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Medial patellofemoral ligament reconstruction appears to be a better treatment than repair, proximal realignment, or conservative management for primary patellar dislocation

A network meta-analysis

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Abstract

Background: The purpose of this study was to compare the functional outcomes and re-dislocation rates of medial patellofemoral ligament (MPFL) reconstruction, MPFL repair, combined proximal realignment (CPR), and conservative management for primary patellar dislocation by conducting a systematic literature search of the available studies. The hypothesis was that MPFL repair and MPFL reconstruction would be better options for treating primary patellar dislocation.

Methods: Randomized controlled trials or prospective studies of primary patellar dislocation treated with MPFL reconstruction, MPFL repair, CPR, or conservative management were identified from the MEDLINE, EMBASE, and the Cochrane Library databases through December 31, 2021. A total of 626 patients met the prespecified inclusion criteria. The methodological quality of each study was assessed using a risk of bias table, Detsky quality index, and Newcastle-Ottawa Scale. The end-point data collected included comparisons of the mean in functional scores on knee outcomes scales and the number of patients who experienced re-dislocation. A network meta-analysis of the relevant literature was performed to investigate which treatment showed better outcomes.

Results: In total, 10 trials were included in this study. There was no statistically significant difference in the subgroup analysis in terms of the functional outcomes among MPFL reconstruction, MPFL repair, CPR, and conservative management. However, MPFL reconstruction showed statistically significantly better outcomes than MPFL repair, CPR, or conservative management in terms of the re-dislocation rate. Additionally, surface under the cumulative ranking curve percentage showed that MPFL reconstruction had a lower probability of re-dislocation than MPFL repair even though there was no significant difference (0.24, 95% confidence interval: 0.02–2.91).

Conclusion: Using a network meta-analysis, this meta-analysis showed that there was no significant difference in functional outcomes in a subgroup analysis. In re-dislocation subgroup analysis, MPFL repair and MPFL reconstruction produced significantly better results than other treatments. Also, surface under the cumulative ranking curve percentage showed that MPFL reconstruction had a lower probability of re-dislocation than MPFL repair.

Abbreviations: CI = confidence interval, CPR = combined proximal realignment, MPFL = medial patellofemoral ligament, NMA = network meta-analysis, RCTs = randomized controlled trials, SUCRA = surface under the cumulative ranking curve.

Keywords: conservative, MPFL, network meta-analysis, primary patellar dislocation, proximal realignment

1. Introduction

Acute primary patellar dislocation is a common injury that represents 2% to 3% of knee lesions.[1] The majority of patients were young and physically active people.[2,3] In most cases, it commonly occurs to the lateral side and leads to ruptures of the medial patellofemoral ligament (MPFL).[4] In

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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addition, it may lead to hemarthrosis of the knee, severe pain, and a decreased ability to take part in sporting activities.[5,6] Traditionally, most primary patellar dislocation cases are treated non surgically unless there are combined injuries, such as osteochondral fragments or associated patellar displacement.[7–10] However, previous studies have reported that conservative management is associated with high re-dislocation rates compared to surgical management. Re-dislocation of the patella could reduce patient's activity level and functional outcomes. Therefore, many surgical treatments have increasingly sought to address primary patellar dislocation.[11,12] Surgical management mainly includes MPFL repair or reconstruction because MPFL is the primary constraint in preventing lateral dislocation of the patella and has shown a good clinical outcome.[13–16] There are several studies on MPFL reconstruction and repair, but there is disagreement about the outcome.[17,18] In addition, proximal realignment (such as lateral retinaculum release) can be used to treat primary patellar dislocation.[19] Proximal realignment procedures typically increase medial tension and improve clinical results. However, other studies have shown that isolated lateral release is not a useful procedure in patellofemoral instability.[20,21] The current treatment guideline of primary patellar dislocation was to perform surgery rather than conservative management to reduce re-dislocation of patella.[22] Furthermore, the recent international survey reported that MPFL reconstruction was preferred to treat primary patellar dislocation if patients were young and enjoyed sports activity.[23]

Although numerous studies have attempted to compare the effects of surgical and nonsurgical treatments, they have only included a small sample size, which can lead to less statistical power and conflicting results. In addition, while there are several surgical methods available for patella dislocation, comparative studies of each surgical and conservative treatment are available, but there has been no comparison across MPFL repair, MPFL reconstruction, and combined proximal realignment (CPR) at the same time, which were commonly used for treating patellar dislocation.[24–33] A network meta-analysis (NMA) can allow a unified, coherent analysis of the data recorded in randomized controlled trials (RCTs) regarding the clinical effectiveness of all available treatment options by drawing together evidence from direct and indirect comparisons of various treatments.[34]

The purpose of this meta-analysis was to evaluate the functional outcomes and re-dislocation rates of MPFL repair, MPFL reconstruction, CPR, and conservative management in the treatment of primary patellar dislocation. It was hypothesized that MPFL repair and MPFL reconstruction would be better options for treating primary patellar dislocation.

2. Methods

2.1. Data and literature sources

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting guidelines for NMA.[35] Although the current study involved human participants, ethical approval and informed consent from the participants were not required because all data were acquired from previously published studies and were analyzed anonymously without any potential harm to any participants. Multiple comprehensive databases, including MEDLINE, EMBASE, and the Cochrane Library, were searched from their conception through December 31, 2021, based on logical keyword combinations and in-text words that are related to primary patellar dislocation. Articles which were written in the English language were collected. After the initial electronics search, additional relevant articles and bibliographies from identified studies were hand searched.

2.2. Study selection

The inclusion criteria were as follows: Articles written in the English language; RCTs or prospective studies; Comparisons between primary patellar dislocation treatments; primary patellar dislocation was defined by first episode of dislocation which has no history of previous knee surgery or major knee injury within 3 weeks before treatment; Reports of clinical and/or re-dislocation results that could be comparable with the findings of other studies.

The exclusion criteria were as follows: Review articles or meta-analysis; Other surgical techniques such as osteotomy or tracheoplasty were combined in the treatment; Patients who had congenital disease related to patellar dislocation; Cadaveric studies, in vitro biomechanical studies or experimental studies on animals.

2.3. Data extraction

Two reviewers (M-H.H. and C-W.L.) independently recorded data from each study using a predefined data extraction form and resolved any differences by discussion. The recorded variables included information about the risk of bias assessment and outcome measures. It also included the following elements: the author's name, publication year, sample size (total number of randomly assigned patients), patient demographics, comparators in the intervention groups, and intervention characteristics. We obtained the mean and standard deviation of function scores which were final scores after treatment in each trial. Disagreement between the reviewers was resolved by consensus or by discussion with a third investigator (Y-S.S.) when consensus could not be reached.

2.4. Methodologic quality assessment

Two reviewers (M-H.H. and C-W.L.) independently assessed the methodologic quality of each study using a risk of bias table that included random sequence generation; allocation concealment; blinding of patients, surgeons, and outcome assessors; blinding of outcome assessment; selective outcome reporting and other bias; and incomplete outcome data as recommended by the Cochrane Bias Methods Group. The risk of bias (low, high, or unclear) was independently assessed by 2 investigators. Additionally, the Detsky quality index was applied to evaluate randomization, blinding, withdrawals and dropouts, inclusion and exclusion criteria, therapeutic regimen, and statistical analysis. Based on previously published papers, studied scoring > 75% of the maximum Detsky score (15/20) was designated high quality.[36] For the Newcastle-Ottawa Scale, as recommended by the Cochrane Non-Randomized Studies Methods Working Group, we assessed the studies based on 3 criteria: selection of the study groups, comparability of the groups, and ascertainment of either the exposure or the outcome of interest for case-control and cohort studies. Studies of high quality were defined as those with scores higher than 6 points. We used k values to evaluate the rater reliability for all items of the Detsky score and Newcastle-Ottawa Scale. Two reviewers resolved all differences by discussion, and their decisions were subsequently reviewed by a third investigator (Y-S.S.).

2.5. Outcome measures

The end-point data collected included the mean in functional scores and the number of patients who experienced re-dislocation. The function subscale of the Kujala score was adopted to evaluate functional improvement. If the Kujala score was not reported, the Lysholm score was applied instead.[37,38] Re-dislocation in all included studies was investigated based on the number of patients who experienced re-dislocation, and the definitions recorded by the author of the original study were used.

2.6. Statistical analysis

We qualitatively synthesized included trials and then developed network diagrams to visualize the relative amount of available evidence on the 4 different treatments.[39] For continuous endpoints, the standardized mean difference as the Hedges g and its associated 95% confidence interval (CI) was calculated using a random-effects model because several different measurement tools were used to assess the same outcome. For binary endpoints, odds ratios and 95% CI were calculated. To test the NMA consistency assumption, we assessed the inconsistency factors with the estimated difference between the effect size from direct comparisons within trials and the effect size from indirect comparisons within trials with 1 treatment in common. If the value approached 1, it suggests that the 2 estimates are consistent with each other.[40] Transitivity implies that the distribution of the effect modifiers is similar across treatment comparisons. The evaluation of the transitivity assumption is critical because the existence of an intransitivity will bias treatment can impact estimates. We explored transitivity through inspection of the follow-up duration of the included trials. Furthermore, NMA is capable of ranking probability distributions of each treatment generated from a simulation of 10,000 replications. The probability values are reported as the mean rank and surface under the cumulative ranking curve (SUCRA). The best treatment has a SUCRA value equal to 100%, whereas the worst treatment has a SUCRA equal to 0%. The publication bias was also assessed using funnel plots.[33,34] In addition, a sensitivity analysis was performed by excluding eligible trials from the analysis to investigate the impact of the risk of bias on the result, with a high risk of bias according to the elements of randomization and blinding of the participants. All statistical analyses were performed with Stata version 14.2 software (Stata Corp LLC, College Stating, TX). This study also conducted classic pairwise meta-analysis of functional scores and re-dislocation rates using RevMan version 5.3 software (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration) and a random-effects model. We measured the extent of heterogeneity with I^2 statistics. I^2 statistics mean to measure the percentage of the total variation across various studies ($I^2 \geq 50\%$ was considered heterogeneous).

3. Result

3.1. Study characteristics

Details on study identification, inclusion, and exclusion are summarized in Figure 1. A total of 10 trials were included in the NMA.[24–33] Figure 2 and Figure 3 show the network of interventions. In most trials, the functional outcomes of treatments were reported as Kujala scores. The 10 trials were published between 1997 and 2019. In the 10 trials with available information, the patient ages ranged from 13.5 to 26.8 years (median: 19.8 years). The maximum length of follow-up ranged from 2 to 14 years (median: 4.7 years). The quality of the 10 trials included in the NMA is summarized in Table 1. The 9 RCTs had randomly allocated the patients to either of 3 different treatments (MPFL repair, MPFL reconstruction, or CPR) or to conservative management. The other 1 trial was prospective non-randomized controlled trial so that we used Newcastle-Ottawa Scale. Inter-rater reliabilities (k values) for all items of the Detsky score and Newcastle–Ottawa Scale ranged from 0.81 to 0.93, 0.76 to 0.89, respectively, suggesting at least more than substantial agreement between the 2 investigators. For evaluable analyses, funnel plots indicated a lack of publication bias among the included studies (symmetric for all).

3.2. Comparative effects on functional outcomes

The comparative effectiveness results for functional outcomes are shown in Table 2. There was no statistically significant difference in the subgroup analysis in terms of the functional outcome. However, SUCRA percentage showed that MPFL reconstruction was most likely the best treatment (with a SUCRA value of 72.9 and a mean rank of 1.3) in terms of functional outcomes, followed by MPFL repair (with a SUCRA value of 61.9 and a mean rank of 1.9) and conservative management (with a SUCRA value of 56.7 and a mean rank of 3.3), whereas CPR ranked last (with a SUCRA value of 57.2 and a mean rank of 3.4) (Table 3).The results of pairwise meta-analysis are summarized in Table 4 and Figure 4. After we excluded trials with a poor methodologic quality, a statistically significant difference could not be shown

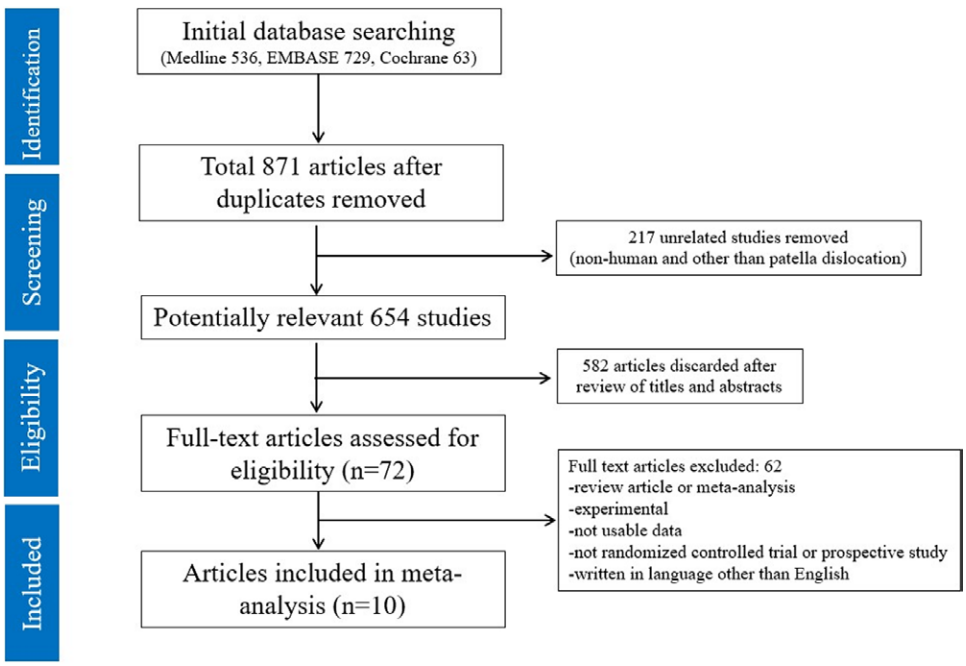

Figure 1. Flow diagram of study identification and selection.

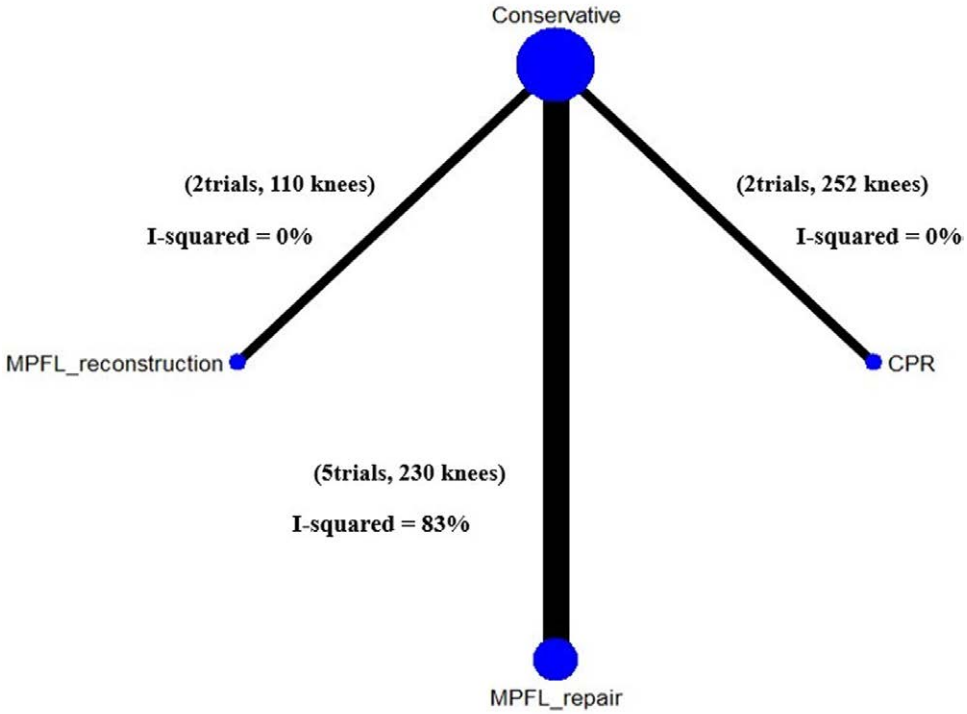

Figure 2. Network of treatment comparisons included in the analysis for functional outcomes. The size of every circle reflects the number of patients. The width of every line corresponds to the number of direct comparisons. Number showed beside the line represented number of trials and number of patients.

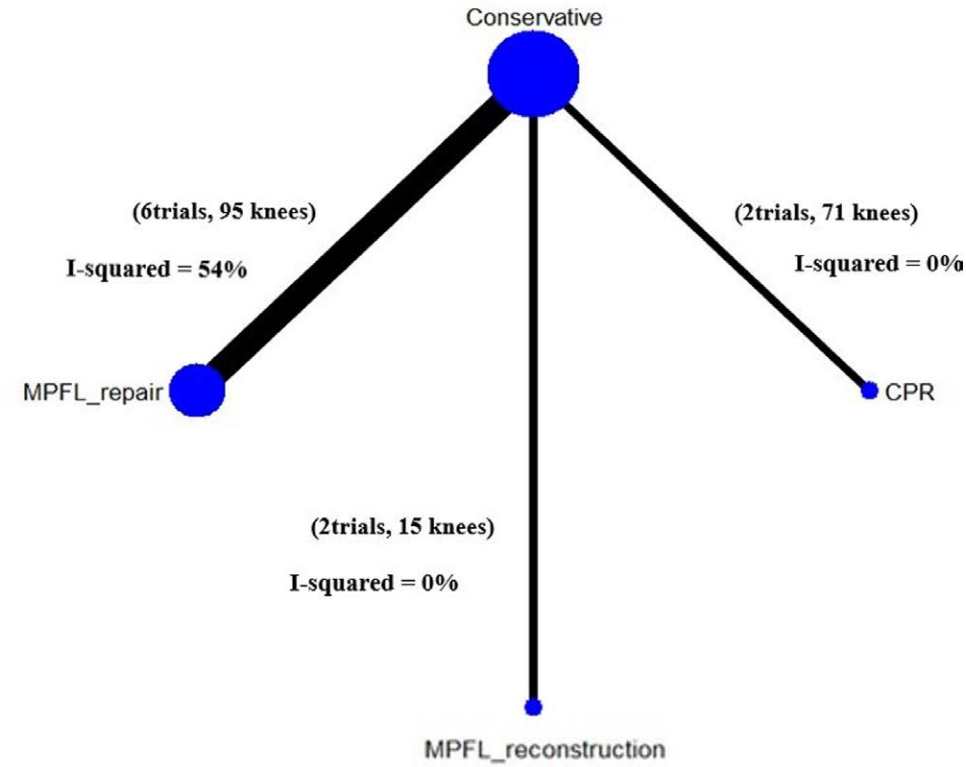

Figure 3. Network of treatment comparisons included in the analysis of re-dislocation rates. The size of every circle reflects the number of patients. The width of every line corresponds to the number of direct comparisons. Number showed beside the line represented number of trials and number of patients.

compared with those of our primary analyses, which indicated that the findings were robust due to decisions made in the data collection process.

3.3. Comparative effects on re-dislocation rates

The comparative effectiveness results for re-dislocation rates are shown in Table 5. MPFL reconstruction was most likely

Table 1

Characteristics and risk of bias and quality of included studies using a Detsky score and Newcastle-Ottawa scale assessment tool summary: review authors judgements about the risk of bias item for each included study.

Study	Random Sequence generation	Allocation Concealment	Blinding of participant and personnel	Blinding of outcome assessment	Incomplete Outcome	Existence of selective reporting	Existence of other bias	Level of evidence	Detsky score	Newcastle-Ottawa scale	Operation	Number OP	Number cons	Mean Age (yr) OP	Mean Age (yr) cons	Functional outcome extracted	Time point extracted
Nikku et al 1997	+	+	–	–	–	?	?	II	14/20		Proximal realignment	70	55	19.5	19.1	Lysholm	2 yr
Nikku et al 2005	–	–	–	–	–	?	?	II	15/20		Proximal realignment	70	57	20.0	20.0	Kujala	7 yr
Palmu et al 2008	–	–	–	–	–	?	?	II	16/20		Repair	36	28	13.0	13.0	Kujala	14 yr
Christiansen et al 2008	+	+	+	?	–	?	?	I	16/20		Repair	42	35	20.0	19.9	Kujala	2 yr
Silanpaa et al 2009	–	–	–	–	–	?	?	I	17/20		Repair	18	22	20.0	20.0	Kujala	7 yr
Camanho et al 2009	–	–	–	–	–	?	?	II	16/20		Repair	16	17	24.6	26.8	Kujala	40.4 mo
Bitar et al 2013	+	+	–	–	–	?	?	I	16/20		MPFL reconstruction	21	20	23.9	24.0	Kujala	2 yr
Regalado et al 2013	+	–	–	–	–	?	?	II	16/20		Repair	15	15	13.5	13.5	NA	6 yr
Petri et al 2013	–	–	–	–	–	?	?	I	17/20		Repair	12	8	27.2	21.6	Kujala	2 yr
Zheng et al 2019	+	+	+	?	–	?	?	II		8	MPFL reconstruction	30	39	18.3	17.9	Kujala	2 yr

Detsky score is applied to evaluate the quality of included studies, showing a score of ≥ 15 points are considered to be high quality. Newcastle-Ottawa Scale is applied to evaluate the quality of included studies, showing a score of ≥ 6 points are considered to be high quality.
– = Low risk of bias, + = high risk of bias, ? = unclear risk of bias, Cons = conservative treatment, OP= operation, NA = not applicable.

Table 2

Comparative effectiveness results for functional outcomes.

Comparison	Functional outcomes
Conservative vs CPR	–0.01 (–1.07, 0.86)
MPFL repair vs CPR	0.57 (–0.10, 1.24)
MPFL reconstruction vs CPR	0.96 (–0.05, 1.98)
MPFL repair vs conservative	0.67 (–0.50, 1.85)
MPFL reconstruction vs conservative	1.07 (–0.33, 2.47)
MPFL reconstruction vs MPFL repair	–0.39 (–1.61, 0.82)

Each cell shows a standardized mean difference (SMD), with a 95% confidence interval (CI) in parentheses.
CPR = combined proximal realignment, MPFL = medial patellofemoral ligament.

Table 3

Network meta-analysis treatment ranking results for each of functional outcomes and re-dislocation rates.

	Functional outcomes		Re-dislocation rates	
Treatment	SUCRA	Mean rank	SUCRA	Mean rank
Conservative	56.7	3.3	80.7	3.8
CPR	57.2	3.4	71.8	3.1
MPFL repair	61.9	1.9	79.7	2.0
MPFL reconstruction	72.9	1.3	87.2	1.2

Surface under cumulative ranking curve (SUCRA) values (0–100) and mean ranks are presented, based on a simulation with 10,000 replications. Higher SUCRA s and lower mean ranks indicate better performing treatments.
CPR = combined proximal realignment, MPFL = medial patellofemoral ligament.

the best treatment (with a SUCRA value of 87.2 and a mean rank of 1.2) in terms of re-dislocation rates, followed by MPFL repair (with a SUCRA value of 79.7 and a mean rank of 2.0) and CPR (with a SUCRA value of 71.8 and a mean rank of 3.1), whereas conservative management ranked last (with a SUCRA value of 80.7 and a mean rank of 3.8) (Table 3). MPFL repair (0.05, 95% CI: 0.01–0.46) and MPFL reconstruction (0.21, 95% CI: 0.07–0.66) produced statistically significantly better results than CPR. However, MPFL reconstruction (0.24, 95% CI: 0.02–2.91) demonstrated higher results than MPFL repair, but they were not statistically significant. The results of pairwise meta-analysis are summarized in Table 4 and Figure 5. After we excluded trials with poor methodologic quality, a statistically significant difference could not be shown compared with those of our primary analyses, which indicated that the findings were robust to decisions made during the data collection process.

4. Discussion

The main findings of the current NMA verified that MPFL reconstruction was a better treatment in terms of re-dislocation rate than MPFL repair, CPR, or conservative management. According to the recent survey, many surgeons considered MPFL procedure for treatment of primary patellar dislocation because of high re-dislocation rate of conservative management.[23] Additionally, CPR and conservative management is the worst treatment in terms of functional outcome and re-dislocation rate when compared to other treatments. However, there was no statistically significant difference in the subgroup analysis in terms of the functional outcome. In an analysis of the re-dislocation subgroup, MPFL repair and MPFL reconstruction produced statistically significantly better results than CPR. As a result, MPFL reconstruction exhibited a better result than conservative management and was also statistically significant. However, MPFL reconstruction demonstrated higher results than MPFL repair, but they were not statistically significant.

Table 4

SMD (standardized mean difference)/OR (odds ratio) and 95% CI of pairwise meta-analysis in terms of functional outcomes and re-dislocation rates.

		Pairwise meta-analysis			
Included studies	**Comparison**	**SMD/OR**	**95% CI**	**I-squared**	***P* value**
Functional outcomes					
5 studies	1 vs 4	0.57	–0.11, 1.26	83%	.10
2 studies	3 vs 4	–0.10	–0.35, 0.15	0%	.41
2 studies	2 vs 4	**0.92**	**0.52, 1.32**	0%	<.01
Re-dislocation rates					
6 studies	1 vs 4	**0.16**	**0.05, 0.57**	54%	<.01
2 studies	3 vs 4	0.65	0.37, 1.13	0%	.13
2 studies	2 vs 4	**0.05**	**0.01, 0.40**	0%	<.01

Bold numbers represent the difference are of significance.

1 = MPFL repair, 2 = MPFL reconstruction, 3 = combined proximal realignment, 4 = conservative, CI = confidence intervals, MPFL = medial patellofemoral ligament, OR = odds ratio, SMD = standardized mean difference.

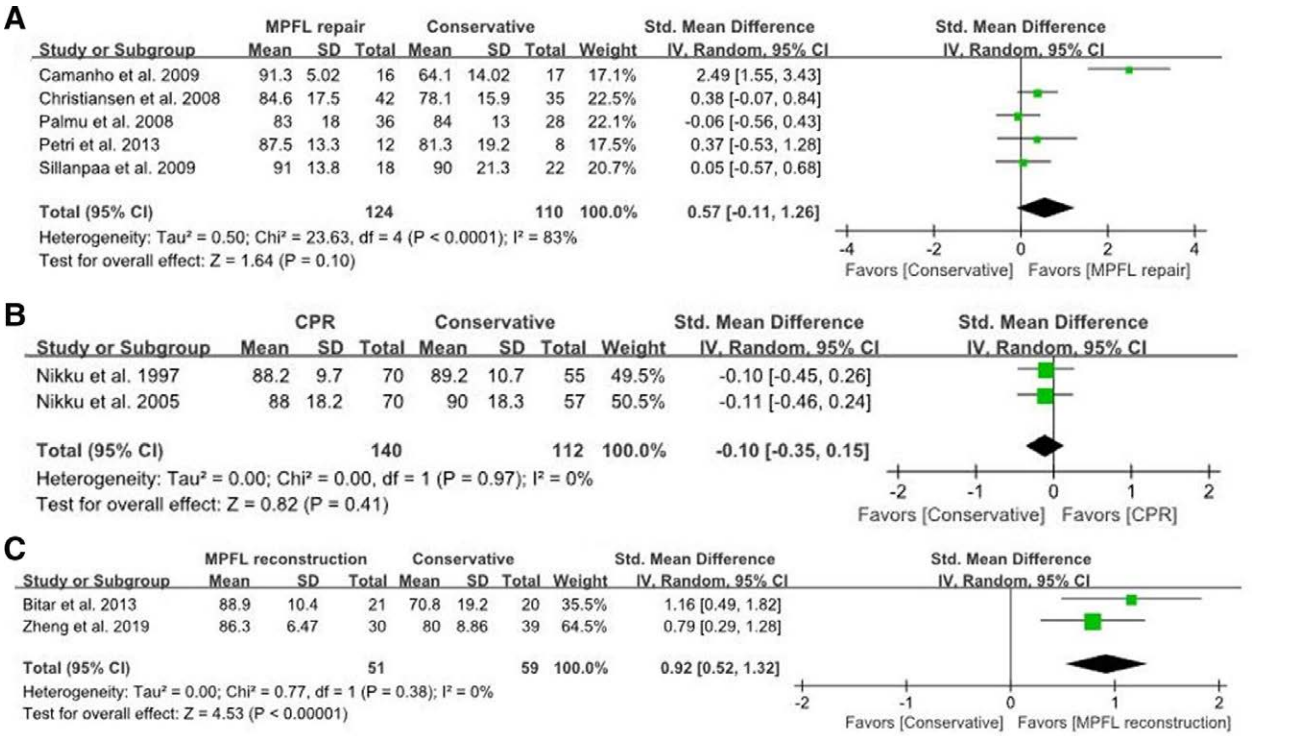

Figure 4. Forest plots for the functional outcomes of MPFL repair and conservative (A), CPR and conservative (B), MPFL reconstruction and conservative (C). CPR = combined proximal realignment, MPFL = medial patellofemoral ligament.

Many previous studies have compared the functional outcomes of surgical treatments and conservative management during the treatment of primary patellar dislocation. Surgeries such as MPFL repair or reconstruction have demonstrated a better functional outcome than conservative management.[41] Proposed explanations for the poor results of conservative management are long-term immobilization and re-dislocation of the patella. Prolonged immobilization could produce stiffness of the knee joint, while re-dislocation of the patella could continuously lead to patellofemoral articular damage.[26,42] However, some studies that compared MPFL repair and reconstruction reported no significant difference in the functional outcome between MPFL repair and reconstruction.[43] In this meta-analysis, we reported that MPFL reconstruction is the best treatment in terms of functional outcomes compared with other treatments,

Table 5

Network meta-analyses comparison between results of re-dislocation rates. Data were pooled odds ratio (OR) and its related 95% confidence interval (CI).

Comparison	**Re-dislocation rates**
Conservative vs CPR	0.64 (0.24, 1.70)
MPFL repair vs CPR	**0.21 (0.07, 0.66)**
MPFL reconstruction vs CPR	**0.05 (0.01, 0.46)**
MPFL repair vs conservative	0.33 (0.07, 1.46)
MPFL reconstruction vs conservative	**0.08 (0.01, 0.89)**
MPFL reconstruction vs MPFL repair	0.24 (0.02, 2.91)

Significant results in bold text.

CPR = combined proximal realignment, MPFL = medial patellofemoral ligament.

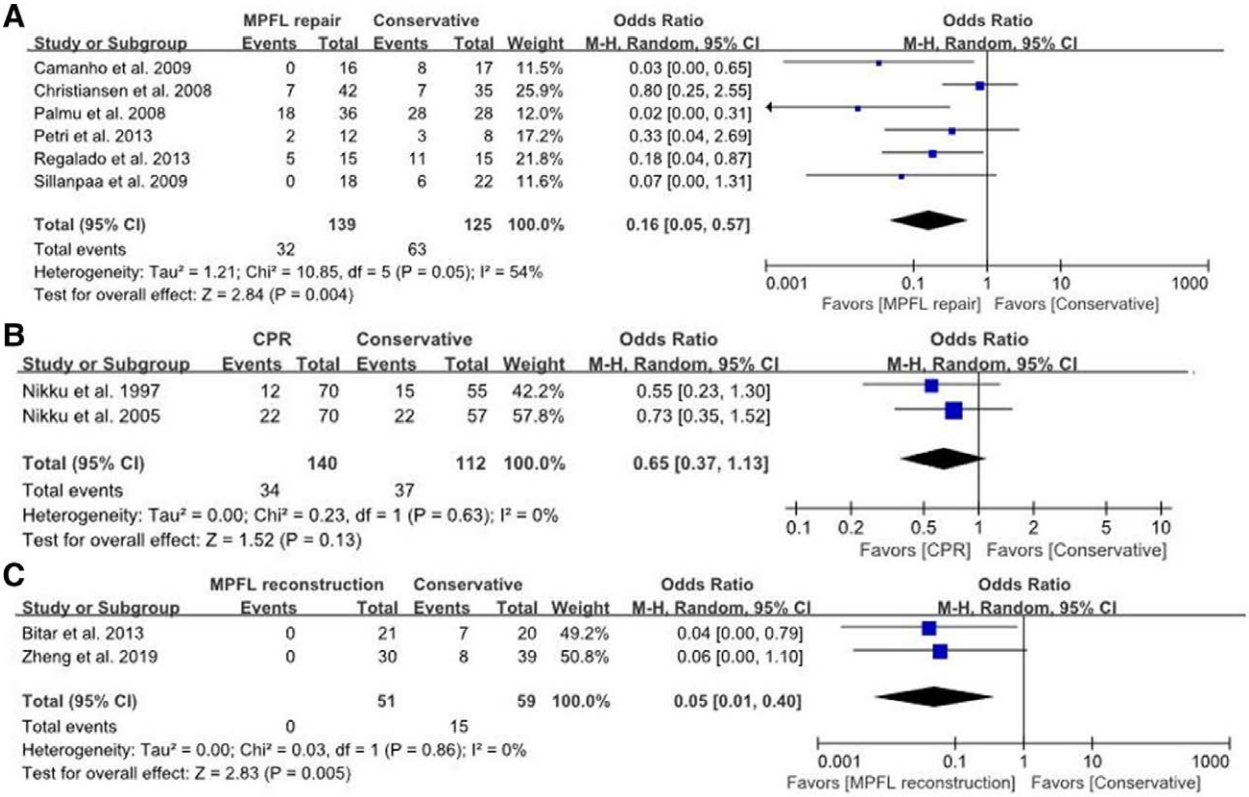

Figure 5. Forest plots for the re-dislocation rates of MPFL repair and conservative (A), CPR and conservative (B), MPFL reconstruction and conservative (C). CPR = combined proximal realignment, MPFL = medial patellofemoral ligament.

followed by MPFL repair, conservative management, and CPR, respectively, even though the functional outcomes did not show statistically significant differences for all 3 surgical procedures compared to conservative management. The reason why CPR showed a poorer outcome was due to the high re-dislocation rate after CPR treatment.[44] The higher re-dislocation rates that occurred after CPR than MPFL repair or reconstruction might cause patients to behave passively and uncomfortably, and these factors may have led to the limited activity levels that were reflected in this study.[45]

Due to the high re-dislocation rates following conservative management, many methods of surgical treatment used to repair or reconstruct the MPFL increase because the MPFL is the most important structure that limits lateral patellar dislocation.[46] Therefore, MPFL repair or reconstruction is effective in preventing re-dislocation after primary patellar dislocation. Recently, MPFL reconstruction is more preferred over MPFL repair because failure rate of MPFL repair was higher than MPFL reconstruction. This reason was supported by the finding that the strength of remnant ligaments is more weakened than autogenous or allogenous tendon grafts, even though they are repaired.[14,43,47] Additionally, the results of this meta-analysis showed that SUCRA percentage showed that MPFL reconstruction had a lower probability of re-dislocation than MPFL repair even though there was no significant difference between MPFL reconstruction and MPFL repair according to odds ratios values. In previous studies, CPR was thought to be one of the best treatments for treating patellar dislocation by strengthening the medial supporting structures and releasing the tight lateral supporting structures.[19,48] Many surgical techniques (such as lateral retinaculum release or Insall proximal realignment) have been studied and used to treat patellar dislocation.[20,49,50] However, these studies have shown a higher re-dislocation rate with CPR compared to other surgical treatments.[44,45] For these reasons, CPR produced a better result than conservative management but a poorer result than MPFL repair or reconstruction.

This meta-analysis had several limitations. First, although we collected the articles from multiple databases, we may have missed articles that were published in papers that are not indexed in those databases. Among the included studies, MPFL repairs were the most common, and CPR was reported in only 2 studies that were published by the same study group and just used a different follow-up period (2 years vs 7 years), so the results were similar. Second, risk factors (such as valgus deformity, torsional deformity, or increased tibial tuberosity-trochlear groove distance) were not mentioned or controlled for in this meta-analysis. Also, we could not further analyze the other complications except re-dislocation of patella because of limited information in the included studies. Third, there were many different surgical techniques of MPFL repair, MPFL reconstruction (e.g., surgical incision, graft type, or method of how to fix the graft), and CPR. Furthermore, anesthesia method or rehabilitation protocol was varied depending on the surgeons. Each technique has advantages and disadvantages and these could have increased the heterogeneity of the findings. Fourth, we only identified level 2 evidences (5 non-homogenous RCTs and 1 observational study) for the assessment of the safety in the real-world setting, irrespective of target condition. In general, if the available evidence base consists of a network of interlinked multiple RCTs (homogenous RCTs and non-homogenous RCTs) involving treatments compared directly, indirectly, or both, the entire body of evidence can be synthesized by means of NMA. Also, a well-controlled cohort study is still needed to confidently determine a causal relationship between various interventions and adverse effects, especially re-dislocation rates in people with primary patellar dislocation. Finally, conservative treatments are also subdivided into physiotherapy and muscle strengthening exercises, and the authors did not consider these differences.

5. Conclusion

Using a network meta-analysis, there was no significant difference in functional outcomes in subgroup analysis. However, SUCRA percentage showed that MPFL reconstruction was superior compared with MPFL repair, CPR, or conservative management. In re-dislocation subgroup analysis, MPFL repair and MPFL reconstruction produced significantly better results than other treatments. Also, SUCRA percentage showed that MPFL reconstruction had a lower probability of re-dislocation than MPFL repair. Therefore, MPFL reconstruction appears to produce the best outcomes in the treatment of primary patellar dislocation and it is especially important treatment for younger patients to prevent patellar re-dislocation. These results could lead more surgeons to consider MPFL reconstruction to treat primary patellar dislocation. Furthermore, studies about comparing various specific techniques of MPFL reconstruction should be required in the future.

Author contributions

Conceptualization: Jae-Doo Yoo, Young-Soo Shin.
Data curation: Young-Soo Shin, Darryl D. D'Lima.
Formal analysis: Min-Hwan Huh, Young-Hak Roh, Chan-Woo Lee.
Methodology: Min-Hwan Huh, Young-Soo Shin.
Software: Young-Soo Shin.
Supervision: Young-Soo Shin.
Writing – original draft: Young-Soo Shin, Min-Hwan Huh.
Writing – review & editing: Young-Soo Shin.

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