Classifying Adolescent Patellar Instability Associated Medial Patellar Injuries Using an Anatomical Perspective

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INTRODUCTION:

Patellar instability accounts for the most prevalent adolescent knee complaint. Patellar instability can be influenced by a multitude of factors that include ligamentous laxity, lower extremity alignment, and both bony and muscular anatomical factors. The medial patellofemoral ligament (MPFL) is considered the primary ligamentous restraint against lateral subluxation of the patella, particularly functioning as a static restraint from 0-70 degrees range of motion. The MPFL consists of a coalescence of fibers from the medial epicondyle of the femur to the superomedial patella and a portion of the undersurface of the quadriceps tendon. Management of patellar instability often includes reconstruction of the MPFL via placement of graft tissue between the medial epicondyle of the femur and the superior equator of the patella (Figure 1).

However, recent literature has demonstrated that the MPFL only accounts for approximately half of the total restraint to lateral patellar displacement and that a portion of the remaining contributions to patellar stability are derived from the medial patellotibial ligament (MPTL) and, to a lesser extent, the medial patellomeniscal ligament (MPML) (Figure 2).

The MPTL and MPML provide more distal attachments and stabilization of the patella. Several small studies within the last decade have argued for the assessment of MPTL injury and consideration for MPTL/MPML reconstruction in conjunction with MPFL reconstruction.

Patellar instability events are often associated with bony injury of the medial patella. Prior attempts at classifying these injuries have focused on the presence of articular cartilage involvement. To the best of our knowledge, no prior studies have used fracture location with consideration of the aforementioned ligamentous structures to classify these injuries. As such, we sought to better characterize medial patella injuries based on fracture pattern and anatomical characteristics in patients treated for patellar instability.

METHODS:

We performed a retrospective records review of adolescent patients diagnosed with patellar instability at our institution from 2011 to 2022. Patient age, presence of fracture, fracture location, fracture size, and articular involvement were recorded based on initial injury MRI and radiographs. In preparation for this study, we reviewed a large series of adolescent knee MRIs to assess for the attachment site of the MPFL and MPTL/MPML. This led us to the creation of a classification system based on location of the medial patellar fracture (Figure 3):

Type 1: no fracture, purely ligamentous injury

Type 2: fracture below the equator of the patella involving the insertion site of the MPTL/MPML)

Type 3: fracture spanning above and below the equator of the patella involving the insertion sites of the MPTL/MPML and MPFL

RESULTS:

Two-hundred-twenty-one knees were identified for inclusion. Of the 221 knees identified, 37% were classified as a Type 1 injury, 25% a Type 2 injury, and 38% a Type 3 injury. Neither injury type was associated with age, sex, or laterality. Type 2 injuries had significantly smaller fracture fragment height than Type 3 injuries. Injuries with intra-articular extension had significantly greater fracture width. Neither Type 2 nor Type 3 injuries were associated with intra-articular extension. Data is summarized in table.

DISCUSSION AND CONCLUSION:

Our findings demonstrate a new classification system for medial patellar injuries in the setting of adolescent patellar instability. This study highlights three unique injury patterns associated with patella instability – the absence of a fracture, an isolated inferior fracture involving the insertion of the MPTL/MPML, and a complete fracture involving the insertion site of the MPTL/MPML and MPFL. These three injury patterns do not appear to be associated with patient demographic characteristics, such as patient age or sex. Future studies will evaluate clinical outcomes for each injury type and determine if specific modifications to surgical technique with consideration of the distinct anatomic characteristics of each of these injuries – such as adjusting the position of the MPFL reconstruction at the patella and including concomitant MPTL/MPML reconstructions – might improve outcomes.

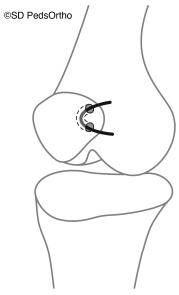

Figure 1. Location of MPFL reconstruction with graft placement within the superior third of the patella.

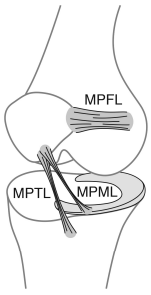

Figure 2. Rendering MPFL, MPTL, and MPM along with their sites of origin and insertion.

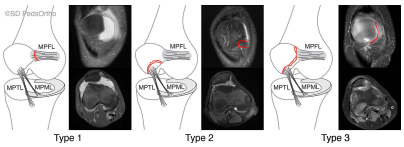

Figure 3. Classification of medial patellar injuries in the setting of patellar instability based on fracture characteristics and ligamentous insertion site. Rendering and MRI examples demonstrated above. Left images demonstrate a Type 1 injury (no fracture – purely ligamentous). Middle images demonstrate a Type 2 injury (fracture fragment below the equator of the patella – MPTL). Right images demonstrate a Type 3 injury (complete fracture spanning above and below the equator of the patella – MPTL and MPFL).

Table 1. Comparison of patellar instability patients with no fracture, Type 1 injury, and Type 2 injury.

		Type 1 (no fracture)	Type 2 (inferior fracture)	Type 3 (complete fracture)	p-value
Lower Extremities (n)		82 (37%)	55 (25%)	84 (38%)	NA
Limb Laterality	**Left**	40 (49%)	29 (53%)	45 (54%)	0.81
	Right	42 (51%)	26 (47%)	39 (46%)	
Sex	**Male**	32 (39%)	27 (49%)	39 (46%)	0.45
	Female	50 (61%)	28 (51%)	45 (54%)	
Mean Age (years) ± SD		15.1 ± 1.9	15.3 ± 1.6	15.5 ± 1.8	0.30
Mean Length of Follow-up (months) ± SD		12.5 ± 13.4	11.9 ± 15.3	14.5 ± 15.3	NA
Mean Fx height (mm) ± SD		N/A	17.5 ± 6.0	25.8 ± 7.0	<0.001
Articular Involvement (n)		N/A	36 (65%)	54 (64%)	0.89
Mean Fx Width (mm) ± SD		N/A	4.8 ± 2.0	6.4 ± 4.0	0.93