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ORIGINAL ARTICLE

Surgical versus non-surgical management for primary patellar dislocations: an up-to-date meta-analysis

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Abstract The aim of this up-to-date meta-analysis was to compare the effects of surgical versus non-surgical treatment of patients following primary patellar dislocation and to provide the best evidence currently available. A comprehensive literature search was conducted using multiple databases, including Medline, Embase, and Cochrane Registry of Clinical Trials. All databases were searched from the earliest records to May 2013. Eligible studies were selected, and data were extracted by two independent investigators. The primary outcome variable was the frequency of recurrent patellar dislocation. The other outcomes included knee function scores, patient-rated outcomes, and radiographic examination. If appropriate, meta-analysis of these variables was performed. Nine independent trials were found to match the inclusion criteria. The pooled results demonstrated that the incidence of recurrent patellar dislocation and Hughston visual analog scale was significantly lower in the surgical treatment group than that in the non-surgical treatment group ($P < 0.05$). There was no statistically significant difference between the two treatment groups in frequency of subsequent surgical interventions, percentage of excellent or good subjective opinion, Kujala score, pain score on visual analog scale, and severity of patellofemoral joint osteoarthrosis ($P > 0.05$). This up-to-date meta-analysis indicates that surgical treatment was associated with a lower risk of recurrent patellar dislocation, but a lower Hughston VAS than non-surgical treatment for primary patellar dislocation. More large high-quality trials and further studies are needed to overcome the limitations of small sample sizes, and varieties of different surgical procedures or non-surgical management strategies adopted in the included trials.

Keywords Primary patellar dislocation · Surgery · Non-surgical treatment · Meta-analysis

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Introduction

The primary patellar dislocation refers to a traumatic disruption of the previously uninjured medial peripatellar structures [1]. Patellar dislocation commonly occurs to the lateral side, leading to the injury of medial restraints of the patella, particularly the lesions of medial patellofemoral ligament (MPFL) and medial retinaculum [2–6]. It is a common knee disorder that mostly presents in adolescents and physically active people [3]. Acute patellar dislocation accounts for 2–3 % of acute knee injuries and is the second most common cause of traumatic hemarthrosis of the knee [7, 8]. Patellar dislocation is associated with a high rate of functional impairment [9]. In the long term, patellar dislocation might result in knee pain, recurrent instability, decreased level of sporting activity, and patellofemoral osteoarthritis [10]. For primary patellar dislocation, the best treatment is still a subject of controversy. The non-operative treatment has been historically suggested unless there is an obvious osteochondral fracture or a relevant disruption of the medial stabilizers with subluxation of the patella [7, 9, 11, 12]. Such non-operative management strategies included a short-term immobilization period used for patient comfort, and followed by a formal physiotherapy [13]. However, the results of this approach have been unpredictable. A high percentage of recurrence, instability symptom, and functional disability after non-surgical treatment were reported in previous studies [10, 14]. Due to the unsatisfied curative effect and deeper understanding of the nature of primary patellar dislocations, some authors advocated immediate surgical treatment to reduce the risk of redislocation [5, 15–17]. Various surgical modalities have been reported, including surgical repair or reconstruction of the medial patellar stabilizers (medial retinaculum [18], and medial patellofemoral ligament [19, 20]), distal patellar realignment surgery [21], lateral retinacular release [22], and trochleoplasty [23, 24]. The initial success of these procedures in preventing recurrent dislocation of the patella is well accepted. However, whether surgical treatment can improve clinical outcome compared with conservative treatment is still debated. Much of the evidence supports the value of surgical interventions [25–27], while some trials have not found significant differences between clinical outcomes in the two patient groups [28–30]. The latest published meta-analysis failed to confirm any significant difference in outcome between surgical and non-surgical initial treatment of people following primary patellar dislocation [31]. Therefore, it remains unclear which technique has more advantages.

The purpose of this up-to-date meta-analysis is to compare the effects of surgical versus non-surgical treatment for the primary patellar dislocation, and to provide the best evidence currently available.

Materials and methods

Search strategy

We conducted an electronic searching using the databases including Medline, Embase, and the Cochrane Registry of Clinical Trials. All databases were searched from the earliest records to May 2013. The search methodology was based on the search strategy of Cochrane Collaboration. As an example, an Ovid Medline database search was undertaken using the MeSH terms and text words “Patellar Dislocation”[Mesh], “Patella”[Mesh], “Dislocations”[Mesh], “Surgical Procedures, Operative”[Mesh], “Physical Therapy (Specialty)”[Mesh], “Immobilization/”[Mesh], “Braces” [Mesh], patell$, dislocat$, sublux$, instability, medial patellofemoral ligament reconstruction, medial reefing, surg$, operat$, arthroscop$, non-surg$, non-operat$, and etc. Additional relevant studies were identified by searching the references of included studies, review articles contemporaneously. There were no restrictions on language of the publications.

Inclusion and exclusion criteria

The criteria for acceptance of the studies were as follows: (1) Randomized or quasi-randomized controlled trials (RCTs, or qRCTs) and prospective controlled studies are evaluating operative versus non-operative interventions. No restrictions on study language and surgical or non-surgical treatment strategies were made. (2) The target population consisted of individuals who presented with primary (or acute) patellar dislocation. No restrictions on subject gender and age were made. (3) Surgical versus non-surgical interventions. No restrictions on the surgical techniques or non-surgical treatment strategies were made. Concerning the exclusion criteria, we stipulated the following: (1) Retrospective studies, duplicated studies, abstracts, reviews, and studies without raw data we need. (2) People with recurrent dislocation of patella.

Two researchers reviewed the title, abstract of all retrieved studies. Any potentially eligible study to this subject was then reviewed in full text. All the studies were reviewed independently, with disagreements being resolved by discussion.

Data collection and outcome measures

Once the studies met the inclusion criteria, data were extracted by two independent authors using predesigned standardized data extraction form. Any disagreement was resolved in review groups through consensus. For each trial, we collected data on the following characteristics: study type, sample size, surgical or non-surgical treatment strategies, subject gender and age, and duration of follow-up. The primary outcome variable was the frequency of recurrent patellar dislocation. The other outcome measures of this meta-analysis included Kujala score [32], Tegner activity score [33], Hughston visual analog scale knee score (Hughston VAS) [34], incidence of Grade I or more severe patellofemoral joint osteoarthritis according to the Ahlbäck classification [35], pain score on visual analog scale (VAS), percentage of knees with an excellent or good result according to Kujala score, percentage of excellent or good subjective opinion, percentage of regaining preinjury activity level, and frequency of subsequent surgical intervention. Results with an average of 2–10 year follow-up were gathered for meta-analysis. If standard deviation (SD) for continuous variables were not presented, the raw data were collected from the original articles, or corresponding authors were contacted if necessary.

Methodological assessment

The methodological quality of the included trials was evaluated using the Jadad quality scale [36]. This scale evaluates the quality of randomization, blinding, and reasons for withdrawal or dropout. It gives either a score of 1 point for each "yes" or 0 point for each "no". A bonus point was awarded if the method of randomization or double-blinding was appropriate, while a bonus point was deducted if the methods were inappropriate. Each study is given a score ranging from 0 to 5 points, with higher points indicating higher quality. Each trial was independently assessed by two authors. All disagreements were resolved by discussion or consultation with a third author. If enough studies (at least 10 trials) were identified, funnel plots were to be used to investigate publication biases [37]. The significance of difference was evaluated with the methods described by Begg and Egger [38]. A value of $P < 0.10$ for publication bias was considered statistically significant.

Statistical analysis

The statistical analysis was conducted using the software Review Manager 5.2 provided by Cochrane Collaboration. The treatment effects were expressed as risk ratios (RR) with 95 % confidence intervals (CI) for dichotomous outcomes and mean differences (MD) with 95 % CI for continuous outcomes. Heterogeneity was tested using the chi-square test with significance set at $P < 0.1$. I-square test was also used to quantify the effect of heterogeneity with an I^2 of 50 % or over representing substantial heterogeneity. If there was no statistical evidence of heterogeneity, a fixed-effect model was used; otherwise, a random-effects model was adopted. If SD was required to be calculated from raw data, the SPSS 13.0 software was used.

Sensitivity analysis

Where appropriate, sensitivity analyses examining various aspects of trial and review methodology, including study type, allocation concealment, outcome assessor blinding, and the reportage of surgical experience, were conducted to explore the robustness of the evidence.

Results

Study identification

A flow chart of the study selection process is presented in Fig. 1. An initial search identified 1,275 articles from the search protocol: 62 were from the Cochrane Registry of Clinical Trials; 545 were from Medline, and 668 were from Embase. After further evaluation of the titles, text words, and abstracts, 31 potentially relevant studies were selected for full-text examination. Finally, 10 published articles [25, 26, 29, 30, 39–44] (9 independent trials) were determined as appropriate to mach the inclusion criteria. Among the

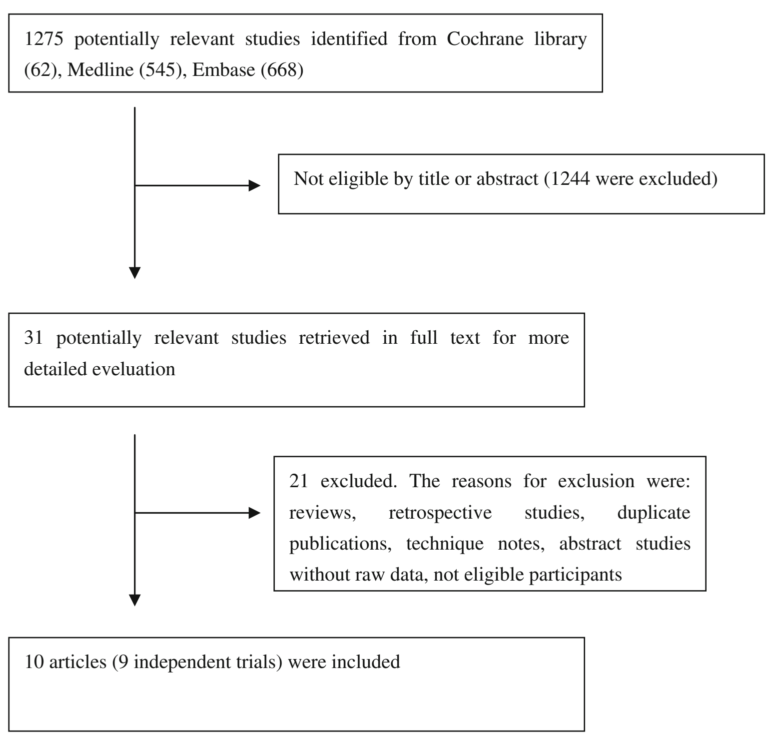

Fig. 1 Flowchart of selection of eligible studies

eligible studies, two published articles were deemed as from a single trial [30, 41], the data at the time of the most recent follow-up were extracted for analyzing [41]. If data were solely reported in the previously published articles, this data were extracted for completeness.

A funnel plot analysis was unable to be performed because of insufficient studies identified, as both visual examination and statistical analysis of funnel plots have limited power to detect bias if the number of trials is small.

Study characteristics and quality

The main characteristics of included studies are summarized in the Table 1. Among the included articles, 7 studies were reported to be randomized controlled trials, and the other 2 studies were prospective non-randomized controlled trials. The sample size in the single study ranged from 20 to 127. Most studies on this subject had involved mainly adolescents or adult patients, except one study focused on pediatric patients [42]. All participants of the included trials had primary lateral patella dislocation, and each trial had a comparable baseline features in surgical and non-surgical groups. As describe in Table 1, there are some variabilities of the surgical stabilization procedures and non-surgical immobilization and rehabilitation strategies adopted by the authors. Most surgical procedures focused on repair or reconstruction of medial soft tissues (medial patellofemoral ligament, medial retinaculum, and capsule) and lateral retinaculum release. The other technique like Roux-Goldthwait procedure was performed in one study [44]. The non-surgical treatments were different in the immobilizers, knee position, duration of immobilization, and rehabilitation program. The follow-up period of the trials ranged from 2 to 14 years. The quality assessment results for eligible trials by using the Jadad quality scale are shown in Table 1.

Meta-analysis of clinical results

Frequency of recurrent patellar dislocation

Nine eligible studies provided data concerning recurrent patellar dislocation. The test for heterogeneity demonstrated that no significant heterogeneity existed among these studies ($P = 0.17$, $\chi^2 = 11.64$, $I^2 = 31$ %), so, a fixed-effect model was performed. A meta-analysis showed that the incidence of recurrent patellar dislocation was significantly higher in the non-surgical treatment group than that in the surgical treatment group (OR 0.56, 95 % CI 0.37–0.85, $P = 0.007$; Fig. 2). Sensitivity analysis, with 2 non-randomized studies excluded, revealed that there was also no significant heterogeneity among the RCTs ($P = 0.14$, $\chi^2 = 9.64$, $I^2 = 38$ %), and the incidence of recurrent patellar dislocation was still significantly lower in the surgical treatment group (OR 0.50, 95 % CI 0.32–0.79, $P = 0.003$; Fig. 3).

Frequency of subsequent surgical interventions

Further surgery was defined as any surgical procedure due to patellofemoral problems. The main reason for subsequent surgical treatment was patellar redislocation or instability. Five studies, including 3 RCTs and 2 prospective non-randomized studies, provided data on the delayed surgery rate. There was no significantly statistical heterogeneity among all these 5 studies ($\chi^2 = 2.53$, $P = 0.64$, $I^2 = 0$ %), and 3 RCTs ($\chi^2 = 1.91$, $P = 0.38$, $I^2 = 0$ %). The meta-analysis of all 5 studies and sensitivity analysis (excluding 2 non-randomized studies), both using fixed-effect model, revealed that the two treatment strategies resulted in comparable reoperation rate (meta-analysis of all 5 studies: OR 1.14, 95 % CI 0.68–1.93, $P = 0.61$; sensitivity analysis: OR 1.13, 95 % CI 0.62–2.06, $P = 0.69$; Figs. 4, 5).

Percentage of excellent or good subjective opinion

Three studies provided data on patient subjective opinion. A pooled excellent and good subjective result from a fixed-effect model ($\chi^2 = 3.09$, $P = 0.21$, $I^2 = 35$ %) showed that the satisfaction rate was similar between the two arms (OR 0.55, 95 % CI 0.30–1.01, $P = 0.05$). Due to lack of sufficient studies, we did not carry out a sensitivity analysis with non-randomized studies excluded (Fig. 6).

Subjective assessment of symptoms and functional outcomes

There are 7 RCTs evaluated knee function using Kujala score. The test for heterogeneity demonstrated that significant heterogeneity existed among the studies ($\chi^2 = 58.04$, $P < 0.00001$, $I^2 = 90$ %), so, a random-effect model was performed. The pooled data indicated that two treatment strategies resulted in a comparable score (MD: 5.55, 95 % CI −3.51 to 14.62, $P = 0.23$; Fig. 7).

Two studies graded the subjective assessment of symptoms and functional outcomes using Kujala score, with Kujala ≥85 as excellent/good and Kujala ≤84 as fair/poor. Overall, the pooled data of excellent/good Kujala rate indicated no statistical difference between the surgical and non-surgical arms (OR 2.10, 95 % CI 0.19–23.48, $P = 0.55$). However, this pooled analysis exhibited statistically significant heterogeneity ($\chi^2 = 7.56$, $P = 0.006$, $I^2 = 87$ %; Fig. 8).

Two included trials reported Hughston VAS score. The test for heterogeneity demonstrated no heterogeneity existed between the studies ($\chi^2 = 0.22$, $P = 0.64$, $I^2 = 0$ %). The pooled result showed a statistically lower Hughston

Table 1 Characteristics and methodological quality of the included studies

Studies	Study design	Sample size (No. of patients)		Age (years)		Gender		Surgical strategies	Non-surgical strategies	follow-up	Jadad score
		SUR	nSUR	SUR	nSUR	F	M				
Apostolovic [29]	pnRCT	14	23	13.07 (12–16)	14.26 (12–16)	28	9	MR and capsular repair, LR	3 weeks' immobilization, quadriceps exercise	6.1 (5–8)y	1
Bitar [26]	RCT	21 (21 knee)	18 (20 knee)	23.95 (12–37)	24.10 (18–38)	20	21	MPFL reconstruction using patellar tendon	3 weeks' brace in extension and physiotherapy	44 (24–61) m	2
Camanho [25]	RCT	17	16	24.6 (15–33)	26.8 (12–74)	20	13	MPFL repair	3 weeks' immobilization, physiotherapy, VMO exercise, hamstrings and articular retinaculum stretching exercises	SUR: 40.4 m; nSUR: 36.3 m	3
Christiansen [40]	RCT	42	35	20.0 (14–30)	19.9 (13–39)	35	42	MPFL repair	2 weeks' brace with motion of 0° to 20°	2y	3
Nikku [41]	RCT	70	55	19.5 ± 9.0	19.1 ± 7.5	82	43	MR repair, MPFL augmentation, LR	3 weeks' immobilization and then thigh muscle exercises	25 (20–45) m	1
Nikku [30]	RCT	70	57	20 ± 9	20 ± 8	82	45	MR repair, MPFL augmentation, LR	3 weeks' immobilization and then thigh muscle exercises	7.2 (5.7–9.1)y	1
Palmu [42]	RCT	36	28	13 ± 2	13 ± 2	51	20	MPFL repair, LR	3 weeks' immobilization in knee extension orthosis, then 3 weeks' patella-stabilizing orthosis, thigh muscle exercises	14 (11–15)y	1
Petri [43]	RCT	12	8	27.2 ± 9.0	21.6 ± 5.6	7	13	Medial structure repair	6 weeks' DonJoy ™ ROM-brace	2y	3
Sillanpaa [3]	pnRCT	26	35	20.0 (19–22)	20.0 (19–22)	4	72	Arthroscopic MR repair, LR	4 weeks' patellar orthosis with flexion limited to 60° and quadriceps exercise	7.5 (6–11)y	1
Sillanpaa [19]	RCT	18	22	20.0 (19–22)	20.0 (19–21)	3	37	Medial reefing (MPFL and MR, Roux-Goldthwait procedure, arthroscopic repair of osteochondral fracture	3 weeks' knee orthosis immobilization with 0–30° motion, then 3 weeks' immobilization with 0–90° motion, quadriceps exercise	7 (6–9)y	1

RCT randomized controlled trial, *pnRCT* prospective non-randomized controlled trial, *SUR* surgica, *nSUR* non-surgical, *No.* number, *MPFL* medial patellofemoral ligament, *MR* medial retinaculum, *LR* lateral release, *VMO* vastus medialis obliquus, *y* years, *m* months, *F* female, *M* male

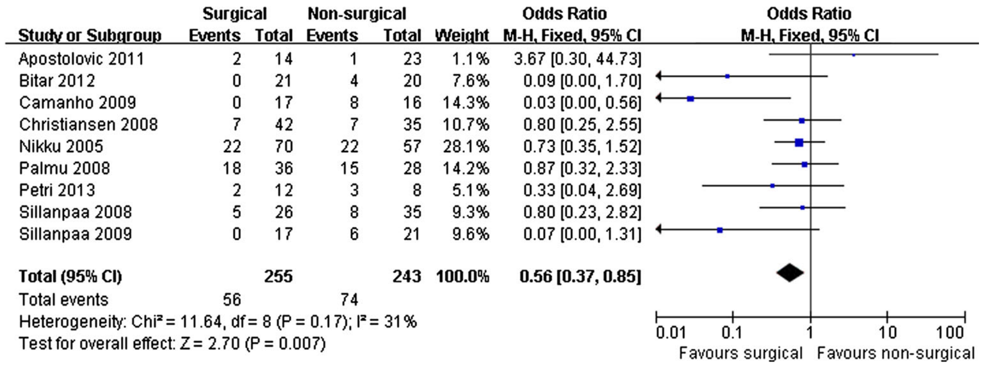

Fig. 2 Forest plot of frequency of recurrent patellar dislocation between surgical and non-surgical management for primary patellar dislocations

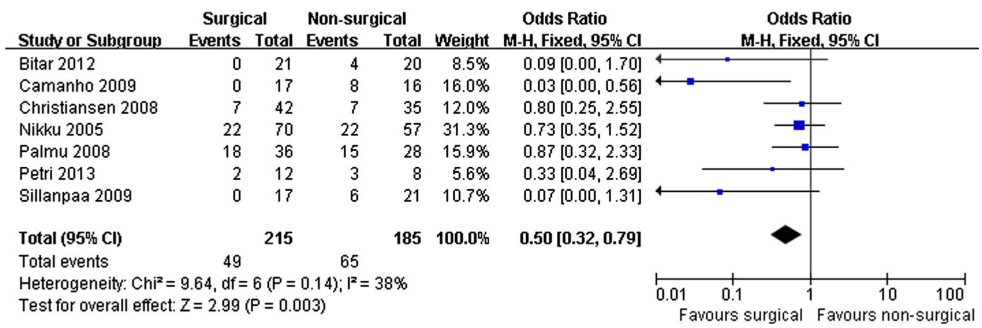

Fig. 3 Sensitivity analysis with non-randomized studies excluded for frequency of recurrent patellar dislocation

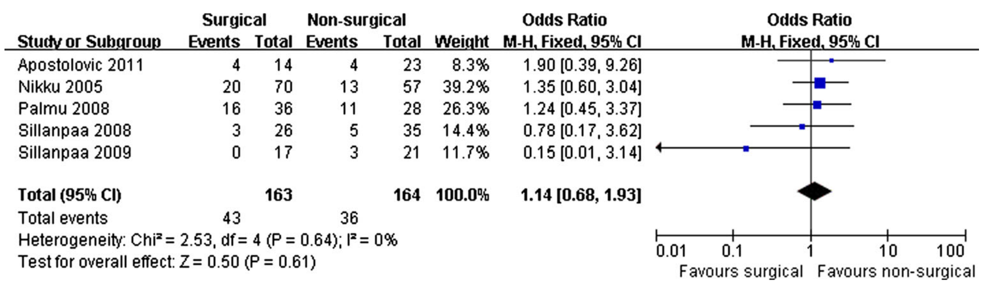

Fig. 4 Forest plot of frequency of subsequent surgical interventions between surgical and non-surgical management for primary patellar dislocations

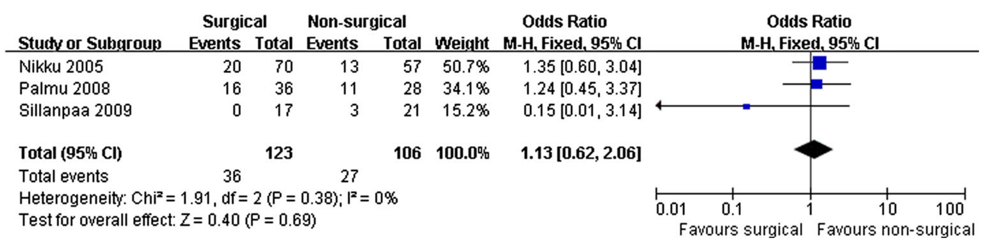

Fig. 5 Sensitivity analysis with non-randomized studies excluded for frequency of subsequent surgical interventions

VAS score recorded in surgical arm compared with non-surgical arm (MD: −5.74, 95 % CI −9.46 to 2.02, $P = 0.003$; Fig. 9).

Two studies assessed knee pain using a visual analog scale (VAS). Statistically significant heterogeneity existed between the studies ($\chi^2 = 5.50$, $P = 0.02$, $I^2 = 82$ %). A meta-analysis using a random-effects model showed that no statistically significant difference was obtained between the two groups (MD: 0.71, 95 % CI −0.37 to 1.78, $P = 0.20$) (Fig. 10).

Figures 11 and 12 illustrated the pooled results of Tegner score, percentage of regaining preinjury activity level. There was no heterogeneity detected (Tegner score: $\chi^2 = 0.78$, $P = 0.68$, $I^2 = 0$ %; percentage of regaining preinjury activity level: $\chi^2 = 0.85$, $P = 0.36$, $I^2 = 0$ %), and no statistically significant difference of pooled results (Tegner score: MD: −0.46, 95 % CI −0.97 to 0.05, $P = 0.07$; percentage of regaining preinjury activity level: OR 2.24, 95 % CI 0.90–5.57, $P = 0.08$) between the two treatment strategies in both fields.

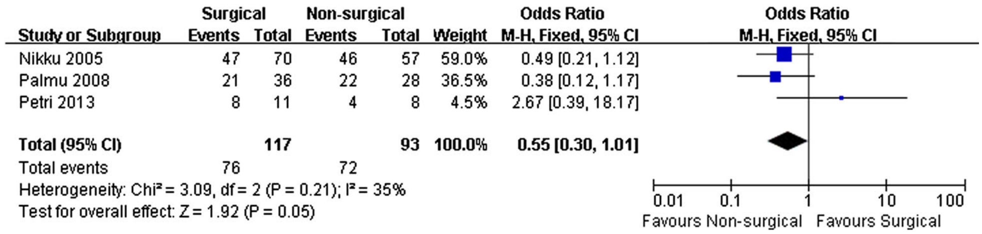

Fig. 6 Forest plot of percentage of excellent or good subjective opinion between surgical and non-surgical management for primary patellar dislocations

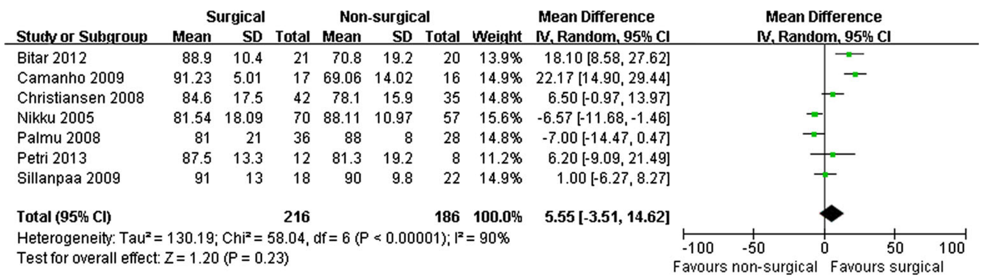

Fig. 7 Forest plot of Kujala score between surgical and non-surgical management for primary patellar dislocations. *Camanho 2009: SD calculated from the raw data provided in the original study [25]. *Sillanpaa 2009: SD obtained from the previous meta-analysis [31]

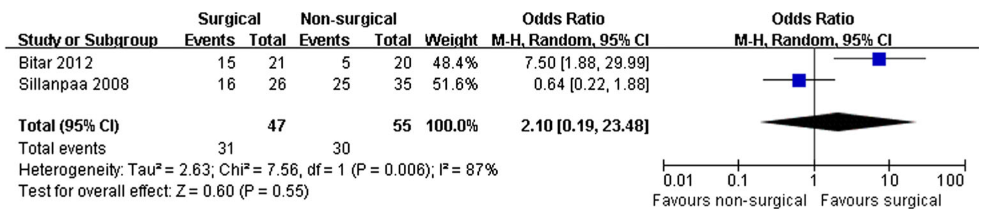

Fig. 8 Forest plot of the rate of excellent/good Kujala score between surgical and non-surgical management for primary patellar dislocations

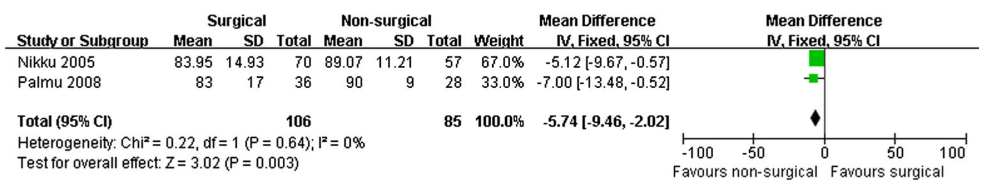

Fig. 9 Forest plot of Hughston VAS score between surgical and non-surgical management for primary patellar dislocations

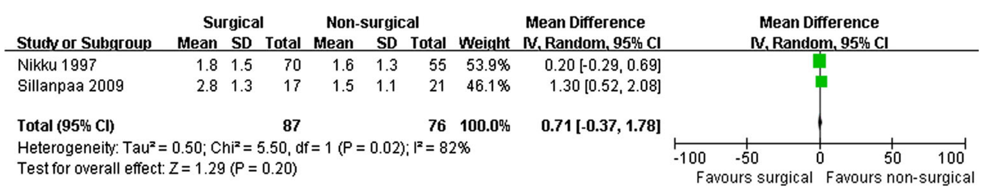

Fig. 10 Forest plot of VAS between surgical and non-surgical management for primary patellar dislocations. *Sillanpaa 2009: SD obtained from the previous meta-analysis [31]

Radiographic examination

Two studies assessed the severity of patellofemoral joint osteoarthrosis using the Ahlbäck classification from plain radiographs examinations. Overall, there was no substantial heterogeneity observed between the studies ($\chi^2 = 0.03$, $P = 0.86$, $I^2 = 0$ %). The pooled result indicated that the incidence of Ahlback grade I or more severe osteoarthrosis was similar between the treatment groups (OR 3.20, 95 % CI 0.32–32.35, $P = 0.32$) (Fig. 13).

Discussion

On the subject of comparing surgical treatment strategies with conservative treatment strategies in the management

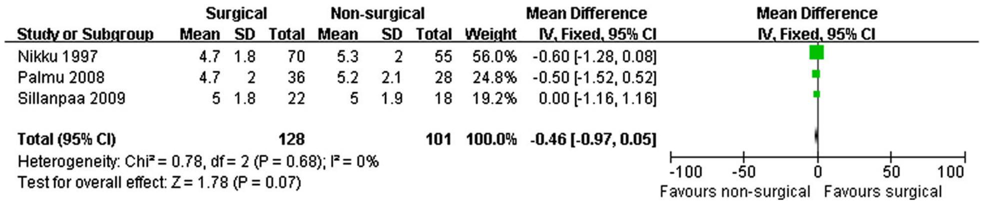

Fig. 11 Forest plot of Tegner score between surgical and non-surgical management for primary patellar dislocations. *Sillanpaa 2009: SDobtained from the previous meta-analysis [31]

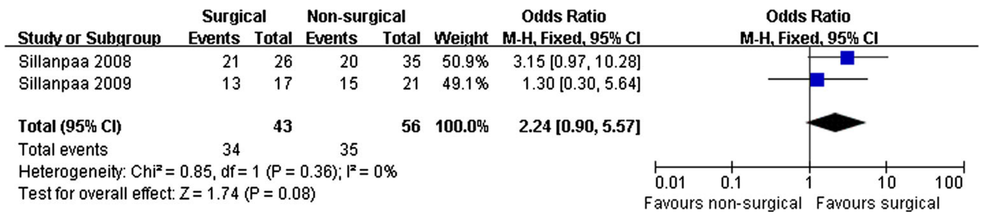

Fig. 12 Forest plot of percentage of regaining preinjury activity level between surgical and non-surgical management for primary patellar dislocations

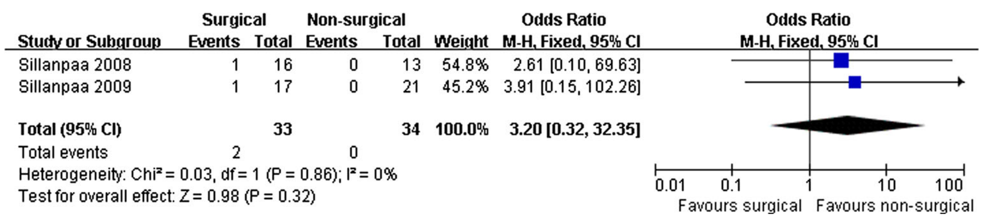

Fig. 13 Forest plot of the incidence of Ahlback grade I or more severe osteoarthrosis between surgical and non-surgical management for primary patellar dislocations

of primary patellofemoral dislocation, two meta-analysis articles [31, 45] have been published. Nevertheless, there are certain limitations in these previous meta-analysis reports. First, studies evaluating both primary and recurrent patellar dislocation episodes were taken together for analysis in one study [45]. It inevitably increases the clinical bias and makes the interpretation of their results difficult. Non-surgical treatment is unsatisfactory for recurrent or habitual patellar dislocation because the normal anatomy is not restored [28, 29]; so, most experts considered surgical strategy as an effective treatment for these patients. Thus, it is not appropriate to mix the primary and recurrent episodes together. Second, the previously published meta-analysis articles provided controversial results and conclusions. The findings of earlier meta-analysis indicated that surgical management was associated with a significantly lower incidence of patellar redislocation but a higher risk of patellofemoral osteoarthritis [45], while the strength of evidence could be weaken due to the limitation of mixed population analyzed together, which has been mentioned above. Later, Hing et al. [31] published another meta-analysis and concluded that there was insufficient evidence to confirm any significant difference in outcome between surgical or non-surgical strategies. Furthermore, the latest search date was October 2010, and the limited number of trials was identified [31]. Since then, several comparative trials for the treatment of primary patellar dislocation have been published and that allowed to update meta-analysis possible.

In this up-to-date meta-analysis, only trials for patients following primary patellar dislocation were included. By taking this measure, we expected to reduce clinical bias to a minimum and focused on the issue of finding a better treatment strategy for patients following primary patellar dislocation. This meta-analysis included 9 trials, some of which were recently published and not included in previous meta-analysis. According to our pooled results, we found a reduced incidence of recurrent dislocation caused by initially surgical management compared to non-surgical management. In addition, no significant heterogeneity was detected among the included studies in this field, although it existed in previous meta-analysis articles [31, 45]. The reason for this change could be that the retrospective studies were excluded, and new high-quality RCTs were added. The results proved that the measures we took to minimize the clinical bias were effective. As to functional outcomes, we found that surgical treatment was associated with a lower Hughston VAS, which corresponded with the previous studies [35, 49]. However, no difference was found in other functional outcomes including further surgery, patient satisfaction rate, VAS, Kujala scores, Tegner score, and rate of regain preinjury activity level. We still found a notable heterogeneity in several fields such as Kujala scores and VAS, although the data in these fields were extracted from RCTs. This could probably be explained by various factors, such as variability in the study design and methodological quality, target populations, intervention strategies, follow-up duration. Subgroup analysis might be a good choice for resolving the problem. However, due to insufficient number of studies identified, we could not split the participant data into subgroups for analysis. This calls for additional large high-quality trials, and should be investigated further. We did not find significant difference in the field of patellofemoral OA according to Ahlback system, which was contrary to the previous meta-analysis studies [45]. This inconsistency could be due to the inclusion of trials dealing with recurrent patellar dislocation, which were excluded in our study.

It is worth noting that various surgical techniques (MPFL repair, MR repair, capsule repair, LR, and Roux-Goldthwait procedure) and non-surgical treatment regimens (ranging from 3 to 6 weeks' immobilization, different immobilization methods, and different physiotherapy and muscles strengthen program) were undertaken in the included studies as describe in Table 1. Previous studies have reported that different surgical techniques or non-surgical rehabilitation program, anatomical abnormality of the knee, and MPFL injury at different locations may be associated with the outcomes. Ma et al. [46] found that the medial retinaculum plasty was better than medial capsule reefing in improving the subjective effects and decreasing the rate of patellar instability. Xie et al. [47] reported that MPFL reconstruction with polyester suture augmentation results in better outcomes than that without augmentation. Rood et al. [48] conducted a prospective randomized trial comparing taping and cylinder cast immobilization, and found a better Lysholm score was associated with tape bandage immobilization. Armstrong et al. [49] carried out a no immobilization rehabilitation program of patients following first-time patellar dislocation, and found a trend of superior short-term functional outcomes compared to those immobilized with cast. The investigators also found that individuals with trochlear dysplasia can be treated successfully by surgical treatment [24] and MPFL-VMO overlap-region injury might response better to non-surgical strategy [50]. These reports indicated that more investigations should be made for seeking a more appropriate surgical or non-surgical treatment algorithm for specific populations. This issue was also discussed in the previous meta-analysis [45]. The suggestion of that the prognostic factors (such as family history, anatomical presentation, soft tissue lesion type, and rehabilitation regimes), which might be associated with the overall outcomes, should be taken into account in choosing treatment strategy in future studies seems reasonable.

Certainly, there are some limitations in our meta-analysis. Firstly, the number of trials included was not so adequate, which just had 9 separate trials. The sample sizes of the trials were generally small, and the follow-up durations were different between the included studies as described in Table 1. These factors might weaken the strength of our pooled results. Secondly, some unpublished studies and data were not available. We could not investigate publication bias because a funnel plot can not be done due to the limited trials identified in this study. In addition, the quality of some trials, which did not provided adequate randomization and blinding method, was not high enough. These limitations should be taken into account and should be avoided as far as possible when drafting new trials. More large high-quality randomized controlled trials could overcome the limitations currently present in this study.

Conclusions

The available evidence indicates that surgical management was associated with a lower risk of recurrent patellar dislocation, but a lower Hughston VAS than non-surgical management for primary patellar dislocation. More large high-quality trials and further studies are needed to overcome the limitations presented in this study.

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References

1. Tsai CH, Hsu CJ, Hung CH, Hsu HC (2012) Primary traumatic patellar dislocation. J Orthop Surg Res 7:21
2. Kepler CK, Bogner EA, Hammoud S, Malcolmson G, Potter HG, Green DW (2011) Zone of injury of the medial patellofemoral ligament after acute patellar dislocation in children and adolescents. Am J Sports Med 39:1444–1449
3. Sillanpää P, Mattila VM, Iivonen T, Visuri T, Pihlajamäki H (2008) Incidence and risk factors of acute traumatic primary patellar dislocation. Med Sci Sports Exerc 40:606–611
4. Colvin AC, West RV (2008) Patellar instability. J Bone Joint Surg Am 90:2751–2762
5. Arendt EA, Fithian DC, Cohen E (2002) Current concepts of lateral patella dislocation. Clin Sports Med 21:499–519

6. Burks RT, Desio SM, Bachus KN, Tyson L, Springer K (1998) Biomechanical evaluation of lateral patellar dislocations. Am J Knee Surg 11:24–31
7. Stefancin JJ, Parker RD (2007) First-time traumatic patellar dislocation: a systematic review. Clin Orthop Relat Res 455:93–101
8. Balcarek P, Jung K, Ammon J et al (2010) Anatomy of lateral patellar instability: trochlear dysplasia and tibial tubercle-trochlear groove distance is more pronounced in women who dislocate the patella. Am J Sports Med 38:2320–2327
9. Beasley LS, Vidal AF (2004) Traumatic patellar dislocation in children and adolescents: treatment update and literature review. Curr Opin Pediatr 16:29–36
10. Atkin DM, Fithian DC, Marangi KS, Stone ML, Dobson BE, Mendelsohn C (2000) Characteristics of patients with primary acute lateral patellar dislocation and their recovery within the first 6 months of injury. Am J Sports Med 28:472–479
11. Cash JD, Hughston JC (1988) Treatment of acute patellar dislocation. Am J Sports Med 16:244–249
12. Panni AS, Vasso M, Cerciello S (2013) Acute patellar dislocation. What to do? Knee Surg Sports Traumatol Arthrosc 21:275–278
13. Sillanpää PJ, Mäenpää HM (2012) First-time patellar dislocation: surgery or conservative treatment? Sports Med Arthrosc 20:128–135
14. Mäenpää H, Huhtala H, Lehto MU (1997) Recurrence after patellar dislocation. Redislocation in 37/75 patients followed for 6-24 years. Acta Orthop Scand 68:424–426
15. Vainionpää S, Laasonen E, Silvennoinen T, Vasenius J, Rokkanen P (1990) Acute dislocation of the patella. A prospective review of operative treatment. J Bone Joint Surg Br 72:366–369
16. Feller JA, Amis AA, Andrish JT, Arendt EA, Erasmus PJ, Powers CM (2007) Surgical biomechanics of the patellofemoral joint. Arthroscopy 23:542–553
17. Amis AA, Firer P, Mountney J, Senavongse W, Thomas NP (2003) Anatomy and biomechanics of the medial patellofemoral ligament. Knee 10:215–220
18. Schöttle PB, Scheffler SU, Schwarck A, Weiler A (2006) Arthroscopic medial retinacular repair after patellar dislocation with and without underlying trochlear dysplasia: a preliminary report. Arthroscopy 22:1192–1198
19. Sillanpää PJ, Mäenpää HM, Mattila VM, Visuri T, Pihlajamäki H (2009) A mini-invasive adductor magnus tendon transfer technique for medial patellofemoral ligament reconstruction a technical note. Knee Surg Sports Traumatol Arthrosc 17:508–512
20. Camanho GL, Bitar AC, Hernandez AJ, Olivi R (2007) Medial patellofemoral ligament reconstruction: a novel technique using the patellar ligament. Arthroscopy 23:108.e1–108.e4
21. Sillanpää P, Mattila VM, Visuri T, Mäenpää H, Pihlajamäki H (2008) Ligament reconstruction versus distal realignment for patellar dislocation. Clin Orthop Relat Res 466:1475–1484
22. Reddy KR, Reddy NS (2012) Trochleoplasty and medial patellofemoral ligament reconstruction for recurrent patellar dislocation. Indian J Orthop 46:242–245
23. Lee JJ, Lee SJ, Won YG, Choi CH (2012) Lateral release and medial plication for recurrent patella dislocation. Knee Surg Sports Traumatol Arthrosc 20:2438–2444
24. von Knoch F, Böhm T, Bürgi ML, von Knoch M, Bereiter H (2006) Trochleaplasty for recurrent patellar dislocation in association with trochlear dysplasia. A 4- to 14-year follow-up study. J Bone Joint Surg Br 88:1331–1335
25. Camanho GL, Viegas Ade C, Bitar AC, Demange MK, Hernandez AJ (2009) Conservative versus surgical treatment for repair of the medial patellofemoral ligament in acute dislocations of the patella. Arthroscopy 25:620–625
26. Bitar AC, Demange MK, D'Elia CO, Camanho GL (2012) Traumatic patellar dislocation: nonoperative treatment compared with MPFL reconstruction using patellar tendon. Am J Sports Med 40:114–122
27. Yamamoto RK (1986) Arthroscopic repair of the medial retinaculum and capsule in acute patellar dislocations. Arthroscopy 2:125–131
28. Buchner M, Baudendistel B, Sabo D, Schmitt H (2005) Acute traumatic primary patellar dislocation: long-term results comparing conservative and surgical treatment. Clin J Sport Med 15:62–66
29. Apostolovic M, Vukomanovic B, Slavkovic N et al (2011) Acute patellar dislocation in adolescents: operative versus nonoperative treatment. Int Orthop 35:1483–1487
30. Nikku R, Nietosvaara Y, Aalto K, Kallio PE (2005) 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 76:699–704
31. Hing CB, Smith TO, Donell S, Song F (2011) Surgical versus non-surgical interventions for treating patellar dislocation. Cochrane Database Syst Rev. CD008106. doi: 10.1002/14651858.CD008106.pub2
32. Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O (1993) Scoring of patellofemoral disorders. Arthroscopy 9:159–163
33. Tegner Y, Lysholm J (1985) Rating systems in the evaluation of knee ligament injuries. Clin Orthop Relat Res:43–49
34. Flandry F, Hunt JP, Terry GC, Hughston JC (1991) Analysis of subjective knee complaints using visual analog scales. Am J Sports Med 19:112–118
35. Ahlbäck S (1968) Osteoarthrosis of the knee. A radiographic investigation. Acta Radiol Diagn (Stockh) Suppl 277:7–72
36. Jadad AR, Moore RA, Carroll D et al (1996) Assessing the quality of reports of randomized clinical trials: is blinding necessary? Control Clin Trials 17:1–12
37. Higgins JPT, Green S (eds) (2011) Cochrane handbook for systematic reviews of interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration. www.cochrane-handbook.org
38. Begg CB, Mazumdar M (1994) Operating characteristics of a rank correlation test for publication bias. Biometrics 50:1088–1101
39. Sillanpää PJ, Mäenpää HM, Mattila VM, Visuri T, Pihlajamäki H (2008) 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 36:2301–2309
40. Christiansen SE, Jakobsen BW, Lund B, Lind M (2008) Isolated repair of the medial patellofemoral ligament in primary dislocation of the patella: a prospective randomized study. Arthroscopy 24:881–887
41. Nikku R, Nietosvaara Y, Kallio PE, Aalto K, Michelsson JE (1997) Operative versus closed treatment of primary dislocation of the patella. Similar 2-year results in 125 randomized patients. Acta Orthop Scand 68:419–423
42. Palmu S, Kallio PE, Donell ST, Helenius I, Nietosvaara Y (2008) Acute patellar dislocation in children and adolescents: a randomized clinical trial. J Bone Joint Surg Am 90:463–470
43. Petri M, Liodakis E, Hofmeister M et al (2013) Operative vs conservative treatment of traumatic patellar dislocation: results of a prospective randomized controlled clinical trial. Arch Orthop Trauma Surg 133:209–213
44. Sillanpää PJ, Mattila VM, Mäenpää H, Kiuru M, Visuri T, Pihlajamäki H (2009) Treatment with and without initial stabilizing surgery for primary traumatic patellar dislocation. A prospective randomized study. J Bone Joint Surg Am 91:263–273

45. Smith TO, Song F, Donell ST, Hing CB (2011) Operative versus non-operative management of patellar dislocation. A meta-analysis. Knee Surg Sports Traumatol Arthrosc 19:988–998
46. Ma LF, Wang CH, Chen BC et al (2012) Medial patellar retinaculum plasty versus medial capsule reefing for patellar dislocation in children and adolescents. Arch Orthop Trauma Surg 132:1773–1780
47. Xie G, Zhao J, Huangfu X, He Y (2012) Medial patellofemoral ligament reconstruction using semitendinosus tendons: polyester suture augmentation versus nonaugmentation. Am J Sports Med 40:1365–1374
48. Rood A, Boons H, Ploegmakers J, van der Stappen W, Koëter S (2012) Tape versus cast for non-operative treatment of primary patellar dislocation: a randomized controlled trial. Arch Orthop Trauma Surg 132:1199–1203
49. Armstrong BM, Hall M, Crawfurd E, Smith TO (2012) A feasibility study for a pragmatic randomised controlled trial comparing cast immobilisation versus no immobilisation for patients following first-time patellar dislocation. Knee 19:696–702
50. Kang HJ, Wang F, Chen BC, Zhang YZ, Ma L (2013) Non-surgical treatment for acute patellar dislocation with special emphasis on the MPFL injury patterns. Knee Surg Sports Traumatol Arthrosc 21:325–331