



Symptomatic medial synovial plica of the knee joint: an underestimated pathology in young patients

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Abstract

Introduction To prospectively evaluate the outcome of arthroscopic resection of a symptomatic medial plica in patients under 30 years with evaluating the influence of sports, knee trauma and plica type.

Methods 35 consecutive patients (38 knees), mean age 16.2 ± 4.7 years (9–26 years), 28 females (73.7%) were prospectively included. Patients with any additional surgical procedures or cartilage lesions > ICRS grade I were excluded. The influence of trauma to the knee, level of sport and the morphologic plica type on the outcome was evaluated in addition to standard knee scores before and 20.1 ± 9.3 months (12–44 months) after surgery.

Results The Knee Injury and Osteoarthritis Outcome Score improved significantly from $50.2 \pm 19.1\%$ (12.5–94.6) to $80.7 \pm 15.3\%$ (48.2–100; $p < 0.001$). The Tegner Activity Scale improved significantly from 2.2 ± 1.5 (0–6) to 4.9 ± 1.7 (3–10; $p < 0.001$) and the Kujala Anterior Knee Pain Scale improved significantly from 52.6 ± 16.6 (16–86) to 80.7 ± 16.5 (46–100; $p < 0.001$). The level of pain in the knee decreased from 7.9 ± 2.0 (1–10) to 3.1 ± 2.6 (0–9; $p < 0.001$) at follow-up on a numeric rating scale (0–10). Neither trauma to the knee, high impact sport, cartilage lesions to the medial femoral condyle nor the plica type or associated ICRS grade I cartilage lesion to the medial femoral condyle had a significant effect on the outcome parameters.

Conclusion Arthroscopic resection of a symptomatic medial plica provides excellent clinical results in young patients. Trauma, high impact sports, ICRS grade I cartilage lesions to the medial femoral condyle or the plica type are not associated with a poorer outcome.

Level of evidence Level IV, prospective case series with no control group.

Keywords Knee · Arthroscopy · Medial plica · Synovial shelf · Plica syndrome

Introduction

Synovial plicae in the knee joint are remnants of separating septa from the embryonic development [15]. Medial and lateral parapatellar as well as a suprapatellar and infrapatellar plicae have been described [12]. The medial plica originates

along the medial wall of the joint, runs obliquely downwards and merges with the synovial membrane covering the infrapatellar fat pad [16]. The presence of plicae in all anatomical locations are anatomic variants and not to be considered pathologic [14]. However, the medial plica can get impinged in the patellofemoral joint causing a typical anteromedial knee pain, infrequently accompanied by a palpable snapping during flexion and can cause cartilage damage to the medial femoral condyle [7, 10, 21]. Blunt trauma, twisting injury, overuse of the knee or athletic activities associated with minor irregularities of knee mechanics can cause progressive inflammation with recurrent synovitis, edema, thickening, and fibrosis of the medial plica, herewith facilitating impingement [13].

Primarily physiotherapy focusing on quadriceps strengthening and stretching of the hamstrings is indicated but when conservative therapy remains unsuccessful, arthroscopic

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resection is indicated [1]. However, the evidence from prospective studies including only patients with the preoperative diagnosis of a symptomatic medial plica, preoperative MRI and arthroscopic resection is still insufficient. In the recently published meta-analysis by Gerrard, the mean patient age in the seven included studies was 30.8 years and most of the studies even included patients 40–60 years of age which makes a symptomatic medial plica as solitary preoperative diagnosis highly unlikely [5].

The purpose of this study was, therefore, the prospective evaluation of arthroscopic medial plica resection in patients under the age of 30 years with preoperative diagnosis based on the distinct history of complaints, clinical examination and MRI.

The primary hypothesis was that arthroscopic resection of the medial plica leads to the absence of tenderness over the medial patellofemoral joint and significant improvement in the established validated scores. In addition, the influence of previous trauma, high impact sport, plica-associated cartilage lesions to the medial femoral condyle and the morphologic plica type according to the classification by Lyu et al. [9] as well as its size according to Sakakibara et al. were analysed [19].

Materials and methods

51 consecutive patients (55 knees) were diagnosed with a symptomatic medial plica. All patients underwent conservative therapy elsewhere and were referred to the institutions outpatient clinic when conservative treatment failed. Here, diagnosis of a symptomatic medial plica and indication for surgery was based on the following criteria:

- Anteromedial knee pain persistent under conservative therapy.
- Aggravated pain while ascending and descending stairs, squatting or bending.
- Tenderness over the medial patellofemoral joint in the clinical examination in the absence of any other relevant peripatellar pathology.
- Preoperative MRI with a medial plica in the axial plane (Fig. 1).

Exclusion criteria

- Patients over 30 years of age.
- Previous surgery on the knee.
- Intraoperative diagnosis of any other pathology with the necessity of an additional surgical procedure in addition to a plica resection.
- Intraoperative diagnosis of a cartilage lesion > grade I according to the ICRS classification [3].

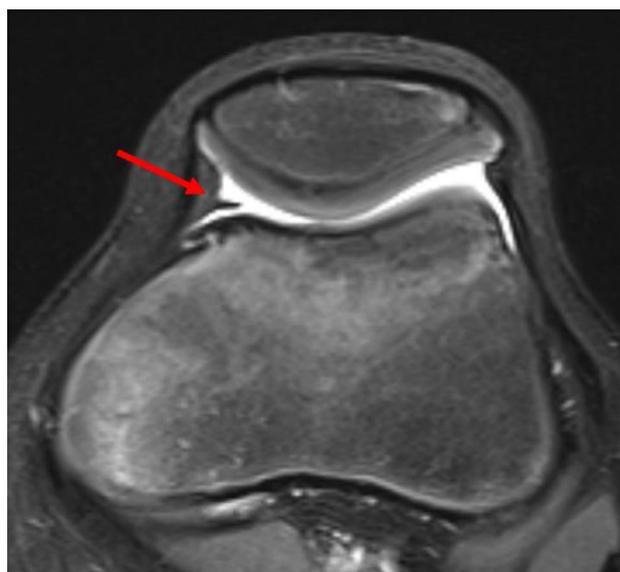


Fig. 1 MRI (1.5 T PD fat sat FSE) coronary plane showing a medial plica (arrow). The intraoperative view of this patient is shown in Fig. 2

Surgical technique

The leg was placed in a leg holder flexed at 90° of flexion and standard anteromedial and anterolateral portals were used. The medial plica overlapping the medial femoral condyle with impingement in the patellofemoral joint was identified and its morphologic aspect was classified according to Lyu et al. (Table 1; Fig. 2) [9]. The size of the medial plica was classified according to Sakakibara in four types: Type A is a cord-like structure in the synovial wall that can be traced to the fat pad. Type B has a shelf-like appearance but does not cover the femoral condyle. Type C has a large shelf-like structure and can be seen to cover the anterior surface of the medial femoral condyle. Type D is a variation of type C in which a fenestration of the medial plica can be seen [19].

Cartilage lesions on the medial femoral condyle caused by friction of the medial plica were noted and staged according to the ICRS classification [3]. Patients with any cartilage lesion > ICRS grade I, meniscal tears or any other pathology with the necessity for an additional surgical procedure were excluded. In all the cases, the medial plica was completely resected using a 3.8-mm shaver blade (Arthrex, Naples, FL, USA). Punches or a radiofrequency probe were not used. Sufficient resection of the plica was controlled by visualization of the medial capsule and the medial patellofemoral joint under full range of motion.

Resection of a concomitant suprapatellar or infrapatellar plica was conducted when present. Suction drains were

Table 1 Plica morphology

Grade I	Soft, somewhat transparent synovial membrane
Grade II	Intransparent, hypertrophied and thickened but still soft plica
Grade III	Fibrotic band with an elastic consistency
Grade IV	Signs of wearing in addition to fibrosis with a frail and fibrillated margin
Grade V	Inflamed grade IV lesion with focal synovitis adjacent to the medial plica

Modified according to Lyu et al. [11]

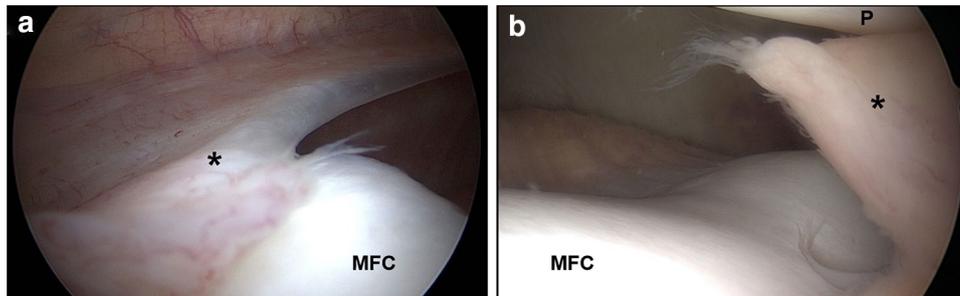


Fig. 2 Intraoperative view from the anterolateral standard portal. **a** Ligament-like medial plica (asterisk) spanning over the medial femoral condyle (MFC) which was classified grade IV according to Lyu

and type C according to Sakakibara. **b** Lyu grade II Sakakibara type C medial plica with impingement between the patella (P) and the MFC

not used. All patients were discharged the same or the following day after surgery. For the postoperative rehabilitation protocol, partial weight-bearing using crutches was administered for the first week after surgery and patients were advised not to participate in any sport for the first 6 weeks.

Outcome evaluation

Age, gender, period from start of symptoms until surgery, history of trauma to the knee and sport activity were recorded. In the clinical examination before surgery and at follow up, tenderness over the medial patellofemoral joint and range of motion were assessed.

The type and level of sport (recreational, school/university sport, club sport, and professional) as well as the frequency (occasional, 1–2 times per week, 3–5 times per week, and 6–7 times per week) were assessed. The sports type was divided into the categories “no impact”, “low impact” and “high impact” according to Vannini et al. [23]. Patients were asked whether the knee complaints started while doing sport, whether they needed to reduce their sports activity or whether they had to quit sports because of the knee complaints. Patients, who did not exercise, were categorised as no impact. Knee Injury and Osteoarthritis Outcome Score (KOOS) [18], Tegner Activity Scale [22], the Kujala Anterior Knee Pain Scale [8] and an 11-point numeric rating scale (NRS; 0–10 points) were assessed before surgery and at the follow-up. In addition, the patients were asked whether

they would undergo the same surgery for the contralateral knee as well in case similar symptoms would occur.

Statistical analysis

Statistical analysis was conducted using SPSS Statistics (Version 25; IBM, Armonk, NY, USA). The *t* test and the McNemar test for dependent samples were used for analysis of the outcome parameters. Linear and logistic regression analyses were used for intergroup comparisons and evaluation of the impact of cofactors on the outcome. An $\alpha=0.05$ was set as significant. Unless otherwise stated, the results are reported as the mean \pm standard deviation.

Compliance with ethical standards

The ethical committee of the university medical faculty granted approval for this prospective trial. The study was conducted in line with good clinical practice and the 1964 Helsinki Declaration and its later amendments. Informed consent was obtained from all individual participants included in the study.

Results

Of the 51 patients, 9 patients were over 30 years of age and, therefore, not recruited for this study. Three patients were excluded due to intraoperative findings with cartilage lesion $>I$ according to the ICRS classification or the

necessity of additional surgical procedures. One patient was excluded because he was diagnosed with monoarticular Lyme arthritis between surgery and the follow-up examination. Four patients (10.5%) did not complete the follow-up examination. 34 patients (38 knees) with a mean age of 16.2 ± 4.7 years (range 9–26 years) at surgery, 10 male (26.3%) and 28 females (73.7%) were prospectively included and reevaluated a mean of 20.1 ± 9.2 months (range 12–44 months) after surgery. The mean duration of symptoms before surgery was 27.0 ± 38.6 months (range 1–150 months). 9 (23.7%) patients reported a knee-associated trauma and 20 (52.6%) sport activity as initiating factor for the knee complaints.

Preoperatively, two patients (5.3%) participated in no impact sport, 12 (31.6%) in low impact sport, 24 (63.2%) in high impact sport. With regard to the frequency of the sport activity, four patients (10.5%) only exercised occasionally, 15 (39.5%) 1–2 times per week, 18 (47.4%) 3–5 times per week and 1 (2.6%) 6–7 times per week. 33 of the patients (86.8%) modified or reduced their sports activity and 22 (57.9%) quit all sports activity due to the knee complaints. All patients had a full range of motion preoperatively.

With regard to the intraoperative findings, the plica type according to Sakakibara [19] and the morphologic aspect according to Lyu [9] were evaluated (Table 2). An additional infrapatellar plica was identified and resected in 17 patients (44.7%) and a suprapatellar plica in one patient (2.6%). A characteristic “Sanding-mark”-like ICRS grade I cartilage lesion to the medial femoral condyle (Fig. 3) was identified



Fig. 3 Intraoperative view from the anterolateral standard portal. A characteristic “Sanding-mark”-like ICRS grade I cartilage lesion extending from the trochlea to the medial femoral condyle (MFC) is revealed following resection of the medial plica

in 29 patients (76.3%). At follow-up, all patients showed an unimpaired range of movement. Tenderness over the medial patellofemoral joint was reduced significantly ($p < 0.001$) and was absent in 31 of 38 (81.6%) at follow-up. All clinical scores showed a significant improvement (Table 3). The total KOOS improved significantly ($p < 0.001$) by 30.5% from $50.2 \pm 19.1\%$ (range 12.5–94.6%) preoperative to $80.7 \pm 15.3\%$ (range 48.2–100%) at follow-up. All KOOS subscales showed an individual significant improvement as well (Fig. 4). The Kujala Anterior Knee Pain Scale improved significantly ($p < 0.001$) by 28.1 points from 52.6 ± 16.6 (range 16–86) preoperative to 80.7 ± 16.5 (range 46–100) at follow-up. The mean NRS improved significantly ($p < 0.001$) by 4.9 points from 7.9 ± 1.9 (range 1–10) preoperative to 3.1 ± 2.6 (range 0–9) at follow-up. The mean Tegner Activity Scale improved significantly ($p < 0.001$) by 2.7 points from 2.2 ± 1.5 (range 0–6) preoperative to 4.9 ± 1.7 (range 3–10) at follow-up (Fig. 5).

Table 2 Patient details and intraoperative findings

Demographics		
Age, median (range), years, SD	16.2 (9–26)	± 4.7
Sex, male:female, number	10:28	
Symptoms start with trauma	9	(23.7%)
Symptoms start with sport	20	(52.6%)
Duration of symptoms before surgery, months	27.0 (1–150)	± 38.6
Total follow-up, median (range), months	20.1 (12–44)	± 9.3
Sakakibara classification [19]		
Sakakibara type B	10	(26.3%)
Sakakibara type C	28	(73.7%)
Plica morphology according to Lyu [11]		
Grade I	1	(2.6%)
Grade II	21	(55.3%)
Grade III	11	(28.9%)
Grade IV	5	(13.2%)
Associated pathologies		
Cartilage lesion to the medial femoral condyle (ICRS grade I)	29	(73.3%)
Infrapatellar plica	17	(44.7%)
Suprapatellar plica	1	(2.6%)

Table 3 Overview of the clinical scores

Score	Preoperative	Follow-up	<i>P</i> value
Kujala (0–100)	52.6 ± 16.6	80.7 ± 16.5	< 0.001
KOOS (0–100)	50.2 ± 19.1	80.7 ± 15.3	< 0.001
Pain	50.6 ± 21.7	82.9 ± 15.8	< 0.001
Symptoms	63.8 ± 23.2	80.8 ± 15.6	< 0.001
ADL	57.2 ± 24.6	88.8 ± 12.3	< 0.001
Sport	26.2 ± 25.8	67.1 ± 27.9	< 0.001
QoL	25.5 ± 17.2	58.1 ± 29.2	< 0.001
Tegner (0–10)	2.2 ± 1.5	4.9 ± 1.7	< 0.001
NRS (0–10)	7.9 ± 2.0	3.1 ± 2.7	< 0.001

Data are presented as mean \pm SD

KOOS Knee Injury and Osteoarthritis Outcome Score, ADL activity of daily living, QoL quality of life, NRS numeric rating scale

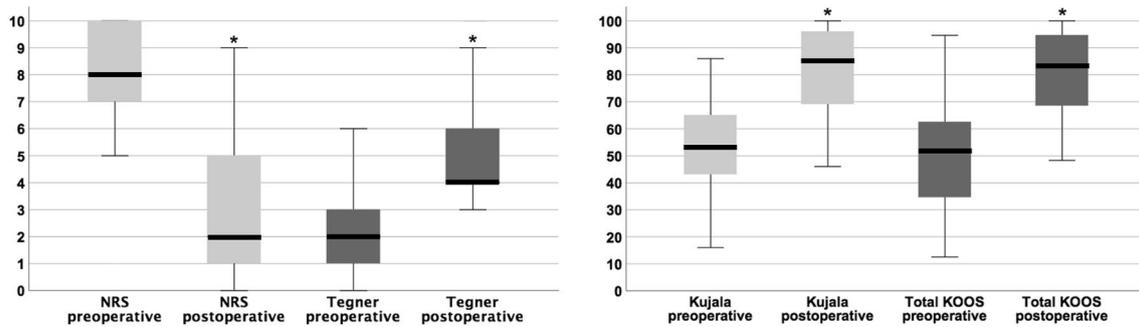
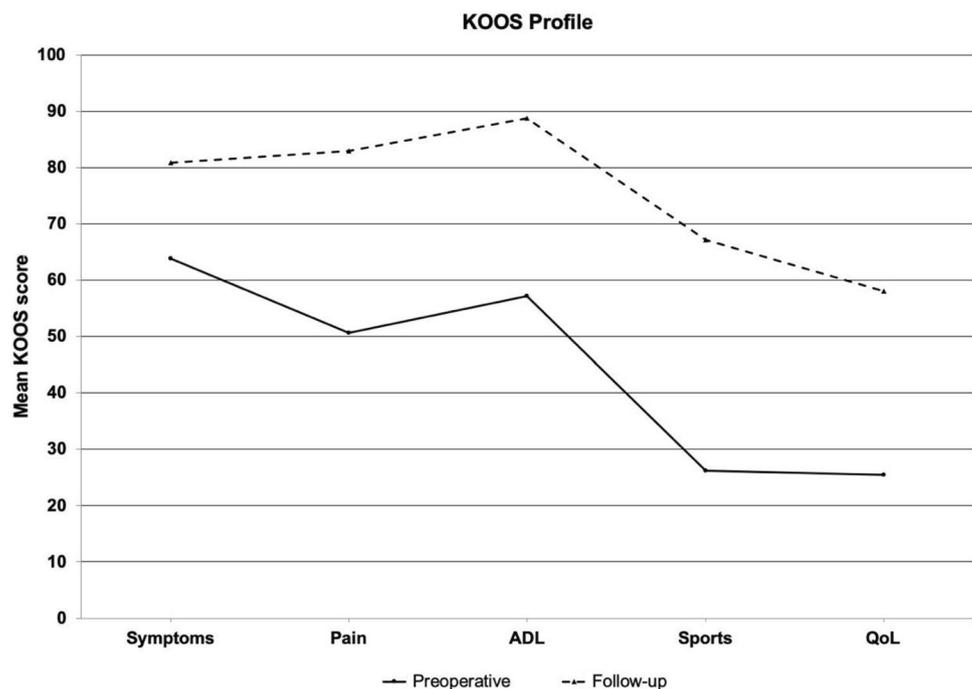


Fig. 4 KOOS profile with overview on the subscale improvement. ADL= activities of daily living; QoL= quality of life

Fig. 5 Boxplot analysis of the subjective clinical scores. NRS=numeric rating scale; total KOOS score; horizontal line=median; * $p < 0.001$ in comparison to preoperative



At follow-up, 33 (86.8%) patients stated they would opt for the same surgery at the contralateral knee if same symptoms would occur with diagnosis of a symptomatic medial plica.

Male patients had a significantly better improvement in the Tegner ($p = 0.001$), KOOS ($p = 0.032$) as well as the Kujala score ($p = 0.01$) in comparison to the female patients. No significant correlation was found between for a history of knee associated trauma or high impact sport. With regard to the intraoperative findings, the presence of an ICRS grade I cartilage lesion in the medial femoral condyle, a concomitant intrapatellar plica or size and morphologic aspect of the medial plica according to Sakakibara and Lyu did not affect any of the outcome parameters significantly.

Discussion

The most important finding of the present study is a significant improvement in all subjective and objective outcome parameters including activities of daily living and patient satisfaction in adolescents and young adults after arthroscopic resection of a symptomatic medial plica, herewith conforming our primary hypothesis. The duration of the preoperative symptoms, trauma or high impact sport were not associated with a poorer outcome in our patient cohort and even this diagnosis is seen less frequently in males, the relative improvement after surgery was significantly better than in the female patients.

To date, there is a lack of prospective studies including only patients in the most relevant age group and especially *preoperative clinical and MRI diagnosis* of a symptomatic medial plica. In the recently published meta-analysis by Gerard, the mean patient age of the seven included studies was 30.8 years and most of the studies even included patients 40–60 years of age. Despite that, the overall rate of good and excellent outcomes was estimated at 84.2% [5]. In the meta-analysis by Schindler, 19 of 22 studies were published before 1995 with the absence of preoperative MRI. Of the included 969 patients, 64% of patients were free of complaints, 26% still had occasional symptoms and 10% did not improve after open or arthroscopic plica resection [20]. Weckstrom et al. reported long-term retrospective results of 25 patients with normal preoperative MRIs and the medial plica rather as a diagnosis of exclusion during surgery. Here, the mean Kujala score was 92 after 6.6 years but without evaluation of the preoperative level of complaints [25]. Prejbeanu et al. published a prospective study including 200 patients with identification of a medial plica in the MRI and chronic knee pain as inclusion criteria but without distinct evaluation of the typical plica-associated history or clinical findings preoperative. Arthroscopic resection resulted in a significant improvement of 26 points in the mean Tegner Lysholm Knee Score at 36-month follow-up with better results in younger patients with intact cartilage and plica types A and B according to the Sakakibara classification [17].

We prospectively included only patients with the preoperative diagnosis of a symptomatic medial plica based on strict inclusion criteria and not by arthroscopically excluding any other preoperatively suspected pathology and, therefore, proclaiming the diagnosis of a symptomatic plica in the absence of an alternative. The present study shows comparable improvements in the evaluated scores and furthermore a significant reduction of the pathognomonic medial parapatellar pain at follow-up. However, in our cohort, the size and morphologic plica type did not affect the outcome parameters. In contrast to Prejbeanu [17], we are not able to confirm the incidence of more than 30% type D plicae. A fenestrated plica with two separate insertions into the capsule could not be identified in any patient in our cohort. In the literature, the incidence is reported to be 0–10% [6, 14]. We could identify plica-associated “sanding-mark”-type ICRS grade I cartilage lesions to the medial femoral condyle in 76.3% of the cases. Those superficial cartilage lesions are typically caused by friction of the plica spanning over the cartilage of the medial femoral condyle [7, 9]. Guney et al. identified cartilage lesions \geq grade II in 63 of 76 (82.9%) of their patients with a mean age of 37.2 years, which might indicate a progression of the cartilage damage in the presence of a pathologic medial plica. However, only 20 of 76 (26.3%) patients in their retrospective study had an isolated medial plica [6]. Lyu et al. found a significantly higher incidence of a medial plica in patients with osteoarthritis in

a retrospective analysis of 1263 patients undergoing arthroscopic surgery for various indications [11]. In advanced age, concomitant lesions of the menisci or not plica-associated cartilage lesions are more frequent and complicate the outcome evaluation of plica-associated knee complaints [6, 7, 24]. We, therefore, excluded all patients with intraoperative diagnosis of a cartilage lesion $>$ ICRS grade I on the medial femoral condyle or anywhere else in the joint to eliminate this potential bias.

Strengths of the present study are the prospective design, the specific preoperative and intraoperative evaluation of the plica pathology and the clearly stated inclusion and exclusion criteria focusing only on the most relevant age group. However, relevant limitations have to be considered. No power calculations were conducted prior to the beginning of the study. The missing control group and a possible bias by a regression to the mean have to be considered when interpreting the results. The conservative treatment prior to surgery was not conducted in our institution and all included patients were referred to our outpatient clinic when non-operative treatment failed. This leads to a possible bias due to the differences in the duration of symptoms as well as the non-standardised conservative treatment before surgery. The low number of included patients is mainly based on the restrictive inclusion criteria and the single-centre design. Besides, in 17 patients (44.7%), an infrapatellar plica in addition to the medial plica was resected as well. We are not able to provide evidence whether the infrapatellar plica was partially responsible for the complaints before surgery. However, only a few reports about an infrapatellar plica being symptomatic are published [2, 4] and when comparing the outcomes to the patient with isolated medial plica resection, no significant difference with regard to the scores was found in our cohort. Furthermore, the heterogenous follow-up of 12–44 months has to be considered when interpreting the results, especially the return to sports.

In conclusion, arthroscopic resection of a symptomatic medial plica provides excellent clinical results in young patients. Trauma, high-impact sports, ICRS grade I cartilage lesions to the medial femoral condyle or the plica type are not associated with a poorer outcome.

Compliance with ethical standards

Conflict of interest M. Hufeland, L. Treder, H. K. Kubo, P. E. Verde, R. Krauspe and T. Patzer declare that they have no conflict of interest.

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