



Surgical management for recurrent patellar dislocations in skeletally immature patients

Filippo Migliorini¹ · Björn Rath¹ · Markus Tingart¹ · Nadine Meisen² · Jörg Eschweiler¹

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Abstract

Background Due to his multifactorial aetiology, treating patellofemoral instability can be a challenge for the orthopaedic surgeon. The incidence of patellofemoral instability shows a peak during adolescence, especially from 11 to 14 years old.

Aim Several clinical studies focusing on recurrent patellar dislocations in skeletally immature patients have been published, reporting inconsistent or controversial results. Currently, there is a lack of consensus regarding the surgical management of these patients. The purpose of this study is to update current evidence and systematically review indications, treatments, and outcomes of surgical management for recurrent patellar dislocations in skeletally immature patients.

Methods A comprehensive review of the literature was performed according to the Preferred Reporting Items for Systematic Review and Meta-Analysis, the PRISMA Statement. The following electronic databases were accessed in February 2019: PubMed, Scopus, Google Scholar, CINAHL, EMBASE. All the articles treating surgical management for recurrent patellar dislocations in skeletally immature patients were considered for inclusion. For the methodological quality assessment, we referred to the Coleman Methodology Score (CMS). For the statistical analysis, we referred to the unpaired t-test to establish whether the results are statistically significant.

Result The overall CMS resulted in 52.78 points, attesting a satisfactory methodological quality assessment to this systematic review. A total of 21 articles including 623 patients (577 knees) were evaluated. The overall mean age was 13.02 years. The mean follow-up was 46.61 months. The mean Kujala score improved from 58.94 ± 10.38 to 87.07 ± 7.68 points. The Lysholm score reported a pre- and post-operative mean values of 49.54 ± 14.20 and 88.32 ± 8.80 , respectively. The mean Tegner Activity Scale scored 4.28 ± 1.22 at baseline, improving to 5.26 ± 0.83 post-operatively. A total of 4.19% of patients incurred into a major complication, while 9.6% sustained a minor one. We observed a total of 89 re-dislocations above 692 treated knees (12%).

Conclusion The main findings of this study are that surgical procedures for skeletally immature patients affected by recurrent patellar dislocations are feasible and effective. Complications and re-dislocations occurred infrequently. It is of fundamental importance to treat precociously these patients in order to reduce the risk of further recurrences, to increase the level of sporting activity and improving the quality of life.

Keywords Patellofemoral instability · Dislocation · Open physéal · Skeletally immature · MPFL · Surgical management

Introduction

Patellofemoral instability affects approximately 3% of all acute knee disorders [1] and represents the second most common cause of traumatic knee haemarthrosis [2]. Due to his multifactorial aetiology, it can be challenging for the orthopaedic surgeon to treat these patients [3, 4]. The incidence of patellofemoral instability shows a peak during adolescence, especially between the ages of 11 and 14 [5]. Given the juvenile onset, an effective treatment must be quickly adopted to avoid further complications [1]. It

✉ Filippo Migliorini
migliorini.md@gmail.com

¹ Department of Orthopaedics, RWTH Aachen University Clinic, Pauwelsstraße 30, 52074 Aachen, Germany

² MVZ Marienhospital Aachen Orthopädie, Roetgen, Germany

has been stated that almost 95% of patients suffering from patellofemoral instability show cartilage damage [6, 7]. Concerning recurrent patellar dislocations in skeletally immature patients, several clinical studies have been published [8–16], reporting inconsistent or controversial results. Currently, there is still no consensus regarding the surgical management of skeletally immature patients [17–19] and no systematic review on this topic has been published yet. Soft tissue procedures, such as the medial patellofemoral ligament (MPFL) reconstruction, reported excellent outcomes [20]. The MPFL is the most important dynamic restraint to the lateralization of the patella during the first 30° of flexion and is always damaged or ruptured after the first episode of patellar dislocation [21]. Bony procedures for patellofemoral instability are reserved only to skeletally mature patients [22–24]. Patellar instability is a complex syndrome to treat, and debates are ongoing. The purpose of this study is to update current evidence and to systematically review indications, treatments, outcomes, and simplifying the decision-making process of the surgical management for recurrent patellar dislocations in skeletally immature patients.

Materials and methods

Search strategy

A comprehensive review of the literature was performed according to the Preferred Reporting Items for Systematic Review and Meta-Analysis, the PRISMA Statement [25]. Two authors (FM and JE) independently performed the literature search. The following electronic databases were accessed in February 2019: PubMed, Scopus, Google Scholar, CINAHL, EMBASE. The following keywords were used in combination: *patellofemoral, instability, luxation, dislocation, open physal, adolescent, young, children, skeletally immature, MPFL, MPTL, dysplasia, distal alignment, proximal alignment, isolated, combined, lateral release, tibial extrarotation, soft tissue repairing, patella alta*. The same authors independently examined titles and abstracts and accessed the full-text version of the articles of interest. The bibliographies of the included articles were also screened.

Eligibility criteria

All the articles regarding the surgical management for recurrent patellar dislocations in skeletally immature patients were considered for inclusion. According to the authors language capabilities, articles in English, Italian, German, Spanish, and French were considered for inclusion. According to the Oxford Centre of Evidence-Based Medicine, articles level of evidence I to IV [26] were eligible for inclusion.

Techniques, guidelines, comments, editorials, letters, protocols, reviews, and meta-analyses were excluded. Biomechanical, animals, in-vitro, and cadaveric studies were also excluded. Articles treating congenital patellofemoral instability and/or acute dislocations were rejected. Only articles reporting quantitative data under the outcomes of interest were included. Disagreements between the authors were debated and mutually solved.

Data extraction

Two investigators (FM and JE) extracted the following data independently: mean age and follow-up, number of patients and knees, indications and surgical procedures, scores, post-operative complications, and re-dislocations. Regarding the scores, we collected the Kujala Anterior Knee Pain Scale [27], the Lysholm Knee Scoring Scale [28], and the Tegner Activity Scale [29]. Post-operative complications were recorded for each publication and divided into major (tibial fractures, patella fractures, subluxation, anterior knee pain, and reduced ROM) and minor (persistent anterior knee pain, superficial wound infection and necrosis, hypertrophic scars, haematoma, asymptomatic patella baja, post-operative swelling of the joint, transient saphenous nerve sensory deficit, joint crepitus, transient quadriceps atrophy, and undescribed joint mechanical symptoms).

Methodological quality assessment

For the methodological quality assessment, we referred to the Coleman Methodology Score (CMS) [30]. This score evaluates the included studies under several aspects, resulting in a value ranging from 0 to 100. The final score is defined as excellent (85–100 points), good (70–84 points), fair (50–69 points), and poor (< 50 points).

Statistical analysis

The arithmetic mean has been used to evaluate the estimated effect. The standard deviation (SD) was used to quantify the amount of variation or dispersion of data values. The unpaired t-test was performed in all the comparisons. Values of $P < 0.05$ were considered statistically significant.

Results

Search result

A total of 1550 articles resulted from the literature search and from cross-referencing the corresponding bibliographies. Of those, 254 were rejected because duplicates. Another 707 were rejected because they did not refer

exclusively on skeletally immature patients. This left 589 possibly suitable articles. A Further 509 articles were rejected because did not match our eligibility criteria. After reading the remaining full-text articles, 59 articles were rejected because inaccurate, unreliable, or unexploitable data. Finally, 21 articles were included, describing surgical procedures for recurrent patellar dislocations in skeletally immature patients. The flow chart of the literature search is shown in Fig. 1.

Methodological quality assessment

The overall CMS resulted 52.78 ± 6.74 points, attesting to this systematic review a good methodological quality assessment. The limitations revealed by the CMS score were the overall low-level of evidence, along with the limited number of enrolled patients of some studies. Points of strength evidenced by the CMS were the overall long duration of the

follow-ups along with the distinct inclusion criteria and surgical techniques. The CMS of each included study is shown in Table 1.

Demographic data and surgical procedures

A total of 623 patients (577 knees) were included in this systematic review. Of these, 357 (61.87%) were female and 220 (38.13%) male. A total of 46 patients underwent bilateral interventions (8%). The mean age was 13.02 ± 2.92 years, and the mean follow-up was 46.61 ± 35.25 months. The following surgical procedures were investigated: tenodesis (4), lateral releases (5), MPFL reconstructions (9), tibial tendon transfer (5), MPTL reconstruction (1), medial plication (2), medial retinaculum plasty (3), medial reefing (2), vastus medialis plasty (2). Demographic data of the included patients, criteria, and related surgical procedures are shown in Table 1.

Fig. 1 PRISMA flow-chart of the literature search

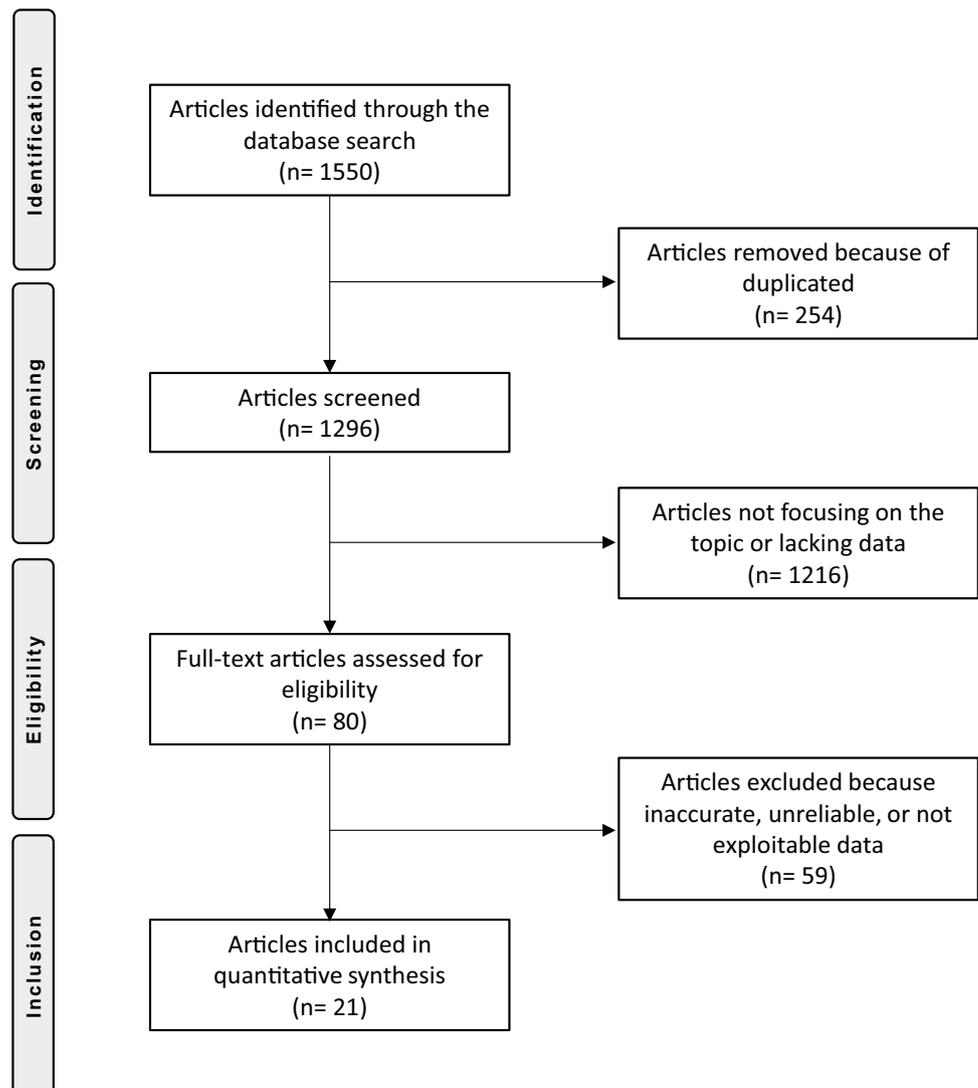


Table 1 Patient's baseline demographic, CMS, and characteristic of the included studies

Author, year	Level of evidence	Mean age	Follow-up (months)	Knees (gender)	CMS	Inclusion criteria	Type of surgery	Complications
Aulisa et al. [8]	II	11.1	52.8	16 (10 F, 4 M)	61	(1) Tanner stage < III. (2) Any meniscal or cartilaginous damages. (3) Signs of subluxated and tilted patella (CT)	Galeazzi ST tenodesis, lateral release	Transient saphenous nerve sensory (4)
Benoit et al. [12]	III	10.3	162	12 (4 F, 4 M)	53	(1) Patella alta. (2) Symptoms > 12 months	Lateral release, vastus medialis obliquus medial advancement, patellar tendon transfer	Superficial infection (1), drop foot in plaster cast (1), patella baja (2), quadriceps atrophy (1)
Brown et al. [13]	III	11	14	2 (1 F, 1 M)	47	(1) No dysplasia. (2) No Malalignment syndrome. (3) Dislocation during athletic participation or activities of daily living	MPFL and MPFL reconstruction (semitendinosus autograft)	0
Camp et al. [9]	IV	19	48	29 (14 F, 15 M)	41		MPFL repair	0
Deie et al. [10]	III	15.5	88.8	4 (2 F, 2 M)	51	(1) No history of joint laxity or associated syndromes. (2) No lateral hyper-pressure syndrome, patella alta, hypoplasia of the lateral femoral condyle	ST tenodesis through MCL pulley	0
Grannatt et al. [31]	IV	11.1	70	34 (19 F, 9 M)	54	(1) Subluxation or dislocation refractory to minimum 6 months of conservative treatments	Galeazzi ST tenodesis, lateral release, medial plication	Superficial infection (1)
Ji et al. [32]	III	15	20.7	17 (10 F, 7 M)	51		Medial retinaculum plasty	Quadratus atrophy (8), reduced ROM (3)
Joo et al. [11]	III	6.1	54.5	6 (5 F)	47	(1) No previous trauma or operation associated with dislocation. (2) All the patellae dislocated easily with or without pain at 15° to 25° of knee flexion both actively and passively	Lateral release, proximal patella realignment, ST tenodesis, patellar tendon transfer	Skin necrosis (2)
Kumahashi et al. [33]	III	13.6	27.8	5 (3 F, 2 M)	44		MPFL reconstruction	0
Lind et al. [18]	III	12.5	39	20 (11 F, 9 M)	51	(1) Open physéal based on MRI scanning. (2) No mental or physical handicap that would inhibit proper rehabilitation	MPFL reconstruction by looping the released gracilis tendon around the adductor magnus tendon insertion	Subluxation (2)
Luhmann et al. [34]	III	14.1	61	27 (22 F, 5 M)	54		Lateral release, medial reef and tendon transfer	Non-displaced tibial fractures (2), superficial infection (1), patellofemoral mechanical symptoms (10)

Table 1 (continued)

Author, year	Level of evidence	Mean age	Follow-up (months)	Knees (gender)	CMS	Inclusion criteria	Type of surgery	Complications
Ma et al. [35]	II	13	50	29 (16 F, 13 M)	64	(1) Patellar lateral shift > 1.5 cm with a soft end-point by the apprehension test. (2) Sulcus angle < 150. (3) TT-TG < 15 mm. (4) No Patella alta. (5) Patellar dysplasia grade I to III by Wiberg	Medial capsule reefing Medial patellar retinaculum plasty	Extension weakness (2), anterior knee pain (1) Anterior knee pain (2)
Malecki et al. [16]	II	16	31	39 (20 F, 13 M)	61		MPFL reconstruction (adductor magnus tendon), patellar tendon transfer, lateral release	0
Nelitz et al. [14]	II	12.2	30	21 (6 F, 15 M)	61	(1) Previous conservative treatments. (2) No ligament laxity, malalignment syndrome, or dysplasia	MPFL using a pedicled superficial quadriceps tendon graft by Nelitz	Reduced ROM with prolonged rehabilitation (1)
Nelitz et al. [15]	II	12.8	31.5	25 (16 F, 9 M)	61	(1) Previous conservative treatments. (2) No ligament laxity, malalignment syndrome, or dysplasia	MPFL using a pedicled superficial quadriceps tendon graft by Nelitz	Swelling (1)
Pariikh et al. [36]	III	14.5	16.2	179 (91 F, 63 M)	54	(1) No congenital dislocation. (2) Age < 21 years	MPFL reconstruction (gracilis autograft)	Patella fractures (6), stiff knee (8), anterior knee pain (5)
Yercan et al. [37]	III	8.7	17.7	4 (4 F)	44	(1) No history of joint laxity or associated syndromes	MPFL tenodesis	0
Zhao et al. [19]	II	14.7	24	28 (23 F, 5 M)	51		Medial retinaculum plasty Vastus medialis plasty	0 0

Clinical outcomes

The mean Kujala score improved from a baseline of 58.94 ± 10.38 to 87.07 ± 7.68 points. The improvement was $+28.3\%$ ($p < 0.0001$). The Lysholm score reported a mean value of 49.54 ± 14.20 pre- and 88.32 ± 8.80 post-operatively, respectively. The improvement was $+38.79\%$ ($p < 0.0001$). The mean Tegner Activity Scale scored 4.28 ± 1.22 at baseline, improving to 5.26 ± 0.83 post-operatively. The improvement was 9.77% ($p = 0.006$).

Complications and recurrence

Complications infrequently occurred. A total of 4.19% of the patients incurred in a major complication, while 9.6% in a minor one. We accounted a total of 89 re-dislocations in 692 treated knees (12%).

Discussion

The main findings of this study are that surgical procedures for skeletally immature patients with recurrent patellar dislocations provide a statistically significant improvement in the Kujala, Lysholm, and Tegner scores. We detected a probability of 4.19% and 9.16% for major and minor complications, respectively. The rate of post-operative re-dislocation was 12%.

Several procedures to treat patellofemoral instability have been described. The standard procedure in treating young patients with open physal is to perform surgery avoiding bony procedures [38]. Bony procedures for patellofemoral instability are performed near or directly to the growth cartilages, damaging them and compromising the physiological bone growth [39]. In the present study, the most commonly performed surgeries were the MPFL reconstruction followed by the lateral release. After the first patellar dislocation, the MPFL is always damaged [5], and tearing requiring surgery afflicts almost 42% of patients [40]. Being a soft tissue intervention, characterized by excellent outcomes [41], this procedure can be successfully applied exclusively to skeletally immature patients suffering from recurrent patellar dislocations. When analyzing the MPFL subgroup, we revealed a considerable statistically significant improvement across all scores of interests. These results are promising and reliable. Despite the excellent outcomes, we remark that the MPFL rupture is not the cause of the dislocation, but rather the consequence. Assessing and examining the presence of patho-anatomical predisposing factors are of fundamental importance to guide the treatment. Most of the patients present two or more predisposing factors to patellofemoral instability [4, 42]. Although the lateral release represents the second most commonly performed surgery, it is no longer considered

treatment of choice for patellofemoral syndrome [43, 44]. The resection of the lateral retinacula reduces the contract pressures of the patella above the trochlea, thus implementing the tendency to the lateralization, predisposing to dislocation. To date, the only indication to perform a lateral retinacula release is the lateral patellar hypercompression syndrome associated with anterior knee pain and patellar tilt [33, 45–47]. Patients suffering from patellofemoral instability should be treated precociously with safe, consolidated, and effective procedures, since patellofemoral instability is associated with a high risk of cartilage damage [48]. A study of Vollberg et al. [49] demonstrated that about 71% of patients showed chondral damages after the first episode of dislocation. In patients with recurrent dislocations, these chondral defects increased up to 91% [49]. After a chondral injury, the physiological cellular reparation process determines the replacement of hyaline cartilage in a fibrous matrix [50], leading to irreversible degenerative diseases in the long term, such as osteoarthritis [51].

Although we tried to attempt a high-quality systematic revision of the literature, this study presents several limitations: first, the overall poor quality of the included study, such as the low level of evidence of the included studies, lack of randomization and blinding methods. Complications were divided into major and minor, thus representing another important limitation. Further studies should report a better analysis of the complications, evaluating the error and the statistical weight. The heterogeneous type of included surgeries represents another important limitation of this study. Further studies should aim to clarify the role of each of the different surgeries and evaluate potential superiority of a technique over the others. The most important strong points of this work are the comprehensive nature of the literature search and the strict eligibility inclusion criteria. Further studies should target determining the role of a prompt surgical intervention for the first patellar dislocation, to prevent chondral damages and further re-dislocation.

Conclusions

Surgical management for skeletally immature patients affected by recurrent patellar dislocations are feasible and effective. Complications and re-dislocations infrequently occurred. It is of fundamental importance to treat precociously these patients in order to reduce the risk of recurrences, to increase the level of activity and to improve the quality of life.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this type of study, informed consent is not required.

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