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ORIGINAL ARTICLE

Pediatric Acute Lateral Patellar Dislocation: MRI Assessment of Medial Patellofemoral Ligament Injury Patterns and Associated Knee Pathologies

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Abstract

Background: We aimed to evaluate the relationship between the medial patellofemoral ligament (MPFL) injury pattern and accompanying anatomical factors, articular cartilage lesions, and knee soft tissue injuries in acute lateral patellar dislocation (ALPD).

Methods: Knee MRIs of 102 children with ALPD were evaluated retrospectively. The location and severity of MPFL injury, associated anatomical variations, cartilage lesions, and injuries to the knee ligaments and menisci were assessed.

Results: Partial MPFL tears were observed in 53 patients, while complete MPFL tears were observed in 49 patients. The injury site was at the patella insertion in 77 patients (77.5%). Trochlear dysplasia and patella alta were present in 86.3% of the patients. Wiberg type B and C patellae were observed in 50 patients each. Patellar cartilage lesions were seen in 45 patients (44.1%) and were more common in complete MPFL tears ($p < 0.001$). Patellar cartilage lesions were more prevalent in the patellar insertion (PAT) subgroup ($p = 0.005$). Medial collateral ligament (MCL) injury was observed in 55 patients and was more prominent in complete MPFL tears ($p = 0.002$). Lateral collateral ligament (LCL) injury was observed in 28 patients (27.5%) and was more common in the PAT subgroup ($p = 0.002$). Muscle injury was observed in 12 patients (11.8%).

Conclusion: In children with ALPD, MPFL injury is more commonly partial and occurs at the patellar insertion site. Cartilage lesions are more frequently observed in cases of complete MPFL tears. MRI is a valuable tool in determining the location and severity of MPFL injury and in evaluating associated cartilage and ligament pathologies.

Keywords: Medial patellofemoral ligament, acute lateral patellar dislocation, MRI, children, anatomic factors, cartilage lesion.

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INTRODUCTION

Acute lateral patellar dislocation (ALPD) is one of the most common acute knee injuries in children, accounting for approximately 3% of all knee injuries (1, 2). It is particularly prevalent in the 14–18 age range and is slightly more common in females (3, 4). The medial patellofemoral ligament (MPFL), being the most critical soft tissue structure preventing lateral displacement of the patella, is injured in 95–100% of ALPD cases (5, 6). In addition to MPFL injury, ALPD may also lead to injuries to adjacent soft tissues and osteochondral structures (4, 7, 8). While X-rays can reveal patellar dislocation, magnetic resonance imaging (MRI) plays a vital role in identifying associated MPFL injuries, osteochondral lesions, and other ligament injuries (9). The characteristic MRI findings of ALPD include joint effusion, edema on the lateral femoral condyle or medial side of the patella, osteochondral lesions, and MPFL injury (10). MRI has high sensitivity and accuracy in detecting MPFL injuries (9, 11). Evidence of MPFL injury on MRI includes disruption of its fibers and soft tissue edema. In some cases, when the injury is not clearly visible, soft tissue edema may be the primary finding, making it challenging to determine the severity of the injury (12, 13).

Several anatomical factors predispose individuals ALPD and MPFL injury. Primary anatomical predispositions include an increased tibial tuberosity to trochlear groove (TT-TG) distance, patella alta, trochlear dysplasia, and patellar morphology (7, 12, 14, 15).

In children with ALPD, where the epiphyseal plates are not fully closed, deciding between conservative and surgical treatments can be challenging. In the short term, surgical treatment is superior to conservative approaches in terms of lower recurrence rates, maintenance of sports activities, and preservation of the quality of life, especially in children. However, no significant long-term differences have been observed regarding degeneration of the patellofemoral joint (16). MRI can assist surgeons in selecting a treatment plan by identifying the associated ligament or osteochondral pathologies in ALPD cases.

There are no detailed MRI studies in the literature evaluating the effects of the tibiofemoral and patellofemoral joints and surrounding anatomical structures in ALPD in pediatric patients. In our study, we aimed to identify, using MRI, the severity and location of MPFL injuries, along with accompanying anatomical predisposing factors and osteochondral lesions in patients with ALPD and MPFL injuries. We also evaluated associated muscle injuries, ligament injuries, and meniscal pathologies.

MATERIALS AND METHODS

Between August 2021 and December 2023, all knee MRI examinations performed in individuals under 18 years of age were retrospectively reviewed using the hospital Picture Archiving Communication Systems (PACS) system. Local ethical committee approval (Date: 08.05.2024 No: AEŞH-BADEK-2024-330) was taken from Ankara Etlik City Hospital Ethical Committee. The research protocol adhered to the principles of the Helsinki Declaration. All knee MR images of patients under 18 years of age were evaluated, and 102 patients diagnosed with ALPD were included in the study.

Inclusion criteria consisted of patients with first acute lateral patellar dislocation, MRI performed within 15 days of the onset of clinical symptoms, and patients under the age of 18. Exclusion criteria included patients with suboptimal imaging quality due to motion artifacts, a history of knee surgery, or chronic lateral patellar dislocation.

MRI Technique and Evaluation

All MRIs were performed using a 1.5T MR scanner with a flex coil, utilizing a routine knee protocol. The protocol included axial axial fat-saturated (FS) proton density (PD) weighted fast spin-echo (FSE), coronal FS PD FSE, sagittal FS PD FSE, and coronal T1 FSE sequences. All MRI images were reviewed by two radiologists with 6 years of radiology experience and 5 years of pediatric radiology expertise. In cases of disagreement, a consensus was reached.

MPFL injury was categorized based on its location as patellar insertion (PAT), femoral attachment (FEM), midsubstance, or combined (COM). If the injury occurred in two or three different areas, it was considered combined. Tear severity was recorded as a partial or complete tear. (7, 14). A partial MPFL tear was defined

as a thickening and irregularity of the contour, including disruption of continuity of normal fibers and periligament edema. A complete MPFL tear was defined as a complete discontinuity or apparent absence of fibers in the expected region of the MPFL.

The main ligaments forming the knee joint, including the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL), and lateral collateral ligament (LCL), were evaluated and a ligament damage classification system was used. Grade 0 was classified as normal, grade I as mild damage (thickening and irregularity of the ligament), grade II as partial tear (significant signal increase and partial tear), and grade III as complete tear (17).

The lateral and medial menisci were evaluated according to meniscal signal characteristics suggested by Lotysch et al. (18). The group without signal change was considered normal, while grade I represented a small focal signal increase not reaching the articular surface, grade II indicated a significant signal increase not reaching the articular surface, and grade III represented a signal increase reaching the articular surface, indicating a tear. Meniscal tears were categorized as horizontal, longitudinal, or vertical (19).

Patellar and trochlear cartilage lesions were classified according to the International Cartilage Repair Society (ICRS) MRI-adapted cartilage damage system. Abnormal signal was categorized as grade I, lesion depth less than 50% as grade II, lesion depth greater than 50% as grade III, and osteochondral damage as grade IV (20). In addition, the presence of loose bodies were evaluated.

Bone signals in the patella, femur, and tibia were evaluated to assess bone edema location, and avulsion fractures at the femoral attachment and patellar insertion sites of the MPFL were examined.

The vastus medialis (VM) and vastus lateralis (VL) muscles were evaluated, and muscle damage, which was considered if a pathological signal increase was observed in at least two slices.

Patellar morphology was evaluated using axial PD images and classified according to the Wiberg classification into types A-C (21). The Insall-Salvati index was calculated by comparing the longest dimension of the patella to the length of the patellar tendon, and a ratio above 1.3 was considered patella alta (14).

Trochlear dysplasia was evaluated using axial PD and sagittal images, and classified according to the Dejour classification into types A-D (22). The TT-TG distance measurement was performed as described by Schoettle et al., with a value greater than 20 mm considered abnormal (23, 24).

Statistical Analysis

Statistical analysis was performed using SPSS 24.0 (IBM, Armonk, NY, USA). Quantitative variables were expressed as the mean ±standard deviation (SD) or median and range. Categorical variables were presented as frequencies and percentage. The Chi-square test, Kruskal-Wallis test, one-way ANOVA test, independent samples t-test and Mann-Whitney U test were used in comparisons between parameters and subgroups. A p value of < 0.05 was considered statistically significant.

RESULTS

A total of 102 patients were included in the study, including of 55 females (53.9%) and 47 males (46.1%). MRI was performed on 50 right and 52 left knees. The mean age of the patients was 15 years (range: 8–18 years). Partial tears were observed in 53 patients (52%), while complete tears were observed in 49 patients (48%) (Figures 1 and 2). The most common MPFL injury location was patellar insertion in 77 patients (75.5%), while COM injuries were found in 17 patients (16.7%). No isolated mid-substance MPFL injuries were detected. MPFL injuries at the COM level were statistically significantly more frequent in complete MPFL tears (p=0.017).

The most common patella morphologies were Wiberg types B and C, with type B being more frequently associated with partial MPFL tears and type C with complete tears. Insall-Salvati index >1.3 was measured in 86 patients (86.3%). The average TT-TG distance was 15 mm (range 7-26 mm), with a distance greater than 20 mm observed in 15 patients (14.7%). The trochlear shape was classified as type B in 44 patients (43.1%) and type C in 27 patients (26.5%), while 14 patients (13.7%) had a normal trochlear shape. No significant statistical relationship was found between MPFL injury location or severity and patella morphology, Insall-Salvati index, TT-TG distance, or trochlear shape. The average

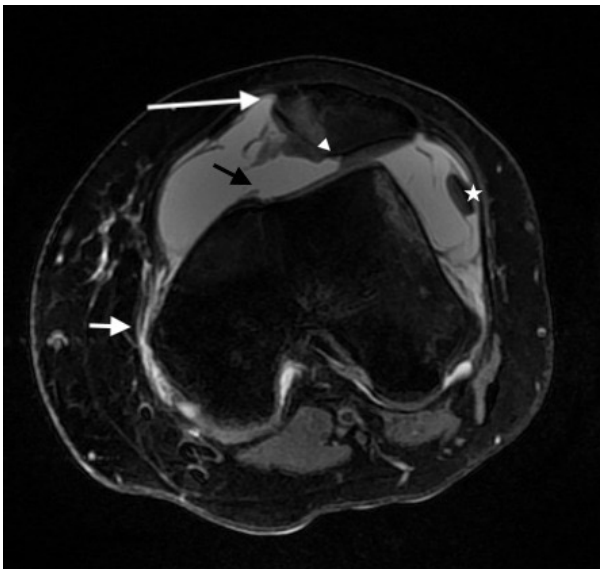

Figure 1. A

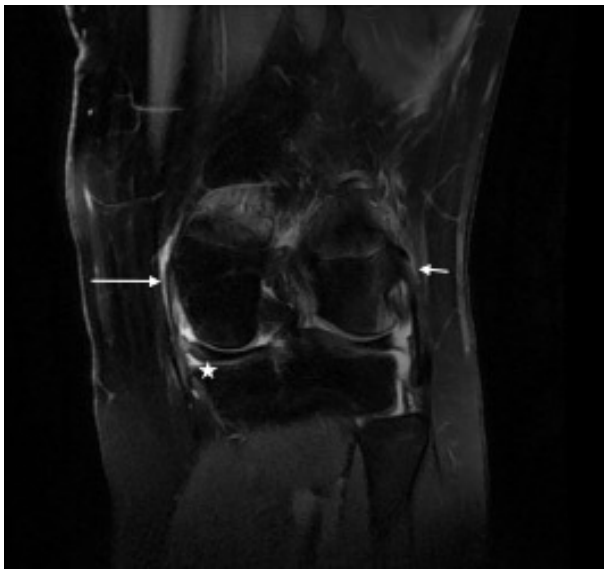

Figure 1. B

Figure 1: 16-year-old girl with complete MPFL tears at its patellar insertion and femoral attachment. A) Axial MRI shows complete-combined disruption of MPFL at both its patellar insertion (long white arrow) and femoral attachment (short white arrow). It represents Grade-III chondral lesion at the patellar crest (arrowhead) and trochlear cartilage (short black arrow). Loose body (asterisk) was also observed. B) Coronal MRI shows increased signal and periligamentous edema-fluid consistent with stage I injury of the LCL (short white arrow) and MCL (long white arrow). There is also a longitudinal tear (asterisk) of the medial meniscus.

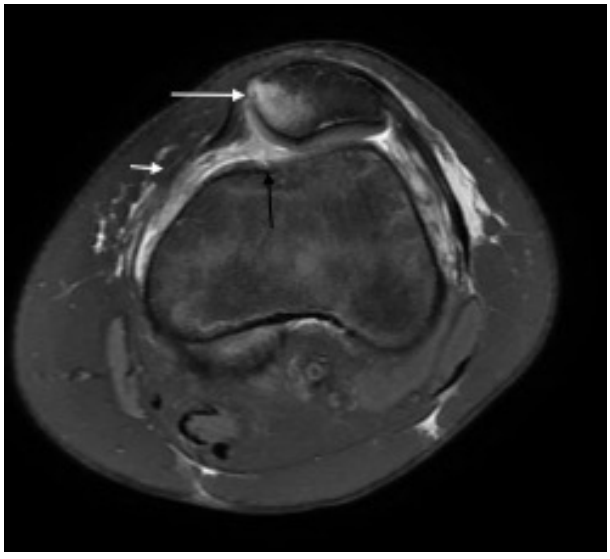

Figure 2. A

Figure 2. B

Figure 2: 15-year-old girl with partial MPFL tears at its patellar insertion and midsubstans. A) Axial MRI shows irregularity with intraligamentous and periligamentous oedema of MPFL at its patellar insertion (long white arrow) and midsubstans (short white arrow). It represents Grade-II chondral lesion at the trochlear cartilage (black arrow). B) Axial computed tomography imaging shows an avulsion fracture at the patellar insertion of the MPFL. C) Sagittal MRI shows grade II signal increase is observed in the posterior horn of the medial meniscus. D) Coronal PD FSE FS imaging sequence shows increased signal and periligamentous edema-fluid consistent with stage II MCL (white arrow).

Figure 2. C

Figure 2. D

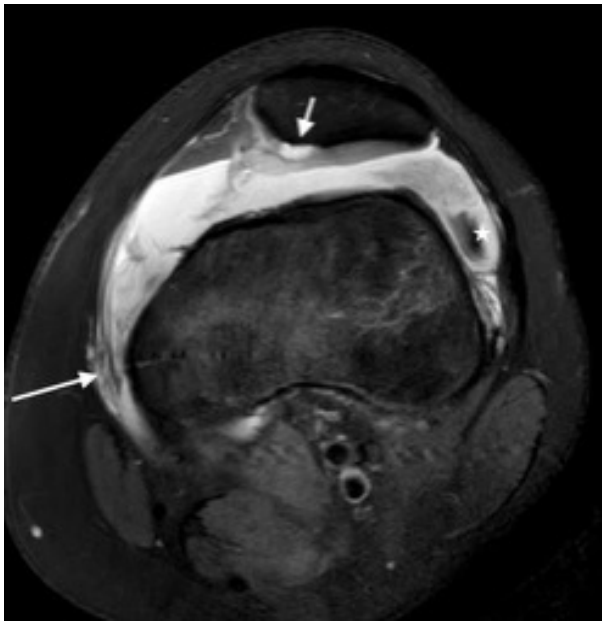

Figure 3. A

Figure 3. B

Figure 3. 14-year-old boy with complete MPFL tears at its femoral attachment. A) Axial MRI shows complete disruption of MPFL at its femoral attachment (long white arrow). It represents Grade-III chondral lesion at the patellar crest (short White arrow) and loose body (asterisk). B) Sagittal MRI shows increased signal in a stage I injury of the ACL (white arrow). There is also a patellar cartilage lesion (asterisk).

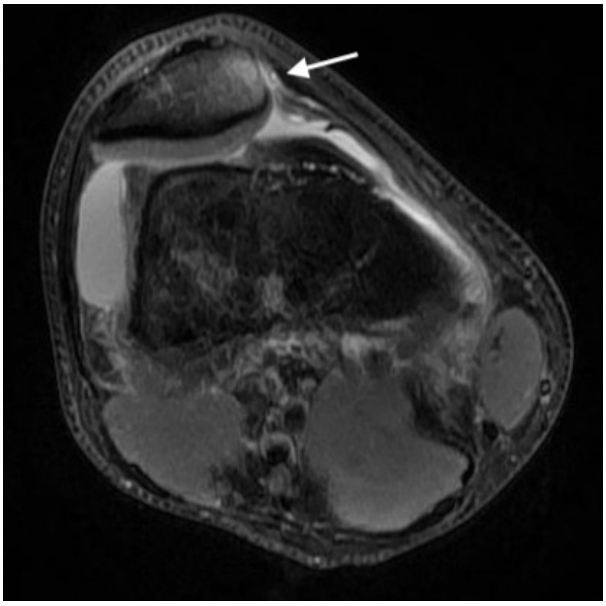

Figure 4. A

Figure 4. B

Figure 4: 17-year-old boy with partial MPFL tears at its patellar insertion A) Axial MRI shows irregularity with intraligamentous and periligamentous oedema of MPFL at its patellar insertion (white arrow). B) Coronal MRI shows increased signal and periligamentous edema-fluid consistent with stage II injury of the LCL (white arrow).

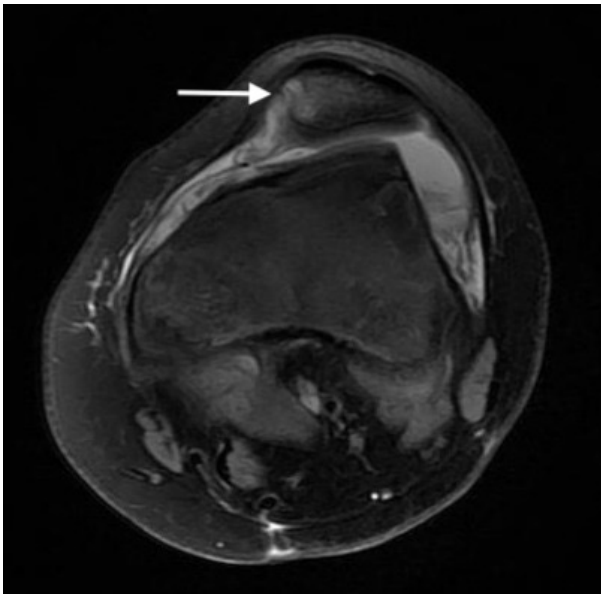

Figure V. A

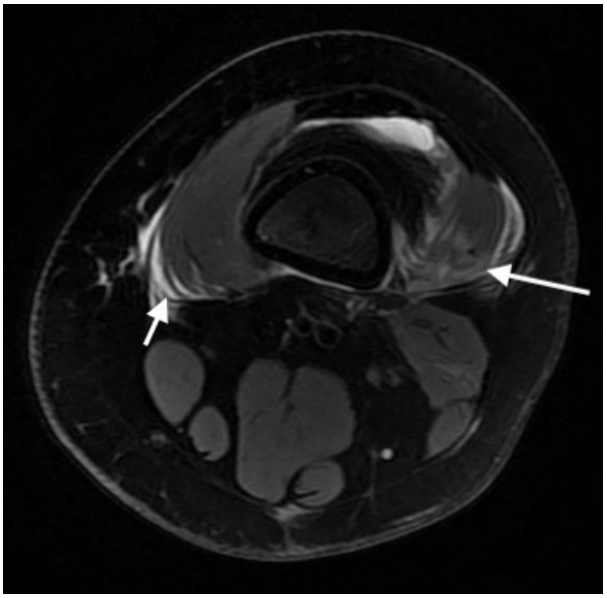

Figure V. B

Figure V. 11-year-old girl with partial MPFL tears at its patellar insertion A) Axial MRI shows irregularity with intraligamentous and periligamentous oedema of MPFL at its patellar insertion (white arrow). B) Axial MRI shows increased signal and epifascial edema-fluid (grade I) in the vastus medialis (short white arrow) and increased signal, irregularity, and epifascial edema-fluid (grade II) in the vastus lateralis (long white arrow).

trochlear sulcus angle was 147 ± 9.3° and was significantly higher in complete MPFL tears (149.9 ± 7.3°) compared to partial tears. However, no significant differences were observed in injury location (Tables 1 and 2).

Table 1. Statistical analysis of anatomical variations and measurements among subgroups of medial patellofemoral ligament (MPFL) injury severity

	Total	Partial	Complete	P value*
Number of Patients-n(%) Age,mean (range), yr Gender (F/M) -n(%) Laterality (R/L) -n(%)	102 15 (8-18) 55/47 (53.9/46.1) 50/52 (49/51)	53 (52) 15 (8-18) 28/25 31/22	49 (48) 15 (8-18) 27/22 19/30	 0.236 0.818 0.047
Patellar Type (Wiberg) - n(%) Type A Type B Type C	 2 (2) 50 (49) 50 (49)	 2 28 23	 0 22 27	 0.236
Patellar tendon length (mm) Patellar height (mm)	52.8±6.6 35.5 (29-47) 1.47 (1.09-1.97)	53.7±6.2 33.6 (29-43)	52.3±7 35 (29-47)	0.417 0.317 0.657
Insall-Salvati index LPFR thickness (mm) Trochlear sulcus ° TT-TG distance (mm)	2.35 (1-4) 147±9.3 15 (7-26)	1.47 (1.21-1.90) 2.55 (1-4) 144.4±10.2 14.5 (7-21)	1.45 (1.09-1.97) 2.1 (1-4) 149.86±7.3 15 (7-26)	0.026 0.003 0.485
Trochlear shape Normal A B C	 14 (13.7) 17 (16.7) 44 (43.1) 27 (26.5)	 12 11 19 11	 2 6 25 16	 0.017
Injury location Femoral Patellar Combine	 8 (7.8) 77 (77) 17 (15.2)	 5 44 4	 3 33 13	 0.534 0.066 0.010

* P <0.05
LPFR: lateral patellofemoral retinaculum
TT-TG: tibial tuberosity to trochlear groove

Table 2. Statistical analysis of osseous, cartilaginous and meniscoligamentous injuries among subgroups of medial patellofemoral ligament (MPFL) injury severity

	Total-n (%)	Partial-n	Complete-n	P value*
Osseous injury				
Patellar medial contusion	90 (88.2)	45	45	0.278
Patellar lateral contusion	1 (1)	0	1	0.296
Medial femoral condyle contusion	16 (15.7)	8	8	0.864
Lateral femoral condyle contusion	81 (79.4)	34	47	0.000
Intraarticular loose-body	5 (4.9)	0	5	0.017
Lipohaemarthrosis	5 (4.9)	0	5	0.017
Cartilaginous injury				
Troclear cartilaginous injury	36 (35.3)	14	22	<0.001
Grade 1	21 (20.6)	10	11	
Grade 2	7 (6.9)	4	3	
Grade 3	8 (7.8)	0	8	
Patellar cartilaginous injury	70(68.6)	25	45	<0.001
Grade 1	24 (23.5)	15	9	
Grade 2	15 (14.7)	5	10	
Grade 3	9 (8.8)	3	6	
Grade 4	22 (21.6)	2	20	
Meniscal-ligament injury				
Medial meniscus injury	45(44.1)	23	22	0.765
Grade 1	27 (26.5)	13	14	
Grade 2	9 (8.8)	4	5	
Grade 3	9 (8.8)	6	3	
Lateral meniscus injury	6(5.9)	1	5	0.069
Grade 1	4 (3.9)	1	3	
Grade 2	1 (1)	0	1	
Grade 3	1 (1)	0	1	
Medial collateral ligament injury	55(53.9)	20	35	0.002
Grade 1	50 (49)	19	31	
Grade 2	5 (4.9)	1	4	
Grade 3	0	0	0	
Lateral collateral ligament injury	28 (27.5)	10	18	0.159
Grade 1	27 (26.5)	10	17	
Grade 2	1 (1)	0	1	
Grade 3	0	0	0	
Anterior cruciate ligament injury	32 (31.3)	11	21	0.023
Grade 1	23 (22.5)	6	17	
Grade 2	4 (3.9)	1	3	
Grade 3	5 (4.9)	4	1	
Muscle injury	12 (11.8)	2	10	0.009
Vastus medialis muscle	7 (6.9)	2	5	0.119
Vastus laterali muscle	8 (7.8)	2	6	0.149

** P <0.05*

Patellar medial contusions were observed in 90 patients (88.2%) and were equally distributed between partial and complete tears. It was significantly more frequent in the PAT subgroup (76 patients) than in the FEM or COM subgroup. Lateral femoral condyle contusions were observed in 81 patients (79.4%) and were significantly more common in complete tears. Patellar cartilage lesions were noted in 70 patients (68.6%) and were more frequent in the complete tear and PAT subgroups. Trochlear cartilage lesions were identified in 36 patients (35.3%), with no significant correlation with MPFL injury location or severity. Additionally, five patients had loose bodies.

Pathological signal changes in the medial meniscus were observed in 45 patients (44.1%), while the lateral meniscus was affected in six patients (5.9%). Grade I changes were the most common, and lateral meniscal injuries were primarily associated with multiligament injuries. No significant association was found between meniscal pathology and MPFL injury location or severity. PCL injuries were not observed. ACL injuries were present in 32 patients (31.4%), with a higher frequency of complete MPFL tears, predominantly grade I injuries (Figure 3). LCL injuries were also more common in complete MPFL tears and were frequently associated with the PAT subgroup (Figure 4). MCL injuries were present in 55 patients (53.9%), with grade I injuries being the most common. These were more frequent in complete MPFL tears than in partial MPFL tears (Tables 3 and 4).

Table 3. Statistical analysis of anatomical variations and measurements among subgroups of medial patellofemoral ligament (MPFL) injury location

	PAT (n=77)	FEM n (n=8)	COM (n=17)	P value*
Age,mean (range), yr	15 (8-15)	15 (9-17)	15 (11-18)	0.206
Gender (F/M)	46/31	1/7	8/9	0.032
Laterality (R/L)	35/42	5/3	10/7	0.443
Patellar Type (Wiberg)				
Type A	2	0	0	
Type B	43	2	5	0.123
Type C	32	6	12	
Patellar tendon length (mm)	52.8±6.8	52±5.9	53.2±6.1	0.715
Patellar height (mm)	36 (29-47)	36.5 (30-43)	35 (30-47)	0.873
Insall-Salvati index	1.46 (1.11-1.97)	1.45 (1.16-1.66)	1.47 (1.09-1.83)	0.690
LPFR thickness (mm)	2.3 (1-4)	2.45 (2-3)	2.3 (2-4)	0.353
Trochlear sulcus °	146.39±9.2	146.38±13.2	150.2±7.6	0.297
TT-TG distance (mm)	14 (7-21)	19 (7-24)	16 (8-26)	0.021
Trochlear shape				
Normal	11	2	1	0.289
A	16	0	4	
B	29	4	11	
C	21	2	1	

** P <0.05*
LPFR: lateral patellofemoral retinaculum
TT-TG: tibial tuberosity to trochlear groove

Table VI. Statistical analysis of osseous, cartilaginous and meniscoligamentous injuries among subgroups of medial patellofemoral ligament (MPFL) injury location

	PAT	FEM	COM	P value*
Osseous injury				
Patellar medial contusion	76	8	14	0.000
Patellar lateral contusion	1	0	0	0.849
Medial femoral condyle contusion	1	8	7	0.000
Lateral femoral condyle contusion	60	5	16	0.153
Intraarticular loose-body	5	0	0	0.426
Cartilaginous injury				
Patellar cartilaginous injury	55	0	15	0.005
Grade 1	18	0	6	
Grade 2	12	0	3	
Grade 3	8	0	1	
Grade 4	17	0	5	
Trochlear cartilaginous injury	28	0	8	0.240
Grade 1	18	0	3	
Grade 2	5	0	2	
Grade 3	5		3	
Meniscal-ligament injury				
Medial meniscus injury	32	3	10	0.170
Grade 1	19	1	7	
Grade 2	6	0	3	
Grade 3	7	2	0	
Lateral meniscus injury	4	0	1	0.434
Grade 1	3	0	1	
Grade 2	0	0	0	
Grade 3	1	0	0	
Medial collateral ligament injury	37	4	14	0.124
Grade 1	33	4	13	
Grade 2	4	0	1	
Grade 3	0	0	0	
Lateral collateral ligament injury	14	4	9	0.002
Grade 1	14	4	8	
Grade 2	0	0	1	
Grade 3	0	0	0	
Anterior cruciate ligament injury	21	4	7	0.845
Grade 1	15	3	5	
Grade 2	3	0	1	
Grade 3	3	1	1	
Muscle injury	8	1	3	0.701
Vastus medialis muscle	4	1	2	0.504
Vastus laterali muscle	7	0	1	0.626

** P <0.05*

Muscle injuries (vastus medialis and vastus lateralis) were identified in 12 patients, with three patients showing injuries in both VM and VL (Figure 5). Additionally, lipohemarthrosis was detected in five patients.

DISCUSSION

The MPFL is the most important passive constraint for lateral patellar dislocation, contributing 50-60% of the restraining force. As a result, MPFL injury occurs in more than 90% of ALPD cases in children (7, 8, 25, 26). In our study, MPFL injuries were observed in all the patients. In children, MPFL is the most common injury at the PAT (7, 12, 25). The more frequent MPFL injury in children may be related to ligament development and skeletal immaturity. Insufficient development of the vastus medialis obliquus and its limited support to the MPFL in the patellar region could cause more frequent and less forceful injuries at the PAT (2, 7, 27). However, in Balcarek et al.'s study of 22 patients, the injury was most frequently observed at the FEM (28). In current study, MPFL injury location was most frequently observed at the PAT.

Combined injury is defined as injury to at least two locations of the MPFL (7, 14). Balcarek et al., the most frequent combined injury was observed after FEM location (28). Similarly, Putney et al. found that the most frequent combined injury occurred after FEM location (29). They considered the co-occurrence of femoral attachment and patellar insertion injury as combined injury (28, 29). In our study, the most common second location of injury was found to be combined as well. However, in our study, in addition to FEM-PAT injury, we also observed PAT-midsubstance and FEM-midsubstance MPFL injuries among combined injury.

In ALPD, MPFL injury is most often a complete tear in children (7, 25). However, in the present study, partial tears were observed more frequently. This is believed to be due to the higher frequency of MPFL injury localized at the PAT in our study.

For ALPD, increased TT-TG distance, patella alta, patella morphology, and trochlear dysplasia are major anatomical variations, with trochlear dysplasia being a major risk factor (7, 24, 30). Wilson et al., studied 36 patients aged 5-18 years, no significant relationship was found between MPFL injury and trochlear dysplasia or patella alta (10). Zhang et al., found no correlation between MPFL injury severity, location, and trochlear dysplasia or TT-TG distance (24). Balcarek et al., found no significant differences in TT-TG distance, patellar height, or trochlear dysplasia in terms of whether the MPFL injury was a partial or complete tear. However, they showed that TT-TG distance was increased in the PAT subgroup compared to the FEM or COM subgroups (14). Likewise, Zhang et al. found that although TT-TG distance was statistically insignificant, it was higher in the PAT subgroup and in patients with partial MPFL tears. Additionally, they found that Wiberg type B patella was more frequently observed in cases of complete MPFL tears (7). In our study, the trochlear sulcus angle was statistically significantly higher in cases of complete MPFL tears. Trochlear dysplasia was present in 86 patients (86.3%), with the most common being type B. Similar to the literature, the majority of our ALPD patients had trochlear dysplasia. However, no significant relationship was found between trochlear shape and MPFL injury location or severity. Among our 86 patients (86.3 %), patella alta was present, but no significant relationship was found between this and MPFL injury location or severity. Furthermore, 100 of our patients had Wiberg type B-C patella. In our study, Wiberg type B patella was more common in partial tears, and type C was more common in complete tears, although this was not statistically significant. The TT-TG distance was abnormal in 14 patients, but no significant relationship was found between this distance and MPFL injury location or severity.

After ALPD, in addition to MPFL injury, over 71% of patients may experience cartilage lesion (2). Zhang et al., no significant relationship was found between MPFL injury location and the frequency of patellar cartilage lesions. However, they demonstrated that complete MPFL tears are a predisposing factor for high-grade patellar cartilage lesions (7). In our study, patellar cartilage lesions were significantly more common in complete tears than in partial tears. Furthermore, partial tears were associated with lower-grade cartilage lesions, whereas complete tears were associated with higher-grade cartilage lesions. Patellar cartilage lesions were significantly more frequent in cases of MPFL injury at the PAT. However, in our study, MPFL injury at the PAT was notably more common.

Seeley et al., observed osteochondral lesions in the lateral femoral condyle in 11.5% of 112 children with ALPD (31). In another study by Zheng et al., cartilage lesions in the lateral femoral condyle were observed in approximately 40%, and osteochondral lesions were seen in 22%. Addi-

tionally, cartilage or osteochondral damage occurs more frequently in the lateral femoral condyle in the PAT and COM subgroups and in complete tears (25). We demonstrated that cartilage lesions in the lateral femoral condyle were observed in 35.3% of cases, and osteochondral injury occurred in 7.8%. Although the cartilage injury rate was similar to that reported by Zheng et al., osteochondral injury was less frequent. This findings was attributed to the higher proportion of partial tears in our study. Additionally, in cases of complete tears, lateral femoral condyle cartilage and osteochondral injury were observed more frequently. Seeley et al., found that grade V osteochondral injury occurred more frequently in the medial patellar facet (32). Similarly, in our study, advanced cartilage injuries were more common on the medial patellar facet. Migliorini et al., in a study including patients aged 15-24 years, found that avulsion fractures were more frequent at the femoral attachment, and cartilage damage was more frequent at the patellar crest (2). In our study, avulsion fractures were more common at the patellar insertion site, and cartilage injuries were more frequently observed on the medial patellar facet. This was likely secondary to the fact that our study included only children, and the predominant injury at the PAT was related to MPFL involvement.

Zhang et al. showed that VM and VL muscle injuries were not associated with the location and severity of MPFL injury (7). In our study, muscle injury was statistically more common in complete tears. However, no relationship was found between the injured muscle and the location and severity of injury in the MPFL.

Guerrero et al., in a study of adult patients, found that the incidence of meniscal tears in cases of MPFL injury was 21% (33). In our study, pathological signal (grade I-III) was observed in 44.1% of the medial meniscus. The most common pathological signal in the medial meniscus was grade I, observed in 26.5% of patients, and meniscal tears were observed in 9 patients (8.8%). Pathological signals in the lateral meniscus were observed in fewer patients. In our study, we not only evaluated meniscal tears but also assessed their pathological signal characteristics.

In the literature, we could not find studies specifically examining MPFL injury and knee ligament evaluations in ALPD. MPFL injury is not commonly associated with multiligament knee injuries. Zheng et al. on multiligament injuries of the knee in children and adults, MPFL injuries were found to be infrequent, and when present, they were more likely to be partial tears (8). In our study, the most frequent ACL injury was grade I (22.5%), with only 5 patients (4.9%) showing complete tears. Among the patients with complete ACL tears, 4 had partial tears of the MPFL. Additionally, in our study, knee ligament injuries other than MCL were rarely observed alongside MPFL injury. The MCL and MPFL femoral attachment sites are anatomically closely related. Collins et al. showed that in cases of MCL injury, 90% of MPFL injuries exhibited pathological signals at the femoral attachment site In our study, MCL injury accompanying MPFL injury was evaluated, and MCL injury was significantly more common in complete tears. Furthermore, MCL injury was more frequently observed the PAT subgroup. This may be due to our patient group consisting mainly of children, and the fact that most MPFL injuries were localized at the PAT. LCL injuries were observed more frequently in complete MPFL tears and in the PAT subgroup.

MPFL is the primary restraint to lateral patellar dislocation. Its treatment, whether surgical or conservative, remains a subject of ongoing debate. After the first ALPD, conservative treatment is typically applied. However, surgical intervention is necessary in cases involving loose bodies or osteochondral defects (2, 34). Therefore, identifying loose bodies and osteochondral defects is crucial. Migliorini et al., found that loose bodies were detected in approximately 19% of cases (2). In our study. loose bodies were found in 4.9% of the cases, all of which involved patients with PAT and complete tear.

Our study has several limitations. First, it is retrospective in nature. Second, anatomical variations were not evaluated in comparison with a control group. Third, the findings of all patients were not surgically confirmed and followed up. Finally, cartilage damage was not assessed quantitatively.

In children with ALPD, MPFL injury is more commonly seen as partial and at the PAT location. MRI is very useful in determining the location and severity of MPFL injury and evaluating associated cartilage and ligament pathologies. Cartilage lesions are more common in complete MPFL tears. The detection of osteochondral defects, the presence of loose bodies, and ligament injuries in the knee is critical in guiding treatment decisions. Therefore, the location and severity of MPFL injury in ALPD should be evaluated together with other accompanying findings such as osseocartilage and meniscus-ligamentous injuries, and these should be included in the report.

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Abbreviations list

MPFL medial patellofemoral ligament
ALPD acute lateral patellar dislocation
PAT patellar insertion
MCL Medial collateral ligament
LCL Lateral collateral ligament
MRI Magnetic resonance imaging
TT-TG tibial tuberosity to trochlear Groove
PACS Picture Archiving Communication Systems
FEM femoral attachment
COM combined
ACL anterior cruciate ligament
PCL posterior cruciate ligament
ICRS International Cartilage Repair Society
VM vastus medialis
VL vastus lateralis

Ethics approval and consent to participate

Local ethical committee approval (Date: 08.05.2024 No: AEŞH-BADEK-2024-330) was taken from Ankara Etlik City Hospital Ethical Committee. The research protocol adhered to the principles of the Helsinki Declaration.

Consent for publication

Informed consent was obtained from the legal guardians of patients under the age of 18 for the anonymous use of their data.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

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