

Surgical versus nonsurgical treatment of primary acute patellar dislocation

A systematic review and meta-analysis

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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

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FY and WG contributed equally to this work and should be considered co-first authors.

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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 Dislocations, Patellar[Title/Abstract]) OR Patellar Dislocations[Title/Abstract])) OR "Patellar Dislocation"[Mesh] AND ("Surgical Procedures, Operative"[Mesh]) OR (((((((((Operative Surgical Procedures [Title/Abstract]) OR Operative Surgical Procedures [Title/Abstract]) OR Procedures, Operative Surgical[Title/Abstract]) OR Surgical Procedure, Operative Surgical[Title/Abstract]) OR Operative Procedures [Title/Abstract]) OR Procedure, Operative [Title/Abstract]) OR Operative Procedure [Title/Abstract]) OR Procedure, Operative Procedure [Title/Abstract]) OR Procedure, Operative [Title/Abstract]] OR Procedure, Operative [Title/Abstract]) OR 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 malformation, 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 disagreements 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 $tau^2 = 0.8543$ and $R^2 = 9.14\%$, indicating that the variation in mean Kujala

Table 1

Characteristics of the included trials and participants.

		Sex r	atio	Num	bers	Mea	n age	Follo	w-up	
Study, yr	Study type	Female	Male	Surg	NS	Surg	NS	Surg	NS	JADAD/NOS
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	Зyr	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	3 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.

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	Exp	eriment	al	0	Control		:	Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Bitar, A.C 2012	88.9	10.4	21	70.8	19.2	20	9.9%	1.16 [0.49, 1.82]	
Camanho,G.L 2009	92.23	5.01	17	69.06	14.02	16	8.7%	2.17 [1.29, 3.06]	· · · · · · · · · · · · · · · · · · ·
Christiansen, S.E 2008	84.6	17.5	42	78.1	15.9	35	11.0%	0.38 [-0.07, 0.84]	
Ji,G 2017	93.5	4.03	30	80.19	5.07	26	9.4%	2.89 [2.13, 3.65]	
Mostrom, E.B 2014	84	10	7	84	7	33	9.1%	0.00 [-0.82, 0.82]	
Nikku,R 2005	88.1	10.76	70	81.51	18.09	57	11.4%	0.45 [0.10, 0.81]	
Petri,M 2013	87.5	13.3	12	81.3	19.2	8	8.6%	0.37 [-0.53, 1.28]	
Sauli Palmu 2008	83	18	36	84	13	28	10.8%	-0.06 [-0.56, 0.43]	
Sillanpaa, P.J 2009	91	12	17	90	10.25	21	10.1%	0.09 [-0.55, 0.73]	
Xiaozuo zheng 2018	86.27	6.47	30	80.03	8.86	39	10.8%	0.78 [0.29, 1.27]	
Total (95% CI)			282			283	100.0%	0.79 [0.30, 1.28]	•
Heterogeneity: Tau ² = 0.5	52; Chi ² =	= 63.11,	df = 9	(P < 0.0	0001); F	² = 86%	,		
Test for overall effect: Z =	: 3.14 (P	= 0.002))						-4 -2 U 2 4 Favours [experimental] Favours [control]
					Figure	2. Fo	rest plot t	or mean Kuiala scor	A

	Exp	eriment	tal	0	Control		5	Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% Cl	IV, Random, 95% Cl
Bitar, A.C 2012	88.9	10.4	21	70.8	19.2	20	10.9%	1.16 [0.49, 1.82]	
Camanho,G.L 2009	92.23	5.01	17	69.06	14.02	16	9.7%	2.17 [1.29, 3.06]	
Christiansen, S.E 2008	84.6	17.5	42	78.1	15.9	35	12.1%	0.38 [-0.07, 0.84]	
Ji,G 2017	93.5	4.03	30	80.19	5.07	26	10.4%	2.89 [2.13, 3.65]	
Mostrom, E.B 2014	84	10	7	84	7	33	0.0%	0.00 [-0.82, 0.82]	
Nikku,R 2005	88.1	10.76	70	81.51	18.09	57	12.5%	0.45 [0.10, 0.81]	
Petri,M 2013	87.5	13.3	12	81.3	19.2	8	9.5%	0.37 [-0.53, 1.28]	
Sauli Palmu 2008	83	18	36	84	13	28	11.9%	-0.06 [-0.56, 0.43]	
Sillanpaa, P.J 2009	91	12	17	90	10.25	21	11.1%	0.09 [-0.55, 0.73]	
(iaozuo zheng 2018	86.27	6.47	30	80.03	8.86	39	11.9%	0.78 [0.29, 1.27]	
fotal (95% CI)			275			250	100.0%	0.87 [0.34, 1.40]	•
Heterogeneity: Tau ² = 0.1	54; Chi ² =	= 60.80,	df = 8	(P < 0.0	0001); P	= 87%		- TO CALL CONSIDER	
Fest for overall effect: Z =	= 3.24 (P	= 0.001)					2	-4 -2 0 2 Favours (experimental) Favours (control)

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.

	Exp	eriment	al	(ontrol		1	Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	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: Tau ² = 0.3	20; Chi ² =	= 27.18.	df = 8	(P = 0.0)	007); I ² :	= 71%			+ + + + + +
Test for overall effect: Z =	3.01 (P	= 0.003)						-4 -2 0 2 4 Favours [experimental] Favours [control]
						Fig	gure 3. (Continued).	

	Exp	eriment	a	0	control		1	Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% Cl	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]	
Kiaozuo zheng 2018	86.27	6.47	30	80.03	8.86	39	14.7%	0.78 [0.29, 1.27]	
fotal (95% CI)			216			229	100.0%	0.64 [0.27, 1.01]	+
Heterogeneity: Tau ² = 0.1	18; Chi ² =	= 21.69.	df = 7	(P = 0.0)	03); =	68%		252 2 6	t t t t t
Test for overall effect: Z =	: 3.36 (P	= 0.000	8)		2000				-4 -2 0 2 4 Favours [experimental] Favours [control]

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 tau²=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).

	Exp	eriment	al	(control		5	Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI	IV, Fixed, 95% Cl
1.8.1 Before 2010									and the second
Camanho, G.L 2009	92.23	5.01	17	69.06	14.02	16	4.1%	2.17 [1.29, 3.06]	
Christiansen, S.E 2008	84.6	17.5	42	78.1	15.9	35	15.5%	0.38 [-0.07, 0.84]	
Nikku,R 2005	88.1	10.76	70	81.51	18.09	57	25.3%	0.45 [0.10, 0.81]	
Sauli Palmu 2008	83	18	36	84	13	28	13.0%	-0.06 [-0.56, 0.43]	
Sillanpaa, P.J 2009	91	12	17	90	10.25	21	7.8%	0.09 [-0.55, 0.73]	
Subtotal (95% CI)			182			157	65.7%	0.40 [0.18, 0.62]	-
Heterogeneity: Chi ² = 19	.89, df =	4(P = 0	.0005);	I= 809	Ж				
Test for overall effect: Z =	= 3.54 (P	= 0.000	(4)						
1.8.2 After 2010									
Bitar,A.C 2012	88.9	10.4	21	70.8	19.2	20	7.2%	1.16 [0.49, 1.82]	
JI,G 2017	93.5	4.03	30	80.19	5.07	26	5.4%	2.89 [2.13, 3.65]	
Mostrom, E.B 2014	84	10	7	84	7	33	4.8%	0.00 [-0.82, 0.82]	
Petri,M 2013	87.5	13.3	12	81.3	19.2	8	3.9%	0.37 [-0.53, 1.28]	
Xiaozuo zheng 2018	86.27	6.47	30	80.03	8.86	39	13.0%	0.78 [0.29, 1.27]	
Subtotal (95% CI)			100			126	34.3%	1.04 [0.73, 1.34]	-
Heterogeneity: Chi ² = 32	.03, df =	4 (P < 0	.00001); I ² = 88	3%				
Test for overall effect: Z =	= 6.69 (P	< 0.000	01)						
Total (95% CI)			282			283	100.0%	0.62 [0.44, 0.80]	•
Heterogeneity: Chi2 = 63	.11, df = !	9 (P < 0	.00001); 1= 86	5%				
Test for overall effect: Z =	= 6.79 (P	< 0.000	01)	5.A.					-1 -0.5 0 0.5 1
Test for subaroup differe	ences: Ch	ni ² = 11.	19. df=	= 1 (P =	0.0008)	. I ² = 91	.1%		Favours (experimental) Favours (control)
				Figu	ire 4. 3	Subgro	oup analy	rsis for mean Kujala so	core.

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).

Surgical and nonsurg	ical 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 2

Meta regres	sion for mean Kujala s	core.				
Meta-regressio	n				Numbe	r of objects=10
REML estimate % residual varia Proportion of be With Knapp-Hart	of between-study variance tion due to heterogeneity tween-study variance explained ung modification	1			tau2 = 0. I-squared Adjusted	8543 residual = 82.61% R-squared = 9.14%
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 = r^2 .

Table 4

Table 3

Meta regressio	n for mean Kujala sco	re.				
Meta-regression					Num	ber of objects=10
REML estimate of bo % residual variation Proportion of betwee Joint test for all cov With Knapp-Hartung	etween-study variance due to heterogeneity en-study variance explained ariates modification				tau2 = 0 I-square Adjuste Model F Probabi	0.09607 ed residual = 0.00% d R-squared = 89.78% (3, 6) = 7.12 ity > F= 0.0211
SMD	Coef.	Std. Err.	t	P > t	[95% Con	f.Interval]
Restrict Year	-2.147524 -0.1509735	0.832709 0.0686433	-2.58 -2.2	0.042 0.07	-4.185089 -0.3189375	-0.1099584 0.0169905
Study quality _cons	-2.104185 307.4036	0.5317074 138.4539	-3.96 2.22	0.007 0.068	-3.405199 -31.38091	-0.8031171 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 = r^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 patiellar 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.

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Evidence evaluation for mean Kujala score.

	Illustrat	ive comparative risks st (95% CI)	Relative	Number of	Quality of	
Outcomes	Assumed risk Control	Corresponding risk	effect (95% Cl)	participants (studies)	the evidence (GRADE)	Comments
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% Cl).

	Experim	ental	Contr	ol		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% Cl	M-H, Fixed, 95% Cl
Bitar,A.C 2012	0	21	4	20	5.0%	0.09 [0.00, 1.70]	ŋ ←
Bucher,M 2005	10	37	17	63	10.1%	1.00 [0.40, 2.50]	n
Bucher,M 2005	2	6	17	63	2.2%	1.35 [0.23, 8.07]	n — — — — — — — — — — — — — — — — — — —
Camanho,G.L 2009	0	17	8	16	9.4%	0.03 [0.00, 0.56]	j +
Christiansen, S.E 2008	7	42	7	35	7.0%	0.80 [0.25, 2.55]	j <u> </u>
Hawkins, R.J 1986	0	7	7	20	4.3%	0.12 [0.01, 2.41]	j •
Ji,G 2017	1	30	4	26	4.6%	0.19 [0.02, 1.82]	
Mostrom, E.B 2014	3	7	22	33	4.8%	0.38 [0.07, 1.98]	j <u> </u>
Nikku,R 2005	22	70	22	57	18.3%	0.73 [0.35, 1.52]	g
Petri,M 2013	2	8	4	11	2.8%	0.58 [0.08, 4.39]	j
Regalado, G 2016	5	15	15	15	11.2%	0.02 [0.00, 0.34]	j +
Sillanpaa, P.J 2008	5	26	8	35	6.1%	0.80 [0.23, 2.82]	
Sillanpaa, P.J 2009	0	17	6	21	6.3%	0.07 [0.00, 1.31]	j +
Xiaozuo zheng 2018	0	30	8	39	8.0%	0.06 [0.00, 1.10]	j -
Total (95% CI)		333		454	100.0%	0.44 [0.30, 0.63]	•
Total events	57		149				•
Heterogeneity: Chi ² = 22.	13, df = 13	(P = 0.1)	$(05); ^2 = 4$	1%			
Test for overall effect: Z =	4.45 (P <)	0.00001))				Favours [experimental] Favours [control]

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

	Experim	ental	Contr	ol		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% Cl	M-H, Fixed, 95% Cl
1.6.1 rct							S
Bitar, A.C 2012	0	21	4	20	5.0%	0.09 [0.00, 1.70]	· · · · · · · · · · · · · · · · · · ·
Camanho,G.L 2009	0	17	8	16	9.4%	0.03 [0.00, 0.56]	• • • • • • • • • • • • • • • • • • •
Christiansen, S.E 2008	7	42	7	35	7.0%	0.80 [0.25, 2.55]	
Hawkins, R.J 1986	0	7	7	20	4.3%	0.12 [0.01, 2.41]	• • •
Ji,G 2017	1	30	4	26	4.6%	0.19 [0.02, 1.82]	
Nikku,R 2005	22	70	22	57	18.3%	0.73 [0.35, 1.52]	
Petri,M 2013	2	8	4	11	2.8%	0.58 [0.08, 4.39]	
Regalado,G 2016	5	15	15	15	11.2%	0.02 [0.00, 0.34]	•
Sillanpaa, P.J 2009	0	17	6	21	6.3%	0.07 [0.00, 1.31]	• • •
(iaozuo zheng 2018	0	30	8	39	8.0%	0.06 [0.00, 1.10]	· · · · · · · · · · · · · · · · · · ·
Subtotal (95% CI)		257		260	76.8%	0.31 [0.20, 0.49]	•
Total events	37		85				
Heterogeneity: Chi ² = 17	.78, df = 9 (P = 0.04	4); I ² = 49	%			
Fest for overall effect: Z =	= 4.99 (P <	0.00001)				
1.6.2 cohort							
Bucher,M 2005	10	37	17	63	10.1%	1.00 [0.40, 2.50]	
Bucher,M 2005	2	6	17	63	2.2%	1.35 [0.23, 8.07]	
Mostrom, E.B 2014	3	7	22	33	4.8%	0.38 [0.07, 1.98]	
Mostrom,E.B 2014 Sillanpaa,P.J 2008	35	7 26	22	33	4.8% 6.1%	0.38 [0.07, 1.98] 0.80 [0.23, 2.82]	
Mostrom,E.B 2014 Sillanpaa,P.J 2008 Subtotal (95% CI)	35	7 26 76	22 8	33 35 194	4.8% 6.1% 23.2%	0.38 [0.07, 1.98] 0.80 [0.23, 2.82] 0.85 [0.45, 1.60]	
Mostrom,E.B 2014 Sillanpaa,P.J 2008 Subtotal (95% CI) Fotal events	3 5 20	7 26 76	22 8 64	33 35 194	4.8% 6.1% 23.2%	0.38 [0.07, 1.98] 0.80 [0.23, 2.82] 0.85 [0.45, 1.60]	•
Mostrom, E.B 2014 Billanpaa, P.J 2008 Subtotal (95% CI) Fotal events Heterogeneity: Chi ² = 1.3	3 5 20 32, df = 3 (P	7 26 76	22 8 64 ; I ² = 0%	33 35 194	4.8% 6.1% 23.2%	0.38 (0.07, 1.98) 0.80 (0.23, 2.82) 0.85 (0.45, 1.60)	•
Mostrom, E.B. 2014 Sillanpaa, P.J. 2008 Subtotal (95% CI) Fotal events Heterogeneity: Chi ² = 1.3 Fest for overall effect: Z =	3 5 20 32, df = 3 (P = 0.50 (P =	7 26 76 '= 0.72) 0.62)	22 8 64 ; I² = 0%	33 35 194	4.8% 6.1% 23.2%	0.38 (0.07, 1.98) 0.80 (0.23, 2.82) 0.85 (0.45, 1.60)	•
Mostrom, E.B 2014 Sillanpaa, P.J 2008 Subtotal (95% CI) Total events Heterogeneity: Chi ² = 1.3 Fest for overall effect: Z = Total (95% CI)	3 5 20 32, df = 3 (P = 0.50 (P =	7 26 76 '= 0.72) 0.62) 333	22 8 64 ; I ² = 0%	33 35 194 454	4.8% 6.1% 23.2%	0.38 (0.07, 1.98) 0.80 (0.23, 2.82) 0.85 (0.45, 1.60) 0.44 (0.30, 0.63)	•
Mostrom, E.B 2014 Sillanpaa, P.J 2008 Subtotal (95% CI) Fotal events Heterogeneity: Chi ² = 1.3 Fest for overall effect: Z = Fotal (95% CI) Fotal events	3 5 20 32, df = 3 (P = 0.50 (P = 1 57	7 26 76 '= 0.72) 0.62) 333	22 8 64 ; I ² = 0%	33 35 194 454	4.8% 6.1% 23.2% 100.0%	0.38 (0.07, 1.98) 0.80 (0.23, 2.82) 0.85 (0.45, 1.60) 0.44 (0.30, 0.63)	•
Mostrom, E.B 2014 Sillanpaa, P.J 2008 Subtotal (95% CI) Fotal events Heterogeneity: Chi ² = 1.3 Fest for overall effect: Z = Fotal (95% CI) Fotal events Heterogeneity: Chi ² = 22	3 5 20 32, df = 3 (P = 0.50 (P = 1 57 .13, df = 13	7 26 76 '= 0.72) 0.62) 333 (P = 0.1	22 8 64 ; 1 ² = 0% 149 35): 1 ² = 4	33 35 194 454	4.8% 6.1% 23.2%	0.38 (0.07, 1.98) 0.80 (0.23, 2.82) 0.85 (0.45, 1.60) 0.84 (0.30, 0.63)	
Mostrom, E.B. 2014 Sillanpaa, P.J. 2008 Subtotal (95% CI) Fotal events Heterogeneity: Chi ² = 1.3 Fest for overall effect: Z = Fotal (95% CI) Fotal events Heterogeneity: Chi ² = 22 Fest for overall effect: Z =	3 5 20 32, df = 3 (P = 0.50 (P = 1 57 .13, df = 13 = 4.45 (P <	7 26 76 '= 0.72) 0.62) 333 (P = 0.1 0.00001	22 8 64 ; I ² = 0% 149)5); I ² = 4	33 35 194 454 1%	4.8% 6.1% 23.2% 100.0%	0.38 (0.07, 1.98) 0.80 (0.23, 2.82) 0.85 (0.45, 1.60) 0.84 (0.30, 0.63)	

Figure 6. Subgroup analysis for redislocation.

Table 6				
Evidence evaluation for redislocation.				
Illustrative comparative risks [*] (95% CI)				
		Number of	Quality of	
• · ·	Deletive			

Outcomes	Assumed risk Control	Corresponding risk	Relative effect (95% CI)	participants (studies)	the evidence (GRADE)	Comments
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% Cl).

	Experimental	Control		Odds Ratio	Odds Ratio
Study or Subgroup	Events Total	Events To	tal Weight	M-H, Fixed, 95% Cl	M-H, Fixed, 95% Cl
Bitar,A.C 2012	0 21	3	20 9.7%	0.12 [0.01, 2.41]	* • • · · · · · · · · · · · · · · · · ·
Camanho,G.L 2009	0 17	5	16 15.2%	0.06 [0.00, 1.19]	+ +
Ji,G 2017	2 30	4	26 11.0%	0.39 [0.07, 2.35]	
Milan Apostolovic 2011	1 14	1	23 1.9%	1.69 [0.10, 29.41]	
Nikku,R 2005	23 70	18	57 36.8%	1.06 [0.50, 2.24]	
Sillanpaa, P.J 2008	3 26	8	35 16.7%	0.44 [0.10, 1.86]	
Sillanpaa,P.J 2009	2 17	4	21 8.7%	0.57 [0.09, 3.55]	
Total (95% CI)	195	a	98 100.0%	0.61 [0.36, 1.03]	•
Total events	31	43			22
Heterogeneity: Chi ² = 6.4	9, df = 6 (P = 0.37)	; I ² = 8%			
Test for overall effect: Z =	1.85 (P = 0.06)	200010-000			Favours [experimental] Favours [control]
Test for overall effect: Z =	1.85 (P = 0.06)	F	aure 7. For	est plot for subluxati	i ioi

	Experim	ental	Contr	ol		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% Cl	M-H, Fixed, 95% Cl
1.9.1 RCT							15
Bitar,A.C 2012	0	21	3	20	9.7%	0.12 [0.01, 2.41]	· · · ·
Camanho,G.L 2009	0	17	5	16	15.2%	0.06 [0.00, 1.19]	• • • • • • • • • • • • • • • • • • •
Ji,G 2017	2	30	4	26	11.0%	0.39 [0.07, 2.35]	
Nikku,R 2005	23	70	18	57	36.8%	1.06 [0.50, 2.24]	
Sillanpaa, P.J 2009	2	17	4	21	8.7%	0.57 [0.09, 3.55]	
Subtotal (95% CI)		155		140	81.4%	0.62 [0.35, 1.10]	•
Fotal events	27		34				
Heterogeneity: Chi ² = 5.7	77, df = 4 (P	= 0.22)	; I ² = 319	5			
Test for overall effect: Z =	= 1.63 (P = 1	0.10)					
1.9.2 cohort							
Milan Apostolovic 2011	1	14	1	23	1.9%	1.69 (0.10, 29,41)	
Sillanpaa.P.J 2008	3	26	8	35	16.7%	0.44 [0.10, 1.86]	
Subtotal (95% CI)		40	1 25	58	18.6%	0.57 [0.16, 2.01]	
Total events	4		9				
Heterogeneity: Chi ² = 0.8	68. df = 1 (P	= 0.41)	: I ² = 0%				
Test for overall effect: Z =	= 0.87 (P = 0	0.38)	ter stati				
fotal (95% CI)		195		198	100.0%	0.61 [0.36, 1.03]	•
Total events	31		43				at 1
Internetionality Ohitz C	49, df = 6 (P	= 0.37)	; I² = 8%				
Heterogeneity: Chir = 6.4	and the second se						0.01 0.1 1 10 100
Fest for overall effect: Z =	= 1.85 (P = 1	0.06)					Envoure (experimental) Envoure (control)

Figure 8. Subgroup analysis for subluxation.

Table 7 Evidence evaluation for subluxation.

Outcomes	Illustrative con	nparative risks * (95% CI)	Relative effect (95% Cl)	Number of		
	Assumed risk Control	Corresponding risk		participants evidence (studies)	Quality of the (GRADE)	Comments
Subluxation	Study population 217 per 1000 Moderate	OR 0.61 145 per 1000 (91 to 222)		393 (0.36 to 1.03)	⊕⊕⊕⊜ moderate (7 studies)	
	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% Cl).

	Experim	ental	Contr	ol		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% Cl	M-H, Random, 95% Cl
Bitar,A.C 2012	15	21	5	20	12.5%	7.50 [1.88, 29.99]	1
Hui Kan 2018	22	24	17	19	8.7%	1.29 [0.17, 10.15]	1
Ji,G 2017	22	30	10	26	14.2%	4.40 [1.42, 13.63]	
Nikku,R 2005	47	70	46	57	16.4%	0.49 [0.21, 1.12]	
Petri,M 2013	8	11	4	8	9.4%	2.67 [0.39, 18.17]	i —
Regalado,G 2016	13	15	11	15	9.6%	2.36 [0.36, 15.45]	
Sauli Palmu 2008	21	36	21	28	14.6%	0.47 [0.16, 1.38]	
Sillanpaa,P.J 2008	16	26	25	35	14.6%	0.64 [0.22, 1.88]	i <u></u>
Total (95% CI)		233		208	100.0%	1.44 [0.64, 3.25]	-
Total events	164		139				
Heterogeneity: Tau ² =	0.87; Chi ²	= 21.70), df = 7 (F	P = 0.0	03); I ² = 6	8%	
Test for overall effect:	Z = 0.88 (F	P = 0.38)		224 53		Favours [experimental] Favours [control]

	Experim	ental Control			Odds Ratio	Odds Ratio			
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% Cl	M-H, Random, 95% Cl		
Bitar, A.C 2012	15	21	5	20	14.5%	7.50 [1.88, 29.99]			
Hui Kan 2018	22	24	17	19	9.6%	1.29 [0.17, 10.15]	• • •		
Ji,G 2017	22	30	10	26	0.0%	4.40 [1.42, 13.63]			
Nikku,R 2005	47	70	46	57	20.0%	0.49 [0.21, 1.12]			
Petri,M 2013	8	11	4	8	10.4%	2.67 [0.39, 18.17]			
Regalado,G 2016	13	15	11	15	10.7%	2.36 [0.36, 15.45]			
Sauli Palmu 2008	21	36	21	28	17.4%	0.47 [0.16, 1.38]	3 1 1 1 1		
Sillanpaa,P.J 2008	16	26	25	35	17.4%	0.64 [0.22, 1.88]			
Total (95% CI)		203		182	100.0%	1.17 [0.52, 2.63]	-		
Total events	142		129						
Heterogeneity: Tau ² =	0.67; Chi	= 15.28	3, df = 6 (f	P = 0.03	2); I ² = 61	%			
Test for overall effect:	Z=0.38 (P = 0.70)		1000		Favours [experimental] Favours [control]		

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, metaregression 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.

	Experime	ental	Contr	ol		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% Cl	M-H, Fixed, 95% CI
1.7.1 rct							
Bitar,A.C 2012	15	21	5	20	3.4%	7.50 [1.88, 29.99]	
Ji,G 2017	22	30	10	26	6.6%	4.40 [1.42, 13.63]	· · · · · · · · · · · · · · · · · · ·
Nikku,R 2005	47	70	46	57	38.4%	0.49 [0.21, 1.12]	
Petri,M 2013	8	11	4	8	2.9%	2.67 [0.39, 18.17]	
Regalado,G 2016	13	15	11	15	3.4%	2.36 [0.36, 15.45]	
Sauli Palmu 2008	21	36	21	28	22.7%	0.47 [0.16, 1.38]	
Subtotal (95% CI)		183		154	77.4%	1.28 [0.82, 2.01]	•
Total events	126		97				
Heterogeneity: Chi ² =	20.37, df=	5 (P=	0.001); I ^z	= 75%			
Test for overall effect	Z=1.10 (F	P = 0.27)				
1.7.2 cohort							
THE OWNER							
Hui Kan 2018	22	24	17	19	3.6%	1.29 [0.17, 10.15]	· · · · · · · · · · · · · · · · · · ·
Hui Kan 2018 Sillanpaa,P.J 2008	22 16	24 26	17 25	19 35	3.6% 18.9%	1.29 [0.17, 10.15] 0.64 [0.22, 1.88]	
Hui Kan 2018 Sillanpaa,P.J 2008 Subtotal (95% CI)	22 16	24 26 50	17 25	19 35 54	3.6% 18.9% 22.6%	1.29 [0.17, 10.15] 0.64 [0.22, 1.88] 0.75 [0.29, 1.93]	
Hui Kan 2018 Sillanpaa,P.J 2008 Subtotal (95% CI) Total events	22 16 38	24 26 50	17 25 42	19 35 54	3.6% 18.9% 22.6%	1.29 [0.17, 10.15] 0.64 [0.22, 1.88] 0.75 [0.29, 1.93]	-
Hui Kan 2018 Sillanpaa,P.J 2008 Subtotal (95% CI) Total events Heterogeneity: Chi ² =	22 16 38 0.35, df = 1	24 26 50	17 25 42 .55); I² = (19 35 54	3.6% 18.9% 22.6%	1.29 [0.17, 10.15] 0.64 [0.22, 1.88] 0.75 [0.29, 1.93]	*
Hui Kan 2018 Sillanpaa,P.J 2008 Subtotal (95% CI) Total events Heterogeneity: Chi ² = Test for overall effect	22 16 38 0.35, df = 1 Z = 0.60 (F	24 26 50 1 (P = 0. P = 0.55	17 25 42 .55); I² = ()	19 35 54 0%	3.6% 18.9% 22.6%	1.29 [0.17, 10.15] 0.64 [0.22, 1.88] 0.75 [0.29, 1.93]	*
Hui Kan 2018 Sillanpaa,P.J 2008 Subtotal (95% CI) Total events Heterogeneity: Chi ² = Test for overall effect Total (95% CI)	22 16 38 0.35, df = 1 Z = 0.60 (F	24 26 50 1 (P = 0. P = 0.55 233	17 25 42 .55); I² = ()	19 35 54 0% 208	3.6% 18.9% 22.6% 100.0%	1.29 [0.17, 10.15] 0.64 [0.22, 1.88] 0.75 [0.29, 1.93] 1.16 [0.78, 1.74]	
Hui Kan 2018 Sillanpaa,P.J 2008 Subtotal (95% CI) Total events Heterogeneity: Chi ² = Test for overall effect Total (95% CI) Total events	22 16 38 2.35, df = 1 Z = 0.60 (F 164	24 26 50 1 (P = 0 P = 0.55 233	17 25 42 .55); I ² = () 139	19 35 54 0% 208	3.6% 18.9% 22.6% 100.0%	1.29 [0.17, 10.15] 0.64 [0.22, 1.88] 0.75 [0.29, 1.93] 1.16 [0.78, 1.74]	*
Hui Kan 2018 Sillanpaa,P.J 2008 Subtotal (95% CI) Total events Heterogeneity: Chi ² = Test for overall effect Total (95% CI) Total events Heterogeneity: Chi ² =	22 16 38 0.35, df = ' Z = 0.60 (F 164 21.70, df =	24 26 50 1 (P = 0 2 = 0.55 233 : 7 (P =	17 25 42 .55); I ² = () 139 0.003); I ²	19 35 54 0% 208 = 68%	3.6% 18.9% 22.6% 100.0%	1.29 [0.17, 10.15] 0.64 [0.22, 1.88] 0.75 [0.29, 1.93] 1.16 [0.78, 1.74]	
Hui Kan 2018 Sillanpaa,P.J 2008 Subtotal (95% CI) Total events Heterogeneity: Chi ² = Test for overall effect Total (95% CI) Total events Heterogeneity: Chi ² = Test for overall effect	22 16 38 0.35, df = ' Z = 0.60 (F 164 21.70, df = Z = 0.73 (F	24 26 50 1 (P = 0 P = 0.55 233 233 7 (P = P = 0.46	17 25 42 .55); I ² = () 139 0.003); I ²)	19 35 54 0% 208 = 68%	3.6% 18.9% 22.6% 100.0%	1.29 [0.17, 10.15] 0.64 [0.22, 1.88] 0.75 [0.29, 1.93] 1.16 [0.78, 1.74]	

Table 8

Evidence eval	Evidence evaluation for satisfaction of patients.											
	Illustrative co	mparative risks [*] (95% CI)	Relative effect (95% Cl)									
Outcomes	Assumed risk Control	Corresponding risk		Number of participants	Quality of the evidence	Comments (GRADE)						
Satisfaction of patients	Satisfaction Study population of patients	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% Cl).



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



Table 9

Evid	ence	eva	luatio	on fo	or VA	AS.
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		Illustrative comparative risks ^{**} (95% CI)	Relative	Number of	Quality of the evidence (GRADE)	
Outcomes	Assumed risk Control	Corresponding risk	(95% CI)	(studies)		Comments
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% Cl).

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 tuberositytrochlear 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

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References

- Fithian DC, Paxton EW, Stone ML, et al. Epidemiology and natural history of acute patellar dislocation. Am J Sports Med 2004;32:1114–21.
- [2] Cheng B, Wu X, Ge H, et al. Operative versus conservative treatment for patellar dislocation: a meta-analysis of 7 randomized controlled trials. Diagn Pathol 2014;9:60.
- [3] Shou-Wen SU, Shi DH, Zhi-Yong LI, et al. Conservative versus surgical interventions for treating acute patellar dislocation:a meta-analysis. J Sun Yat-sen Univ (Med Sci) 2014;35:624–31.
- [4] Zheng X, Kang K, Li T, et al. Surgical versus non-surgical management for primary patellar dislocations: an up-to-date meta-analysis. Eur J Orthop Surg Traumatol 2014;24:1513–23.
- [5] Nwachukwu BU, So C, Schairer WW, et al. Surgical versus conservative management of acute patellar dislocation in children and adolescents: a systematic review. Knee Surg Sports Traumatol Arthrosc 2016;24: 760–7.
- [6] Wang SN, Qin CH, Jiang N, et al. Is surgical treatment better than conservative treatment for primary patellar dislocations? A metaanalysis of randomized controlled trials. Arch Orthop Trauma Surg 2016;136:371–9.
- [7] Kang H, Li J, Chen X-X, et al. Fixation versus excision of osteochondral fractures after patellar dislocations in adolescent patients: a retrospective cohort study. Chin J Med 2018;131:1296–301.
- [8] Zheng X, Hu Y, Xie P, et al. Surgical medial patellofemoral ligament reconstruction versus non-surgical treatment of acute primary patellar dislocation: a prospective controlled trial. Int Orthop 2018;43:1495– 501.
- [9] Ji G, Wang S, Wang X, et al. Surgical versus nonsurgical treatments of acute primary patellar dislocation with special emphasis on the MPFL injury patterns. J Knee Surg 2017;30:378–84.
- [10] Kujala UM, Jaakkola LH, Koskinen SK, et al. Scoring of patellofemoral disorders. Arthroscopy 1993;9:159–63.
- [11] Moher D, Cook DJ, Eastwood S, et al. Improving the quality of reports of meta-analyses of randomised controlled trials: the QUOROM statement. QUOROM Group. Br J Surg 2000;87:1448–54.
- [12] Moher D, Shamseer L, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev 2015;4:1.
- [13] Stang A. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. Eur J Epidemiol 2010;25:603–5.
- [14] Mbeye NM, Kuile FO, Davies M-A, et al. Cotrimoxazole prophylactic treatment prevents malaria in children in sub-Saharan Africa: systematic review and meta-analysis. Trop Med Int Health 2014;19:1057–67.
- [15] Chen M, Wei S, Hu J, et al. Can comprehensive chromosome screening technology improve IVF/ICSI outcomes? A meta-analysis. PLoS One 2015;10:e0140779.
- [16] Cheng X, Tian X, Yan Z, et al. Comparison of the fertility outcome of salpingotomy and salpingectomy in women with tubal pregnancy: a systematic review and meta-analysis. PLoS One 2016;11:e0152343.
- [17] Smith JD, MacDougall CC, Johnstone J, et al. Effectiveness of N95 respirators versus surgical masks in protecting health care workers from acute respiratory infection: a systematic review and meta-analysis. Cmaj 2016;188:567–74.
- [18] Flandry F, Hunt JP, Terry GC, et al. Analysis of subjective knee complaints using visual analog scales. Am J Sports Med 1991;19:112–8.
- [19] Jadad AR, Moore RA, Carroll D, et al. Assessing the quality of reports of randomized clinical trials: is blinding necessary? Control Clin Trials 1996;17:1–2.

- [20] Banares R, Albillos A, Rincon D, et al. Endoscopic treatment versus endoscopic plus pharmacologic treatment for acute variceal bleeding: a meta-analysis. Hepatology 2002;35:609–15.
- [21] Buchner M, Baudendistel B, Sabo D, et al. Acute traumatic primary patellar dislocation: long-term results comparing conservative and surgical treatment. Clin J Sport Med 2005;15:62–6.
- [22] Nikku R, Nietosvaara Y, Aalto K, et al. Operative treatment of primary patellar dislocation does not improve medium-term outcome: a 7-year follow-up report and risk analysis of 127 randomized patients. Acta Orthop 2005;76:699–704.
- [23] Christiansen SE, Jakobsen BW, Lund B, et al. Isolated repair of the medial patellofemoral ligament in primary dislocation of the patella: a prospective randomized study. Arthroscopy 2008;24:881–7.
- [24] Sillanpaa PJ, Maenpaa HM, Mattila VM, et al. Arthroscopic surgery for primary traumatic patellar dislocation: a prospective, nonrandomized study comparing patients treated with and without acute arthroscopic stabilization with a median 7-year follow-up. Am J Sports Med 2008;36:2301–9.
- [25] Camanho GL, Viegas AdC, Bitar AC, et al. Conservative versus surgical treatment for repair of the medial patellofemoral ligament in acute dislocations of the patella. Arthroscopy 2009;25:620–5.
- [26] Bitar AC, Demange MK, D'Elia CO, et al. Traumatic patellar dislocation: nonoperative treatment compared with MPFL reconstruction using patellar tendon. Am J Sports Med 2012;40:114–22.
- [27] Petri M, Liodakis E, Hofmeister M, et al. Operative vs conservative treatment of traumatic patellar dislocation: results of a prospective randomized controlled clinical trial. Arch Orthop Trauma Surg 2013;133:209–13.
- [28] Regalado G, Lintula H, Kokki H, et al. Six-year outcome after nonsurgical versus surgical treatment of acute primary patellar dislocation in adolescents: a prospective randomized trial. Knee Surg Sports Traumatol Arthrosc 2016;24:6–11.
- [29] Hawkins RJ, Bell RH, Anisette G. Acute patellar dislocations. The natural history. Am J Sports Med 1986;14:117–20.
- [30] Palmu S, Kallio PE, Donell ST, et al. Acute patellar dislocation in children and adolescents: a randomized clinical trial. J Bone Joint Surg Am 2008;90:463–70.
- [31] Sillanpää PJ, Mattila VM, Mäenpää H, et al. Treatment with and without initial stabilizing surgery for primary traumatic patellar dislocation: a prospective randomized study. J Bone Joint Surg Am 2009;91:263–73.
- [32] Apostolovic M, Vukomanovic B, Slavkovic N, et al. Acute patellar dislocation in adolescents: operative versus nonoperative treatment. Int Orthop 2011;35:1483–7.
- [33] Moström EB, Mikkelsen C, Weidenhielm L, et al. Long-term follow-up of nonoperatively and operatively treated acute primary patellar dislocation in skeletally immature patients. Sci World J 2014; 2014: 473281.
- [34] Saccomanno MF, Sircana G, Fodale M, et al. Surgical versus conservative treatment of primary patellar dislocation. A systematic review and metaanalysis. Int Orthop 2016;35:1–1.
- [35] Lee DY, Park YJ, Song SY, et al. Which Technique Is Better for Treating Patellar Dislocation? A Systematic Review and Meta-analysis. Arthroscopy 2018;34:3082–93.
- [36] Longo UG, Ciuffreda M, Locher J, et al. Treatment of primary acute patellar dislocation: systematic review and quantitative synthesis of the literature. Clin J Sport Med 2017;27:511–23.
- [37] Duthon VB. Acute traumatic patellar dislocation. Orthop Traumatol Surg Res 2015;101:S59–67.
- [38] Wang HD, Dong JT, Gao SJ. Medial patellofemoral ligament reconstruction using a bone groove and a suture anchor at patellar: a safe and firm fixation technique and 3-year follow-up study. J Orthop Surg Res 2016;11:138.
- [39] Turkmen I, Saglam Y, Turkmensoy F, et al. Influence of sagittal plane malpositioning of the patella on anterior knee pain after tibia intramedullary nailing. Eur J Orthop Surg Traumatol 2017;27:133–9.
- [40] Lee HL, Yau WP. Management of traumatic patellar dislocation in a regional hospital in Hong Kong. Hong Kong Med J 2017;23:122–8.
- [41] Sillanpaa PJ, Maenpaa HM. First-time patellar dislocation: surgery or conservative treatment? Sports Med Arthrosc Rev 2012;20:128–35.
- [42] Nikku R, Nietosvaara Y, Kallio PE, et al. Operative versus closed treatment of primary dislocation of the patella. Similar 2-year results in 125 randomized patients. Acta Orthop Scand 1997;68:419–23.