Systematic Review

Medial Patellofemoral Ligament Reconstruction Combined With Bony Procedures for Patellar Instability: Current Indications, Outcomes, and Complications

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Purpose: The aim of this literature review is to analyze current indications, outcomes, and complication rates of medial patellofemoral ligament (MPFL) reconstruction associated with bony procedures in order to clarify efficacy and adoptability in selected patients with patellar instability. **Methods:** A systematic review of the literature was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A search on PubMed, Medline, CINAHL, Cochrane, Embase, and Google Scholar databases was performed, using various combinations of the keywords *patellar instability*, *MPFL reconstruction*, *tibial tubercle osteotomy*, and *trochleoplasty*. **Results:** Fourteen of 501 articles were included. Indications for surgery included dysplasia and malalignment. All studies reported significant improvements in overall clinical outcomes. The most frequently used score was the Kujala score, with a mean value of 83.26. Functional failures ranged from 0% to 8.8%. Major complications were not described. Minor complications ranged from 0% to 40%. Reoperations ranged from 4.5% to 17.7%. **Conclusions:** A combined approach seems indicated in patients with patellar instability, especially among those with high tibial tuberosity–trochlear groove or severe trochlea dysplasia. Indications for combined MPFL and bony procedure are influenced by anatomy, including dysplasia and malalignment. We are unable to identify an absolute indication. Bony procedures are associated with increased morbidity. **Level of Evidence:** Level IV, systematic review of Level I to IV studies.

Patellofemoral instability is a debilitating condition, which commonly affects young patients,[1] limiting physical activity and leading to osteoarthritis.[2-5] Stability of the patellofemoral joint relies on a complex interplay of bony anatomy, soft tissue restraints, and dynamic muscle action to maintain congruency of the joint. The goal of surgery is to stabilize the patella, restore normal kinematics, and optimize load transmission through the joint. Surgical techniques include bony procedures, such as distal and/or medial transfer of the anterior tibial tubercle and trochleoplasty, and soft-tissue procedures, such as medial patellofemoral ligament (MPFL) reconstruction and medial retinacular reefing.[6,7] The MPFL is the most important restraint to lateral patellar displacement from zero to 30° of knee flexion.[8-11] It has been demonstrated that MPFL is injured during all lateral patellar dislocations.[12] Therefore, MPFL reconstruction has become popular to address patellofemoral instability. However, the causation of patellar instability is multifactorial,[13] and in some cases, it could be necessary to pair MPFL reconstruction with other surgical procedures. Although several studies described the outcome of isolated MPFL reconstruction, there is a general lack of knowledge on appropriate indications and outcomes of MPFL reconstruction combined with bony procedures.

The aim of this literature review was to analyze current indications, outcomes, and complication rate of

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MPFL reconstruction associated with bony procedures, in order to clarify efficacy and adoptability in selected patients with patellar instability. We hypothesized that a combined approach is indicated in patients with high tibial tuberosity–trochlear groove (TT-TG) distance or severe trochlea dysplasia.

Methods

A comprehensive review of the literature was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[14] PubMed, Medline, CINAHL, Cochrane, Embase, and Google Scholar bibliographic databases were searched using the following keywords: patellar instability in combination with MPFL reconstruction, tibial tubercle osteotomy, and trochleoplasty. We selected articles published from 1985 to 2015. Three independent reviewers (A.B., F.M., G.S.) separately conducted the search. Given the linguistic capabilities of authors, all publications in English, French, Spanish, Italian, and German were reviewed. According to the Oxford Centre of Evidence Based Medicine, Level I to IV articles were considered. Case reports, techniques, comments, letters, editorials, protocols, and guidelines were excluded. Biomechanical, animal, and cadaveric studies were also excluded. We included articles that reported clinical and/or radiographic outcome after MPFL reconstruction associated with bony procedures for the management of patients with patellar instability. Missing data pertinent to these parameters warranted exclusion from this systematic review. The same investigators screened the articles for inclusion. A cross-reference research of the selected articles was performed to identify any article omitted from the initial search.

Data Extraction

Data extraction was performed by 3 independent reviewers (A.B., F.M., G.S.), and any differences were reconciled by mutual agreement. All investigators extracted the following data independently: demographic, indications for surgery, type of surgery, outcome measures, radiographic measurements, complications, and reoperations. Postoperative complications were recorded for each publication and divided into functional failures (clinical apprehension sign, repeat subluxation, repeat dislocation, subjective instability), major complications (patellar fracture, range of motion deficit $>10^{\circ}$, unable to run), and minor complications (persistent pain, range of motion deficit $>10^{\circ}$, corrected, stiffness requiring manipulation under anaesthesia, superficial wound infection, wound complications, subcutaneous hematoma, extensor lag).[15]

Quality Assessment

To assess the quality of the studies, we used the Coleman Methodology Score (CMS), which assesses methodology using 10 criteria, giving a total score ranging between 0 and 100 points. A score of 100 indicates that the study largely avoids chance, various biases, and confounding factors. The final score can be defined as excellent (85 to 100 points), good (70 to 84 points), fair (50 to 69 points), or poor (<50 points). The subsections that make up the CMS are based on the subsections of the CONSORT statement (for randomized controlled trials) and are modified to allow for other trial designs.[16]

We have modified the Coleman criteria to make them reproducible and relevant for the systematic review of MPFL reconstruction combined with bony procedures in patients with patellar instability. Each study has been scored by 3 reviewers (A.B., F.M., G.S.) independently and in triplicate for each of the criteria adopted to give a total CMS between 0 and 100. Each author performed this procedure twice.

Results

The literature search identified 501 articles, of which 19 were found to be eligible for inclusion in the present systematic review. After reading the 19 eligible full-text articles, we rejected 5 owing to a lack of sufficient details. Finally, 14 articles were included in the present review. The flowchart of literature search is shown in Figure 1.

Demographic Data

A total of 248 patients were included, with an overall mean age of 20.88 years. The mean follow-up was 61.4 months. The following studies were included: 1 Level I,[17] 1 Level II,[18] 6 Level III,[19-24] and 6 Level IV.[25-30] There was considerable risk of bias in most of the included studies. The majority of the studies were longitudinal analyses of a single cohort without controls and without randomization. This situation, however, is representative of the studied field[31] (Table 1).

Indications

All included studies evaluated preoperative anatomy, dysplasia, and malalignment using at least one of the following radiographic parameters. Patellar height and patellar tendon length were measured in 7 studies. The Insall–Salvati index was calculated in 3 studies, with an average value of 1.3.[19,27,29] Four studies used the Caton-Deschamps Index, with an average value of 1.14.[17,20,29,30] The tibial tubercle–trochlear groove (TT-TG) distance was measured in 7 studies with an average value of 17.5 mm.[17-20,27,29,30] Trochlear dysplasia was graded according to the Dejour classification into A, B, C, and D in 6 studies.[17,20,27-30] The average percentage of patients for each category was 44% type A, 30% type B, 22% type C, and 26% type D. The patellar configuration was categorized according to Wibeeg[32] as grade 1, 2, or 3 in one study. The average percentage of

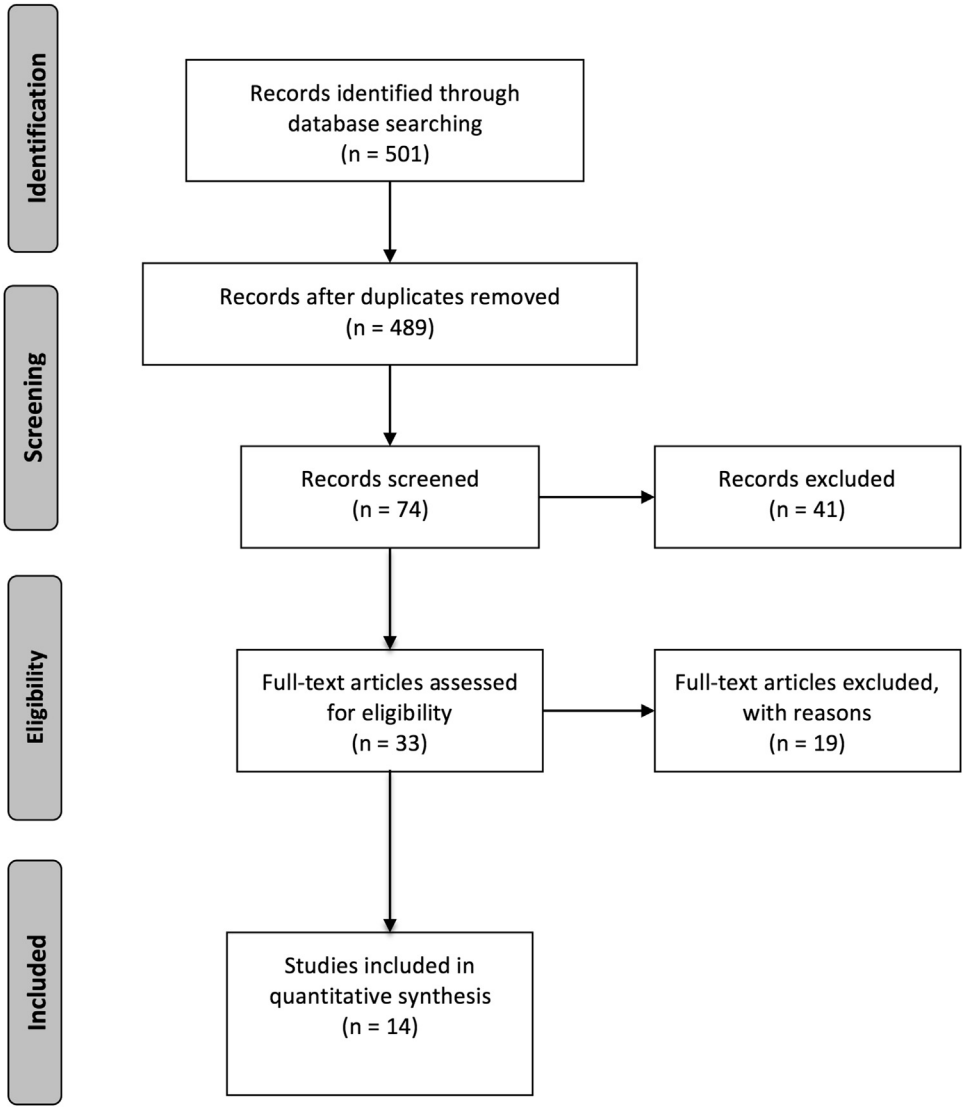

Fig 1. Flowchart of literature search.

Table 1. Details of Included Studies

Author	Level of Evidence	Coleman Score	Number of Patients	Number of Knees	Mean Age, yr	Mean Follow-up, mo
Banke et al., 2014[30]	IV	73	17	18	22.2	30.5
Blond et al., 2014[29]	IV	71	31	37	19	29
Christiansen et al., 2008[25]	IV	54	12	NR	22	22
Cossey et al., 2005[26]	IV	61	19	21	NR	23
Enderlein et al., 2014[27]	IV	73	52	NR	23	41
Faruqui et al., 2012[24]	III	43	3	3	19.3	NR
Feller et al., 2014[19]	III	46	10	NR	19.8	32.4
Kohn et al., 2013[22]	IV	63	8	NR	22	24
Mikashima et al., 2006[23]	III	50	20	20	26	31.7
Mulliez et al., 2015[24]	I	61	NR	38	22.8	34.5
Schottle et al., 2005[20]	III	47	8	NR	30.1	47.5
Vivod et al., 2014[21]	III	55	22	NR	44	270
Watanabe et al., 2008[22]	III	47	13	NR	20	52.8
Zhao et al., 2012[18]	II	76	45	45	NR	60

NR, not reported.

patients for each category was 6% type I, 60% type II, and 34% type III. Sulcus angle was measured in 4 studies, with an average value of 148°. Other radiographic measurements, such as Q angle and patellofemoral congruence angle, were occasionally reported.

MPFL reconstruction was associated with tibial tubercle transfer in 10 studies[17-20,22,23,25-28] and with trochleoplasty in 3 studies[24,29,30] (Table 2). One study reported the outcome of MPFL reconstruction with both tibial tubercle transfer and trochleoplasty.[21]

Surgical procedures differed in some aspects, such as graft used and tibial tubercle osteotomy type. The graft used to reconstruct the MPFL was the gracilis tendon in 3 studies[19,25,28] and the semitendinous tendon in 3 studies.[17,18,20,27] The strip of the medial retinaculum was used as a graft in one study,[26] and the reefing of medial soft-tissues was performed in another one.[21] The tibial tubercle transposition was Elmslie-Trillat procedure in 1 study,[23] anteromedial tibial tubercle osteotomy in 2 studies,[17,18,27] and tibial tubercle medialization in 3 studies.[20-22,27]

Outcomes

Several outcome measures were used in the included studies. The most frequently reported was the Kujala score, used in 9 studies,[17,18,20,23,25,27-30] with a mean value of 83.26. Other less consistently reported scoring systems were the IKCD score (mean value 77.7), which was used in 4 studies,[18,28,30,33] the Tegner score (mean value 4.4), and the Lysholm score (mean value of 95.6), which were used in 5 studies each.[18,26,28-30] All studies reported significant improvements ($P < .05$) in overall clinical outcomes at the final follow-up (Table 2).

Failures, Complications, and Reoperations

Only few studies described failures, complications, and reoperations.[17,19,21,23,27,29,30] Functional failures ranged from 0% to 8.8%. Major complications were not described. Minor complications ranged from 0% to 40%. The highest rate was seen in the study by Feller et al.,[19] who described similar percentage of anterior knee pain among patients undergoing isolated or combined MPFL reconstruction. Reoperations ranged from 4.5% to 17.65% (Table 2).

Quality Assessment

The mean value of the CMS score was 59 points, with a range from 43 to 76, showing that the mean quality of included study was fair (Table 1). Significant difference was not found between the mean CMS values calculated by the 3 examiners.

Discussion

The main finding of this review is that MPFL reconstruction combined with bony procedures is usually performed in patients with high TT-TG or severe trochlea dysplasia. MPFL reconstruction combined with tibial tuberosity osteotomy or trochleoplasty leads to good clinical results and low rate of functional failures. However, there are still concerns about potential complications.

Patellar instability is a multifactorial condition.[13,34,35,36] To properly treat patellar instability, all static and dynamic factors that contribute to the stability of the patellofemoral joint should be taken into account. A key question is to understand the instances when a combination of procedures becomes necessary to fully address all factors involved in causing pain, loss of function, and risk of recurrence. The indications for the addition of bony procedures to an MPFL reconstruction are not yet fully clear.

Overviewing the recent literature, key radiographic measures are used to accurately describe patient characteristics. Patellar height, lateralization of the tibial tuberosity, and trochlear dysplasia are the main criteria to guide the choice of surgical procedure. Most patients from the included studies had patella alta, high TT-TG distance, and moderate or severe trochlear dysplasia. However, no absolute threshold values were used as indications for MPFL reconstruction combined with bony procedures. More likely, the interplay between those factors influenced the decision-making process for individual patients. Surgical management should be individualized to address anatomic causes of instability. Multiple anatomic factors were identified in the majority of patients with recurrent dislocation. Steensen et al. compared the combined prevalences of patella alta, increased TT-TG distance, rotational deformities, and trochlear dysplasia in a group of patients with and without histories of recurrent dislocation of the patella.[13] In the study group, 35 of 60 knees (58.3%) had 2 or more abnormal factors present, compared with only 2 of 120 controls (1.7%). Among the patients with recurrent dislocation, 26.7% had 2 abnormal factors, 16.6% had 3, and 15% had 4. Improved outcome scores and low functional failure rate of the studies included in this review suggest the importance of recognizing additional risk factors, since the underlying anatomy in patients with patellar instability is not always the same. The mean postoperative Kujala score for all patients included in this review was 84.1, up from a mean preoperative score of 53.5; this was observed alongside a low failure rate (4.9%). Unfortunately, no studies have compared the outcome of combined procedures with those of isolated procedures. Thus, this decision to consider an isolated MPFL reconstruction or combine it with 1 or more additional stabilization procedures is still a matter of concern.

The decision to treat is also influenced by the increased morbidity associated with combined procedures for patellar instability. In this review, no major complications were reported, and minor complications

Table 2. Outcome Measure, Failures, Complications, and Reoperations

Author	Surgical Procedure	Outcome Measures	Mean Preoperative Kujala Score	Mean Postoperative Kujala Score	Functional Failures	Major Complications	Minor Complications	Reoperations
Banke et al., 2014[30]	MPFL+Trochleoplasty	Kujala, IKDC and Tegner score, VAS, physical examinations, radiography	51.1	88	5.88% (1)	NR	11.76% (2)	17.65% (3)
Blond et al., 2014[29]	MPFL+Trochleoplasty	Kujala, Tegner and KOOS score, physical examinations	64	95	6.45% (2)	NR	9.6% (3)	16.13% (5)
Christiansen et al., 2008[25]	MPFL+TTT	Kujala and KOOS score, physical examination	46	84	NR	NR	NR	NR
Cossey et al., 2005[26]	MPFL+TTT	Tegner and Lysholm score, radiography	NR	NR	NR	NR	NR	NR
Enderlein et al., 2014[27]	MPFL+TTT	Subjective outcome scores, Kujala score	62	77	NR	NR	NR	5.77% (3)
Faruqui et al., 2012[19]	MPFL+Trochleoplasty	KOOS and WOMAC score, radiography	NR	NR	NR	NR	NR	NR
Feller et al., 2014[19]	MPFL+TTT	Subjective outcome scores	NR	NR	0%	0	40% (4)	0
Kohn et al., 2013[28]	MPFL+TTT	Kujala, IKDC, and Tegner score, physical examinations	47	80	NR	NR	NR	NR
Mikashima et al., 2006[23]	MPFL+TTT	Kujala score, radiography	30.1	89	0%	0	0	NR
Mulliez et al., 2015[17]	MPFL+TTT	Kujala score, radiography	53.1	74	2.63% (1)	NR	5.2% (2)	NR
Schottle et al., 2005[20]	MPFL+TTT	Kujala score, radiography	60.25	92	NR	NR	NR	NR
Vivod et al., 2014[29]	MPFL+TTT/ MPFL+Trochleoplasty	Kujala and KOOS score, physical examinations, radiography	NR	68	7 dislocations, 11 apprehension sign	NR	NR	4.5% (1)
Watanabe et al., 2008[22]	MPFL+TTT	Lysholm scores, VAS	NR	NR	NR	NR	NR	NR
Zhao et al., 2012[18]	MPFL+TTT	Kujala, IKDC, Tegner and Lysholm score, physical examinations, radiography	68.9	87	8.8% (4)	NR	NR	NR

IKDC, International Knee Documentation Committee score; KOOS, Knee injury and Osteoarthritis Outcome Score; MPFL+TTT, medial patellofemoral reconstruction combined with tibial tuberosity transfer; NR, not reported; VAS, visual analog scale; WOMAC, Western Ontario and McMaster Universities Osteoarthritis score.

ranged from 0% to 40%. The highest rate was seen in the study by Feller et al.,[20] who described similar percentages of anterior knee pain among patients who had undergone isolated or combined MPFL reconstruction. Thus, the effective risk of complications following bony procedures is in need of further clarification.

Limitations

There are limitations associated with this review. The majority of studies are Level III retrospective or prospective studies, relegating the review to the inherent limitations of this level of evidence. Therefore, the available data must be interpreted with caution. The ability to draw conclusions is conditioned by the lack of a uniform reporting methodology across studies. Given the complex nature of patellar instability, literature could benefit from a detailed description of radiographic measurements and clinical parameters that drive surgical indications. A number of studies mixed isolated and combined MPFL reconstruction. None of these studies were included in this review, but it is likely that they contained at least some valuable data that could not be extracted.

Despite these limitations, to our knowledge, this study was the first to investigate the indications, outcomes, and complication rate of combined procedures for patellar instability, which might be helpful for knee surgeons in making clinical decisions.

Conclusions

A combined approach seems indicated in patients with patellar instability, especially among those with high TT-TG or severe trochlea dysplasia. Indications for combined MPFL and bony procedure are influenced by anatomy, including dysplasia and malalignment. We are unable to identify an absolute indication. Bony procedures are associated with increased morbidity.

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