

Management of traumatic patellar dislocation in a regional hospital in Hong Kong

HL Lee *, WP Yau

ABSTRACT

Introduction: The role of surgery for acute patellar dislocation without osteochondral fracture is controversial. The aim of this study was to report the short-term results of management of patellar dislocation in our institute.

Methods: Patients who were seen in our institution with patella dislocation from January 2011 to April 2014 were managed according to a standardised management algorithm. Pretreatment and 1-year post-treatment International Knee Documentation Committee score, Tegner activity level scale score, and presence of apprehension sign were analysed.

Results: A total of 41 patients were studied of whom 20 were first-time dislocators and 21 were recurrent dislocators. Among the first-time dislocators, there was a significant difference between patients who received conservative treatment versus surgical management. The conservative treatment group had a 33% recurrent dislocation rate, whereas there were no recurrent dislocations in the surgery group. There was no difference in Tegner activity level scale score or apprehension sign before and 1 year after treatment, however. Among the recurrent dislocators, there was a significant difference between those who

received conservative treatment and those who underwent surgery. The recurrent dislocation rate was 71% in the conservative treatment group versus 0% in the surgery group. There was also significant improvement in International Knee Documentation Committee score from 67.7 to 80.0 ($P=0.02$), and of apprehension sign from 62% to 0% ($P<0.01$).

Conclusions: A management algorithm for patellar dislocation is described. Surgery is preferable to conservative treatment in patients who have recurrent patellar dislocation, and may also be preferable for those who have an acute dislocation.

Hong Kong Med J 2017;23:122–8

DOI: 10.12809/hkmj164872

HL Lee *, FHKCOS, FHKAM (Orthopaedic Surgery)

WP Yau, FHKCOS, FHKAM (Orthopaedic Surgery)

Division of Sports and Arthroscopic Surgery, Department of Orthopaedics and Traumatology, Queen Mary Hospital, Hong Kong

This paper was presented at the Hong Kong Orthopaedic Association 35th Annual Congress, 7 November 2015, Hong Kong.

* Corresponding author: ricklhl@gmail.com

▶ A video clip showing management of traumatic patellar dislocation is available at www.hkmj.org



This article was published on 12 Dec 2016 at www.hkmj.org.

New knowledge added by this study

- This study reveals the short-term results regarding local management of traumatic patellar dislocation. A suggested treatment algorithm is provided that can help approach this problem systematically.

Implications for clinical practice or policy

- The results of this study support surgery as the first-line treatment of recurrent patellar dislocation. It is inconclusive whether conservative treatment or surgery is preferable in first-time dislocators although there is a trend towards better results with surgery.

Introduction

Patellar dislocation is a common injury in young, active individuals and accounts for approximately 3% of all knee injuries. The overall incidence is about 1 in 1000.^{1,2} Without appropriate treatment, these injuries may result in significant morbidity, including significant limitations in activity and patellofemoral arthritis.^{3,4} The management of patellar dislocation must take into account numerous clinical factors including the number of dislocations, chronicity of the dislocation, bony alignment, and status of the articular cartilage.

The management of acute first-time patellar dislocators is controversial. Traditionally, these

patients have been managed conservatively but the results of such treatment are highly variable and unpredictable. The recurrent instability rate following conservative treatment in these patients has been reported to be between 17% and 44%.^{1,5} Limitation of strenuous activity after conservative treatment was reported in 58% of these patients, and failure to return to sports activity in 55%.⁴ Therefore some authors have recommended early primary surgical stabilisation for this group of patients.^{3,6,7} Surgery is also indicated in patients who have concomitant osteochondral fractures.⁸

The management of recurrent patellar dislocators is less controversial. Studies have shown

that in patients who have had two dislocations, the risk of further dislocation is as high as 50%.¹ Most surgeons would recommend surgical stabilisation for these patients.

The aim of this study was to review and document the short-term results of management of patients with traumatic patellar dislocations in our institute, which is a university hospital that serves as a tertiary and quaternary referral centre in Hong Kong.

Methods

Patients with patellar dislocation who were seen in our institution from January 2011 to April 2014 were included in the current study. All patients were cared for according to the institution's patellar dislocation management algorithm (Fig).

Patients followed up for less than 1 year were excluded from the study. Those who had chronic dislocations (persistent dislocation for more than 6 weeks' duration) and a history of patellar surgery or osteochondral fracture detected on X-ray were also excluded.

The patellar dislocation management algorithm used in our institution is as follows. Patients are first categorised as first-time dislocators or recurrent dislocators. First-time dislocators are further subcategorised as an acute dislocator or subacute dislocator according to the time interval between presentation and time of injury. If this time interval is 3 weeks or less, they are considered acute dislocators; if more than 3 weeks, they are

香港一所分區醫院對創傷性髌骨脫位的治理

李顯倫、丘偉鵬

引言：對於沒有骨軟骨骨折的急性髌骨脫位是否應施以手術具爭議性。本研究報告我們醫院處理髌骨脫位的短期結果。

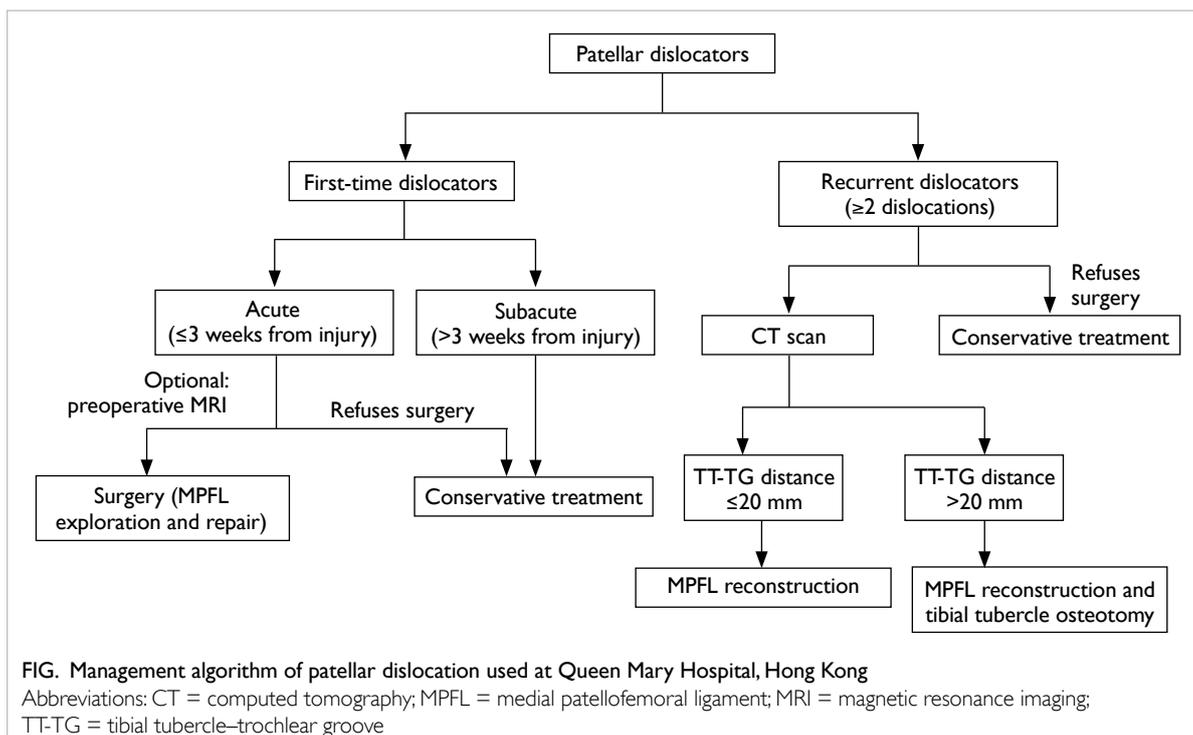
方法：我們根據標準管理方法治理2011年1月至2014年4月期間因髌骨脫位入院的患者，並分析患者治療前和治療1年後的國際膝關節文獻委員會（IKDC）評分、Tegner活動水平和髌骨恐懼試驗的結果。

結果：41例中20例屬首次髌骨脫位，其餘21例屬復發性髌骨脫位。首次髌骨脫位的患者中接受保守治療和進行手術的患者有顯著差異；前者的脫位復發率為33%，後者則沒有復發性脫位的病例。然而，兩組的Tegner活動水平和髌骨恐懼試驗方面在治療前後沒有分別。復發性脫位的患者中，接受保守治療和進行手術的患者有顯著差異；前者的脫位復發率為71%，後者則沒有復發性脫位的病例。IKDC評分由治療前的67.7分升至治療後的80.0分（ $P=0.02$ ），而髌骨恐懼試驗結果則由治療前的62%減至治療後的0%（ $P<0.01$ ）。

結論：本文描述了髌骨脫位的處理方法。如果出現復發性脫位，手術會比保守治療優勝，對於急性脫位患者也可能較為適合。

subcategorised as subacute dislocators.

For first-time acute dislocators, medial patellofemoral ligament (MPFL) repair surgery is advised. Preoperative magnetic resonance imaging (MRI) is not routinely performed. The exact site of MPFL tear is identified intra-operatively by combining knee arthroscopy and MPFL endoscopy. If the MPFL is found avulsed at the femoral origin or



patellar insertion, it is repaired to bone using suture anchors. If the MPFL is torn at mid-substance, a direct end-to-end repair is performed. Minimal plication of the medial retinaculum was observed in all our cases. A hinged knee brace from full extension to 20-degree flexion is applied for 3 weeks, followed by patellar stabilisation orthosis for another 3 weeks. Supervised physiotherapy in terms of quadriceps strengthening exercises, range of motion training, and patellar mobilisation exercises is offered for 3 to 6 months and the patient is also advised to avoid pivoting sports for at least 6 months.

For first-time subacute dislocators, conservative treatment is offered. This includes wearing of a patellar stabilisation orthosis for a total of 6 weeks after the dislocation and a period of supervised physiotherapy (focusing on quadriceps strengthening exercises and range of motion training) for at least 6 weeks to 3 months. Patients are advised to avoid any pivoting sports for a total of 6 months. A similar regimen of conservative treatment is offered to those first-time acute dislocators who refuse surgical intervention. The whole course of rehabilitation usually lasts 4 to 6 months before the patient is permitted to resume full activity.

For recurrent dislocators, patients are advised to have MPFL reconstruction. Plain computed tomography of the knee is performed to measure the tibial tubercle–trochlear groove (TT-TG) distance. If this distance measures ≤ 20 mm, MPFL reconstruction surgery is advised. If this distance measures > 20 mm, MPFL reconstruction and tibial tubercle osteotomy surgery for anteromedialisation of the tibial tubercle are advised. The rehabilitation protocol following MPFL reconstruction is the same as that for MPFL repair. For recurrent dislocators who refuse surgery, conservative treatment is advised. This consists of a 3- to 6-month course of supervised physiotherapy.

The following outcome measures were recorded before treatment and 1 year after treatment in our study patients: (1) International Knee Documentation Committee (IKDC) score; (2) Tegner activity level scale score; and (3) presence of apprehension sign on physical examination. The redislocation rate at 1 year after treatment was also measured for the different groups of treatment.

The IKDC score is a knee-specific self-evaluation score for reporting patient symptoms, function, and sports activity.⁹ Tegner activity level scale score is a functional score describing a patient's activity level.¹⁰ The presence of apprehension sign was documented by one of the two observers, who were experienced sports surgeons in the authors' institute. The test was performed with the patient lying supine on the examination couch. The knee was passively flexed to 20 degrees. A lateral displacing force was applied manually on the medial side of

patella in an attempt to sublux the patella laterally. Apprehension sign was defined as positive if the patient reported a sense of subluxation or attempted to stop the examiner.

Data were analysed and compared with the Statistical Package for the Social Sciences (Windows version 23.0; SPSS Inc, Chicago [IL], US). The Wilcoxon signed-rank test (non-parametric, paired samples test) was used to compare IKDC score and Tegner activity level scale results before and after treatment within the same treatment group. The McNemar test (non-parametric, paired samples test) was used to compare the percentage of patients with apprehension sign before and after treatment within the same treatment group. The Mann-Whitney *U* test (non-parametric, independent samples test) was used to compare IKDC score as well as Tegner activity level scale results between conservative treatment group and surgery group. The Pearson's Chi squared test (non-parametric, independent samples test) was used to compare the percentage of patients with apprehension sign as well as recurrent dislocation rate between conservative treatment group and surgery group. Whenever expected counts were less than five, Fisher's exact test was used instead of Pearson's Chi squared test. This study was done in accordance with the principles outlined in the Declaration of Helsinki.

Results

A total of 81 patients were identified. Of these, 40 patients were excluded—27 were excluded due to follow-up of less than 1 year, six due to osteochondral injury detected by X-ray, three due to chronic dislocation, two due to development of patellofemoral osteoarthritis, and two due to a history of patellar surgery (Table 1). This left us with 41 patients comprising 17 males and 24 females. Their mean age was 23.6 years (range, 13-44; standard deviation, 7.4 years). A summary of patient demographics is shown in Table 2.

There were 20 patients who were first-time dislocators and 21 patients who were recurrent dislocators. Among the first-time dislocators ($n=20$), 45% ($n=9$) were treated conservatively and 55% ($n=11$) were treated with MPFL repair surgery. Among the recurrent dislocators, 33% ($n=7$) were treated conservatively, 62% ($n=13$) were treated with MPFL reconstruction surgery, and 5% ($n=1$) were treated with combined tibial tubercle osteotomy and MPFL reconstruction surgery. Their results are summarised in Table 3.

Among the first-time dislocators who received conservative treatment ($n=9$), recurrent dislocation occurred in 33% ($n=3$) within 1 year of treatment. The findings are shown in Table 3. There were no statistically significant differences between the

TABLE 1. Patients excluded

Reason of exclusion	No. of patients	Conservative vs surgery	No. of recurrent patellar dislocation
Follow-up <1 year	27	Conservative: 25 Surgery: 2	1
Preoperative X-rays showing osteochondral fracture	6	Conservative: 2 Surgery: 4	0
Chronic patellar dislocation	3	Conservative: 3 Surgery: 0	-
Patellofemoral joint arthritis	2	Conservative: 2 Surgery: 0	1
History of patellar surgery	2	Conservative: 2 Surgery: 0	2

TABLE 2. Patient demographics

	No. of patients	Age at index management (years)*	Sex (male / female)	First dislocation at ≤20 years old
First-time patellar dislocation	20	22 ± 8 (13-42)	8 / 12	11 out of 20
Conservative group	9	24 ± 9 (15-42)	4 / 5	5 out of 9
Surgery group (MPFL repair)	11	21 ± 6 (13-32)	4 / 7	6 out of 11
P value†		0.67‡	0.54§	0.66§
Recurrent patellar dislocation	21	25 ± 7 (18-44)	9 / 12	17 out of 20¶
Conservative group	7	27 ± 10 (18-44)	3 / 4	5 out of 6¶
Surgery group (MPFL reconstruction)	13	24 ± 5 (19-34)	6 / 7	11 out of 13
P value†		0.94‡	0.63§	0.71§

Abbreviation: MPFL = medial patellofemoral ligament

* Mean ± standard deviation (range), unless otherwise indicated

† Statistical comparison between conservative group and surgery group

‡ Mann-Whitney U test

§ Fisher's exact test

|| Including one patient with MPFL reconstruction + Fulkerson osteotomy which was not statistically analysed

¶ No record in first dislocation in one case

TABLE 3. Results of different groups of patients preoperatively and 1 year post-treatment*

	IKDC score, mean ± SD (range)		Tegner activity level scale score, mean ± SD (range)		Apprehension sign		Recurrent dislocations
	Pretreatment	1 Year	Pre-treatment	1 Year	Pre-treatment	1 Year	
First-time dislocators							
Conservative (n=9)	N/A	82.5 ± 11.5 (63.2-95.4)	4.1 ± 2.5 (1-7)	3.1 ± 2.3 (1-7)	22%	33%	33%
MPFL repair (n=11)	N/A	83.6 ± 9.2 (73.5-100)	4.8 ± 2.3 (2-9)	4.1 ± 2.0 (2-7)	88%	9%	0%
Recurrent dislocators							
Conservative (n=7)	60.6 ± 15.2 (37.9-77.0)	67.7 ± 9.9 (49.4-79.3)	3.7 ± 2.6 (1-7)	2.0 ± 2.5 (1-7)	14%	29%	71%
MPFL reconstruction (n=13)	67.7 ± 14.2 (42.5-90.8)	80.0 ± 10.5 (60.9-100)	3.5 ± 2.6 (1-9)	5.0 ± 2.4 (2-9)	62%	0%	0%
		↕ P=0.02					↕ P<0.01
	↔ P=0.02		↔ P=0.04		↔ P<0.01		

Abbreviations: IKDC = International Knee Documentation Committee; MPFL = medial patellofemoral ligament; N/A = not available; SD = standard deviation

* Only P values of significant findings are shown

Tegner activity level scale or percentage of patients with apprehension sign before and 1 year after treatment.

Among the first-time dislocators who underwent MPFL repair surgery (n=11), intra-operative MPFL exploration showed 55% (n=6) of

them had tears at the patellar insertion, 27% (n=3) had MPFL tear at the femoral origin, and 18% (n=2) had MPFL mid-substance tear (one of which was only a partial mid-substance tear). Preoperative MRI was performed in seven of the 11 patients. Among six of these seven patients, MPFL detected on preoperative MRI correlated with the tear site on intra-operative MPFL exploration. In the remaining patient, only a partial tear of MPFL at mid-substance was found intra-operatively; this was not detected by the preoperative MRI. Regarding the outcome of surgery, there were no recurrent dislocations within 1 year of surgery (Table 3). Apprehension sign was present in 88% before surgery and 9% 1 year after surgery ($P=0.07$, McNemar test). There were no statistically significant differences between the Tegner activity level scale or percentage of patients with apprehension sign before and 1 year after surgery.

Comparison of first-time dislocators who received conservative treatment with first-time dislocators who underwent MPFL repair surgery 1 year after treatment revealed no significant difference in IKDC score. There was a lower percentage of patients with apprehension sign (9% vs 33%) and a lower rate of redislocation in the MPFL repair surgery group (0% vs 33%, $P=0.07$, Fisher's exact test) but the differences were not statistically significant.

Among the recurrent dislocators who received conservative treatment (n=7), recurrent dislocation occurred in 71% (n=5) of patients within 1 year of treatment (Table 3). Apprehension sign was present in 14% before treatment and 29% 1 year after treatment. There was no statistically significant difference between the IKDC score, Tegner activity level scale, or percentage of patients with apprehension sign before and 1 year after treatment.

Among the recurrent dislocators who underwent MPFL reconstruction surgery (n=13), there were no recurrent dislocations within 1 year of surgery (Table 3). Apprehension sign was present in 62% before surgery and no patients had apprehension sign 1 year after surgery. There were statistically significant improvements in the IKDC score ($P=0.02$, Wilcoxon signed-rank test), Tegner activity level scale score ($P=0.04$, Wilcoxon signed-rank test), as well as percentage of patients with apprehension sign ($P<0.01$, McNemar test).

One year after treatment, comparison of recurrent dislocators who received conservative treatment with recurrent dislocators who underwent MPFL reconstruction surgery revealed that the mean IKDC score was significantly better in the MPFL reconstruction surgery group (80.0 vs 67.7; $P=0.02$, Mann-Whitney U test). The redislocation rate was significantly lower in the MPFL reconstruction surgery group (0% vs 71%; $P<0.01$, Fisher's exact test). There was a lower percentage of patients with

apprehension sign in the MPFL reconstruction surgery group (0% vs 29%) although the difference was not statistically significant.

Discussion

For acute first-time patellar dislocators, it has been widely agreed that in the presence of concomitant osteochondral fracture, surgical treatment is indicated.¹¹ The indication of surgery for acute first-time patellar dislocators without osteochondral fractures is controversial. The recurrent instability rate after conservative treatment in these patients has been reported to be 17% to 44%.¹⁵ It has traditionally been held that these patients should be treated conservatively.¹¹ Nine prospective randomised controlled trials have compared conservative and surgical treatment in first-time dislocators and the results have been inconsistent.¹²⁻²⁰ In their systematic review, Stefancin and Parker¹¹ recommended conservative treatment for most patients after first-time dislocation, except those with concomitant osteochondral fracture and those with significant medial soft tissue damage who may benefit more from surgical treatment. Smith et al²¹ reviewed 11 studies that included five randomised controlled trials. They found that surgical treatment of patellar dislocation was associated with a significantly higher risk of patellofemoral joint osteoarthritis but a significantly lower risk of subsequent patellar dislocation compared with conservative treatment.²¹ A recent Cochrane review of six studies with 344 participants found that participants managed surgically had a significantly lower risk of recurrent dislocation following first-time dislocation at 2 to 9 years of follow-up compared with those managed conservatively.²² There were no differences in physical function scores. The authors, however, pointed out that the quality of evidence was very low because of the high risk of bias and the imprecision of the effect estimates.²² They recommended that adequately powered, multicentre, randomised controlled trials are needed to substantiate this evidence.²² Erickson et al²³ carried out a systematic review of four meta-analyses on surgical treatment of first-time patellar dislocations. Three meta-analyses showed a lower subsequent patellar dislocation rate in first-time dislocators managed surgically compared with those managed conservatively, whereas one meta-analysis did not show any difference in redislocation rates. Using the combined results of all studies, the overall recurrent dislocation rate was 24% in the surgery group and 34.6% in the conservative treatment group. One meta-analysis found a significantly higher rate of patellofemoral osteoarthritis in the surgery group. There were no differences in functional outcome scores between the conservative treatment group and surgery group.²³ Our study showed that

conservative treatment and surgical treatment were both effective in restoring knee function at 1-year follow-up. Nonetheless there was a trend towards a lower rate of redislocation in the MPFL repair surgery group, although it did not reach statistical significance. This suggests that operative treatment may be more beneficial for this group of patients.

In the current study, for first-time dislocators with delayed presentation of more than 3 weeks, conservative treatment was advised. This was because a certain degree of healing of the torn MPFL in the elongated position with a variable amount of scar tissue in the gap was anticipated if the patient presented subacutely. As the operative protocol of direct repair of MPFL was adopted in this study, the presence of partial healing in an elongated position affects the decision of correct tension in the MPFL during direct repair. As a result, a conservative approach was adopted to minimise the possibility of overtensioning (which might lead to medial patello-femoral joint pain) or undertensioning (which might lead to recurrent instability).

For recurrent patellar dislocators, studies have shown a redislocation rate of up to 50%.¹ Therefore, it has been widely agreed that recurrent dislocation is a strong indication for surgical treatment.²⁴ Reconstruction of MPFL, tibial tubercle osteotomy, and trochleoplasty have all been well-described surgical procedures for management of recurrent patellar dislocators. Reconstruction of MPFL alone is indicated in the presence of a physiological TT-TG distance (<20 mm) and no significant trochlear dysplasia.²⁵ Patients with increased TT-TG distance of >15 to 20 mm have been shown to have patellar instability.²⁶ Thus, tibial tubercle osteotomy procedures, aiming to shift the tibial tubercle medially to correct the TT-TG distance to within physiological limits of around 9 to 15 mm, with or without concomitant MPFL reconstruction have been advocated for these patients.²⁵ The cut-off point of 20 mm above which tibial tubercle osteotomy is indicated has been well accepted by most orthopaedic surgeons.²⁶⁻³⁰ One study has shown that 18% of recurrent patellar dislocators had TT-TG distances of >20 mm.³¹ For patients with significant trochlear dysplasia, trochleoplasty procedures have been advocated.²⁵ There have been no prospective randomised controlled trials to date comparing conservative treatment and the various surgical treatment modalities for recurrent patellar dislocators. Short-term results of these various surgical procedures have been satisfactory, however. Our study demonstrated similar results to the current literature, showing a clear advantage in terms of knee function, return to activity, and apprehension in the MPFL reconstruction surgery group compared with the conservative treatment group.

There are several limitations of this study. First, the sample size was small and a large number of patients were lost to follow-up, making the study underpowered. This was reflected by the non-significant finding in the positive apprehension sign before (88%) and 1 year (9%) after MPFL repair in first-time dislocators ($P=0.07$, McNemar test). Second, we did not adjust for confounding factors for patellar dislocation, for example, patella alta, increased Q-angle, and ligamentous laxity. Third, one of the outcomes compared (apprehension sign) was highly assessor-dependent. Although the method of detecting apprehension sign was standardised and the number of assessors was limited to two, potential bias could still be introduced. In addition, no inter-observer or intra-observer repeatability tests were carried out. Fourth, the final assessment in the current study was performed at 12-month follow-up. This short follow-up may not allow adequate evaluation of postoperative outcome. Readers of the journal need to be aware of this during extrapolation of the conclusion of the current study to their clinical practice. Lastly, since there was only one recurrent dislocator who underwent tibial tubercle osteotomy, we are unable to conclude the results of this form of treatment.

Conclusions

A management algorithm for patella dislocation is presented. Repair of MPFL reduced the risk of recurrent dislocation in first-time dislocators.

Declaration

All authors have disclosed no conflicts of interest.

References

1. Fithian DC, Paxton EW, Stone ML, et al. Epidemiology and natural history of acute patellar dislocation. *Am J Sports Med* 2004;32:1114-21.
2. Hsiao M, Owens BD, Burks R, Sturdivant RX, Cameron KL. Incidence of acute traumatic patellar dislocation among active-duty United States military service members. *Am J Sports Med* 2010;38:1997-2004.
3. Hawkins RJ, Bell RH, Anisette G. Acute patellar dislocations. The natural history. *Am J Sports Med* 1986;14:117-20.
4. Atkin DM, Fithian DC, Marangi KS, Stone ML, Dobson BE, Mendelsohn C. Characteristics of patients with primary acute lateral patellar dislocation and their recovery within the first 6 months of injury. *Am J Sports Med* 2000;28:472-9.
5. Cofield RH, Bryan RS. Acute dislocation of the patella: results of conservative treatment. *J Trauma* 1977;17:526-31.
6. Sallay PI, Poggi J, Speer KP, Garrett WE. Acute dislocation of the patella. A correlative pathoanatomic study. *Am J Sports Med* 1996;24:52-60.
7. Ahmad CS, Stein BE, Matuz D, Henry JH. Immediate surgical repair of the medial patellar stabilizers for acute patellar dislocation. A review of eight cases. *Am J Sports Med* 2000;28:804-10.

8. Colvin AC, West RV. Patellar instability. *J Bone Joint Surg Am* 2008;90:2751-62.
9. Irrgang JJ, Anderson AF, Boland AL, et al. Development and validation of the international knee documentation committee subjective knee form. *Am J Sports Med* 2001;29:600-13.
10. Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. *Clin Orthop Relat Res* 1985;(198):43-9.
11. Stefancin JJ, Parker RD. First-time traumatic patellar dislocation: a systematic review. *Clin Orthop Relat Res* 2007;455:93-101.
12. Christiansen SE, Jakobsen BW, Lund B, Lind M. Isolated repair of the medial patellofemoral ligament in primary dislocation of the patella: a prospective randomized study. *Arthroscopy* 2008;24:881-7.
13. Bitar AC, Demange MK, D'Elia CO, Camanho GL. Traumatic patellar dislocation: nonoperative treatment compared with MPFL reconstruction using patellar tendon. *Am J Sports Med* 2012;40:114-22.
14. Camanho GL, Viegas Ade C, Bitar AC, Demange MK, Hernandez AJ. Conservative versus surgical treatment for repair of the medial patellofemoral ligament in acute dislocations of the patella. *Arthroscopy* 2009;25:620-5.
15. Nikku R, Nietosvaara Y, Aalto K, Kallio PE. Operative treatment of primary patellar dislocation does not improve medium-term outcome: A 7-year follow-up report and risk analysis of 127 randomized patients. *Acta Orthop* 2005;76:699-704.
16. Nikku R, Nietosvaara Y, Kallio PE, Aalto K, Michelsson JE. Operative versus closed treatment of primary dislocation of the patella. Similar 2-year results in 125 randomized patients. *Acta Orthop Scand* 1997;68:419-23.
17. Palmu S, Kallio PE, Donell ST, Helenius I, Nietosvaara Y. Acute patellar dislocation in children and adolescents: a randomized clinical trial. *J Bone Joint Surg Am* 2008;90:463-70.
18. Sillanpää PJ, Mäenpää HM, Mattila VM, Visuri T, Pihlajamäki H. Arthroscopic surgery for primary traumatic patellar dislocation: a prospective, nonrandomized study comparing patients treated with and without acute arthroscopic stabilization with a median 7-year follow-up. *Am J Sports Med* 2008;36:2301-9.
19. Sillanpää PJ, Mattila VM, Mäenpää H, Kiuru M, Visuri T, Pihlajamäki H. Treatment with and without initial stabilizing surgery for primary traumatic patellar dislocation. A prospective randomized study. *J Bone Joint Surg Am* 2009;91:263-73.
20. Petri M, Liidakis E, Hofmeister M, et al. Operative vs conservative treatment of traumatic patellar dislocation: results of a prospective randomized controlled clinical trial. *Arch Orthop Trauma Surg* 2013;133:209-13.
21. Smith TO, Song F, Donell ST, Hing CB. Operative versus non-operative management of patellar dislocation. A meta-analysis. *Knee Surg Sports Traumatol Arthrosc* 2011;19:988-98.
22. Smith TO, Donell S, Song F, Hing CB. Surgical versus non-surgical interventions for treating patellar dislocation. *Cochrane Database Syst Rev* 2015;(2):CD008106.
23. Erickson BJ, Mascarenhas R, Sayegh ET, et al. Does operative treatment of first-time patellar dislocations lead to increased patellofemoral stability? A systematic review of overlapping meta-analyses. *Arthroscopy* 2015;31:1207-15.
24. Koh JL, Stewart C. Patellar instability. *Orthop Clin North Am* 2015;46:147-57.
25. Petri M, Ettinger M, Stuebig T, et al. Current concepts for patellar dislocation. *Arch Trauma Res* 2015;4:e29301.
26. Dejour H, Walch G, Nove-Josserand L, Guier C. Factors of patellar instability: an anatomic radiographic study. *Knee Surg Sports Traumatol Arthrosc* 1994;2:19-26.
27. Drexler M, Dwyer T, Dolkart O, et al. Tibial rotational osteotomy and distal tuberosity transfer for patella subluxation secondary to excessive external tibial torsion: surgical technique and clinical outcome. *Knee Surg Sports Traumatol Arthrosc* 2014;22:2682-9.
28. Paulos L, Swanson SC, Stoddard GJ, Barber-Westin S. Surgical correction of limb malalignment for instability of the patella: a comparison of 2 techniques. *Am J Sports Med* 2009;37:1288-300.
29. Pandit S, Frampton C, Stoddart J, Lynskey T. Magnetic resonance imaging assessment of tibial tuberosity-trochlear groove distance: normal values for males and females. *Int Orthop* 2011;35:1799-803.
30. Alemparte J, Ekdahl M, Burnier L, et al. Patellofemoral evaluation with radiographs and computed tomography scans in 60 knees of asymptomatic subjects. *Arthroscopy* 2007;23:170-7.
31. Köhllitz T, Scheffler S, Jung T, et al. Prevalence and patterns of anatomical risk factors in patients after patellar dislocation: a case control study using MRI. *Eur Radiol* 2013;23:1067-74.