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ARTHROSCOPY AND SPORTS MEDICINE

Surgical treatment is better than non-surgical treatment for primary patellar dislocation: a meta-analysis of randomized controlled trials

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Abstract

Background At present, the best treatment for primary patellar dislocation (PPD) has not been unified. Moreover, meta-analyses comparing the non-surgical and surgical treatments of PPD are lacking. Thus, we aimed to compare the clinical efficacy of surgical or non-surgical treatment of PPD.

Methods Randomized controlled studies of surgical and non-surgical treatments of PPD from 1966 to 2018 were retrieved from the following databases: PubMed, EMBASE, Cochrane Library, Wanfang Database, China Knowledge Network, Google Scholar, and Weipu Database. We screened for literature that met the inclusion criteria and extracted useful data for our meta-analysis.

Results Nine studies, involving 492 patients, met the inclusion criteria and were analyzed in this study. The recurrence rate of patellar dislocation in the surgical group was lower than that in the non-surgical group ($P=0.04$]). Subgroup analysis according to the follow-up time showed that the Kujala score ($P<0.001$) and lower recurrence rate of dislocation ($P=0.05$) than the non-surgical group in the short term. Subgroup analysis according to surgical year showed that the surgical group get higher Kujala score ($P<0.001$) and lower recurrence rate of dislocation ($P=0.01$) than the non-surgical group in recent years.

Conclusion Surgical treatment can provide better clinical results in a short period of time, and patients may achieve good results within 10 years owing to the advances in surgical techniques and instruments. Thus, we recommend surgical treatment as the preferred treatment for primary patellar dislocation.

Keywords Patellar dislocation · Surgical · Non-surgical · Randomized controlled trial

Abbreviations

PPD	Primary patellar dislocation
RR	Relative risk
CI	Confidence intervals
WMD	Weighted mean difference
TT-TG distance	Tibial tuberosity-trochlear groove distance
MPFL	Medial patellofemoral ligament
SD	Standard deviation
PEDro scale	Physiotherapy evidence database scale

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Background

Patellar dislocation is one of the most common diseases of the knee joint, according to statistics, and it accounts for 2–3% of all knee lesions. It is more common in young women aged 15–17 years and is often accompanied by a family history; Most patellar dislocations are lateral dislocations [1, 2]. If not treated in time, it often causes knee pain, repeated instability, decreased function, patellofemoral arthritis, and so on [3–5]. There are various factors that could lead to patellar dislocation such as the anatomical factors (abnormal development of the patella or trochlea, increased Q angle, increased tibial tuberosity-trochlear groove distance (TT-TG distance), abnormal knee extension device, loose medial retinaculum, and tight lateral retinaculum) [6–9]. Patellar dislocation can be divided into primary dislocation, recurrent dislocation, and habitual dislocation. The majority of primary dislocations are caused by trauma, which may be accompanied by anatomical abnormalities.

At present, the best treatment for primary patellar dislocation has not been unified. Panni et al. [10] believe that non-surgical treatment is suitable for those patients who do not have cartilage lesions, osteochondral fractures, and severe tear of the medial retinaculum. The non-surgical treatment method is usually 3–6 weeks of splinting with physiotherapy [4, 11]. Studies have shown that the recurrence rate of patellar instability is more than 63% after non-surgical treatment; thus, surgical treatment has been highly praised by many researchers in recent years. The surgical methods mainly include repair or reconstruction of the medial retinaculum and medial patellofemoral ligament (MPFL), medial transfer of the tibial tuberosity, and release of the lateral retinaculum.

To date, there have been few meta-analyses comparing the non-surgical and surgical treatments of primary patellar dislocation. Existing meta-analyses have problems such as fewer included studies, large differences, incomplete analysis, and incorporation of outdated literature [7, 12–15]. Thus, this study aimed to analyze recent randomized controlled trials of surgical and non-surgical treatments of primary patellar dislocation. Analysis was performed from multiple directions and expected to provide medical evidence for the choice of clinical treatment.

Method

Search strategy

We searched PubMed, EMBASE, Cochrane Library, Wanfang Database, China Knowledge Network, Google Scholar, and Weipu Database for literature published from January 1966 to April 2018. We included articles written in English and Chinese. The search terms included “patellar dislocation”, “patellar subluxation”, “patellar instability”, “surgery”, “non-surgical”, “conservative”, “control trial”, “random assignment”, and son. The further search included filtering the references in the article, and if necessary, contacting the author for more information.

Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) randomized controlled study; (2) comparison of the efficacy between surgical and non-surgical treatments on patients; and (3) published in English or Chinese. Exclusion criteria were as follows: (1) non-randomized controlled studies; (2) absence of statistical analysis of clinical outcome data; (3) absence of summary data or systematic review; and (4) animal, cadaveric, and other laboratory studies.

Data extraction and article quality evaluation

The data were extracted independently by two researchers. The extracted information included: (1) first author’s name, publication time, type of study, and study period; (2) general characteristics of the study and the patient included; (3) surgical and non-surgical interventions performed and duration of treatment; and (4) results of treatment including recurrence rate of patellar dislocation, recurrence rate of subluxation and instability, patient satisfaction, and Kujala score [16]. The two evaluators were required to agree on the selected article and the extracted information. If no agreement can be reached, a third reviewer was invited to assist in the evaluation. If the data were not complete or lack data on mean or standard deviation (SD) as well surgical year, the appropriate author was contacted to obtain these data.

The physiotherapy evidence database (PEDro) scale was used to assess the methodological quality of each study [17]. Using this scale, studies are evaluated primarily in terms of eligibility criteria, random allocation, concealed allocation, baseline comparability, blinding, adequate follow-up, intention-to-treat analysis, between-group analysis, point estimates, and variability, to minimize selection bias. Two investigators independently evaluated each study using the PEDro scale.

Evaluation index

The main evaluation indicators were the frequency of recurrent patellar dislocation and the function of the knee joint. The knee function was measured primarily using the Kujala score. The scale consists of 13 indicators, including daily function, pain, motor function, and symptoms of the affected limb. It is the most commonly used standard for the evaluation of the patellofemoral joints worldwide. Secondary outcomes in the study included recurrent rate of subluxation and instability and patient satisfaction.

Statistical analysis

The frequency of recurrent patellar dislocation, patient satisfaction, and patellar instability and subluxation rate were considered as two-category variables, using relative risk (RR), and the Kujala score as a continuous variable. The average Kujala score in both surgical and non-surgical groups was calculated, and the score is expressed by weighted mean difference (WMD). As one of the main results of the study, we divided the patients into the following two subgroups: short-term follow-up subgroup (follow-up within 5 years) and long-term follow-up subgroup (follow-up of more than 5 years), according to the follow-up time. In another subgroup analysis of the recurrence rate of the patellar dislocation, we divided the patients into two subgroups (surgery performed within 10 years, surgery performed more than 10 years ago) based on the year of surgery. The heterogeneity between studies was tested by using chi-squared test. $P < 0.10$ was utilized as the test level. The size of the heterogeneity was judged according to I^2. If $I^2 < 50\%$, $P > 0.10$ and $P > 0.05$ in the subgroup indicate that the studies were considered to have a low degree of heterogeneity. If there is a low degree of heterogeneity between studies, the data are combined using a fixed-effect model. If there is a high degree of heterogeneity between studies, a random effects model is used. For continuous outcomes with the same measurement scale, means were computed with 95% confidence intervals (CIs). All statistical analyses were performed using Review Manager 5.3. A P value < 0.05 was considered to be a significant statistical difference.

Result

Search results

After screening according to the inclusion and exclusion criteria, 492 patients from nine articles were included in the study [8, 18–25]. Two of the studies [19, 26] were by the same authors and included the same set of patients at different times; thus, only the more recent article was included in this meta-analysis. The screening flow chart is shown in Fig. 1. The patients' characteristics included in the study are shown in Table 1. The characteristics of the included studies are shown in Table 2.

Quality evaluation of literature

Table 3 lists the total scores of the randomized controlled trials. The results indicate that most of the studies obtained were of a good quality according to the PEDro scale. Most of the studies had research design scores of six points, but there were two studies with seven points and one with five points. Most of the studies had the following problems: did not use the concealed allocation method, subjects and clinicians were not blinded, and intention-to-treat analysis was not performed, which may lead to a possible bias. In addition, the rate of loss to follow-up was higher in some studies, and information on extraction and loss to follow-up in the studies were not recorded in detail. These reasons all reduced the quality of the articles.

Results of the meta-analysis

Comparison of the recurrence rate of patellar dislocation

The recurrence rate of postoperative patellar dislocation was recorded in all nine studies included. A total of 492 patients with primary patellofemoral dislocation were evaluated, including 261 patients in the surgical group and 231 patients in the non-surgical group. The heterogeneity test between the short- and long-term follow-up subgroups showed high heterogeneity. Thus, the random-effects model was used for the

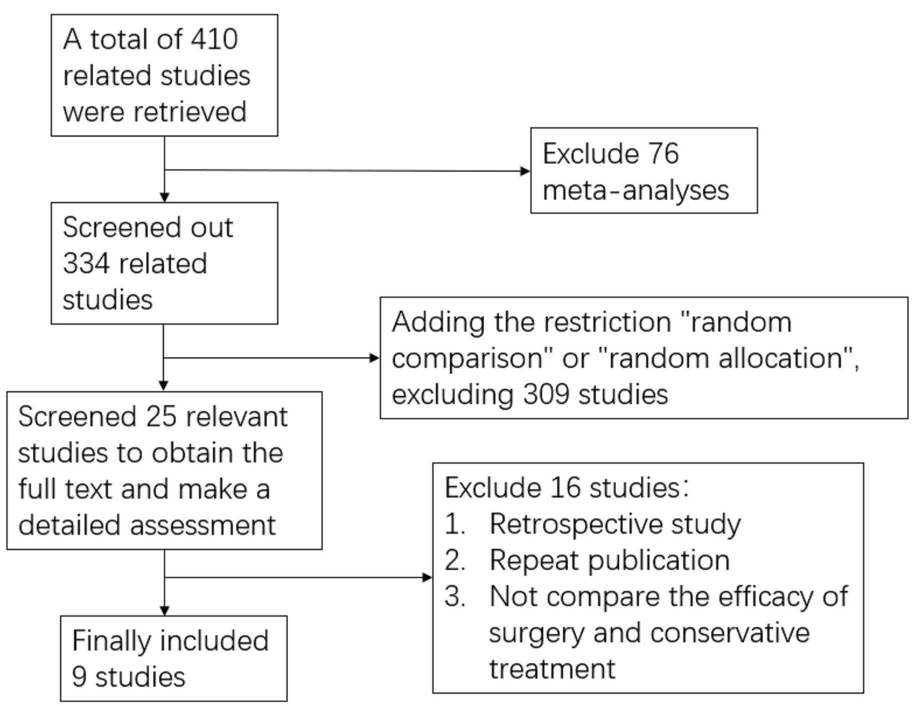

Fig. 1 Study selection flow chart

Table 1 Patient characteristics included in the study, "OP" indicates the surgical group, "N-OP" indicates the non-surgical group

	Level of evidence	Cases		Mean age (years)		Gender (M/F)		Follow-up (years)
		Op	N-Op	Op	N-Op	Op	N-Op	
Nikku, 2005 [19]	II	70	57	20	20	18/52	27/33	7
Christiansen, 2008 [21]	I	42	35	20	19.9	24/18	18/17	2
Palmu, 2008 [20]	II	36	28	13	13	9/27	9/19	14
Camanho, 2009 [22]	II	17	16	24.6	26.8	6/11	7/9	3
Sillanpaa, 2009 [18]	I	18	22	20	20	7/1	20/2	7
Bitar, 2012	II	21	20	23.9	24.1	9/12	11/9	2
Petri, 2012	I	12	8	27.2	21.6	8/4	5/3	2
Regalado, 2014 [24]	II	16	20	13.5	13.5	5/11	9/11	6
Ji, 2016 [25]	II	32	30	20	20	11/19	9/17	3.5

Table 2 Characteristics of the included studies

	National	Study design	Operative interventions	Non-surgical interventions
Nikku, 2005 [19]	Japan	RCT	Medial retinaculum stitch, MPFL augmentation, lateral release	3 weeks immobilization in cast or orthosis then thigh muscle exercises
Christiansen, 2008 [21]	Denmark	RCT	MPFL repair with anchor	0–2 weeks orthosis immobilization 0°–20° motion. Quadriceps exercises and general physiotherapy
Palmu, 2008 [20]	Finland	RCT	Stitch the tear, lateral release	3 weeks immobilization in cast or orthosis then thigh muscle exercises
Camanho, 2009 [22]	Brazil	RCT	MPFL repair with anchor	3 weeks immobilization then physiotherapy with VMO exercises
Sillanpaa, 2009 [18]	Finland	RCT	Medial reefing; R-G procedure; repair osteochondral fracture	3 weeks orthosis immobilization 0°–30° motion. Week 3–6 weeks, 0°–90° full motion at 6 weeks. Quadriceps exercises commence immediately
Bitar, 2012	Brazil	RCT	MPFL reconstruction using patellar tendon	3 weeks immobilization then physiotherapy with quadriceps exercises
Petri. 2012	Germany	RCT	Repair the tear, or lateral release	3 weeks orthosis immobilization 0°–30° motion with partial weight-bearing. Week 3–6 weeks, 0°–90° motion with progression to pain-adapted full weight-bearing
Regalado, 2014 [24]	Finland	RCT	R-G procedure, lateral release	3 weeks orthosis immobilization 0°–30° motion. Week 3–6 weeks, 0°–90° motion with progression to pain-adapted full weight-bearing
Ji, 2016 [25]	China	RCT	MPFL repair with anchor	At least 3 weeks orthosis immobilization 0°–60° motion, with quadriceps exercises, partial weight bearing with the assistance of crutches

analysis. The short-term follow-up subgroup in the surgical group had better recurrence rate of patellar dislocation than that in the non-surgical group. The difference was statistically significant (RR = 0.38, 95% CI 0.15–0.99, $P=0.05$), and there was no significant difference in the results of the long-term follow-up subgroups (RR = 0.71, 95% CI 0.38–1.32, $P=0.28$). After sub-combination, the surgical group had superior results than the non-surgical group, and the difference was statistically significant (RR = 0.54, 95% CI 0.30–0.96, $P=0.04$) (Fig. 2).

Heterogeneity test between the subgroup of surgery performed within 10 years and subgroup of surgery performed more than 10 years ago showed high heterogeneity. Thus, the random effect model analysis was used. In the subgroup of surgery performed within 10 years, the recurrence rate of patellofemoral dislocation in the surgery group was less than that in the non-surgical group, indicating that the surgical group had superior results than the non-surgical group. The difference was statistically significant (RR = 0.26, 95% CI 0.09–0.75, $P=0.01$). In the subgroup of surgery performed

Table 3 PEDro assessment scores, "Y" for compliance and "N" for non-compliance

	Eligibility criteria	Random allocation	Concealed allocation	Baseline Comparability	Blind subject	Blind Clinician	Blind assessor	Adequate follow-up	Intention-to treat analysis	Between-group analysis	Point estimates and variability	Total score
Nikku, 2005 [19]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	6
Christiansen, 2008 [21]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	6
Palmu, 2008 [20]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	6
Camanho, 2009 [22]	Y	Y	N	Y	N	N	N	Y	N	Y	N	5
Sillanpaa, 2009 [18]	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	7
Bitar, 2012	Y	Y	N	Y	N	N	N	Y	N	Y	Y	6
Petri. 2012	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	7
Regalado, 2014 [24]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	6
Ji, 2016 [25]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	6

more than 10 years ago, there was no significant difference in the results between the surgical and non-surgical groups (RR = 0.73, 95% CI 0.43–1.25, $P = 0.25$). After sub-combination, the surgical group showed superior results than the non-surgical group, and the difference was statistically significant (RR = 0.54, 95% CI 0.30–0.96, $P = 0.04$) (Fig. 3).

Comparison of patient satisfaction

Four articles mentioned results for patient satisfaction. A total of 240 patients, including 132 in the surgical group and 108 in the non-surgical group, were analyzed. Using a fixed-effects model, the pooled data showed no significant difference between the surgical and non-surgical groups (RR = 0.88; 95% CI 0.75–1.03; $P = 0.12$) (Fig. 4).

Comparison of recurrence rate of instability and subluxation

Patellar instability and subluxation indicate that the patella is not stable, it can move more than half width of the patella towards lateral, but is not completely dislocated. There are six articles that provided data on the recurrence rate of instability and subluxation. A total of 315 patients, including 167 in the surgical group and 148 in the non-surgical group, were analyzed. Using a fixed-effects model, no significant differences were found between the surgical and non-surgical groups (RR = 0.70, 95% CI 0.45–1.08, $P = 0.10$) (Fig. 5).

Comparison of Kujala scores

Eight studies evaluated the Kujala score of the patients. A total of 456 patients, including 245 in the surgical group and 211 in the non-surgical group, were analyzed. We also divided the patients into the short-term follow-up subgroup (follow-up duration within 5 years) and long-term follow-up subgroup (follow-up duration of more than 5 years) based on the follow-up time. The heterogeneity test performed between subgroups showed high heterogeneity; thus, random effect model analysis was used. After the surgical or non-surgical treatment, in the short-term follow-up subgroup, the Kujala score in the surgical group was better than that in the non-surgical group, with the difference showing statistical significance (WMD = 13.94, 95% CI 8.78–19.11, $P < 0.001$). In the long-term follow-up subgroup, the difference was not statistically significant (WMD = −2.20, 95% CI −4.28 to 0.42, $P = 0.10$). After sub-combination, the difference was not statistically significant (WMD = 7.17, 95% CI −0.31 to 14.66, $P = 0.06$) (Fig. 6).

In another analysis of the Kujala score, the patients were divided into two subgroups (surgery performed within 10 years and surgery performed more than 10 years ago) based on the year of surgery. Heterogeneity test

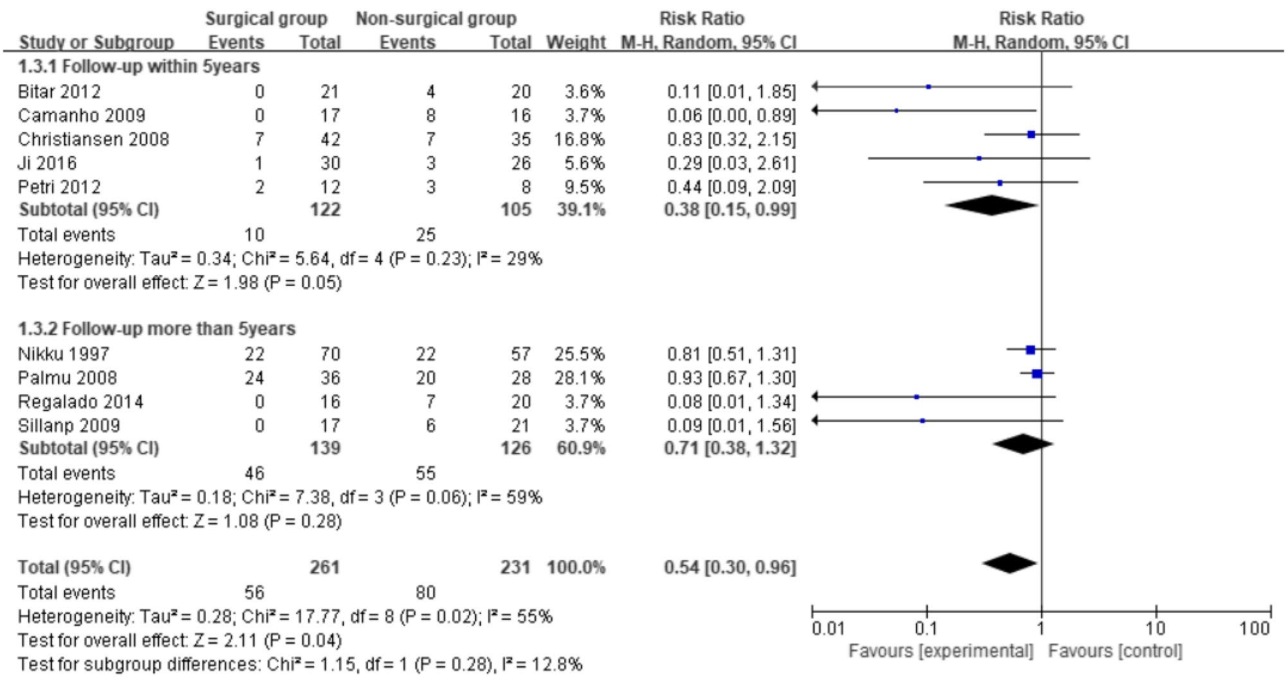

Fig. 2 Comparison of recurrence rates of dislocation based on follow-up time

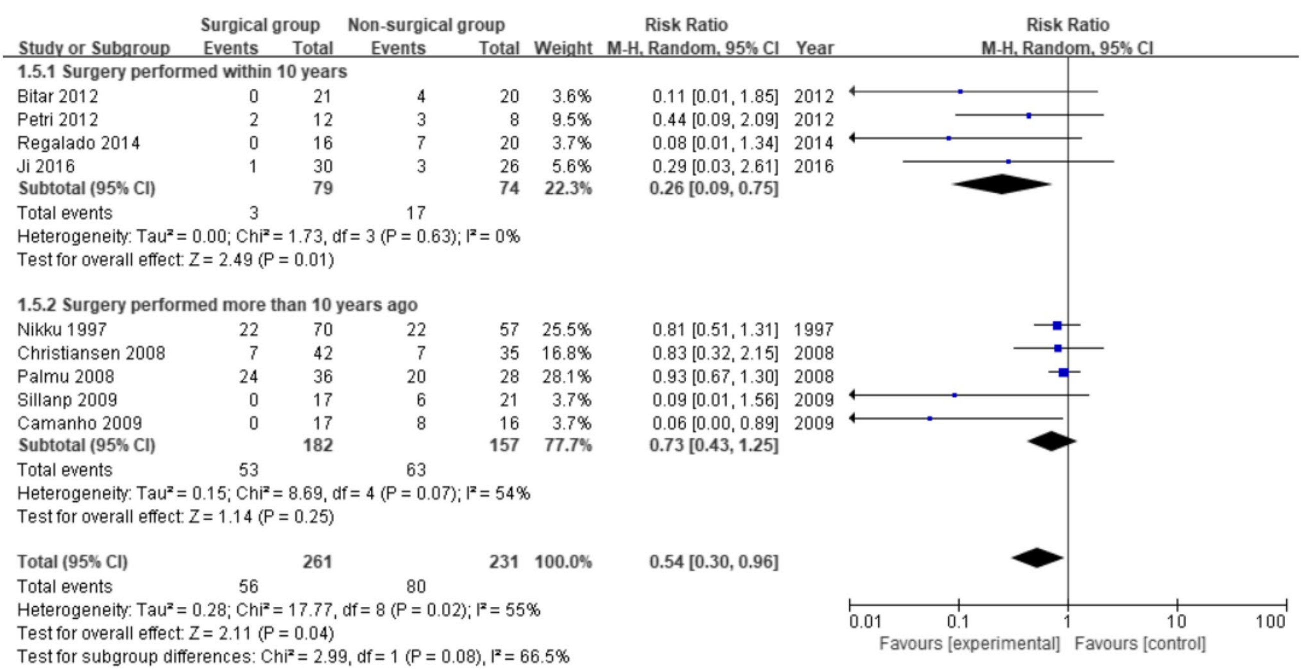

Fig. 3 Comparison of recurrence rates based on the year of surgery

performed between the subgroups showed high heterogeneity; thus, we used a random effect model analysis. After the surgical or non-surgical treatment, in the subgroup of surgery performed within 10 years, the surgical treatment was demonstrated to be better than the non-surgical treatment, with the difference showing statistical significance (WMD = 13.50, 95% CI 11.17–15.82, $P < 0.001$), whereas in the subgroup of surgery performed more than 10 years ago, the difference was not statistically significant (WMD = 3.95, 95% CI − 4.63 to 12.54, $P = 0.37$).

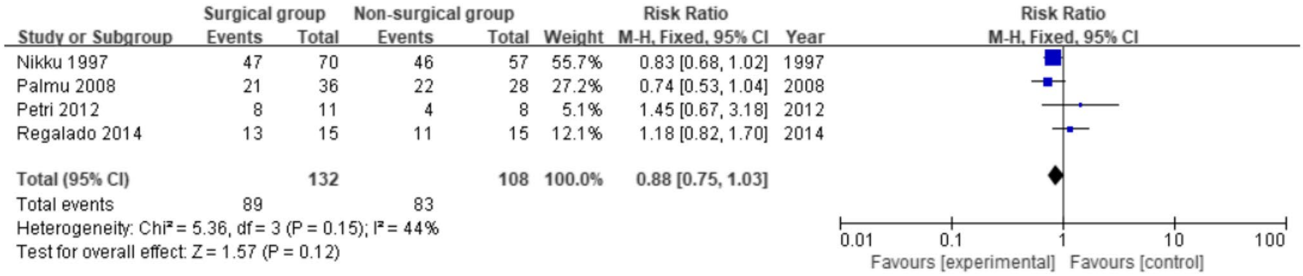

Fig. 4 Comparison of patient satisfaction

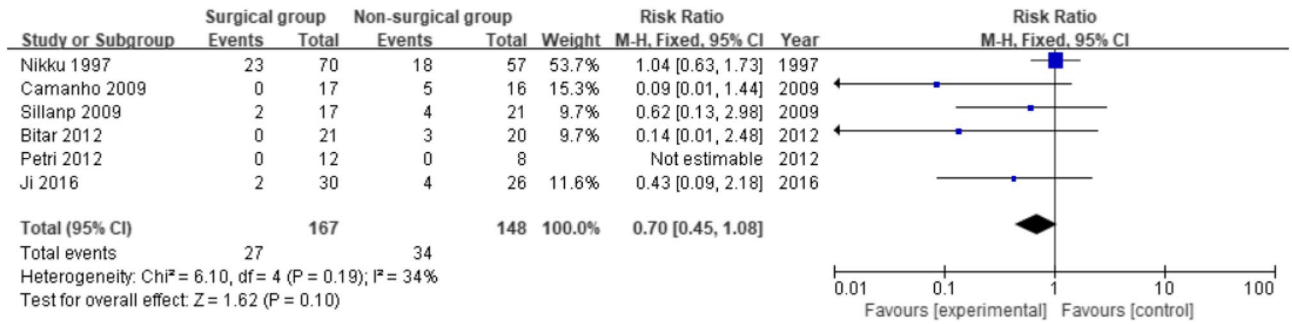

Fig. 5 Comparison of patellofemoral instability and subluxation recurrence

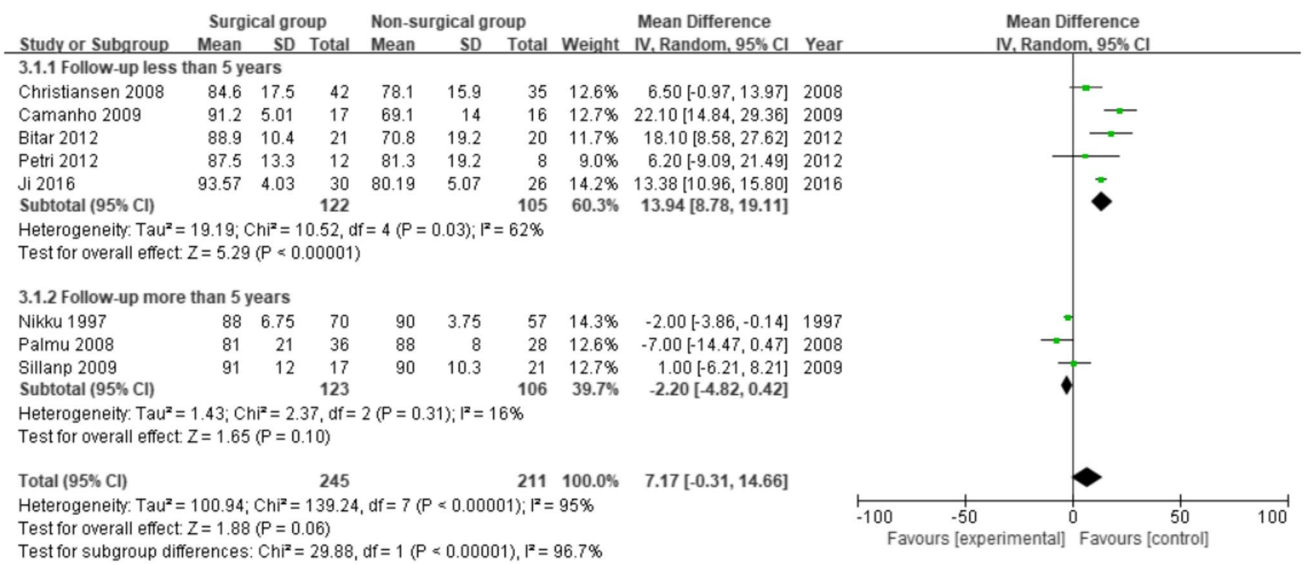

Fig. 6 Comparison of Kujala scores based on follow-up time

After sub-combination, the difference was not statistically significant (WMD = 7.17, 95% CI −0.31 to 14.66, $P = 0.06$) (Fig. 7).

Publication bias analysis

The funnel plot analysis of the recurrence rate of the patellar dislocation was performed and showed that the funnel plot was symmetrically distributed, suggesting that publication bias was small, and the results were stable (Fig. 8).

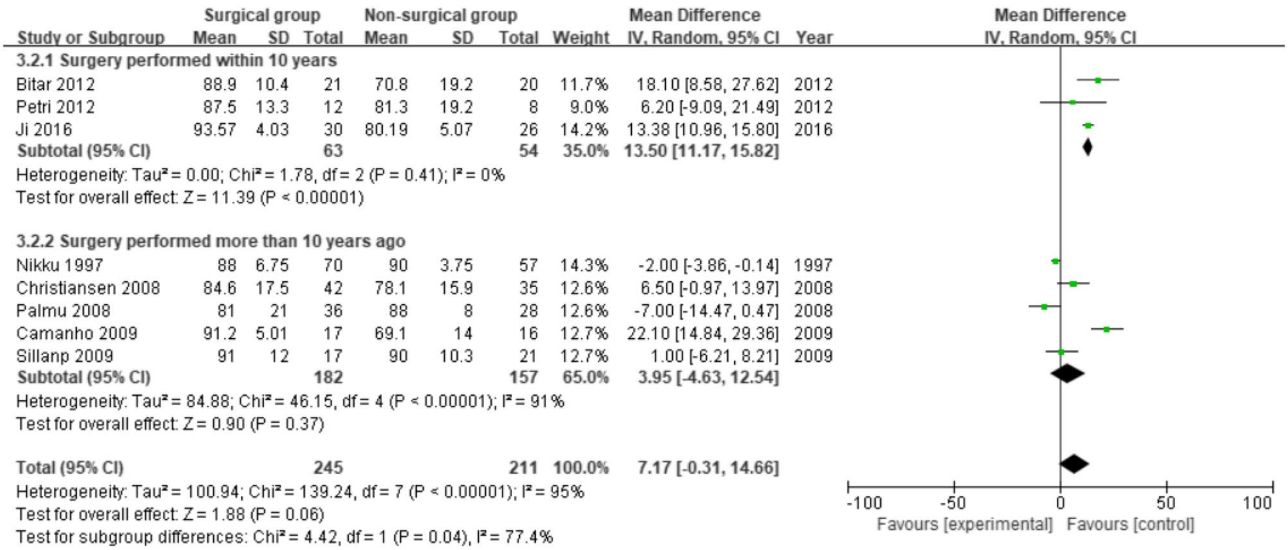

Fig. 7 Comparison of Kujala scores based on the year of surgery

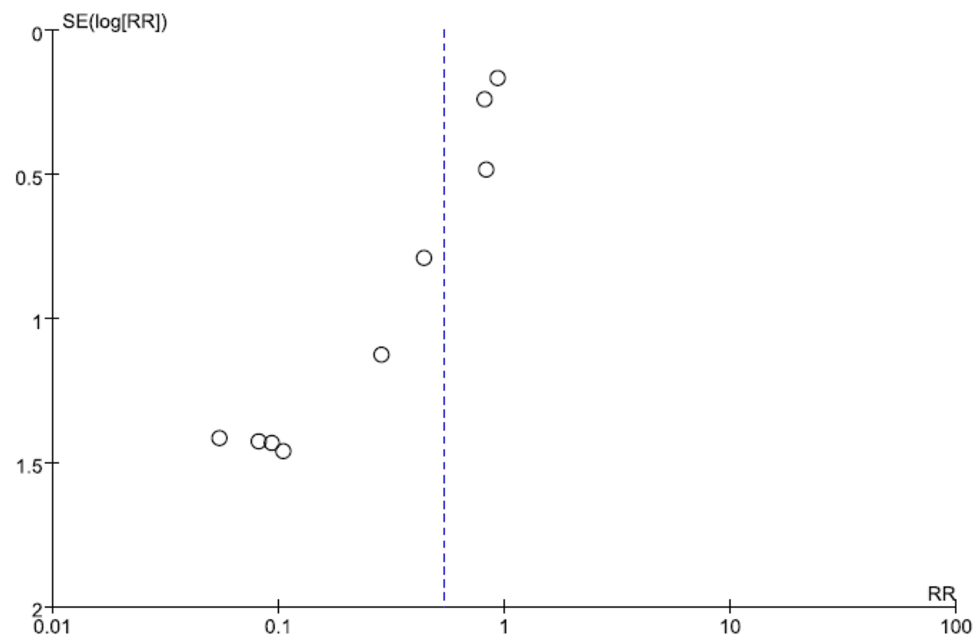

Fig. 8 Funnel plot analysis of the recurrence rate of patellar dislocation

Discussion

There are five meta-analyses of non-surgical treatment versus surgical treatment of patellar dislocation [7, 12–15]. However, these studies had some limitations. Hing et al. [12] studied the recurrent patellar dislocation. Patients with recurrent patellar dislocation often have anatomical abnormalities, such as an abnormal shape of the trochlea, increased TT-TG distance, high patellar, abnormal Q angle, and force line, among others. Most scholars believe that such patients need surgical treatment to correct the anatomical abnormalities, as non-surgical treatment is not effective [27]. Therefore, their inclusion of patients with recurrent patellar dislocation may have led to bias and affected the results of the analysis. Moreover, they incorporated some retrospective studies or low-quality clinical controlled studies; thus, the risk of bias was greater. The research of Yao et al. and Saccomanno et al. [13, 15] made great progress in the selection and analysis of the literature, but they did not realize that surgical instruments and surgical techniques are constantly updated and improved.

The effect of surgery performed 10 years ago or within the past 10 years may be varied; however, no study had performed a subgroup analysis in this direction. In addition, systematic reviews of evidence-based medicine should be updated at least every 2 years to incorporate the latest research results. The search time of the previous meta-analysis was February 2016; thus, there were some limitations in timeliness.

The results of the study showed that surgery could reduce the recurrence rate of patellar dislocation in short term, but there was no significant difference in the long-term follow-up. This was basically the same as the results of the previous four meta-analyses. Thus, it is safe to say that surgical treatment provides sufficient stability for the patella in a short period of time. After a long time, the lateral retinaculum may loosen, and the repaired medial retinaculum may not be tough enough to provide sufficient inward pull of the patella.

The results based on the subgroup analysis according to the year of the surgery showed that the recurrence rate of patellar dislocation in the surgical group was significantly lower than that in the non-surgical group in recent years. This may be associated with the surgical conditions and the progress of surgical instruments and is closely related to the choice of surgical methods. Most of the early surgical methods selected were suture stitch or reinforcement of the medial retinaculum, release of the lateral retinaculum, and R-G procedure. However, in recent years, more scholars have selected MPFL reconstruction and MPFL repair with anchor combined with lateral release. Many scholars have also gradually realized the importance of the MPFL. Studies have shown that MPFL provides approximately 55–80% of the patellar inward pull force [28, 29]; thus, it is the most important source of static pull force that limits the lateral movement of the patella. Recent research found that MPFL reconstruction is superior to non-surgical treatment or other surgical methods in treating patellar dislocation [30–33]. And other studies found that MPFL reconstruction is safe and effective in treating patellar dislocation [34–37]. But if the patients have a severe genu valgum, isolated MPFL reconstruction may not enough, some researchers reported that the femoral varisation osteotomy is effective for patellofemoral disbalance cause by genu valgum [38]. Among the literature included in the study, four selected MPFL repair with anchor or MPFL reconstruction as their surgical treatment [21–23, 25]. Their results showed that the surgical treatment was significantly better than the non-surgical treatment in terms of the recurrence rate and Kujala score. All of these suggest that MPFL reconstruction or repair may be superior to non-surgical treatment or other surgical procedures, but this hypothesis requires more research evidence and long-term follow-up for validation.

In the study, we found that the Kujala score in the surgical group was superior to that in the non-surgical group in the short-term follow-up, but there was no significant difference in long-term follow-up. Two early studies reported that the Kujala score in the non-surgical treatment group was even better than that in the surgical group. This may because surgery provided enough patellar stability in the short-term and improved the knee function. However, after a long time, due to surgical trauma and complications associated with surgery such as pain, scar adhesion, infection, and so on, knee function of the patients may become limited. Moreover, the Kujala score itself is a subjective functional score of the patient. The surgery caused trauma and burden the patient in terms of medical cost, which may result in the patient's negative feeling towards the surgical treatment; this could have resulted in lower Kujala score in the surgical group. The results based on the year of the surgery showed that the Kujala score in recent years in the surgical group was significantly better than that in the non-surgical group, which may be related to the improvement of surgical conditions and the choice of surgical methods.

The results of the study showed no significant difference in patient satisfaction between the surgical and non-surgical groups. There was no significant difference in the instability of the patella and the rate of subluxation between the surgical and non-surgical groups. This indicates that it is difficult to completely restore the stability of the patient's patella, as surgery only improved the stability of the patient's patella so that it does not completely dislocate.

There are still many shortcomings and deficiencies in this study. First, after careful searching, only nine randomized controlled trials were included in this study, which included a total of 492 patients analyzed. In the nine randomized controlled trials, the population included in the study varied, including children, adolescents, and adults of both sexes. Second, only two studies used concealed allocation for random grouping, which may increase the selection bias. Third, blinding of subjects, clinicians, and assessors were not applied to any of the included randomized controlled trials, which may have increased detection bias. Finally, although surgical and non-surgical interventions were compared in the included studies, most studies did not describe the specific management procedures in detail, especially the poor description of non-surgical treatment strategies, thus limiting the replication of these clinical trials. These reasons all increase the risk of bias in this study. In the future, to better evaluate the efficacy of the two treatment strategies, it is recommended to uniformly integrate the study population, standardize interventions for these patients, and carry out larger and higher-quality randomized controlled studies.

Conclusion

For primary patellar dislocation, surgery can result in the recovery of the knee function in the short term and reduce the recurrence rate of patellar dislocation. Especially from the surgery performed within 10 years, the knee function score and the recurrence rate of patellar dislocation in the surgical group were significantly better than those in the non-surgical group. Therefore, surgical treatment is still the recommended treatment for primary patellar dislocation.

Author contributions ZDF carried out the entire procedure including the literature search and data extraction. He performed the statistical analysis, drafted the manuscript. ZQZ and HTC contributed to the statistical analysis and data extraction. SQZ conceived of the study, coordinated and participated in the entire process of drafting, and revised the manuscript. All authors have contributed significantly. All authors read and approved the final manuscript.

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Data availability All the data of the manuscript are presented in the paper.

Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

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