were excised without consideration, resulting in areas of bare bone lacking cartilage. The absence of cartilage, particularly on weight-bearing portions like the lateral condyle and the patella's medial articular surface, increases the susceptibility to premature osteoarthritis in affected individuals.[4] For acute fractures exceeding 1 cm in size, surgical repair coupled with fixation is recommended for enhanced clinical outcomes.[9] Extensive comparative studies over the long term have indicated that fixation yields more favorable results in terms of patient-reported outcome scores and incidences of secondary surgery and subsequent instability, when compared to mere debridement.[5] Nevertheless, reported rates of second surgery and recurrent instability demonstrate variation based on the specific fixation method employed and whether concurrent patellar stabilization surgery was undertaken.[6]

Various options for OCFs fixation have been reported, including the utilization of fibrin glue, sutures, bioabsorbable screws, metal screws, and bioabsorbable nails.[4,7,8] While recurrent patellar dislocation patients often undergo procedures like medial patellofemoral ligament (MPFL) reconstruction, first-time dislocation patients are typically treated non-surgically.[10] Surgeons have the opportunity to address both patellofemoral instability and OCF simultaneously. A growing consensus suggests that OCFs resulting from patellofemoral instability should undergo simultaneous MPFL reconstruction to reduce instability recurrence and preserve cartilage.[5,11]

To the best of the authors' knowledge, limited evidence exists regarding the impact of combined treatment involving OCFs and MPFL reconstruction on outcomes.[12,13] Therefore, the aim of this study was to evaluate the outcomes of the patients who underwent OCF fixation and simultaneous MPFL reconstruction after first patellar dislocation in children. The hypothesis postulated that performing OCF fixation simultaneously with MPFL reconstruction would have favorable clinical outcomes..

MATERIAL AND METHOD

After receiving approval from the Institutional Review Board (IRB) (decision number 682/2021-29.07.2021) of the Ethics Committee at Ankara Training and Research Hospital, we conducted a retrospective review to identify patients who underwent OCF fixation and simultaneous MPFL reconstruction at our institution between 2018 and 2021. Informed consent was obtained from each patient. Demographic data, surgical particulars, the latest radiographic and clinical follow-up dates, and details about subsequent surgical procedures were all gathered for analysis. The study included patients who met specific criteria: (1) diagnosis of acute OCF of the patella following a first patellar dislocation, (2) presentation within four weeks of the injury, (3) confirmation of osteochondral injury and the presence of loose bodies through MRI, (4) undergoing both OCF fixation and MPFL reconstruction, and (5) age under 18. Patients were excluded if they met any of the following criteria: (1) age over 18, (2) a history of previous ipsilateral knee surgery, (3) a follow-up duration of less than 24 months, or (4) had osteochondral fragments smaller than 1 cm^2. From a total of 15 patients with simultaneous OCF fixation and MPFL reconstruction 12 patients met the study inclusion criteria. Preoperative evaluations for each patient included knee anteroposterior and lateral X-ray views, CT scans, and MRI exams. The surgical procedures were all performed by the same surgeon and their team.

Surgical Technique

All surgical procedures were carried out by a board-certified orthopedic surgeon. Following an examination for patellar instability under anesthesia, diagnostic arthroscopy was performed. The arthroscope was used to assess patellar tracking, examine the integrity of the medial patellar retinaculum, and inspect the articular surfaces for signs of fracture. The osteochondral loose body was evaluated to determine if it had sufficient bone for fixation. If the fragment was larger than 1 cm^2 in size and the defect was located on the weight-bearing surface of the knee or the facet of the patella, a medial parapatellar arthrotomy was performed to access the medial patellar facet. Any fibrous tissue and frayed edges were removed from both the fragment and the parent bone. The OCF fragment was repositioned into the donor site and fixed using 3.5 mm headless screws (Acutrak Headless Compression Screw, Acumed, Hillsboro, OR) or absorbable sutures (PDS, Ethicon, Johnson & Johnson, New Jersey). If the fragment was located at the routine level of the patellar tunnel, the fracture was fixed by positioning the screws at 30-45 degree angles without changing the tunnel position. Semitendinosus was used as the graft and single patellar tunnel technique was used as the surgical approach, as described in previous studies(Figure 1).[14] Following surgery, patients were advised to wear a knee brace for the initial six weeks, engage in range of motion and isometric quadriceps exercises, and initiate mobilization with partial weight-bearing.

Evaluations

Patients underwent regular follow-up appointments at six weeks, three months, six months, and then annually following surgery. Radiological assessments of the knee joint were conducted preoperatively using native X-ray images of the knee at a 30° flexion angle, CT scans, and MRI (1.5 T) in full extension. Throughout the follow-up period, regular X-ray and MRI scans were performed to monitor fracture healing

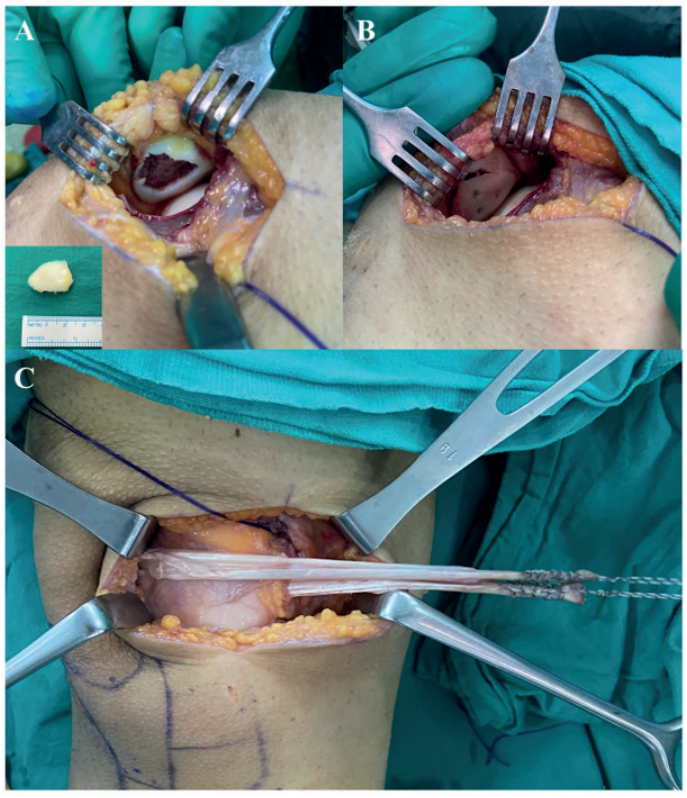

Figure 1. Intraoperative images of patellar osteochondoral fracture (A), OCF fixation (B) and simultaneous MPFL reconstruction (C).

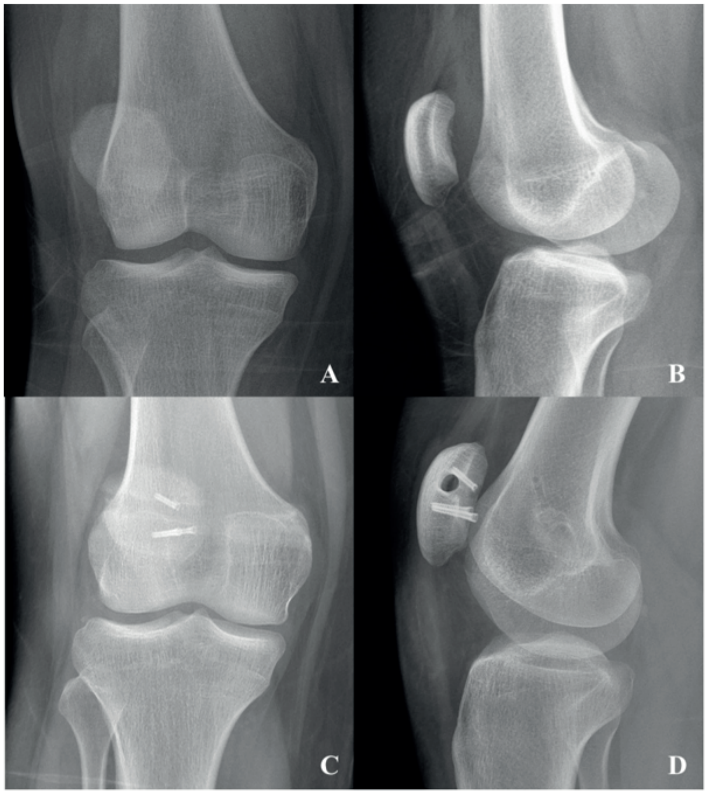

Figure 2. Comparison of preoperative AP (A), lateral (B) and final postoperative AP (C), lateral (D) radiographs

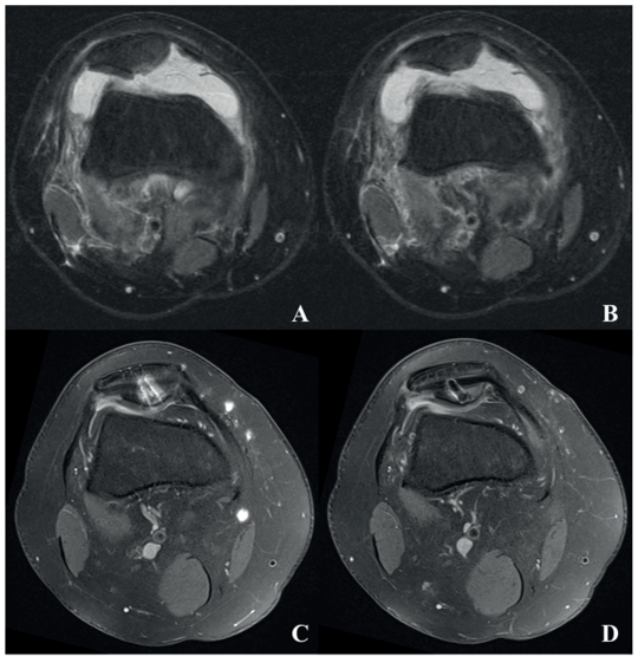

Figure 3. Comparison of preoperative axial MRI (A, B) and final postoperative axial MRI (C, D)

The Insall–Salvati index (ISI) was measured from X-ray images to evaluate the vertical position of the patella relative to the trochlea.[15] MRI was used to examine the location and size of OCFs and to identify any MPFL injuries. The three-dimensional measurements included the height, width, and depth of the loose fragment. To assess patellar lateralization, the tibial–trochlear groove (TT-TG) distance was measured using MRI. Normal TT-TG values in a pediatric population with a normal patella have been reported to range between 8.9 mm and 11.1 mm, with values exceeding 12 mm considered pathological.[16] Clinical evaluations were performed at the latest follow-up using the Lysholm and Kujala knee function scores.

Statistical Analysis

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM Corp., Armonk, NY). Continuous variables were presented as mean with standard deviation(SD), while discrete variables were expressed as frequencies and percentages. The paired sample t-test was employed to assess the differences between preoperative and postoperative functional tests. A significance level of $p < 0.05$ was considered statistically significant.

RESULTS

From 2018 to 2021, a total of twelve patients met the inclusion criteria. The demographic data and descriptive statistics of the patients are presented in Table 1.

Table 1: The demographic data and descriptive statistics

	N=12
Age (years) (mean±SD)	10.4±3.5
Sex	
Male	8 (%67)
Female	4 (%33)
Laterality	
Right	7 (%58)
Left	5 (%42)
BMI (kg/m^2) (mean±SD)	22.4±4.7
Time to operation (days)(min-max)	3.5(1-8)
Follow-up period (months)(min-max)	36.5(24-58)
Size (cm^2) (mean±SD)	2.5±1.4
Width (mm)	13.9±.1
Height (mm)	16.8±4.7
Depth (mm)	5.6±2.4
Insall-Salvati index (mean±SD)	1.1±0.1
TT-TG distance (mm) (mean±SD)	10.5±1.6

SD: standard deviation, BMI: body mass index

TT-TG: Tibial tubercle-trochlear groove

The mean age of the patients was 10.4 years (SD: 3.5 years; range, 7–15). The mean follow-up period was 36.5 months (range, 24–58). Among the patients, eight were male and four were female. Two patients had a previous history of patellar dislocation in the same knee. Preoperative MRI scans for all patients revealed patellar osteochondral fractures and bony contusions on the medial patella and lateral femoral condyle, indicative of patellar dislocation/relocation injury. All knees had OCFs larger than 1 cm, necessitating fixation. The mean dimensions of the fragments, including width, height, and depth, were 13.9 mm (SD: 3.1), 16.8 mm (SD: 4.7), and 5.6 mm (SD: 2.4), respectively. The mean surface area of the fragments was 2.5 cm^2 (SD: 1.4). While two out of 12 patellar osteochondral fractures were centrally located on the patella, 10 out of 12 (83%) were localized on the medial patellar facet. MPFL reconstruction was carried out in all patients, utilizing a semitendinosus graft. At the final postoperative examination, nine patients had painless knees, and their range of motion was comparable to that of the contralateral knee. Two patients reported pain, snapping, and a sensation of locking in the ipsilateral knee. One patient underwent second surgery due to postoperative stiffness. Arthroscopic release and debridement were carried out eight months after the initial procedure. 23 months after the initial surgery, the patient had pain-free movement of the knee. No recurrences of

patellar dislocation or signs of knee infection were seen in any patient during the follow-up period. X-ray and MRI assessments demonstrated complete healing of the fractures in all patients. The Kujala score exhibited a significant increase from an initial mean of 38.2 (SD: 13.3) to 87.6 (SD: 11) at the latest follow-up with a p-value of 0.032, while the Lysholm score also demonstrated a notable improvement, rising from an initial mean of 44.1 (SD: 10.4) to 88.2 (SD: 10.3) at the latest follow-up with a p-value of 0.021. These improvements were found to be statistically significant ($p<0.05$) (Table 2).

Table 2: Clinical results

	Preoperative	Final postoperative	p
Kujala score	38.2±13.3	87.6±11	0.032
Lysholm score	44.1±10.4	88.2±10.3	0.021

Data are presented as mean±standard deviation

DISCUSSION

The most important finding of this study is that OCF fixation and simultaneous MPFL reconstruction can be safely performed in patients with OCF due to first patellar dislocation, with satisfactory OCF healing, low incidence of recurrent instability and good clinical outcomes.

The management of OCFs of the patella can present challenges but commences with precise diagnosis. Given its common occurrence, this injury should be considered in any patient who experiences a patellar dislocation. Radiographic assessment of the knee is recommended. Moreover, an MRI can be requested to evaluate evidence of OCFs and loose fragments, which are often not visible on radiographs. Upon identifying the OCF, a decision regarding the treatment approach must be made. The choice between conservative and surgical treatment for patients experiencing a first-time acute patellar dislocation remains a topic of controversy.[17] Surgical fixation is recommended for cases of patellar dislocation complicated by OCFs, even in primary dislocations.[10] Approximately 31% of all surgical interventions related to patellar dislocation are dedicated to surgical procedures aimed at cartilage repair.[18] Buckwalter et al. argued that in the presence of large OCFs, failure to achieve effective reduction and fixation, even if fibrous cartilage forms in the fracture area, could potentially accelerate the process of articular degeneration.[19] Fragments measuring 3–4 mm in diameter could be managed conservatively or removed as loose bodies, whereas those larger than 9 mm in diameter necessitated surgical fixation.[9,20]

Several materials have been reported for the fixation of patellar OCFs, including metal screws, bioabsorbable screws or pins, and sutures.[4,7,8] The absence of comparative studies with long-term follow-up makes it challenging to recommend one implant over another.[8] Metal screws offer significant compression and stability but may lead to abrasive wear on the corresponding articular surface. In the current study, we routinely employed headless screws for fragment refixation. This technique provides adequate compression and stability, facilitating early range of motion exercises. None of the patients required removal of the implant, only one patient underwent reoperation because of postoperative stiffness.

In the current study, unlike other studies, no recurrent instability was observed. In addition, the postoperative clinical scores of all patients were significantly better than the preoperative period and there was only one patient who needed a second surgery.

Research investigations that explore recurrent instability following OCF fixation without simultaneous MPFL reconstruction consistently report elevated rates of recurrent instability. Gesslein et al. reported a redislocation rate of 43% in a cohort of 53 patients treated exclusively for OCFs.[5] A recent study by Pedowitz et al. in which OCF treatment was performed without MPFL reconstruction showed that 61% of the patients had recurrent instability at 4.1 years of follow-up, and 39% subsequently underwent MPFL reconstruction.[11] Gurusamy et al. demonstrated that MPFL reconstruction results in reduced instability compared to repair or no MPFL treatment in patients with loose bodies following dislocation. However, it's worth mentioning that only 24% of the patients in this study had their loose body fixed.[21] These findings may be attributed to studies indicating that MPFL reconstruction is more effective and successful in preventing instability compared to conservative treatment and MPFL repair.[22] Schlichte et al. documented a 22% occurrence of secondary surgeries among pediatric patients who had undergone MPFL reconstruction and OCF fixation procedures. Within this group, 8% of individuals received additional interventions for patellar stabilization, including procedures like TTO.[23] In a recent study by Aitchison et al., 28% of 40 patients who underwent OCF fixation and simultaneous MPFL reconstruction required second surgery, and only 1 of them underwent revision MPFL reconstruction.[12] Additionally, the study by Repo et al. reported that short-term results were encouraging.[13] Considering the elevated recurrence rate of patellofemoral instability in adolescents undergoing osteochondral surgery without simultaneous ligament reconstruction, there was an 89% consensus among the members of the International Patellofemoral Study Group that instability should be addressed concomitantly during OCF repair following a first-time dislocation. Among those opting for concurrent intervention, 60% indicated a preference for performing MPFL or MQTFL reconstruction.[24] These studies indicate that if the surgeon neglects to address patellar instability or malalignment following any cartilage repair technique, the outcomes are likely to be suboptimal and can impact the overall success of OCF fixation.

This study has certain limitations. The sample size is relatively small, which necessitates further investigation in the future. Additionally, this is a retrospective study without a control group. Longer-term follow-up and a comparative controlled study involving various fixation methods could yield more robust results. The findings should be confirmed in the future through prospective studies. Nonetheless, the current study offers encouraging clinical results when it comes to MPFL reconstruction and OCF fixation using headless screws. Surgeons should consider this treatment approach for individuals experiencing patellar instability and OCF.

CONCLUSION

The combination of OCF fixation using headless screws and simultaneous MPFL reconstruction proves to be a viable approach for treating OCF resulting from first patellar dislocation in children. Mid-term follow-up from the current study revealed complete recovery of knee function outcomes and no recurrence of patellar instability. However, studies with extended follow-up periods and control groups are still necessary for further validation.

Author contributions: Concept and design: NE, GA, Sİ; Supervision: Sİ, KBA; Materials: NE, GA, HÇK; Data collection and/or processing: NE, HÇK; Analysis and interpretation: NE, GA, HÇK, Sİ, KBA; Writing: NE, GA, HÇK

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