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Surgical versus nonsurgical treatment of primary acute patellar dislocation
A systematic review and meta-analysis

Fan Yang, MS[a], Wenlai Guo, PhD[b], Qian Wang, MS[d], Zhe Zhu, PhD[b], Congying Guan, MS[a], Shishun Zhao, PhD[a],*, Baoming Yuan, PhD[c],*

Abstract

Background: To systematically review the efficacy of surgical versus nonsurgical treatment for acute patellar dislocation.

Materials and Methods: PubMed, Cochrane, and Embase were searched up to February 12, 2019. After removing duplicates, preliminary screening, and reading the full texts, we finally selected 16 articles, including 11 randomized controlled trials and 5 cohort studies. The quality of the enrolled studies was evaluated by Jadad score or Newcastle–Ottawa scale. Meta-analyses were performed using odds ratio (OR) and standardized mean difference (SMD) as effect variables. The clinical parameters assessed included mean Kujala score, rate of redislocation, incidence of patellar subluxation, patient satisfaction, and visual analog scale (VAS) for pain. Evidence levels were determined using GRADE profile.

Results: The 16 included studies involved 918 cases, 418 in the surgical group and 500 in the nonsurgical group. The results of the meta-analysis showed higher mean Kujala score (SMD = 0.79, 95% confidence interval [CI] [0.3, 1.28], P = .002) and lower rate of redislocation (OR = 0.44, 95% CI [0.3, 0.63], P < .00001) in the surgical group than the nonsurgical group, but showed insignificant differences in the incidence of patellar subluxation (OR = 0.61, 95% CI [0.36, 1.03], P = .06), satisfaction of patients (OR = 1.44, 95% CI [0.64, 3.25], P = .38), and VAS (SMD = 0.84, 95% CI [−0.36, 9.03], P = .84).

Conclusion: For patients with primary acute patellar dislocation, surgical treatment produces a higher mean Kujala score and a lower rate of redislocation than nonsurgical treatment.

Abbreviation: NS = nonsurgical treatment, Surg = surgical treatment.

Keywords: dislocation or subluxation, functional evaluation, meta-analysis, primary acute patellar dislocation, surgical treatment

1. Introduction

The patella, located below the knee joint, is the largest sesamoid bone in the human body. Acute patellar dislocation is one of the most common diseases of the knee joint. Improper treatment can lead to recurrence, pain, arthritis, or functional disorders. The probability of relapse is up to 40%.[1] Therefore, it is urgent in clinical practice to treat the condition effectively in order to reduce the recurrence rate and to ease the pain of patients.

Nowadays, therapeutic approaches include surgical and nonsurgical methods. The surgical method has a higher cure rate, but can easily cause complications. The nonsurgical method is simpler and safer, but the recurrence rate is higher. Researchers have conducted a large number of basic studies to compare the therapeutic effects of surgical treatment and nonsurgical treatment for acute patellar dislocation, but the results are still controversial. In recent years, several meta-analyses have compared the efficacy of surgical versus nonsurgical treatment for acute patellar dislocations,[2–6] providing clinicians with evidence-based medicine data for clinical practice. There are also some new experimental studies not previously included in meta have emerged in 2017 and 2018, which may have an impact on existing conclusions.

In this review, we conduct an up-to-date meta-analysis, including the latest randomized controlled trials and cohort studies[7–9] published in 2017 and 2018. The purpose of this review

is to cover studies that compared outcome indicators for surgical and nonsurgical treatment. We focus on Kujala score and on clearly presenting the level of evidence for each finding,[10] in order to provide evidence-based medical criteria for clinical selection.

2. Materials and methods

2.1. Search strategy
2.1.1. Ethical approval.
The Second Hospital of Jilin University, Changchun 130012, China. (Serial number: 2018-167)

2.1.2. Retrieval method.
According to the method of Cochrane system evaluation and the list of PRISMA declaration,[11,12] 3 databases, Pubmed, Cochrane, and Embase were retrieved by computer in this paper (all up to February 12, 2019). The references for relevant reviews and systematic reviews were manually retrieved.

2.1.3. Basic PubMed search.
The search performed in PubMed was for: ((((Dislocation, Patellar[Title/Abstract]) AND Disloca- tions, Patellar[Title/Abstract]) OR Patellar Dislocations[Title/ Abstract])) OR "Patellar Dislocation"[Mesh] AND ("Surgical Procedures, Operative"[Mesh]) OR (((((((((((Operative Surgical Procedure[Title/Abstract]) OR Operative Surgical Procedures [Title/Abstract]) OR Procedures, Operative Surgical[Title/Ab- stract]) OR Surgical Procedure, Operative[Title/Abstract]) OR Operative Procedures[Title/Abstract]) OR Operative Procedure [Title/Abstract]) OR Procedure, Operative[Title/Abstract]) OR Procedures, Operative[Title/Abstract]) OR Procedure, Operative Surgical[Title/Abstract]) OR Surgery, Ghost[Title/Abstract]) OR Ghost Surgery[Title/Abstract])

2.2. Assessment of study eligibility

The inclusion criteria comprised randomized controlled trials (RCTs) and cohort studies with scores ≥6 on the Newcastle– Ottawa scale (NOS)[13] that

were written in English,

investigated primary acute patellar dislocation in human patients of any age, and

compared surgical and nonsurgical treatments for acute patellar dislocation.

Surgical treatments included medial structural repair and medial patellofemoral ligament (MPFL) reconstruction, while nonsurgical treatments included fixation, physiotherapy, and so on. We chose both RCT and cohort studies, because these years there are many studies[14–17] that mix RCT and cohort studies, this method could increase the sample size, take more information into account, and also meet the need of later Egger test.

The exclusion criteria comprised studies concerning recurrent or chronic patellar dislocation; animal or cadaver studies; and studies addressing chondromalacia patella, patellar malforma- tion, or patellar subluxation.

2.3. Effect indicators

The 5 effect indicators defined in this study were mean Kujala score, rate of redislocation, incidence of patellar subluxation, satisfaction of patients, and visual analog scale (VAS) for pain.[18] The Kujala score is currently the most commonly used criterion for evaluation of the patella.[3] The scale includes 13 items involving daily function, pain, motor function, and symptoms. The range of possible scores is 0 to 100, with lower scores indicating higher levels of pain or disability. Rate of redislocation

and incidence of patellar subluxation are 2 indicators objectively reflecting the risk for redislocation after treatment. Satisfaction of patients and VAS score intuitively reflect the therapeutic effect through the patient's subjective feelings.

2.4. Data extraction

Two researchers (FY, WG) independently extracted the data, recording the first author, publication year, sample size, age, sex, follow-up time, rate of redislocation, incidence of patellar subluxation, satisfaction of patients, mean Kujala score and VAS for each included study. A third researcher (RL) was responsible for resolving any disagreements.

2.5. Literature analysis and quality assessment

Modified Jadad [19,20] and NOS scores were used to assess the quality of the included RCTs and cohort studies. These 2 scales were scored independently by 2 researchers (FY, WG). Any disagree- ments were resolved by a third researcher (SZ). The modified Jadad score mainly focused on the following 4 aspects: randomization, concealment of allocation, double blinding, withdrawals, and dropouts. The NOS mainly focused on the selection of experimental and control groups, comparability, and outcomes. These 2 methods are quantifiable and helpful for subsequent analysis

2.6. Statistical analysis

Revman5.3 and Stata MP14 were used for the meta-analysis. Odds ratios (OR) were used as combined effect indicators for dichotomous variables (redislocation, patellar subluxation, patient satisfaction), and standardized mean differences (SMD) were used for continuous variables (mean Kujala score, VAS). The chi-square test was adopted to assess heterogeneity, with a threshold of $P < .05$. A value of $I^2 > 50\%$ was considered to indicate high heterogeneity. We followed the rule that a random- effects model should be established when $I^2 > 50\%$, otherwise a fixed effects model should be used. Subgroup analyses, sensitivity analyses and meta-regression were used to find the sources of heterogeneity. Indicators included in more than 10 studies were tested for bias by funnel plots. Finally, GRADE profile software was used to determine the level of evidence.

3. Results

3.1. Literature search

Two researchers (FY, WG) independently screened the literature. The results of the search are shown in Figure 1: 878 articles from PubMed, 1354 from Embase, and 8 from the Cochrane database, for a total of 2240 studies. After excluding duplicates, 2028 studies were retained. 1646 studies were retained after reading titles, keywords, and abstracts. After reading full texts, 441 studies were assessed for eligibility, and only 14 studies involved not only qualitative but also quantitative synthesis. The remaining 16 articles (11 RCTs and 5 cohort studies) were included in this meta-analysis (see Fig. 1).

3.2. Study characteristics

There were a total of 918 patients, with 418 in the surgery group and 500 in the nonsurgery group. The basic characteristics of the subjects are shown in Table 1.
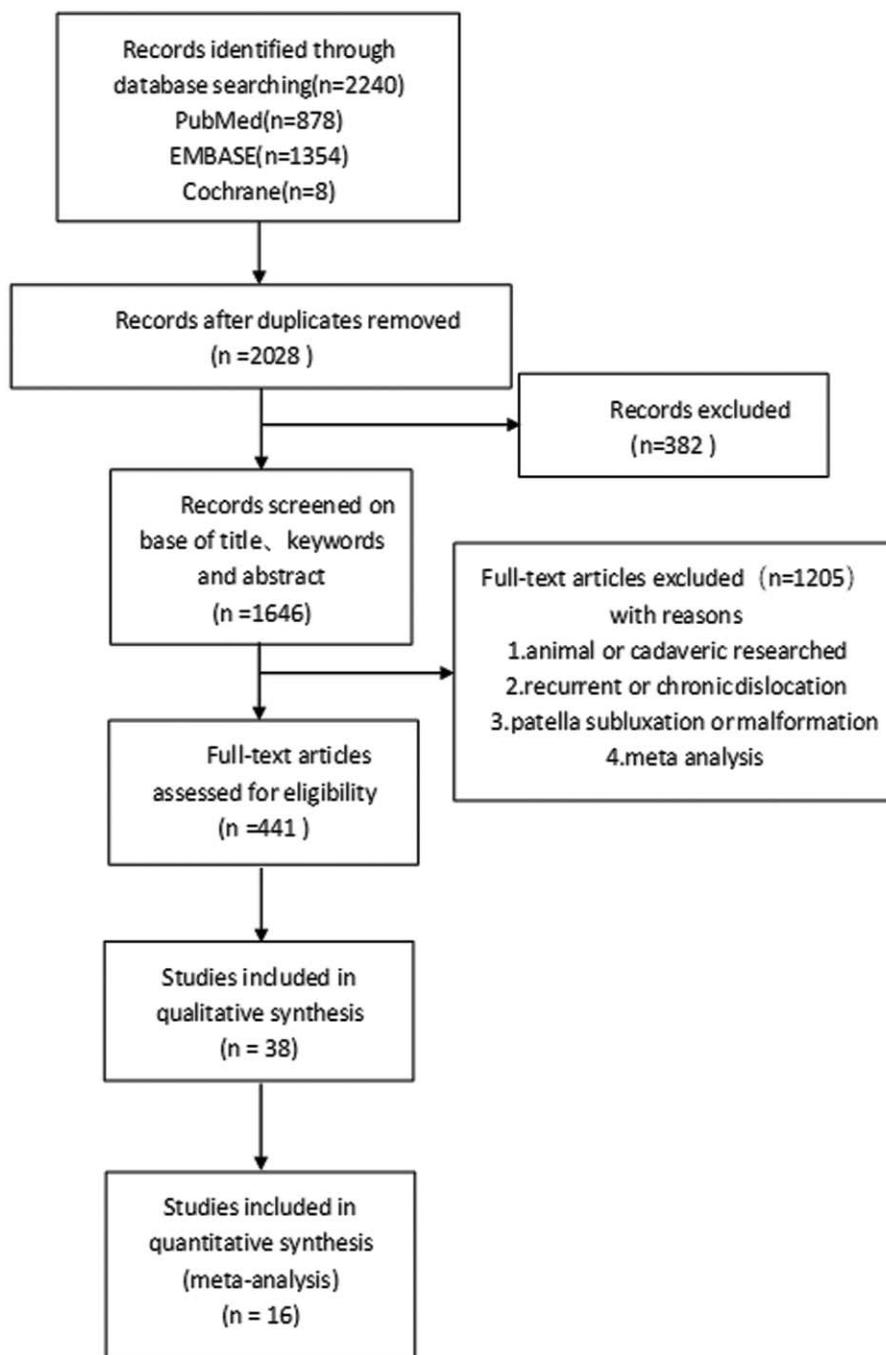
Figure 1. Literature search strategy and results.

3.3. Meta-analysis results
3.3.1. Mean Kujala score. Ten studies reported mean Kujala score, including 282 cases in the surgical group and 283 cases in the nonsurgical group. Among them, the standard deviation of the mean Kujala score was not indicated in Nikku [22] and Camanho.[25] However, we obtained the relevant data through the study of Sheng-nan Wang.[6] We calculated $I^2 = 86\%$, so a random effects model was selected. There was a significant difference between the surgical group and the nonsurgical group (SMD = 0.79, 95% confidence interval [CI] = 0.3–1.28, $P < .002$), with the mean Kujala score of the surgical group higher (see Fig. 2).

The calculated value of $I^2 = 86\%$ indicated strong heterogeneity. To find the sources of heterogeneity, a cohort study by Mostrom[33] was removed for sensitivity analysis, low-quality RCTs were removed for sensitivity analysis, and a subgroup analysis was performed according to the year of publication. However, none of these efforts produced any decline in heterogeneity, and the conclusions of the 2 subgroups were consistent with the overall conclusion (see Figs. 3 and 4).

Results from a meta-regression on the place of residence (Europe, Non-Europe) showed that $\text{tau}^2 = 0.8543$ and $R^2 = 9.14\%$, indicating that the variation in mean Kujala

Table 1

Characteristics of the included trials and participants.

| Study, yr	Study type	Sex ratio		Numbers		Mean age		Follow-up		JADAD/NOS
		Female	Male	Surg	NS	Surg	NS	Surg	NS	
Buchner, M. 2005[21]	Cohort			43	83			8.1 yr		7
Nikku, R. 2005[22]	RCT	82	45	70	57	20	20	7.2 yr		6
Christiansen, S.E. 2008[23]	RCT	35	42	42	35	20	19.9	2 yr		4
Sillanpaa, P.J. 2008[24]	Cohort	4	72	30	46	20	20	7.5 yr	7 yr	7
Camanho, G.L. 2009[25]	RCT	20	13	17	16	24.6	26.8	3.4 yr	3 yr	5
Bitar, A.C. 2012[26]	RCT	20	21	21	18	23.95	24.1	3.1 yr	4 yr	6
Petri, M. 2013[27]	RCT	9	15	14	10	23.95	24.1	1 yr	6	
Regalado, G. 2016[28]	RCT	22	14	16	20	13.5	13.5	6 yr	4	
Ji, G. 2017[9]	RCT			30	32			3.5 yr	3	
Hawkins, R.J. 1986[29]	RCT	13	14	7	20	19	19	2.25 yr	3.3 yr	1
Sauli Palmu 2008[30]	RCT	46	18	36	28	13±2		14 yr		2
Sillanpaa, P.J. 2009[31]	RCT	3	35	17	21	20	20	7 yr		7
Milan Apostolovic 2011[32]	Cohort			14	23			5–8 yr		7
Mostrom, E.B. 2014[33]	Cohort	20	20	7	33	12.6±2.3	13.5±1.3	5 yr		6
Hui Kan 2018[7]	Cohort	30	13	24	19	14.2	13.9	31 mo	25 mo	6
Xiaozuo Zheng 2018[8]	RCT	40	29	30	39	18.3	17.9	2 yr		4

NS = nonsurgical group, Surg = surgical group.
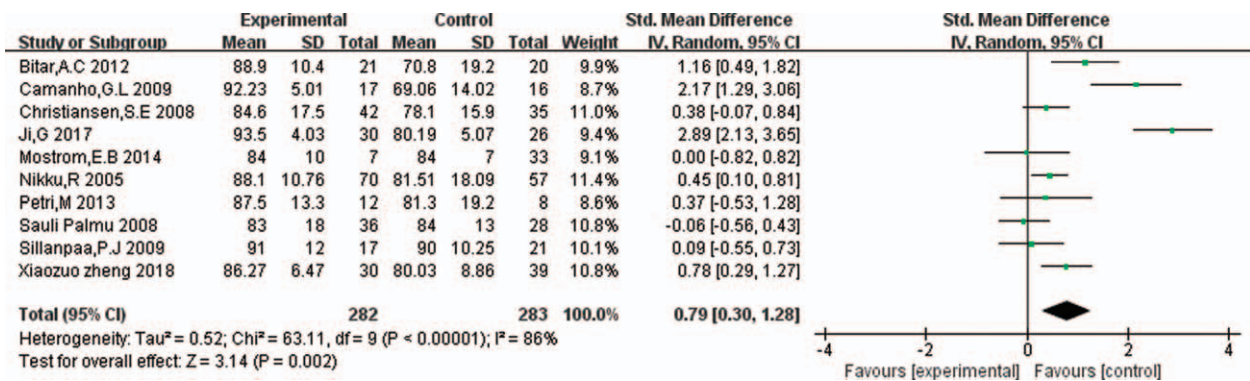
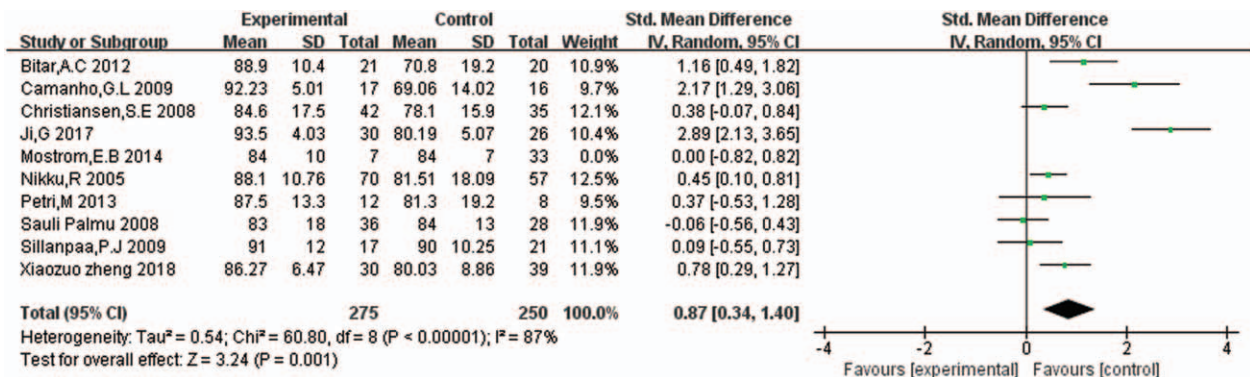**Figure 2.** Forest plot for mean Kujala score.

Figure 3. Sensitivity analysis for mean Kujala score. 3.1 Remove the cohort study. 3.2 Remove the RCT with the lowest score. 3.3 Remove the RCT with the sub-low score.
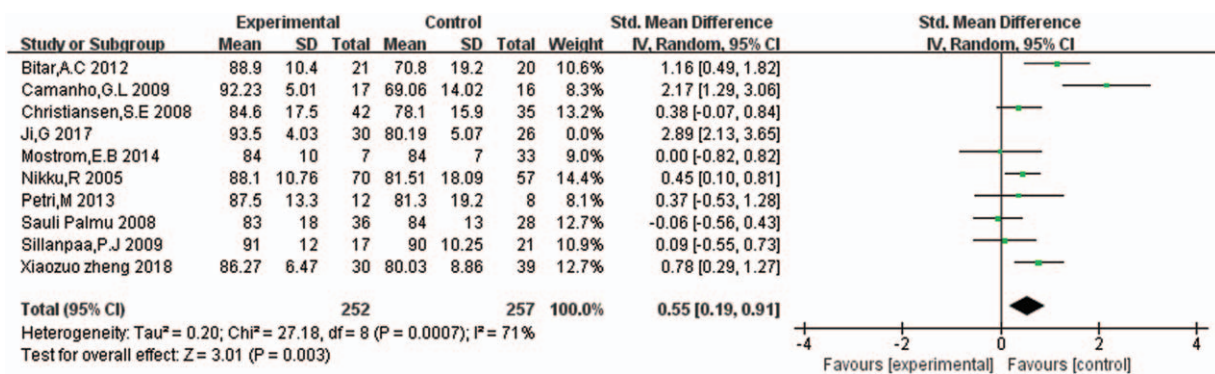
Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Bitar,A.C 2012	88.9	10.4	21	70.8	19.2	20	10.6%	1.16 [0.49, 1.82]
Camanho,G.L 2009	92.23	5.01	17	69.06	14.02	16	8.3%	2.17 [1.29, 3.06]
Christiansen,S.E 2008	84.6	17.5	42	78.1	15.9	35	13.2%	0.38 [-0.07, 0.84]
Ji,G 2017	93.5	4.03	30	80.19	5.07	26	0.0%	2.89 [2.13, 3.65]
Mostrom,E.B 2014	84	10	7	84	7	33	9.0%	0.00 [-0.82, 0.82]
Nikku,R 2005	88.1	10.76	70	81.51	18.09	57	14.4%	0.45 [0.10, 0.81]
Petri,M 2013	87.5	13.3	12	81.3	19.2	8	8.1%	0.37 [-0.53, 1.28]
Sauli Palmu 2008	83	18	36	84	13	28	12.7%	-0.06 [-0.56, 0.43]
Sillanpaa,P.J 2009	91	12	17	90	10.25	21	10.9%	0.09 [-0.55, 0.73]
Xiaozuo zheng 2018	86.27	6.47	30	80.03	8.86	39	12.7%	0.78 [0.29, 1.27]
Total (95% CI)			252			257	100.0%	0.55 [0.19, 0.91]

Heterogeneity: Tau² = 0.20; Chi² = 27.18, df = 8 (P = 0.0007); I² = 71%
Test for overall effect: Z = 3.01 (P = 0.003)

Figure 3. (Continued).

Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Bitar,A.C 2012	88.9	10.4	21	70.8	19.2	20	12.1%	1.16 [0.49, 1.82]
Camanho,G.L 2009	92.23	5.01	17	69.06	14.02	16	9.4%	2.17 [1.29, 3.06]
Christiansen,S.E 2008	84.6	17.5	42	78.1	15.9	35	15.3%	0.38 [-0.07, 0.84]
Ji,G 2017	93.5	4.03	30	80.19	5.07	26	0.0%	2.89 [2.13, 3.65]
Mostrom,E.B 2014	84	10	7	84	7	33	10.2%	0.00 [-0.82, 0.82]
Nikku,R 2005	88.1	10.76	70	81.51	18.09	57	16.8%	0.45 [0.10, 0.81]
Petri,M 2013	87.5	13.3	12	81.3	19.2	8	9.1%	0.37 [-0.53, 1.28]
Sauli Palmu 2008	83	18	36	84	13	28	0.0%	-0.06 [-0.56, 0.43]
Sillanpaa,P.J 2009	91	12	17	90	10.25	21	12.5%	0.09 [-0.55, 0.73]
Xiaozuo zheng 2018	86.27	6.47	30	80.03	8.86	39	14.7%	0.78 [0.29, 1.27]
Total (95% CI)			216			229	100.0%	0.64 [0.27, 1.01]

Heterogeneity: Tau² = 0.18; Chi² = 21.69, df = 7 (P = 0.003); I² = 68%
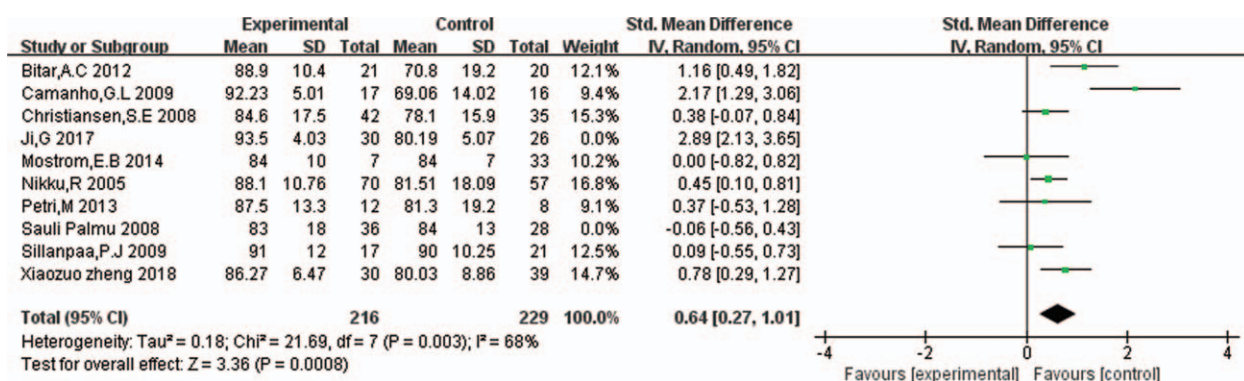Test for overall effect: Z = 3.36 (P = 0.0008)

Figure 3. (Continued)

score resulting from the place of residence was 9.14% (see Table 3).

Univariate and multivariate meta-regression analysis was performed in the order of publication year, research method, original study quality, and place of residence (Europe, Non-Europe). We found excellent meta-regression model fits for the year of publication, original study quality, and place of residence, with a significantly reduced tau^2 = 0.09607 and R^2 = 89.78%, indicating that the heterogeneity accounted for by these 3 indicators was up to 89.78% (see Table 4).

The quality of the above evidence was evaluated by the GRADE system as moderate (see Table 5).

3.3.2. Redislocation. Thirteen studies reported redislocation, including 333 cases in the surgical group and 454 cases in the nonsurgical group. In Buchner,[21] there are 2 different surgical groups, so the nonsurgical group is compared with these 2 surgical groups, separately. We calculated I^2 = 41%, so a fixed effects model was selected. There was a significant difference between the surgical group and the nonsurgical group (OR = 0.44, 95% CI = 0.3–0.63, P < .00001), with less redislocation in the surgical group (see Fig. 5).

A subgroup analysis was performed according to the type of researches (RCT, cohort), there was no significant decrease in heterogeneity, and the conclusion of the RCT subgroup was consistent with the overall conclusion (see Fig. 6).

The quality of the above evidence was evaluated by the GRADE system as moderate (see Table 6).

3.3.3. Subluxation. Seven studies reported subluxation, including 195 cases in the surgical group and 198 cases in the nonsurgical group. We calculated I^2 = 8%, so a fixed effects model was selected. As shown in Figure 7, there was no significant difference between the surgical group and the nonsurgical group (OR = 0.61, 95% CI = 0.36–1.03, P = .06).

A subgroup analysis was performed according to the type of researches (RCT, cohort), the results of the 2 subgroups were consistent, and the conclusions of the 2 subgroups were consistent with the overall conclusion (see Fig. 8).

The quality of the above evidence was evaluated by the GRADE system as moderate (see Table 7).

3.3.4. Satisfaction of patients. Eight studies reported satisfaction of patients, including 233 cases in the surgical group and 208 cases in the nonsurgical group. With patient-evaluations of "excellent" or "good" as the criteria for the occurrence of the event, I^2 = 68%, so the random effect model was selected. As shown in Figure 9, there was no significant difference between the surgical group and the nonsurgical group (OR = 1.44, 95% CI = 0.64–3.25, P = .38).

To find the sources of heterogeneity, a RCT of low grade was removed for sensitivity analysis, but the value of I^2 was not be decreased (see Fig. 10).
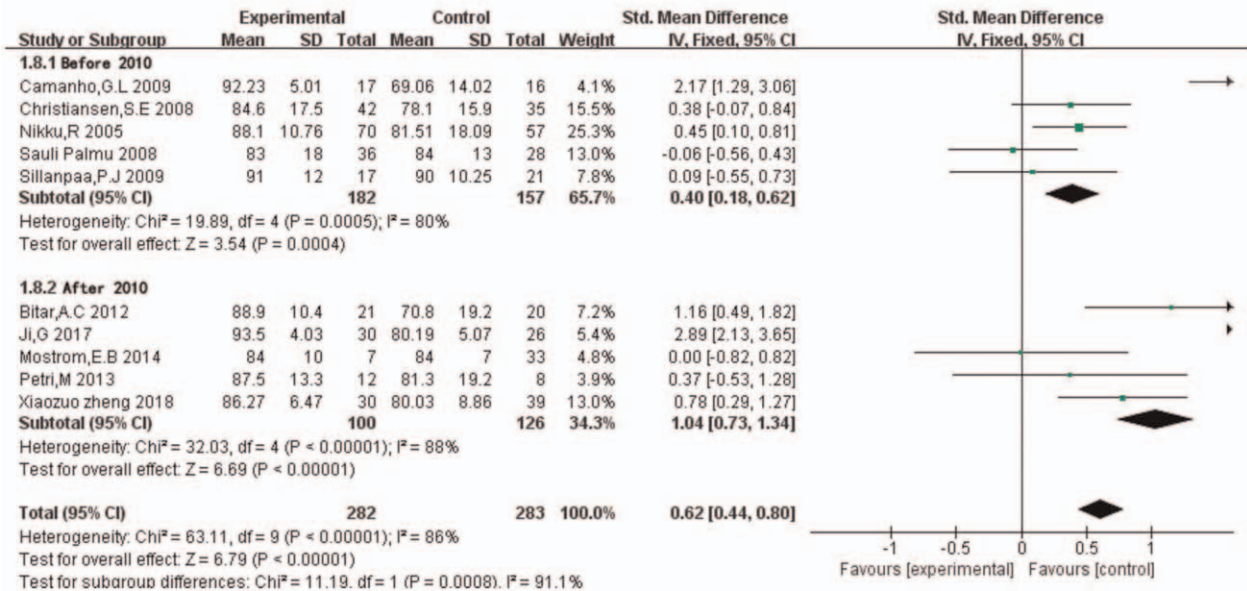
Figure 4. Subgroup analysis for mean Kujala score.

A subgroup analysis was performed according to the type of researches (RCT, cohort), there was no significant decrease in heterogeneity, indicating that heterogeneity did not come from the literature type, and the conclusions of the 2 subgroups were consistent with the overall conclusion (see Fig. 11).

The quality of the above evidence was evaluated by GRADE system as low (see Table 8).

3.3.5. VAS. Three studies reported VAS pain scores, including 113 cases in the surgical group and 113 cases in the nonsurgical group. The standard deviation data for VAS were calculated according to the data conversion formula of the Cochrane method. We calculated $I^2 = 66\%$, so a random effects model was selected. As shown in Figure 12, there was no significant difference between the surgical group and the nonsurgical group (SMD = 0.84, 95% CI = −7.36 to 9.03, $P = .84$).

To find the sources of heterogeneity, a cohort study by Sillanpaa, 2008[24] was removed for sensitivity analysis, and the value of I^2 was not be reduced (see Fig. 10).

Table 2

Surgical and nonsurgical treatment.

Author, yr	Surgical method	Nonsurgical method
Buchner, M. 2005	Rearrangement of the supporting band and the medial patellar ligament complex with the patella. Refixation of the osteochondral fragment. Reconstruction of the medial retinaculum	None
Nikku, R. 2005	Repair of the medial retinaculum	Closed
Christiansen, S. E. 2008	MPFL reconstruction	Brace usage
Sillanpaa, P.J. 2008	Repair of the acute arthroscopic medial retinacular	Immobilization
Camanho, G.L. 2009	MPFL reconstruction	Immobilization with splints physiotherapy
Bitar, A.C. 2012	MPFL reconstruction	Immobilization physiotherapy
Petri, M. 2013	Repair of the open soft tissue	DonJoyTM ROM-brace
Regalado, G. 2016	Lateral retinacula release. Modified Roux–Goldwaithe (RG) procedure.	Conventional lateral patellar support-Rehabbrace. Physiotherapy
Ji, G. 2017	Open repair of the MPFL	Immobilized with brace
Hawkins, R.J. 1986	Arthrotomy. Excision of osteochondral fragments Repair of the medial retinaculum.	Cylinder cast or splint immobilization. Physiotherapy
Sauli Palmu 2008	Repair of the damaged medial structures.	None
Sillanpaa, P.J. 2009	Patellar stabilization surgery	Patellar orthosis
Milan Apostolovic 2011	Arthroscopic surgery	Closed immobilisation local cold packs
Mostrom, E. B.2014	Proximal realignment. Patellar-stabilizing surgery.	Patella-stabilizing knee brace physiotherapy
Hui Kan 2018	Medial contraction suture. MPFL suture repair Lateral release Lateral release fixation cohort	Fixation
Xiaozuo Zheng. 2018	MPFL reconstruction	Aspiration

MPFL = medial patellofemoral ligament.

Table 3

Meta regression for mean Kujala score.

Meta-regression						Number of objects=10
REML estimate of between-study variance						tau2=0.8543
% residual variation due to heterogeneity						I-squared residual=82.61%
Proportion of between-study variance explained						Adjusted R-squared=9.14%
With Knapp-Hartung modification						

SMD	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Restrict	−1.343476	1.17135	−1.15	0.285	−4.044613	1.357662
_cons	1.793476	0.4827175	3.72	0.006	0.6803273	2.906624

Adj R squared = adjusted R-squared, Coef = coefficient, Conf. Interval = confidence interval, cons = constant, I-squared_res = I-squared residual, Number of obs = number of objects, Prob = probability, SMD = standardized mean difference, Std. Err = standard error, $tau2 = \tau^2$.

Table 4

Meta regression for mean Kujala score.

Meta-regression						Number of objects=10
REML estimate of between-study variance						tau2=0.09607
% residual variation due to heterogeneity						I-squared residual=0.00%
Proportion of between-study variance explained						Adjusted R-squared=89.78%
Joint test for all covariates						Model F (3, 6)=7.12
With Knapp-Hartung modification						Probability>F=0.0211

SMD	Coef.	Std. Err.	t	P>|t|	[95% Conf.Interval]	
Restrict	−2.147524	0.832709	−2.58	0.042	−4.185089	−0.1099584
Year	−0.1509735	0.0686433	−2.2	0.07	−0.3189375	0.0169905
Study quality	−2.104185	0.5317074	−3.96	0.007	−3.405199	−0.8031171
_cons	307.4036	138.4539	2.22	0.068	−31.38091	646.188

Adj R squared = adjusted R-squared, Coef = coefficient, Conf. Interval = confidence interval, cons = constant, I-squared_res = I-squared residual, Number of obs = number of objects, Prob = probability, SMD = standardized mean difference, Std. Err = standard error, $tau2 = \tau^2$.

The quality of the above evidence was evaluated by GRADE system as low (see Table 8).

4. Discussion

The results of this meta-analysis indicate that surgical treatment method resulted in generally higher Kujala score and lower rate of redislocation than nonsurgical treatment. Therefore, the surgical method has a good curative effect in the treatment of acute patellar dislocation. In clinical practice, an appropriate treatment is chosen with reference to the patient's economic level and prognosis, as far as possible.

This study followed the Cochrane systematic review process, and clear inclusion and exclusion criteria for literature screening were established on the basis of the PRISMA checklist.[11,12] Literature quality was evaluated based on modified Jadad scores or NOS scores. Cohort studies were included to ensure that there were enough studies included for each effect index. In this study, the total number of patients and the number of patients for each index were both higher than those reported in other meta-analyses of surgical and nonsurgical treatment of patellar dislocation published in the last 3 years.[2–4,6,34–36] The average follow-up time was 5.08 years. These factors all ensure the reliability of the results in this study.

Table 5

Evidence evaluation for mean Kujala score.

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk Control	Corresponding risk				
Mean Kujala score		The mean Kujala score in the intervention groups was 0.79 standard deviations higher (0.3 to 1.28 higher)		565 (10 studies)	⊕⊕⊕⊖ moderate	SMD 0.79 (0.3 to 1.28)

CI = confidence interval, SMD = standardized mean difference.

* The basis for the assumed risk, such as the median control group risk across studies. The corresponding risk (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
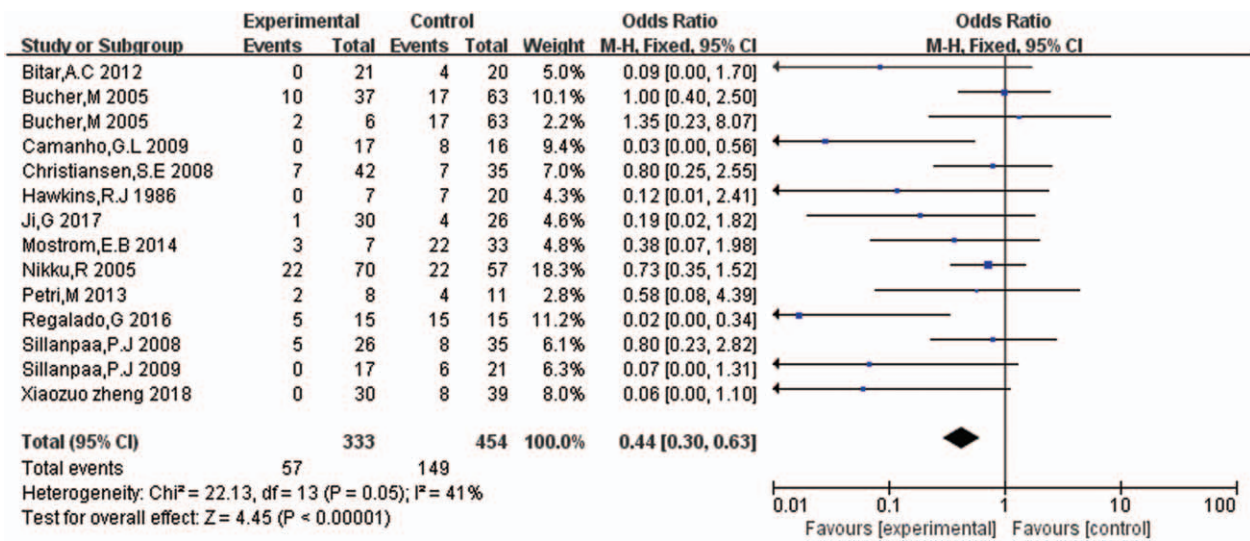
Figure 5. Forest plot for redislocation.

In this study, the Kujala score of the surgical group was higher than that of the nonsurgical group. This is inconsistent with the conclusions of meta-analyses published in 2014 and 2016,[3,4,6] in which there were no differences between surgical and nonsurgical treatments in terms of Kujala score. Herein, we reassessed the Kujala score based on the latest researches published in 2017[9] and 2018,[8] together with the preliminary data previously published. As the Kujala score showed strong heterogeneity, the Egger test was performed to ensure the reliability of the results. The results showed no evidence of publication bias ($P = .209$). Also, the GRADE score indicated that the evidence was moderate (Table 5). These results indicate that the conclusion that the mean Kujala score of the surgical group was higher than that of the nonsurgical group is reliable and
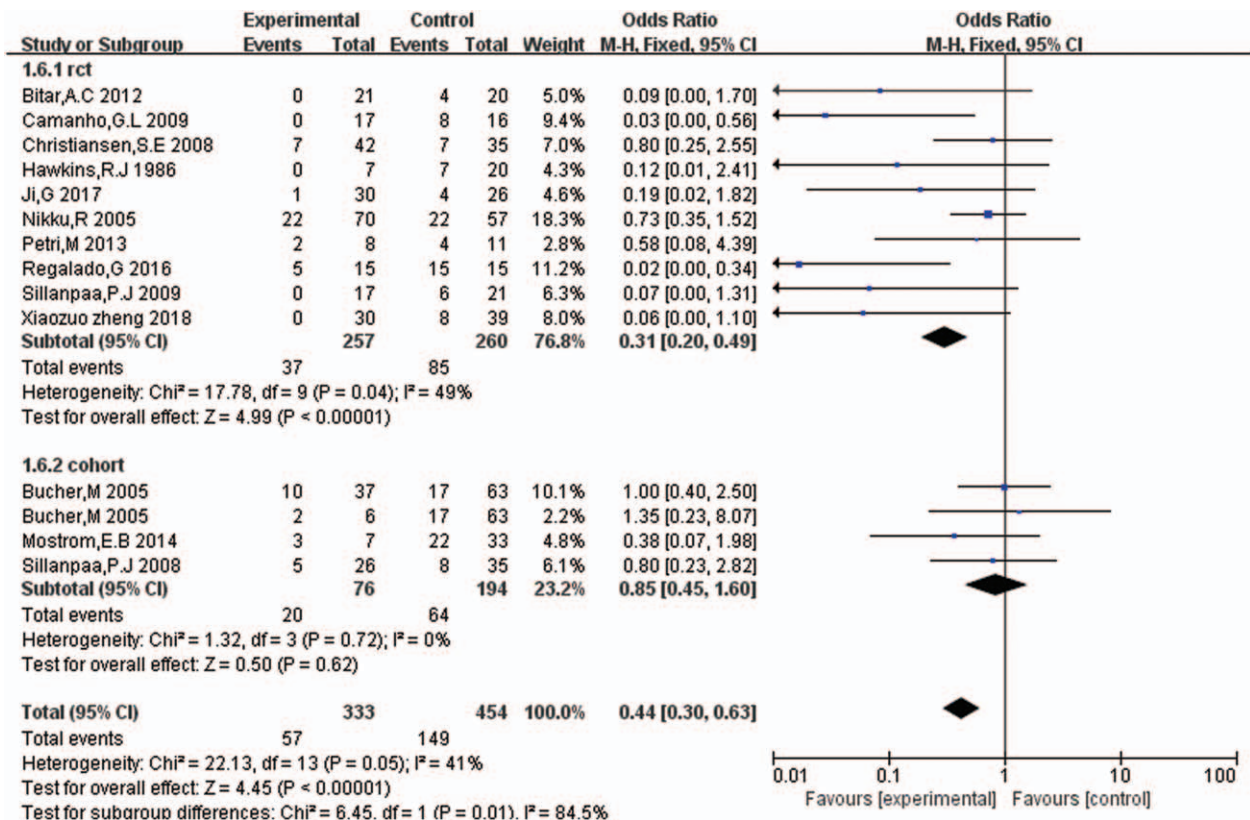

Figure 6. Subgroup analysis for redislocation.

Table 6

Evidence evaluation for redislocation.

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk Control	Corresponding risk				
Redislocation	Study population	OR 0.44 (0.3 to 0.63)		787 (13 studies)	⊕⊕⊕⊝ moderate	
	328 per 1000	177 per 1000 (128 to 235)				
	Moderate					
	278 per 1000	145 per 1000 (104 to 195)				

CI = confidence interval.

* The basis for the assumed risk, such as the median control group risk across studies. The corresponding risk (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
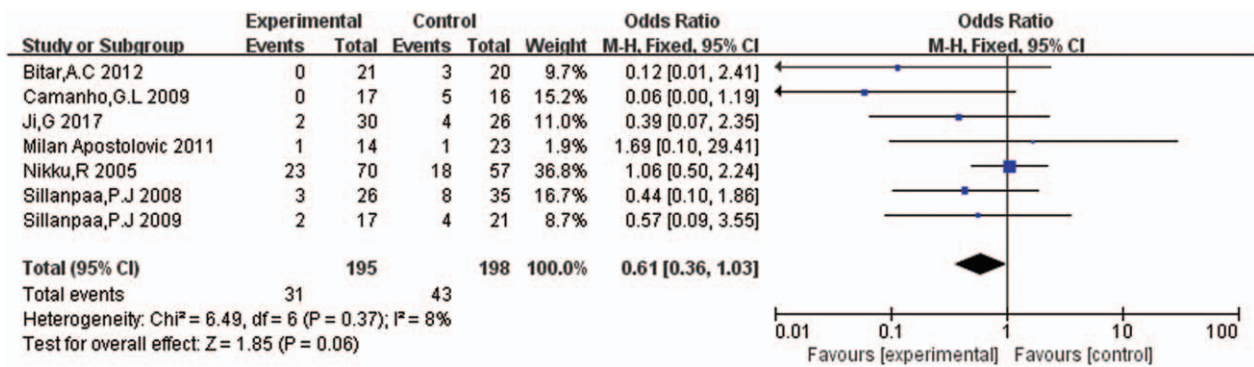

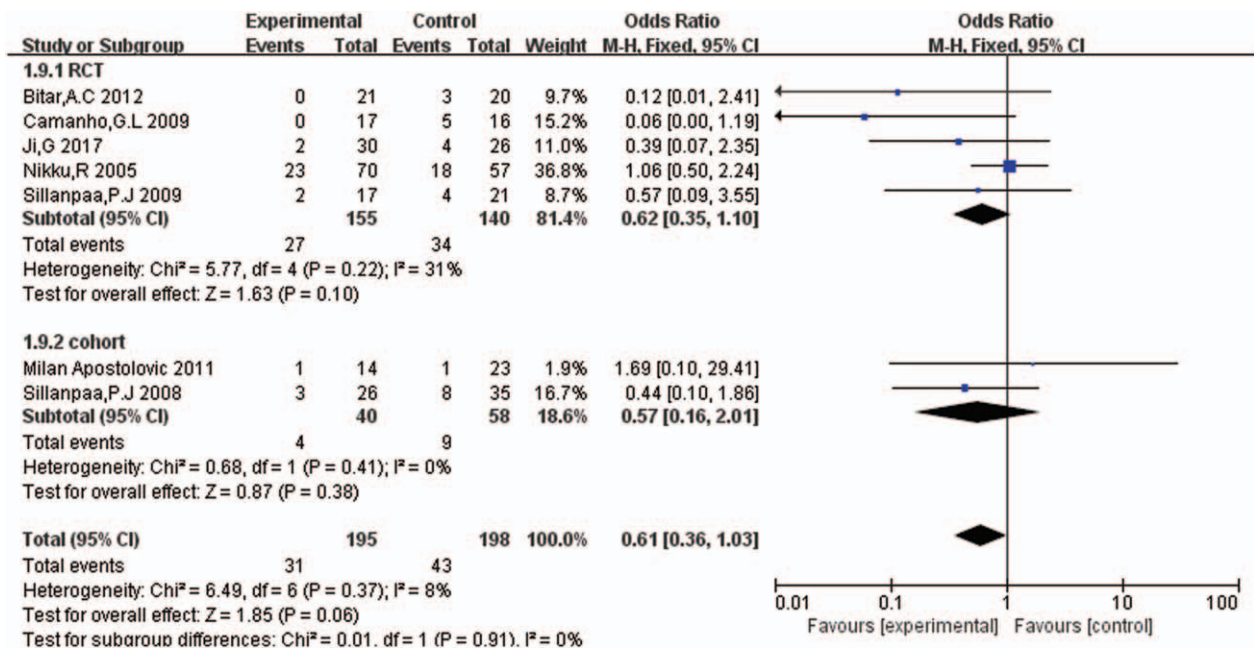Figure 7. Forest plot for subluxation.

Figure 8. Subgroup analysis for subluxation.

Table 7

Evidence evaluation for subluxation.

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	Number of participants evidence (studies)	Quality of the (GRADE)	Comments
	Assumed risk Control	Corresponding risk				
Subluxation	Study population	OR 0.61		393	⊕⊕⊕⊖ moderate	
	217 per 1000	145 per 1000 (91 to 222)	(0.36 to 1.03)	(7 studies)		
	Moderate					
	191 per 1000	126 per 1000 (78 to 196)				

CI = confidence interval, OR = odds ratio.
* The basis for the assumed risk, such as the median control group risk across studies. The corresponding risk (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
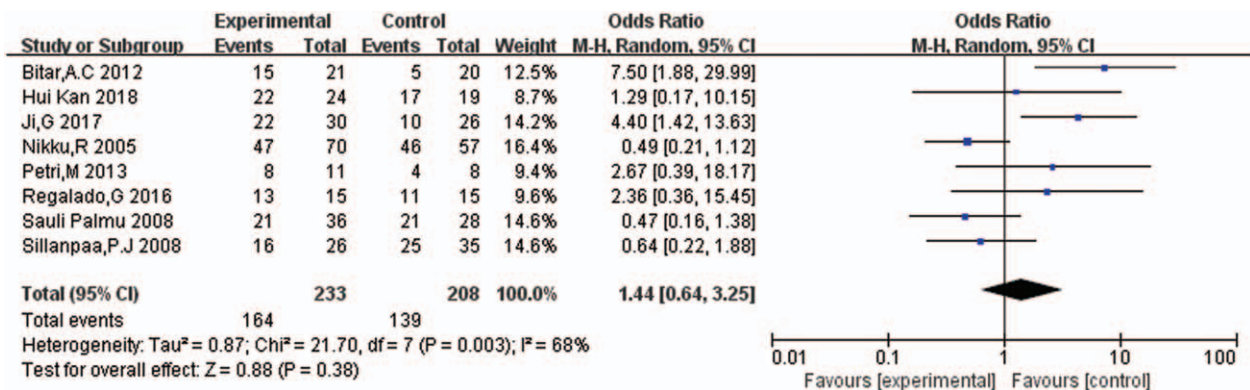

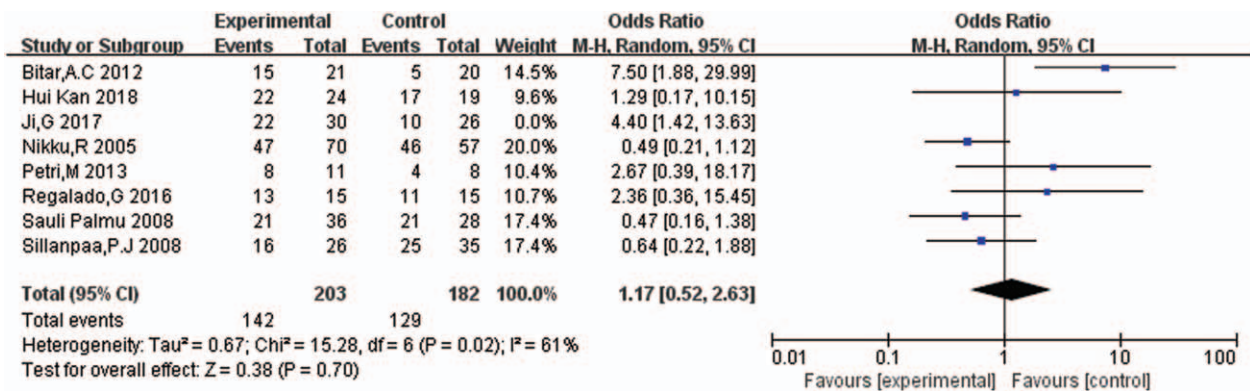Figure 9. Forest plot for satisfaction of patients.

Figure 10. Sensitivity analysis for satisfaction of patients.

valid. Existing evidence from meta-analyses shows that surgical treatment produces less recurrence of patellar dislocation than nonsurgical treatment, but there are no significant differences between the 2 treatments in the incidence of patellar subluxation, satisfaction of patients and VAS score. Our article also confirmed these points based on the latest and preliminary data.

Heterogeneity was tested using sensitivity analysis, subgroup analysis, and meta-regression. For the Kujala score, meta-regression was conducted for the year of publication, original study quality, and place of residence. The heterogeneity that could be explained by the aforementioned meta-regression analysis was up to 89.78%, so it can be concluded that the 3 factors aforementioned were the sources of heterogeneity.
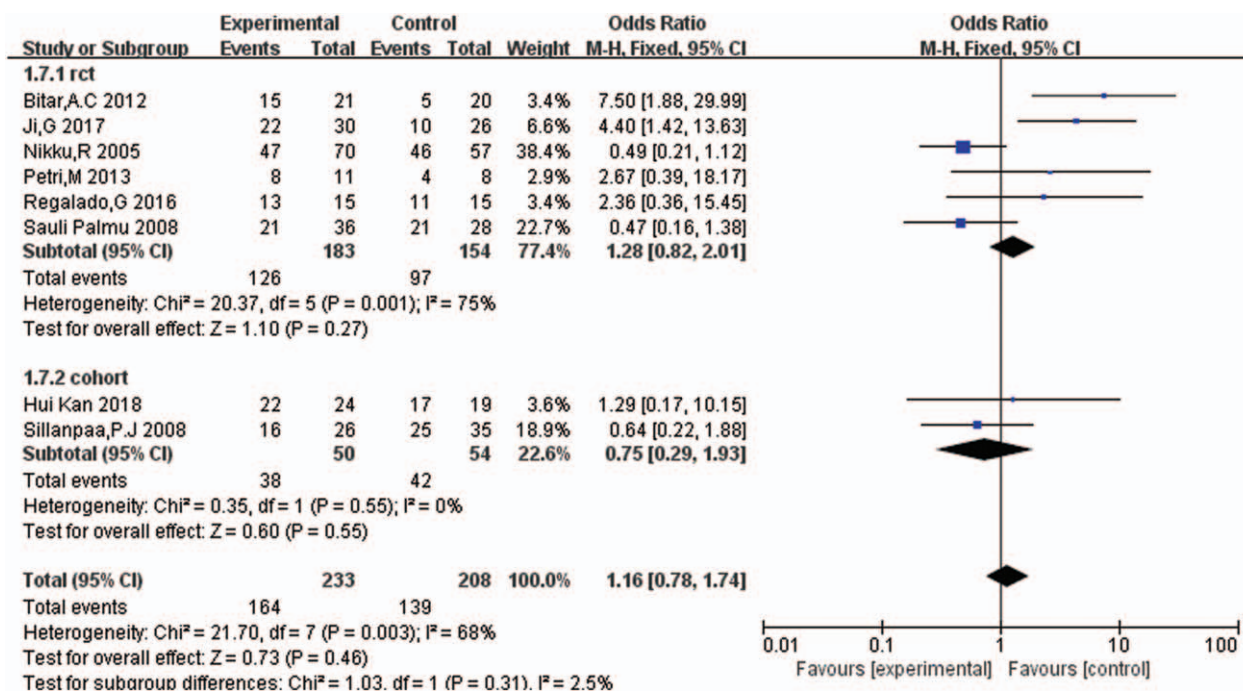
Figure 11. Subgroup analysis for satisfaction of patients.

Table 8

Evidence evaluation for satisfaction of patients.

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	Number of participants	Quality of the evidence	Comments (GRADE)
	Assumed risk Control	Corresponding risk				
Satisfaction of patients	Study population	OR 1.44 (0.64 to 3.25)		441 (8 studies)	⊕⊕⊕⊕ low	
	668 per 1000 Moderate	744 per 1000 (563 to 867)				
	724 per 1000	791 per 1000 (627 to 895)				

CI = confidence interval, OR = odds ratio.

* The basis for the assumed risk, such as the median control group risk across studies. The corresponding risk (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
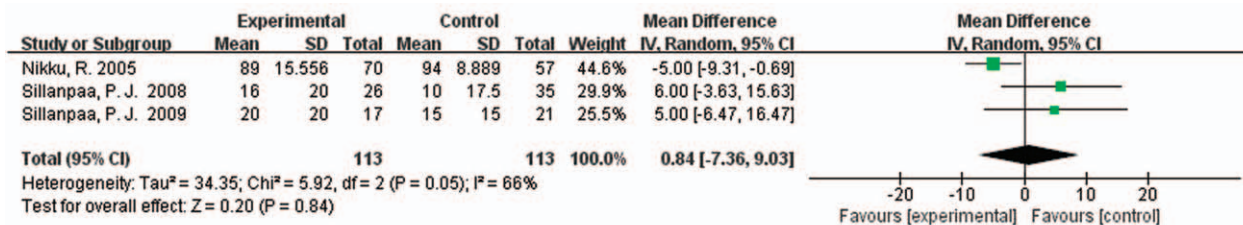

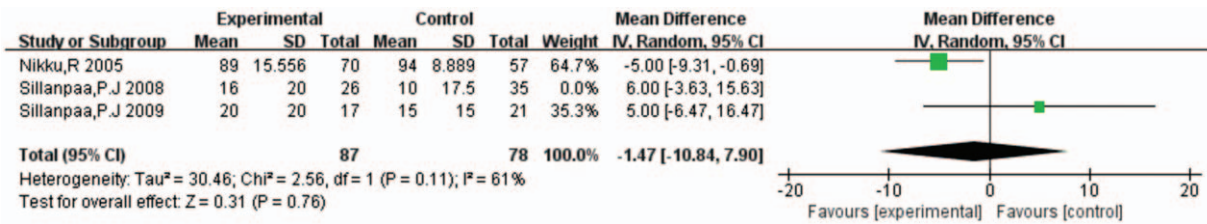**Figure 12.** Forest plot for VAS. VAS = visual analog scale.

Figure 13. Sensitivity analysis for VAS. VAS = visual analog scale.

Table 9

Evidence evaluation for VAS.

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk Control	Corresponding risk				
VAS		The mean vas in the intervention groups was 0.84 higher (7.36 lower to 9.03 higher)		226 (3 studies)	⊕⊕⊝⊝ low	

CI = confidence interval, VAS = visual analogue scale.

* The basis for the assumed risk, such as the median control group risk across studies. The corresponding risk (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

The GRADE system was used in this study to evaluate the quality of the results: the results for Kujala score, rate of redislocation and incidence of patellar subluxation were confirmed as having moderate levels of evidence; the results for patient satisfaction and VAS were confirmed having a low level of evidence. The main factors that reduced the level of evidence were as follows:

In the included studies, the randomization was not fully hidden, and the description of blinding method used was unclear. Due to the feature of this indicator, it was rarely possible to conduct a double-blind experiment. Only in the study reported by Ji et al,[9] was the blinding method clearly described. Moreover, randomization concealment was unclear. It was only in the studies of Petri et al[27] and Sillanpaa et al[31] that the use of "opaque envelopes" was described.

The high values of I^2 for the Kujala score and satisfaction of patients indicated high heterogeneity.

There was a certain degree of publication bias in the rate of redislocation, as indicated by the funnel plot.

Studies have shown that 2/3 of acute patellar dislocations occur in young active patients (less than 20 years of age). The main mechanism underlying patellar dislocation is noncontact knee sprain causing dislocation of the knee, accounting for 93% of all cases.[37] Four predisposing factors for patellar dislocation include sulcus angle, Insall-Salvati ratio, tibial tuberosity-trochlear groove distance, and femoral anteversion angle. Among these, sulcus angle is the most important factor.[37] Generally, clinicians choose a favorable treatment, surgical or nonsurgical, for patellar dislocation through a comprehensive evaluation of these factors. After medical imaging examination such as arthroscopy, a surgical or nonsurgical treatment will be performed. Surgical methods include knee replacement and MPFL reconstruction,[38] while nonsurgical methods include physical fixation. Poor outcomes result in recurrence, infection and other complications, of which knee pain is the most

common.[39] A recent related study by Lee pointed out that surgical treatment is suitable for both acute and recurrent patellar dislocations,[4,40] and that it can improve knee joint function.[9] More importantly, patients often have a low recurrence rate after surgical treatment.[6,28] Moreover, the risk of redislocation after nonsurgical treatment is 5 times the risk after surgical treatment.[5] Some researchers have proposed that normal or mildly abnormal patella joints can be treated nonsurgically, while surgical treatments are suitable for major abnormalities in the patella.[41] However, Risto Nikku pointed out that patients undergoing surgical treatments may experience serious complications.[42] Yet considering the different definitions and standards of complications in the basic studies, this paper did not do it, which could be done by the follow-up studies.

This study has some limitations. There were differences in target population, follow-up time, and interventions in the included studies, which may lead to partial bias in the results. We also found that there were differences in the efficacy of different surgical methods. Therefore, further investigations on a single surgical method are warranted to analyze the differences between surgical and nonsurgical methods in the treatment of patellar dislocation.

5. Conclusions

Based on the available evidence, surgical treatment of acute patellar dislocation is associated with a higher mean Kujala score and a lower rate of redislocation. The therapeutic method should be selected cautiously based on the physical findings.

Author contributions

Conceptualization: Zhe Zhu.
Data curation: Fan Yang, Wenlai Guo, Congying Guan.
Formal analysis: Fan Yang, Wenlai Guo.

Investigation: Fan Yang, Wenlai Guo.
Methodology: Shishun Zhao, Baoming Yuan.
Project administration: Fan Yang, Wenlai Guo.
Software: Fan Yang, Wenlai Guo.
Supervision: Qian Wang, Zhe Zhu, Baoming Yuan.
Visualization: Fan Yang, Wenlai Guo, Congying Guan.
Writing – original draft: Fan Yang, Wenlai Guo.
Writing – review and editing: Fan Yang, Wenlai Guo.
Shishun Zhao orcid: 0000-0002-1180-9708.

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