



Treatment of congenital bipartite patella in pediatric population – a systematic review of the published studies

Venla SOINI, Arimatias RAITIO, Ella VIRKKI, Johanna SYVÄNEN

From the Department of Paediatric and Paediatric Orthopaedic Surgery, University of Turku and Turku University Hospital, Kiinamylynkatu 4-8, 20521 Turku, Finland

Bipartite patella is an abnormality where patella is incorrectly ossified resulting in fibrocartilagenous synchondrosis. In most cases bipartite patella is asymptomatic and incidental finding but can also be painful especially in adolescents. The aim of our analysis was to determine the preferable treatment for pediatric bipartite patella.

We conducted a systematic review based on PubMed and Embase searches. All original articles with reference to treatment in the population of ≤ 20 years of age, were included. Case reports, and articles without individualized data were excluded. In total, the individual data of 126 knees in 116 patients was analyzed. In 77.8% (98/126) of the analyzed knees the result was excellent, and the majority of the knees, 89.7% (105/126) received surgical intervention, and seven different techniques were used. None of operative methods were superior to others. Excellent treatment outcomes were achieved more often in younger patients ($p=0.004$), and the median duration of symptoms in operatively treated patients was shorter ($p=0.018$).

If operative treatment is used after unsuccessful conservative treatment, it should be considered early in adolescence and also within a relatively short period after the onset of symptoms. The best

operative method could not be found. More research and RCTs are needed concerning the conservative methods and different operative techniques.

Keywords: Bipartite patella; patella; knee pain; adolescent.

INTRODUCTION

Bipartite patella is an abnormality where patella, the largest sesamoid bone in the human body is incorrectly ossified into two or multiple fragments. The early ossification of patella typically occurs between the age of three to five years, from separate ossification centers and (1) that results in fibrocartilagenous synchondrosis. In most cases

- Venla Soini, BM¹
- Arimatias Raitio, MD, PhD¹
- Ella Virkki, MD¹
- Johanna Syvänen, MD, PhD¹

Department of Paediatric and Paediatric Orthopaedic Surgery, University of Turku and Turku University Hospital, Kiinamylynkatu 4-8, 20521 Turku, Finland.

Correspondence : Venla Soini, +358451200850, Department of Paediatric and Paediatric Orthopaedic Surgery, University of Turku and Turku University Hospital, Kiinamylynkatu 4-8, 20521 Turku, Finland.

E-mail: veviso@utu.fi

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adolescents. The pain has been linked to repetitive traction of the synchondrosis. (2-5) overall prevalence of bipartite patella has been previously reported to be 0.2-6.0% (6-8).

Traditionally bipartite patella has been classified according to Saupe (1921) classification, which divides the bipartite patella into three classes based on the anatomic position of the accessory ossification center (Figure 1).

Direct trauma or minor repetitive overuse of the knee might trigger symptoms. When symptomatic, bipartite patella is primarily treated with conservative methods, such as rest, physiotherapy and pain medication. If conservative treatment is unsuccessful, surgical intervention is usually considered. (9, 10) Yet the most preferable operative treatment option is unclear.

Surgical treatment of bipartite patella in adults was recently assessed in a systematic review by Matic et al. (11). To the best of our knowledge, there are no systematic reviews about the treatment options in pediatric and adolescent population. Given the rarity of this condition, and the sparsity of patients in individual centers, most published reports are case series, and no randomized controlled trials exist. The aim of this systematic review was to assess treatment options of bipartite patella in pediatric and adolescent patients.

MATERIALS AND METHODS

According to PRISMA guidelines (12), an encompassing search to the currently published

Bipartite patella

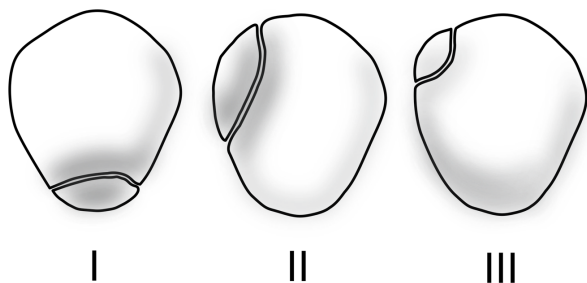


Figure 1. — Type 1 has an inferior transverse pole, type 2 is a lateral horizontal split, and type 3 is the most common, and has a bipartite fragment on the superolateral side.

literature on the matter was performed in PubMed and Embase databases. The terms used as keywords were “patella bipartita” and “bipartite” in combination to “child*” or “young*” or “youth” or “pediatric” or “paediatric” or “adolescent”. All articles published before 11th of November 2020 were included in the review.

The articles found from the databases on comprehensive search were screened based on the title and abstract, and all original papers with reference to treatment in the pediatric population were included for a more detailed review. Moreover, case reports, non-English papers, and studies concerning adult population only were excluded. When data on the cases was described separately in the articles, patients over the age of 20 were exclusively excluded. The illustrating PRISMA flow chart of the process is attached (Figure 2) (12).

Selected papers were independently reviewed by the first two authors and additionally approved by the senior author. The data on patient details, provided treatments, their outcomes, outcome markers, time for recovery, and follow-up were extracted from the original publications and further summarized, overview in table I. Hence the data was executable for statistical analysis for all desired outcomes. Moreover, owing to the differences of the datasets, all clinical scores and evaluations were categorized into simplified outcome classes as excellent 1 (no symptoms), good 2 (only minimal symptoms occasionally), fair 3 (some improvement), or poor 4 (no recovery). As most of the results were excellent, and the groups in worse outcome classes were small, we created a two-class factor, and divided the results simply into excellent and non-excellent classes.

A comprehensive statistical analysis was performed using JMP Pro (JMP®Pro, Version 15.1.0 SAS Institute Inc., Cary, NC, USA). As the data was not normally distributed, we used nonparametric methods (Wilcoxon rank sum test). Chi-square test and Fisher’s exact test were utilized to analyze categorical variables. P values < 0.05 were considered statistically significant.

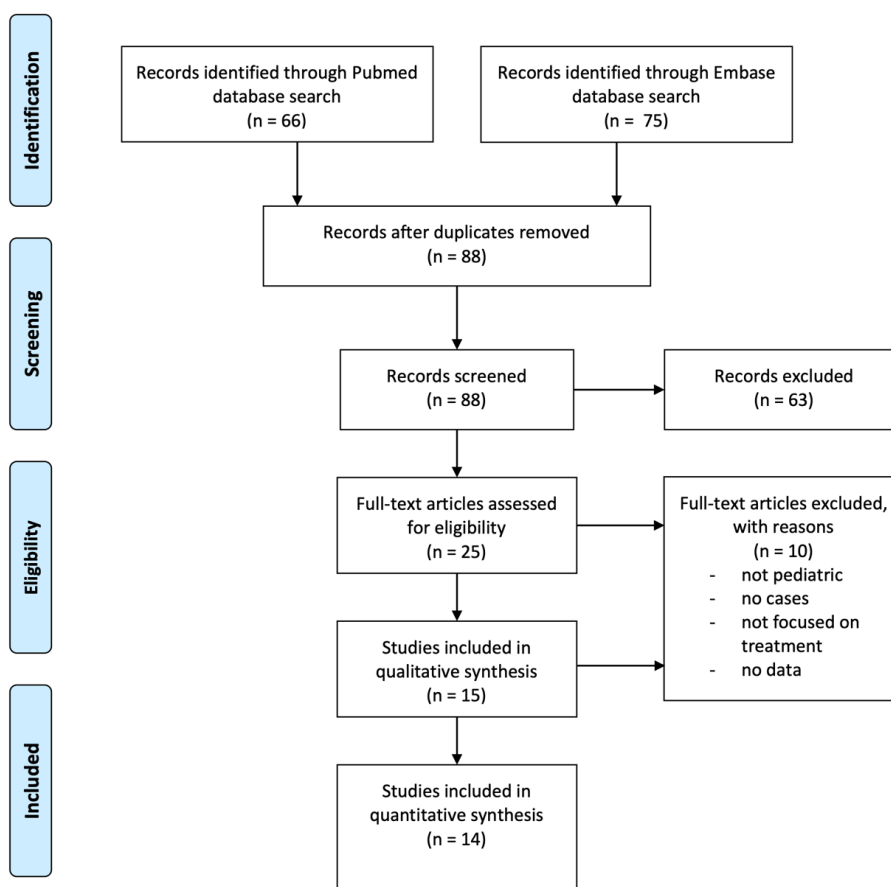


Figure 2. — Prisma flow-chart of the paper selection process.

RESULTS

In total, the individual data on 116 patients, and 126 knees was analyzed. Male patients were overrepresented, 87.9% (102/116). Left knee was affected in 52.4% (66/126), right knee in 40.5% (51/126), and bilateral disease was found in 8.6% (10/116) of the patients. In 7.1% (9/126) of the cases the side was not reported. Eighty-one per cent (103/126) of the bipartite patellae were classified as Saupé class III, 14.9% (19/126) class II, and only 3.2% (4/126) were class I patellae. Majority of the knees (88.9%, 112/126) were treated conservatively preoperatively with insufficient results. Of the remaining 14 (11.1%) it was unclear whether conservative treatment was used.

In 77.8% (98/126) of the analyzed knees the result was excellent and in 22.2% (26/126) outcome was categorized as non-excellent. Gender

had no statistically significant impact on the result ($p=0.378$). The results were excellent in 76.6% (85/103) of males and 86.7% (13/15) in females. Patients with excellent result were significantly younger than those with inferior outcome (Median age 14.5 vs 17.0, $p=0.004$). This was also observed in the male group only ($p=0.012$) and independently in Saupé Class III patellae ($p=0.008$) (Table II).

Median duration of symptoms preoperatively was 6.0 months (range 0.5-120). Duration of symptoms was shorter in patients with excellent result ($p=0.018$, Table II). Median follow-up time was 42.5 months (range 3-264), and this did not correlate with the outcome ($p=0.357$, Table II). There was no significant association with Saupé classification groups and patient outcome ($p=0.814$).

Majority of the knees, 89.7% (105/126) were treated operatively, and seven different techniques were used as presented in Table III. The results of

Table I. — Comparison of the studies concerning the treatment of symptomatic bipartite patella in the review

Author	Level of evidence / Article type	N of patients / N of knees in patients	Age, range median	Saupe Class	Conservative treatment prior operation	Treatment method	Proportion of excellent results (N of knees)
Adachi (2002) (18)	Non-randomized control and crossover trial	15 / 17	10-18, 14	III	+	Vastus lateralis incision 46.6% Arthroscopic YAG Laser 53.7%	71.4% (5) 80.0% (8)
Bourne (1990) (14)	Clinical trial	16 / 16	11-19, 14	III	+	Open excision	81.3% (13)
Felli (2018) (16)	IV Case reports	4 / 5	19-20, 19	III	+	Arthroscopic lateral release	100.0% (5)
Green (1975) (8)	Case reports	3 / 3	13-15, 15	III	+	Open excision	66.7% (2)
Ishikawa (1994) (19)	Clinical trial	8 / 8	14 -18, 16	III	+	Open excision	100.0 (8)
Kumashashi (2008) (13)	Case report	2 / 3	13, 13	II (33.3%) III (66.6%)	+	Low intensity ultrasound	100.0% (3)
Mori (1995) (21)	Clinical trial	11 / 12	13-19, 15	II (50.0%) III(50.0%)	-	Lateral release	75.0% (9)
Nakase (2019) (15)	Retrospective Case reports	14 / 15	10-16, 13	III	+	US-guided injection	60.0% (9)
Ogata (1994) (22)	Clinical trial	10 / 11	13-19, 14	II (50.0%) III (50.0%)	+	Vastus lateralis incision 80.0% Open excision 20.0%	88.9% (8) 100.0% (2)
Ogden (1982) (5)	Case reports	2 / 2	12-15, 13,5	III	+	Immobilization 50.0% Open excision 50.0%	100.0% (1) 100.0% (1)
Okuno (2004) (4)	Case reports	3 / 4	16,16	I	+/-	Internal fixation 50.0% Immobilization 50.0%	50.0% (1) 100.0% (2)
Oohashi (2006) (23)		6 / 8	13-16, 14	II (25.0%) III (75.0%)	+	Open excision	100.0% (8)
Vaishya (2015) (24)	Case reports	3 / 3	16-19, 17	III	+	Arthroscopic excision 50.0% Open Reduction, internal fixation 50%	100.0% (2) 100.0% (1)
Weckström (2008) (17)	IV Therapeutic study	19 / 19	18-20, 20	II (21.1%) III (78.9%)	+	Open excision 94.7 % Arthroscopic excision (5.3%)	55.0% (10) 0%
Total		116 / 126	10 - 20				77.8% (98)

all surgical methods were mainly successful. The open excision of the accessory fragment was the most common treatment method (38.0%,48/126), with excellent result in 75.0% (13).

DISCUSSION

To the best of our knowledge, this is the first systematic review assessing the treatment of bipartite patella in pediatric and adolescent population. This study demonstrated that younger age was significantly associated with better outcome. Also, patients with excellent results had significantly shorter duration of symptoms before surgical intervention.

Inevitably, there are limitations in this review. Due to the rarity of this condition, the number of studies and patients is relatively small. Comparison of conservative and operative methods as first line treatment was impossible, as almost all studies had attempted conservative treatment before surgery. Also, there was no data available of the conservative treatment alone. The timespan of the articles included is wide (1975-2020), making it likely that the surgical techniques have advanced between studies. Simplification of the data into an analyzable form with only two outcome groups gives us only a rough estimate of the results. Moreover, as the majority of the clinical results were excellent, clear differences regarding the beneficial operative

techniques cannot be made. Additionally, in some of the clinical characteristic, such as the follow-up duration, the data was not available for all patients.

Based on the current recommendations (9), conservative treatment should be intended before considering surgery. The mainstay of conservative treatment for bipartite patella consists of physical therapy, activity modification, and non-steroidal anti-inflammatory drugs. Unfrequently cryotherapy (2) and pulsed ultra-sound (13) are described as conservative methods in the literature. Cast or brace immobilization can also be used in rare cases with a sudden onset of symptoms (4). The amount of conservatively treated patients is rather limited in the literature, but alone the recent retrospective case-cohort study from Kallini et al. (2) indicates that the amount of conservatively treated patients with bipartite patella is significant compared to the operatively treated counterparts. However, due to lack of individualized data, this study could not be included in our analyses. If conservatively treated patients received at least a satisfactory relief to their symptoms when no operative treatment was needed, we can assume that conservative methods seem to lead to good results. As there is no detailed data available, more work needs to be done to find out the optimal conservative protocol.

In this study we found out that younger age and shorter duration of symptoms were prognostic for better outcome. This suggests that early inter-

Table II. — Result statistics of the studies concerning the treatment of symptomatic bipartite patella

	Excellent result	Non-excellent result	P value
Number of knees (%)	98 (77.8%)	28 (22.2%)	-
Male knees (%)	85 (76.6%)	26 (23.4%)	P=0.353
Female knees (%)	13 (86,7%)	2 (13,3%)	
Median age (range)	14.5 (10.0-20.0)	17.0 (10.0-20.0)	P=0.004
Median age in male (range)	15.0 (10.0-20.0)	17.0 (10.0-20.0)	P=0.012
Median age in Saupe III (range)	14.0 (10-20)	17.0 (10-20)	P=0.008
Median duration of symptoms in months (range)	6.0 (0.5 – 120.0)	9.0 (2.0-60.0)	P=0.018
Median follow up duration in months (range)	48.0 (3.0-216.0)	27.0 (3.0-264.0)	P=0.357

Table III. — Comparison of the different treatment methods used to treat symptomatic bipartite patella

	Treatment method	N of knees Percentage	Patients with excellent result (n)
Operative techniques	Open Excision of the accessory fragment	48 38.0%	75% (36)
	Vastus lateralis insertion excision	24 19.0%	87.5% (21)
	Ultrasound guided injection and pie crust technique	15 11.9%	60.0% (9)
	Lateral retinacular release	12 9.7%	75.0% (9)
	Arthroscopic YAG laser	10 9.5%	80.0% (8)
	Arthroscopic lateral retinacular release	5 3.9%	100.0% (5)
	Arthroscopic excision of the accessory fragment	3 2.4%	66.0% (2)
	Internal fixation with k-wires	3 2.4 %	66.0% (2) 33.0% inconclusive (1)
	Conservative treatment	Low intensity pulsed ultrasound	3 2.4%
Conservative (immobilization)		3 2.4%	100% (3)
Total		126	77.8% (98)

vention could be beneficial. However, none of the studies were RCTs. Therefore, we cannot say whether the good outcomes were related to surgery or spontaneous healing. Also, no exact recommendations for length of conservative treatment, advisable operative age or timespan after the onset of symptoms can be made. In line with our results male preponderance in bipartite patella has been reported in previous studies (3, 7, 14). What is more, most studies evaluated the result of a treatment by clinical examination, and only few studies used a clear repetitive clinical score for assessing the clinical outcome, as VISA (15), VAS (16), Kujala (16, 17) or Ogata (8, 19, 19) score. Weckström (17) and Felli (16) evaluated the clinical outcome in their papers by using the Kujala scoring (20) developed for patellofemoral disorders. Use of standardized scoring system would be beneficial in future studies assessing different treatment modalities of bipartite patella.

In conclusion, early operative treatment could be considered in cases not responding to conservative treatment. However, we cannot make any clinical treatment guidelines based on current evidence highlighting the importance of future studies and RCTs. More research is needed of the conservative treatment as the first line treatment for bipartite patella. Based on this review, it appears that successful results can be reached with multiple different operative techniques. Also, a unified clinical scoring system should be used in future studies.

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