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Characteristics and Outcome of Patellofemoral Pain in Adolescents: Do They Differ From Adults?

Patellofemoral pain (PFP) is a frequent knee condition, characterized by retropatellar or peripatellar pain. This condition is especially present in young, physically active individuals and seems to arise during puberty; after the age of 40 years, it is generally regarded as patellofemoral osteoarthritis.[4]

The prevalence of PFP at adolescence is about 7% in the general population,[10] and, although there is no conclusive evidence available, it has been suggested that PFP at a young age could be a predictor for patellofemoral osteoarthritis at a later age.[3]

It has been shown that symptoms can persist for long periods.[9,11] Exercise therapy is often the first choice of treatment, although success rates of only 60% have been reported in the adult population at 12-month follow-up.[1,19] Very little information has been reported on prognosis and treatment effectiveness in the adolescent population with PFP, as most studies have excluded this group. One exception is the work by Rathleff et al,[12] who reported that 62% of adolescents with PFP continue to have persistent symptoms at 1-year follow-up, despite the use of exercise therapy. This indicates that even at a very young age, symptoms can persist for a long period of time. Therefore, because PFP can significantly impact physical activity levels, which can influence current and future general health, it is important to further investigate this population.

One of the few studies performed in adolescents showed that differences do seem to exist in treatment outcome between adults and adolescents with PFP.[13] As a consequence, the importance of getting a better understanding of the pathology and prognosis in both adolescents and adults was emphasized. The present study investigated potential differences in patient characteristics, reported symptoms, and reported pain and function at 1-year follow-up between adolescents and adults with PFP.

STUDY DESIGN: Case series with 1-year follow-up.

BACKGROUND: Most of the recommendations for the diagnosis, treatment, and prognosis of patellofemoral pain (PFP) are based on research performed in adults. The literature suggests that there are potential differences between adolescents and adults with PFP.

OBJECTIVES: To investigate differences in characteristics, symptoms, and prognosis at 1-year follow-up between adolescents and adults with PFP.

METHODS: Data from 64 patients with PFP, assessed at baseline and 1-year follow-up, were used. At baseline, data on demographics, symptoms, and coping strategies were obtained by questionnaire. Physical examination included strength and flexibility measurements of the quadriceps and hamstrings. At 1-year follow-up, a questionnaire was used to collect data on pain, function, and recovery. Differences between adolescents (14-18 years) and adults (18-40 years) were analyzed using regression techniques, adjusted for sex, body mass index, and the presence of bilateral pain.

RESULTS: Of the 64 patients with PFP included at baseline, 78.1% were available for follow-up. At baseline, adolescents with PFP had a significantly lower body mass index (20.7 versus 24.9 kg/m^2) and a greater percentage of bilateral pain (70% versus 43.2%) than adults with PFP. There were no differences in reported pain and symptoms between the 2 groups. In total, 25% of the adolescents regarded themselves as recovered after 1 year, compared to 22.7% of the adults (adjusted $P = .725$).

CONCLUSION: The sample size of the study, in relation to the number of statistical tests performed, urges caution in the interpretation of the results. In contrast to what has been suggested previously, only minor differences seem to exist between adolescents and adults with PFP. In both groups, PFP is clearly not a self-limiting disease, with nearly 75% of those in this study reporting persistent pain at 1-year follow-up.

LEVEL OF EVIDENCE: Prognosis, level 4.

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METHODS

Design and Participants

This is a secondary analysis of data from a previously published case-control study with a 1-year follow-up.[17] Patients (n = 64) were consecutively recruited by general practitioners (n = 24), physical therapists (n = 16), and sports physicians (n = 24) between January 2013 and September 2014. All patients had to be between 14 and 40 years of age and had to have anterior knee pain for a minimum of 2 months and a maximum of 24 months. All patients had to have at least 3 of the following symptoms, as determined by the person doing the recruitment: retropatellar or peripatellar pain while walking up or down stairs, squatting, running, or cycling; retropatellar or peripatellar pain while sitting with knees flexed for a prolonged period; and self-perception of grinding of the patella. Patients were excluded if they had other defined pathological conditions of the affected knee, such as patellar tendinopathy or osteoarthritis; if the onset of PFP occurred after trauma; or if they had previous knee injuries or surgery, or episodes of PFP that occurred more than 2 years previously. The study protocol was approved by the Medical Ethics Committee of Erasmus University Medical Center (protocol MEC-2012-342).

All recruited patients were contacted by the research team. The study was further explained to all potential participants, and a reassessment of inclusion and exclusion criteria took place. After signing a written informed consent, all participants were asked to complete an online questionnaire and were invited to a physical examination. After 1 year, all participants who consented for a follow-up measurement were asked to complete an online questionnaire.

Measurements

The baseline online questionnaire included questions on demographics (age, sex, body mass index [BMI], sport participation, and level of sport participation), symptoms (duration of complaints, bilaterality), pain (both at rest and active, measured on an 11-point numeric rating scale), function (assessed using the Anterior Knee Pain Scale,[8] with scores ranging from 0 to 100 and 100 indicating no disability; and the Knee injury and Osteoarthritis Outcome Score [KOOS],[15] including 5 subscales, with a normalized score for each subscale calculated separately from 0 [extreme knee problems] to 100 [no knee problems]), and coping strategy using the Cognitive Emotion Regulation Questionnaire.[7] The Cognitive Emotion Regulation Questionnaire was divided into 5 categories, which included self-blame, rumination, concentrating on planning, positive reappraisal, and blaming others. Each category consists of 2 subquestions consisting of a 5-point Likert scale (ranging from "never" to "always"). The total score ranged from 4 to 20 for each subcategory, with higher scores indicating strong presence of each item.

The physical examination consisted of a standardized set of measurements performed by a trained medical doctor (R.H.). This included determining the presence of crepitation, defined as a hearable grinding noise and/or palpable vibrations in the knee, detected by the hand of the investigator resting on the patella of the participant during active knee flexion/extension.[16] Additionally, the presence of pain with palpation of the apex and medial facet of the patella (yes or no) was assessed, and Clarke's compression test was performed (positive or negative).[6] Strength of the quadriceps and hip musculature for abduction and external rotation was measured using a handheld dynamometer (MicroFET2; Fabrication Enterprises Inc, Elmsford, NY), which is a reliable method to measure strength in individuals with PFP.[18] Strength measurements were repeated 3 times, and the mean of the highest 2 values was used for analyses (Newton meters per square centimeter). All strength data were subsequently normalized to body weight (Newtons per kilogram). Finally, hamstring flexibility was assessed by measuring the knee flexion angle with an inclinometer during the active knee extension test, with the hip at 90° of flexion.[14]

Assessments of pain and symptoms at the 1-year follow-up included pain at rest and activity (numeric rating scale), function (Anterior Knee Pain Scale and KOOS), and recovery (measured on a 7-point Likert scale ranging from 1 [completely recovered] to 7 [worse than ever]). The scores were consequently dichotomized into recovered (corresponding to scores of 1 [completely recovered] or 2 [strongly improved]) and not recovered (corresponding to scores from 3 [slightly improved] to 7 [worse than ever]).[19] All respondents were additionally asked to report whether they visited a physical therapist, general practitioner, sports physician, and/or orthopaedic surgeon in the period between baseline and follow-up.

Statistical Analyses

Descriptive statistics were used to describe the patient population. Differences in baseline characteristics between the adolescent (14-18 years of age) and adult (18-40 years of age) groups, and also between participants with follow-up data and those lost to follow-up, were analyzed using chi-square tests for dichotomous variables and independent *t* tests for continuous variables.

Differences between adults and adolescents in pain and symptoms, both at baseline and follow-up, were analyzed using regression techniques, with adjustment for potential confounders including sex, BMI, and bilateral symptoms. Linear regression was used for continuous outcomes of pain and function, with additional adjustment for baseline scores for the follow-up outcomes of pain and function. Logistic regression was used to analyze differences in recovery rates. A *P* value of .05 was considered as statistically significant, and all data were analyzed using SPSS Version 22.0 (IBM Corporation, Armonk, NY).

RESULTS

Of the 64 patients with PFP at baseline, 50 (78.1%) were available for follow-up. A total of 55% of the adolescent patients responded to the follow-up questionnaire, compared to 89% of the adult sample. Participants with complete follow-up were significantly older (mean ± SD, 24.6 ± 6.9 years) and had a significantly lower KOOS quality of life subscale score (44.6 ± 10.0) at baseline compared to those lost to follow-up.

Adolescent patients with PFP had a lower BMI, reported more bilateral symptoms, and had stronger quadriceps compared to the adult patients (**TABLE 1**). Adjusted analyses revealed a significantly lower baseline Anterior Knee Pain Scale score in the adolescent group compared to the adult patients (**TABLE 2**). There were no differences between groups for pain and KOOS function scores at baseline. Significantly more adolescent patients experienced pain at both the apex and under the medial facet of the patella with palpation. Overall, on 2 of 5 items of the Cognitive Emotion Regulation Questionnaire, relatively higher scores were seen in the adolescents compared to the adults (**TABLE 3**). A significantly higher score on "concentrating on planning" was seen in the adult patients.

No differences were observed on any of the outcome measures at 1-year follow-up (**TABLE 4**). Adolescent patients improved in pain with activity from a mean ± SD of 7.2 ± 1.9 at baseline to 4.0 ± 2.9 at 1 year. In total, 25% of the adolescents regarded themselves as recovered after 1 year, compared to 22.7% in adults (adjusted P = .725). Additionally, no differences were observed in reported medical consumption.

TABLE 1 Baseline Characteristics of the Study Population*

	Adolescents With PFP (n = 20)	Adults With PFP (n = 44)	*P* Value†
Age, y	15.9 ± 1.2	26.8 ± 5.8	<.001
Sex (male), n (%)	6 (30)	23 (52.3)	.303
BMI, kg/m^2	20.7 ± 2.2	24.9 ± 3.7	<.001
Sport participant, n (%)	10 (50)	28 (63.6)	.303
Duration of symptoms, mo	14.2 ± 8.3	11.0 ± 6.4	.104
Bilateral symptoms, n (%)	14 (70)	19 (43.2)	.047
Tegner score (0-10)‡	4.5 (3-9)	4 (0-9)	.157
Crepitus present, n (%)	6 (30)	23 (52.3)	.097
Quadriceps strength, N/kg	4.07 ± 1.15	3.39 ± 1.17	.036
Hip abduction strength, N/kg	1.49 ± 0.46	1.44 ± 0.40	.682
Hip external rotation strength, N/kg	1.42 ± 0.42	1.36 ± 0.46	.580
Hamstring flexibility (knee flexion), deg	67.1 ± 19.2	58.8 ± 10.6	.435

Abbreviations: BMI, body mass index; PFP, patellofemoral pain.
**Values are mean ± SD unless otherwise indicated.*
†Chi-square test for dichotomous variables and independent t test for continuous variables.
‡Values are median (range).

TABLE 2 Pain and Symptoms at Baseline*

	Adolescents With PFP (n = 20)	Adults With PFP (n = 44)	*P* Value†
Pain at rest (0-10 NRS)	3.8 ± 2.1	4.0 ± 2.6	.669
Pain with activity (0-10 NRS)	7.2 ± 1.9	6.3 ± 2.3	.273
AKPS (0-100)	60.8 ± 10.5	68.9 ± 11.3	.021
KOOS (100-0)			
Pain	58.2 ± 18.3	60.4 ± 16.9	.844
Other symptoms	50.0 ± 12.4	51.8 ± 11.7	.602
Function in daily living	70.7 ± 20.3	71.7 ± 18.0	.916
Function in sport and recreation	35.5 ± 20.8	41.1 ± 20.7	.687
Health-related quality of life	43.4 ± 13.8	47.3 ± 9.9	.335
Apex of patella painful, n (%)	7 (35)	2 (4.5)	.006
Medial facet of patella painful, n (%)	14 (70)	17 (38.6)	.017
Positive Clarke test, n (%)	6 (30)	8 (18.2)	.767

Abbreviations: AKPS, Anterior Knee Pain Scale; KOOS, Knee injury and Osteoarthritis Outcome Score; NRS, numeric rating scale; PFP, patellofemoral pain.
**Values are mean ± SD unless otherwise indicated.*
†Adjusted for sex, body mass index, and bilateral symptoms.

DISCUSSION

The present study suggests that there may be minimal differences in baseline characteristics and recovery over a 1-year period between adolescent and adult patients with PFP. The pathophysiology of PFP is likely multifactorial, and many of these potential factors have been discussed in the literature.[5,20] Yet, little emphasis has been placed on potential differences between adolescent and adult patients. In fact, many studies exclude the adolescent patient population. However, we have recently shown that structural abnormalities, as seen on magnetic resonance imaging, are present in both adolescents and adults with PFP, with no differences between groups.[17] The present study additionally shows that no difference seems to exist between adoles-

TABLE 3 Coping Strategies at Baseline*

Cognitive Emotion Regulation Questionnaire	Adolescents With PFP (n = 20)	Adults With PFP (n = 44)	*P* Value†
Self-blame (0-20)	6.7 ± 3.6	7.9 ± 3.6	.107
Rumination (0-20)	9.0 ± 4.6	7.7 ± 3.7	.845
Concentrating on planning (0-20)	9.1 ± 4.3	11.0 ± 4.6	.050
Positive reappraisal (0-20)	8.4 ± 4.9	9.2 ± 4.5	.267
Blaming others (0-20)	5.3 ± 2.3	4.6 ± 1.3	.328

Abbreviation: PFP, patellofemoral pain.
**Values are mean ± SD unless otherwise indicated.*
†*Adjusted for sex, body mass index, and bilateral symptoms.*

TABLE 4 Reported Symptoms, Function, and Medical Consumption at 1-Year Follow-up*

	Adolescents With PFP (n = 11)	Adults With PFP (n = 39)	Mean Difference/ Odds Ratio†	*P* Value‡
Pain at rest (0-10 NRS)	2.3 ± 2.7	2.5 ± 2.3	−0.77 (−2.43, 0.89)	.879
Pain with activity (0-10 NRS)	4.0 ± 2.9	4.6 ± 2.8	−0.41 (−2.32, 1.49)	.942
AKPS (0-100)	75.3 ± 16.7	77.7 ± 14.2	−0.17 (−10.44, 10.09)	.239
KOOS (100-0)				
Pain	77.5 ± 16.1	73.0 ± 18.4	4.16 (−9.15, 17.48)	.988
Other symptoms	57.5 ± 9.0	54.7 ± 14.5	1.74 (−7.59, 11.07)	.150
Function in daily living	84.2 ± 13.8	82.9 ± 17.6	5.84 (−11.26, 12.25)	.378
Function in sport and recreation	58.9 ± 26.0	63.5 ± 26.6	−2.35 (−21.08, 16.39)	.746
Health-related quality of life	55.6 ± 14.1	54.6 ± 10.1	1.86 (−6.24, 9.96)	.254
Medical consumption, n (%)				
Visit to physical therapist in last 12 mo	6 (54.5)	19 (48.7)	0.88 (0.23, 3.40)	.440
Visit to GP in last 12 mo	2 (18.2)	13 (33.3)	2.44 (0.46, 13.00)	.276
Visit to sports physician in last 12 mo	4 (36.4)	12 (30.8)	0.84 (0.20, 3.43)	.431
Visit to orthopaedic surgeon in last 12 mo	2 (18.2)	6 (15.4)	0.87 (0.15, 5.08)	.787

Abbreviations: AKPS, Anterior Knee Pain Scale; GP, general practitioner; KOOS, Knee injury and Osteoarthritis Outcome Score; NRS, numeric rating scale; PFP, patellofemoral pain.
**Values are mean ± SD unless otherwise indicated.*
†*Values for NRS, AKPS, and KOOS are mean difference (95% confidence interval); values for medical consumption are odds ratio (95% confidence interval).*
‡*Adjusted for sex, body mass index, bilateral symptoms, and baseline pain with activity (NRS).*

cent and adult patients in clinical characteristics, with the potential exception of the bilateral nature of the symptoms and pain reproduction with palpation in the adolescent population.

In contrast to our findings, Rathleff et al[13] showed that the success rate of treatment differed between adult and adolescent patients with PFP who performed similar exercises and had comparable compliance. Others have also reported lower success rates (29%-53%) in adolescent patients with PFP.[12,19] It has been suggested that these differences in success rates with treatment may be due to differences in the characteristics of patients, including the longer duration of symptoms, the bilateral nature of symptoms, and the higher physical activity level in the adolescent population. While this study also shows that adolescents with PFP report a longer symptom duration, more bilateral symptoms, and a slightly higher physical activity level compared to adults with PFP, the outcomes of pain, function, and recovery did not differ between the 2 groups. This is in contrast to what has previously been published, with longer symptom duration being a strong predictor for persistent symptoms in patients with PFP.[2,9] However, the low response rate at the 1-year follow-up in the adolescent group may have caused a selection bias, as the young patients who completed the follow-up reported less pain at baseline and had a higher BMI. This may indicate that the relatively "better" adolescent patients were more likely to complete the follow-up questionnaire.

Strengths and Limitations

To our knowledge, this is one of the first studies performed in both adolescents and adults with PFP, providing the opportunity to compare patient and symptom characteristics between groups. Because this was a secondary analysis of data, the study was not designed to make this comparison. Consequently, the limited number of adolescents with PFP and the relatively high number of statistical tests that were performed are significant limitations of the study, urging caution in the interpretation of the results.

CONCLUSION

In contrast to what has been suggested previously, limited differences seem to exist between adolescent and adult patients with PFP who present to health care providers. Patellofemoral pain is clearly not a self-limiting disease, with nearly 75% of those in this study reporting persistent symptoms at 1-year follow-up. This suggests the need for appropriate referral policies in primary care, because only half of the study population visited a physical therapist, and

supervised exercise therapy has proven to be effective for patients with PFP.

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