Early results of surgically treated patellar osteochondral fracture following patellar dislocation in adolescents: a case series of ten patients

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Background
Adolescents having knee ligaments laxity are more predisposed to patellar dislocation. Associated patellar osteochondral fractures (OCFs) denote a main complication. Many surgical options have been described to treat such injury. This study aimed to assess the early results of operated patellar OCFs following traumatic patellar dislocation in adolescents.

Patients and methods
Ten adolescent patients diagnosed to have patellar OCFs following traumatic patellar dislocation were surgically treated. After employing an initial arthroscopic examination, if the fragment was big enough, it was fixed by headless titanium compression screws, or else, the loose body was removed and the base was managed with microfracture. Preoperatively and postoperatively, patients evaluation was carried out using the visual analogue scale for pain and postoperatively via the International Knee Documentation Committee score.

Results
The mean follow-up was 24 months. Five of 10 patients underwent fixation, whereas the other five underwent loose fragments removal with microfracture. The median of visual analogue scale for pain scores demonstrated highly significant improvement (from 8.8 preoperative to 1.55 postoperative, P=0.002). The median International Knee Documentation Committee scores of the nonfixation and fixation group were 85.1 and 74.7, respectively (P=0.144).

Conclusion
According to this study, the surgical treatment for patellar OCFs following traumatic patellar dislocation in adolescents using headless titanium compression screws or excision and microfracture gave significant improvement. Studies with more patients' numbers and longer follow ups are still necessary to properly assess the benefits of such management protocol. Level of Evidence: IV.

Keywords:
adolescent, osteochondral fracture, patella, patellar dislocation

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Introduction

Acute patellar dislocation in early adolescence is common, with a frequency of 29–42/100 000 children under the age of 16 years [1,2]. The etiology is mainly traumatic, either direct or twisting injury. Adolescents with preexisting ligamentous laxity, patella Alta, trochlear dysplasia, and large *Q* angle are susceptible to patellar dislocation [3]. Patellar or lateral femoral condyle osteochondral fracture (OCF) represents a main complication after dislocation with a frequency from 5 to 39% [2]. The OCFs are composed of both cartilaginous and osseous parts.

This injury occurs after patellar dislocation and reduction, with the engagement of the medial patellar facet and the lateral femoral condyle producing shear stress [2]. At the initial stages of flexion, the patella is not totally engaged in the femoral sulcus. In this phase, the majority of lateral patellar dislocations occur [1,4].

In the past, OCFs were regarded as loose bodies and were simply removed, leaving a bare area of bone devoid of cartilage that can predispose to early knee osteoarthritis [5]. Many surgical options have been suggested to treat this defect, such as microfracture, fixation by means of screws or pins, allogeneic or autogenous osteochondral transplantation, and autologous chondrocyte implantation (ACI) [6–8].

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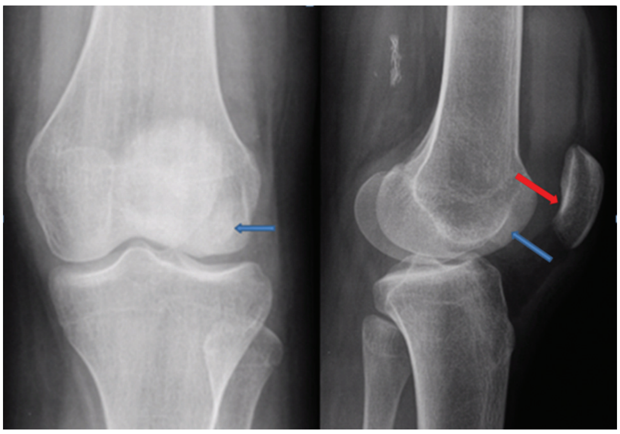
This prospective study aimed to evaluate the early results of operated patellar OCFs following traumatic patellar dislocation in adolescents. A question was raised about the value of surgery for such injury using headless titanium compression screws or excision and microfracture to improve the final clinical outcome.

Patients and methods

Between March 2013 and April 2015, 10 (seven females and three males) adolescents with a mean age of 14.4 (range: 11–16) years were treated at an academically supervised level A trauma center. The inclusion criteria were acute patellar OCF after patellar dislocation, less than 1 month from injury, with MRI scan documentation, and age less than 18 years. Prior ipsilateral knee surgery was an exclusion criterion.

Seven patients had right patellar dislocation and three left. The injury mechanism was twisting in seven and a direct trauma in three patients. On initial clinical evaluation, the patella was dislocated in two patients with swollen flexed knee needing instant reduction, and in eight patients, as stated by the patient, a spontaneous reduction occurred at the scene of injury. Four patients had intense hemarthrosis that was treated by aspiration with the aid of local anesthesia. Full radiographic knee assessment of all patients included anteroposterior, tangential, and lateral views (Fig. 1). Preoperative knee MRI scans were performed to settle the diagnosis, reveal the magnitude of cartilage damage, and exclude any associated cruciate or collateral ligaments injury (Fig. 2). The mean time from trauma to operation was 2 (range: 1–4) days. Patients' characteristics are presented in Table 1.

Figure 1



Preoperative plain radiographs showing the osteochondral fragment (blue arrows) and the patellar defect (red arrow).

In the operative room, lateral patellar stability was examined under anesthesia before preparation and draping. A diagnostic knee arthroscopy was done to evaluate patella tracking and the medial patellar retinaculum integrity. Small fragments were recognized and removed. The articular surfaces, especially of the lateral femoral condyle and medial patellar facets, were also inspected for evidence of cracking. The OCF was checked to ascertain whether it contained enough bone to support internal fixation. In this case, a medial parapatellar arthrotomy to access the medial patellar facet was made (Fig. 3a). The OCF was reduced to its bed and fixed with 2–3 headless titanium compression screws (7s Medical, Schenkon, Switzerland) (Fig. 3a–e). If it did not bear enough bone surface area for fixation, the loose adjoining cartilage was debrided and a microfracture procedure was used with an awl at its bed to stimulate a reparative fibrocartilaginous response. If the patella demonstrated lateral instability, the medial patellofemoral ligament (MPFL) was repaired by direct sutures and the medial capsule was tightened in a pants-over-vest fashion.

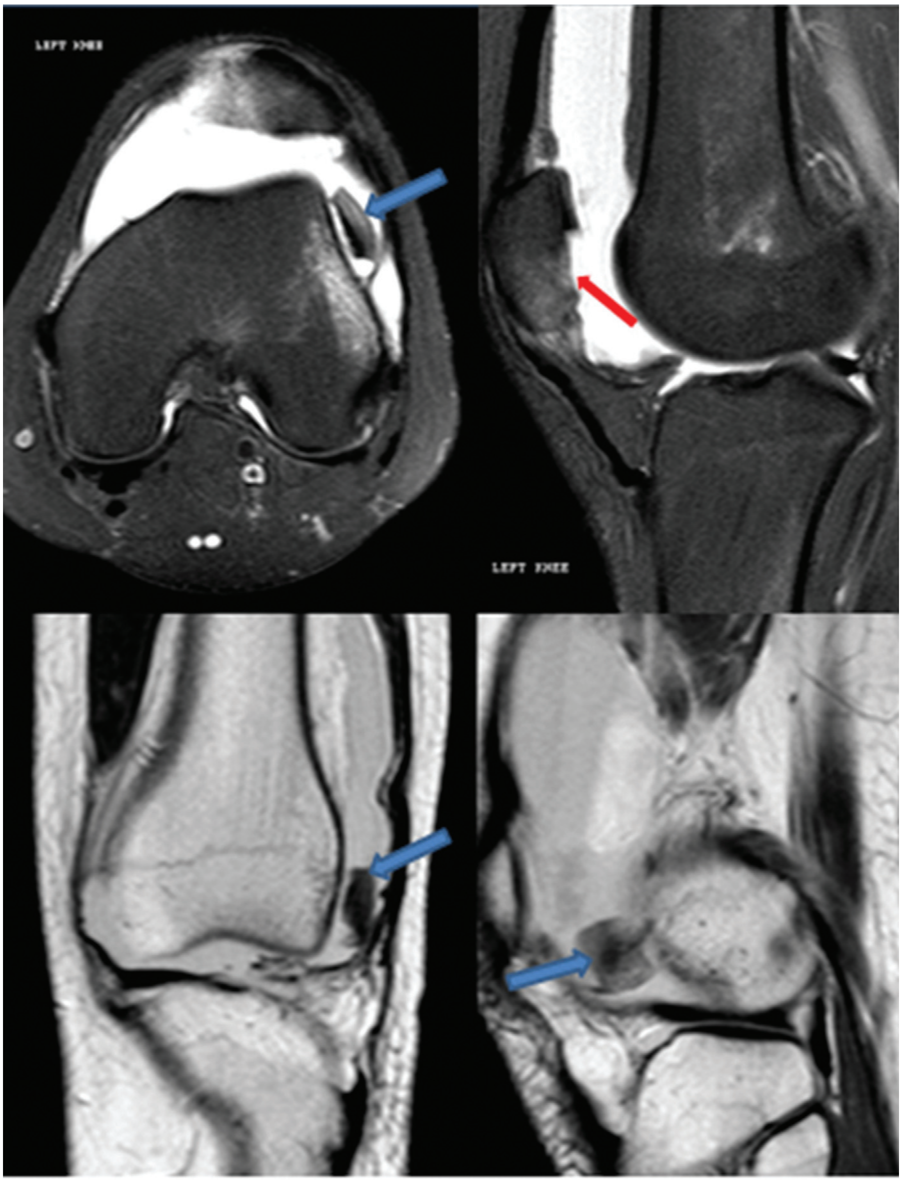
Postoperatively, fixation group patients were permitted weight bearing as tolerated in an extension knee brace and had passive range of motion and isometric quadriceps exercises for 6 weeks. For the next 6 weeks, they marched on to open chain exercises and gentle strengthening till full strengthening beginning after 3 months. For the nonfixation group, patients were immobilized for 2 postoperative days to stabilize the blood clot. Nonweight bearing was used in the first 6 postoperative weeks. Continuous passive motion machine was used from the third postoperative day and for at least 6–8 h/day for 6 weeks to stimulate chondrogenic matrix production under biological pressure and deforming forces. Gradual weight bearing, active movement, and gentle strengthening exercises were allowed from the seventh week till full strengthening beginning after 3 months.

Bone healing was assessed using plain radiographs monthly after surgery for 6 months and knee MRI scan was done at 6 months after surgery. Preoperatively and at the third month follow-up visit, the patients were requested to complete a visual analogue scale (VAS) for pain. In addition, at the last follow-up, the International Knee Documentation Committee (IKDC) form was applied to evaluate the result.

Statistical analysis

VAS scores were expressed in medians. A nonparametric equivalent for paired *t*-test, Wilcoxon signed-rank test, was used to assess the difference

Figure 2



Preoperative MRI showing the osteochondral fractures fragment (blue arrows) and the patellar defect (red arrow).

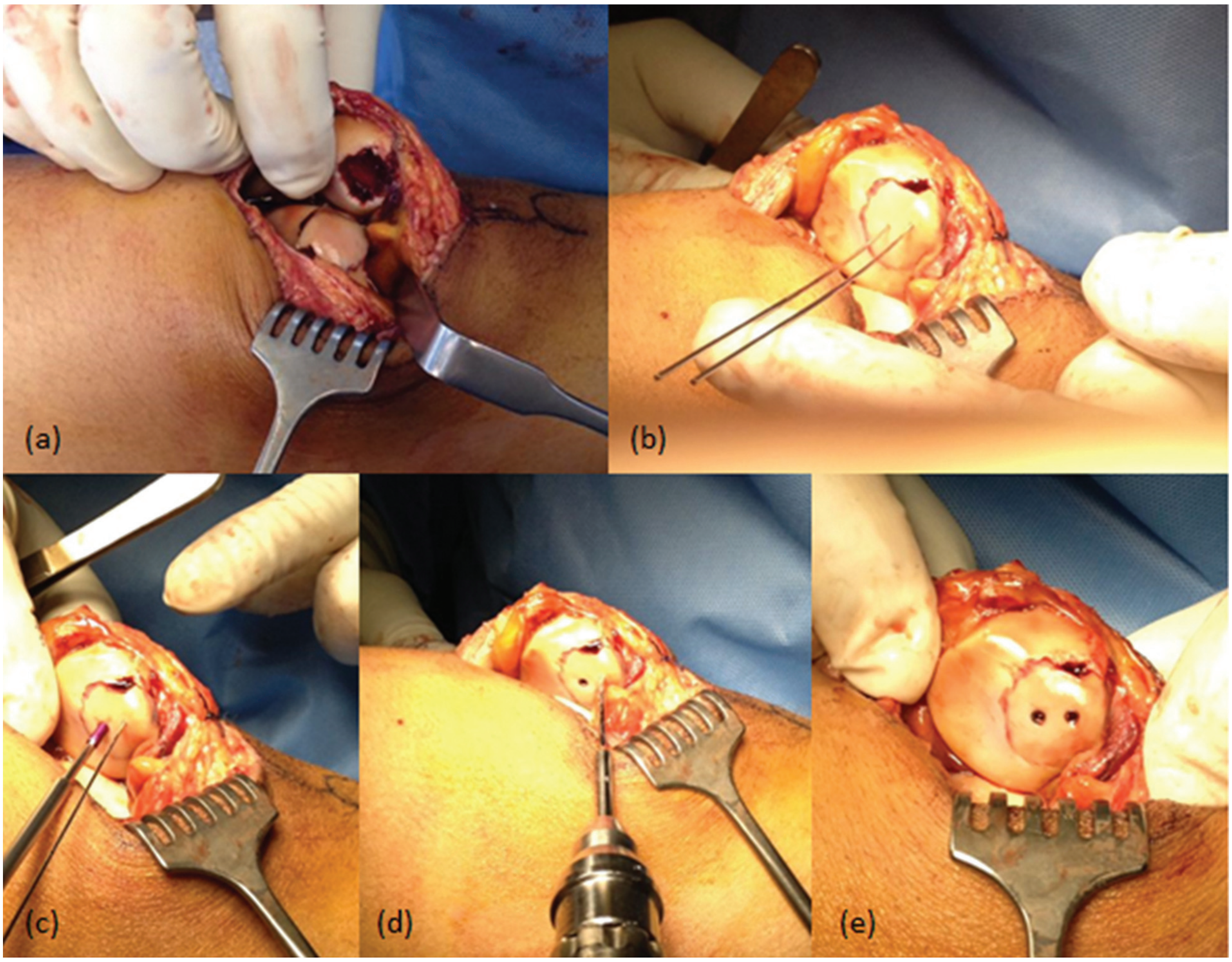
Table 1 Patient characteristics

Characteristic	1	2	3	4	5	6	7	8	9	10
Age (years)	11	13	14	15	16	15	16	15	14	15
Sex	Female	Female	Male	Female	Female	Male	Male	Female	Female	Female
Side	Right	Right	Right	Left	Left	Right	Left	Right	Right	Right
Mech. Of inj.	Tw.	Tw.	Tw.	Tr.	Tw.	Tr.	Tr.	Tw.	Tw.	Tw.
Inj.-Surg. (d)	1	2	1	3	2	2	1	1	3	4
Init. reduced	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
FU (months)	36	12	24	30	24	18	18	12	30	36

FU, follow up; Init. reduced, Initially reduced; Inj.-Surg. (d), Injury-Surgey (days); Mech. Of inj., Mechanism of injury; Tr., Direct trauma; Tw., Twisting.

significance in VAS scores between preoperative and follow-up measurements. Postoperative IKDC scores were expressed in medians. A nonparametric equivalent for *t*-test, Mann–Whitney test, was used to assess the difference significance in IKDC scores between fixation and nonfixation groups. The *P* value was set at 0.05, so that *P* values of at least 0.05 are statistically nonsignificant, *P* values less than 0.05 are significant, and *P* values less than 0.01 are highly significant.

Figure 3



Fixation of the OCF to its bed using two headless compression screws. (a) Medial parapatellar arthrotomy with the OCF fragment and its bed in the patella revealed. (b) Reduction of the fractured fragment and provisional fixation using two guide wires. (c) Driving the first headless compression screw. (d) Cannulated drill bit for the second screw. (e) Final picture with fragment properly reduced and fixed.

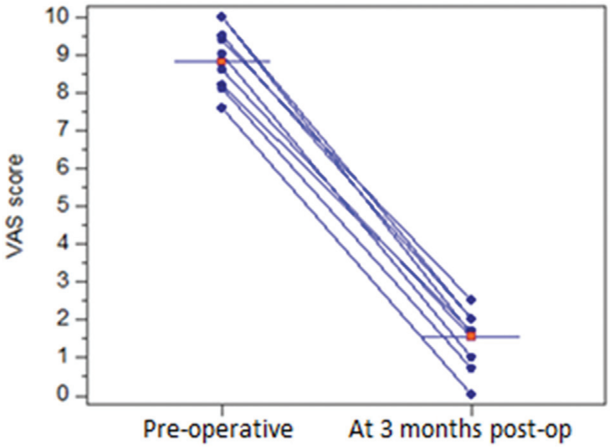
Results

The average follow-up period was 24 (range: 12–36) months. No patients experienced previous ipsilateral patellar dislocation. Preoperative radiographs allowed diagnosis of the OCF in some but not all the patients (six out of 10). In all patients, preoperative MRI was pathognomonic and confirmed the diagnosis and revealed evidence of dislocation and relocation injury, including bone marrow edema of the anterolateral aspect of the lateral femoral condyle and the medial patellar facet in combination with OCFs and injury to the knee medial soft-tissue stabilizers and hemarthrosis. Two patellar OCFs were located centrally and the remaining eight were localized to the medial patellar facet.

Five of the 10 patients were determined to have OCFs with enough subchondral bone justifying fixation with headless titanium compression screws. The remaining patients had too small chondral fragments or fragments with only tiny bony layer which did not allow secure fixation for osseous healing. All fixation group patients underwent a concomitant MPFL repair, whereas only one patient in the nonfixation group required an open MPFL repair. The average defect size in this group was 1.3 (range: 1–1.5) cm^2 compared with 3 (range: 1.5–5.5) cm^2 in the fixation group. No surgical complications or difficulties were met in any patient.

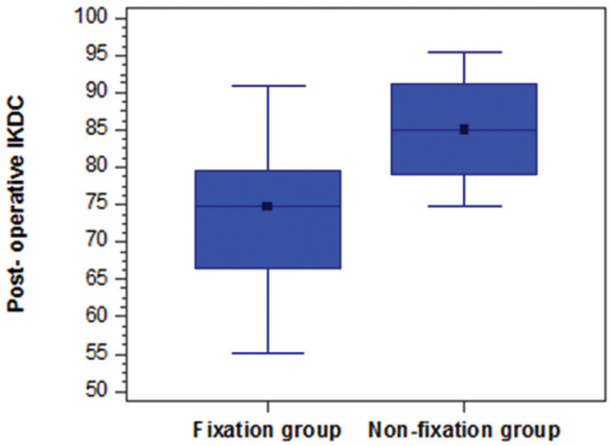
The median of VAS for pain scores demonstrated highly significant improvement (from 8.8 preoperative to 1.55 postoperative, P=0.002, highly significant) (Fig. 4). At final follow-up, all patients were doing well with an almost painless knee range of motion and resumed their normal activity. The median of the IKDC scores for the nonfixation group was 85.1 and that for the fixation group was 74.7 (P=0.144, NS) (Fig. 5).

Figure 4



Preoperative and 3-month postoperative follow-up visual analogue scale scores (markers indicating medians).

Figure 5



Postoperative International Knee Documentation Committee scores in fixation and nonfixation groups. Median values are indicated by horizontal lines with markers in the center. The horizontal boundaries of the boxes represent the interquartile range (first and third quartiles).

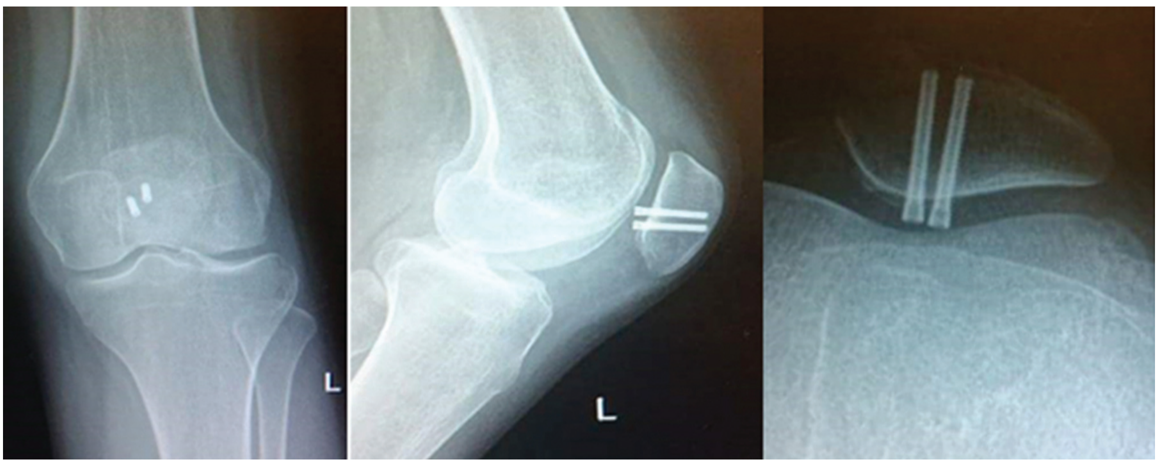
Follow-up radiographs showed complete fracture consolidation of OCFs within 8–12 weeks with no significant arthritis at the last follow-up visits in any patient (Fig. 6). Postoperative MRI scans confirmed the fragments' consolidation with congruent intact articular cartilage surfaces with minor areas of thinning but no areas of full-thickness loss. No patients in both groups sustained re-dislocation till the last follow-up. No patients in the fixation group had symptoms requiring hardware removal. At early follow-up, although slight quadriceps muscle atrophy was detected in all patients, full muscle strength was restored 2–4 weeks after active exercises. No sign of knee infection was noticed in any patient.

Discussion

Patellar osteochondral injuries are relatively common sequelae after lateral patellar dislocations. Managing these injuries begins with accurate diagnosis. Based on its high prevalence, a great degree of suspicion should be employed in any patient sustaining patellar dislocation. Fracture evidence can be seen by the occurrence of a loose fragment or patellar subchondral bone irregularity. Plain radiographs often misjudge the displaced fragments size; therefore, clinical signs such as hemarthrosis and the awareness of such injuries are the key to proper diagnosis of OCFs. In addition, an MRI should be done to evaluate the OCFs, loose bodies, and the medial patellar stabilizers [9].

The treatment is whether to excise the loose fragment, fix it back to its bed, or use a biological way of treatment such as ACI [10]. Fragment excision may predispose to patellofemoral arthrosis. Technical difficulties may

Figure 6



12-week postoperative plain radiographs showing complete healing of osteochondral fragment without significant arthritis.

prevent proper fragment fixation. According to some reports, purely chondral fragments could heal [11,12], but the general consensus is that osseous healing is essential for adequate fixation. The main challenge with treating this fracture is the existence of only a tiny layer of bone attached to the larger chondral component. This makes attaining rigid fixation more difficult [13].

In the past few years, numerous studies reported this injury as a case report or small number case study, including multiple fixation techniques as the usage of suture, metal screws, bioabsorbable pins, and fibrin glue [13–21].

The goal of an MPFL repair is to bring back the medial soft-tissue patellar stability, which is injured during patellar dislocation. Few of the published reports have age ranges to contain the skeletally immature patient, and none stratify findings to separate by age [22]. In this study, if the patella demonstrated lateral instability, the MPFL was repaired. No patient sustained re-dislocation till the last follow-up.

This study results are quite satisfactory and similar to many recent studies concerned with managing such injury. Comparing the preoperative and postoperative medians of VAS for pain scores for the 10 patients demonstrated highly significant improvement (from 8.8 preoperative to 1.55 postoperative, P=0.002). In the study done by Gkiokas *et al.* [23], using bioabsorbable pins in 18 adolescents, the VAS for pain demonstrated significant improvement (from 8.6 preoperative to 1.2 postoperative, $P<0.005$). In this study, comparing the medians of final IKDC scores for the fixation and nonfixation group demonstrated a better result of the nonfixation group (85.1) than that of the fixation group (74.7), but this difference was statistically nonsignificant (P=0.144). In the study done by Lee *et al.* [24], the final IKDC scores showed a better result of the nonfixation group (76.1) than that of the fixation group (63.9). This may be explained by the more severe injuries in the fixation group.

This study has some limitations, including the small patient number and the relatively short-term follow-up, with an average of 24 months, which may not reveal mid-term to long-term outcomes to draw significant conclusions. Further studies with larger patient numbers and extended periods of follow-up are needed. Another shortcoming of this study is the potential need of metal hardware removal. However, the relatively higher cost of other modalities of treatment such as biodegradable pins and ACI is in favor of headless screws use. In addition, synovitis or foreign body response may be associated with biodegradable pins, as reported in the literature [25–27].

Conclusion

According to this study, the treatment for patellar OCFs following traumatic patellar dislocation in adolescents using headless titanium compression screws or excision and microfracture gave significant improvement with a relative efficacy, safety, and cost-effectiveness. Studies with larger patient numbers and longer follow-up are still required to properly assess the benefits of this management protocol.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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