Male Sex is an Independent Risk Factor for Patellar Osteochondral Fractures following Acute Patellar Dislocation in Pediatric Patients

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INTRODUCTION: Although most patellar dislocations are associated with medial patellofemoral ligament (MPFL) injury, many patients also sustain concomitant patellar osteochondral fractures following a patella dislocation. Few prior studies have described or evaluated risk factors for patellar osteochondral fractures in pediatric patients. The primary aim of the present study was to describe the incidence, size, and location of patellar osteochondral fractures in pediatric patients with acute patella dislocations. The secondary aim of the study was to describe risk factors for concomitant patellar osteochondral fracture, surgical management, and recurrent dislocation rate in this patient population at mid-term follow up. The authors hypothesized that the majority of fractures would involve the inferomedial quadrant of the patella and occur more frequently following traumatic injury mechanisms.

METHODS: Following Institutional Review Board approval, the electronic medical record was queried to identify pediatric patients ≤18 years old who underwent MPFL reconstruction (MPFLR) or nonsurgical treatment for patellar instability between July 2016 and February 2020. Osteochondral fractures were defined as full-thickness chondral injuries with attached subchondral bone (osteochondral) or purely osseous injuries (without associated articular cartilage) measuring ≥3 millimeters (mm) in at least two magnetic resonance imaging (MRI) planes. Patients were included in the study if they had complete preoperative x-ray and MRI studies with minimum 6-month follow up. Patients were excluded if they had incomplete imaging, isolated chondral fractures, or less than 6 months follow up. Patellar osteochondral fractures were categorized by location, size (in mm, on coronal and sagittal MRI), and maximum displacement (in mm, on coronal and axial MRI). Patellar tilt and Caton Deschamps Index (CDI) were measured on preoperative radiographs, and tibial tubercle-trochlear groove (TT-TG) distance was measured on preoperative MRI. Univariate analysis was used to identify patient factors associated with osteochondral fractures. Multivariate regression analysis was used to identify risk factors for osteochondral fractures.

RESULTS: A total of 84 patients were identified, 63 of whom were included in the study, and 15 (23.8%) of whom had a patellar osteochondral fracture. Of the patients included in the study, the mean age was 14.2 ± 1.8 years, and mean BMI was 21.9 ± 7.8. Thirty-two patients (50.8%) were female, and 30 (47.6%) were right knees. Thirty-six patients (57.1%) were first-time dislocators, 49 (77.8%) were skeletally immature, and 45 (76.3%) had a traumatic injury mechanism. Fifty-six patients (89.9%) underwent surgery, the majority of whom underwent MPFLR + chondroplasty (29 patients, 51.8%). The average follow up was 2.7 ± 1.5 years. The majority of osteochondral fractures involved the inferomedial quadrant of the patella (Zone IV, 9 fractures, 60%) or the inferomedial and superomedial quadrants (Zones I and IV, 5 fractures, 33.3%). On MRI, the fractures measured 12.3±3.7 mm in the superior-to-inferior dimension and 4.8±3.4 mm in the medial-to-lateral dimension in the coronal plane. In the sagittal plane, fractures measured 9.8±3.6 mm in the superior-to-inferior dimension and 5.1±1.9 mm in the anterior-to-posterior dimension. The maximum fracture displacement was 4.1 ± 2.5 mm in the coronal plane and 5.2 ± 2.9 mm in the axial plane. Univariate analysis showed an association between male sex (p=0.041), skeletal immaturity (p=0.028), and decreased patellar tilt (p=0.021) and patellar osteochondral fractures. Multivariate regression analysis identified male sex as an independent risk factor for osteochondral fractures (relative risk: 4.8, 95% confidence interval [CI]: 1.08-20.9, p=0.039). No patients had recurrent dislocation at minimum 6-month follow up.

DISCUSSION AND CONCLUSION: In this study, 23% of pediatric patients with acute patellar dislocations had a concomitant patellar osteochondral fracture after one or more patellar dislocations. The majority of patellar osteochondral fractures involve the inferomedial quadrant of the patella. Male sex is an independent risk factor for patellar osteochondral fractures, and skeletal immaturity is associated with patellar osteochondral fractures in this population. The majority of patients have good outcomes, including a low recurrence rate, at short-term follow up.

Table 1. Demographics of All Patients (n = 63).

	Mean ± SD
Age (years)	14.2 ± 1.8
BMI (kg/m^2)	21.9 ± 7.8
Average Follow-up (years)	2.7 ± 1.5
	n (%)
Sex	
Male	31 (49.2)
Female	32 (50.8)
Laterality	
Right	30 (47.6)
Left	33 (52.4)
Osteochondral Fracture	
Yes	15 (23.8)
No	48 (76.2)
First-Time Dislocators	
Yes	36 (57.1)
No	27 (42.9)
Skeletal Maturity	
Mature	14 (22.2)
Immature	49 (77.8)
Injury Mechanism	
Traumatic	45 (76.3)
Atraumatic	14 (23.7)
Surgery	
Yes	56 (89.9)
No	7 (11.1)
Type of Surgery	
MPFLR	18 (32.1)
MPFLR + Chondroplasty	29 (51.8)
MPFLR + ORIF Patella	9 (16.1)

Table 2. Data for Fractures.

		Mean ± SD
Coronal MRI	Inferior/Superior Size (mm)	12.3 ± 3.7
	Medial/Lateral Size (mm)	4.8 ± 3.4
	Maximum Displacement (mm)	4.1 ± 2.5
Sagittal MRI	Inferior/Superior Size (mm)	9.8 ± 3.6
	Anterior/Posterior Size (mm)	5.1 ± 1.9
Axial MRI	Maximum Displacement (mm)	5.2 ± 2.9
		n (%)
Articular Cartilage Involvement	Yes	13 (86.7)
	No	2 (13.3)
Fracture Location	Zone 1	1 (6.7)
	Zone 4	9 (60.0)
	Zone 1 + Zone 4	5 (33.3)
Visible on AP Knee XR	Yes	8 (53.5)
	No	7 (46.5)
Visible on Merchant Knee XR	Yes	13 (86.7)
	No	2 (13.3)
Surgery	Yes	13 (86.7)
	No	2 (13.3)
Type of Surgery	MPFLR	2 (15.4)
	MPFLR + Chondroplasty	6 (46.2)
	MPFLR + ORIF Patella	5 (38.4)

Table 3. Demographics and Measurements by Fracture (n=15) or No Fracture (n=48)

	Fracture (n = 15)	No Fracture (n = 48)	P-value
	Mean ± SD		
Age (years)	13.6 ± 1.7	14.4 ± 1.8	0.13
BMI (kg/m^2)	21.6 ± 3.8	22.1 ± 5.1	0.82
Average Follow-up (years)	2.5 ± 1.8	2.8 ± 1.4	0.25
CDI	1.33 ± 0.2	1.42 ± 0.2	0.079
TT-TG	15.7 ± 5.4	17.8 ± 4.7	0.12
Patellar Tilt (°)	12.6 ± 5.9	17.8 ± 6.8	**0.021***
	n		
Sex			
Male	11	20	**0.041***
Female	4	28	
Laterality			
Right	7	23	1.0
Left	8	25	
Recurrent Dislocators			
Yes	4	23	0.23
No	11	25	
Skeletal Maturity			
Mature	0	14	**0.028***
Immature	15	34	
Injury Mechanism			
Traumatic	14	29	0.15
Atraumatic	1	12	

Table 4. Data for Fractures Treated Surgically by Type of Surgery.

		MPFLR + ORIF (n = 5)	MPFLR ± Chondroplasty (n = 8)	P-value
		Mean ± SD		
Coronal MRI	Medial/Lateral Size (mm)	6.6 ± 5.0	3.7 ± 2.0	0.055
	Maximum Displacement (mm)	5.4 ± 2.7	3.5 ± 2.4	**0.036***
Sagittal MRI	Superior/Inferior Height (mm)	11.4 ± 1.3	12.2 ± 3.8	0.63
	Superior/Inferior Height (mm)	9.3 ± 3.0	9.9 ± 4.1	0.86
	Anterior/Posterior Depth (mm)	6.0 ± 2.0	4.5 ± 1.7	0.14
Axial MRI	Maximum Displacement (mm)	5.7 ± 3.4	5.0 ± 2.8	0.57
Articular Cartilage Involvement	Yes	5 (100)	6 (75)	0.47
	No	0 (0)	2 (25)	
Recurrent Dislocation	Yes	0 (0)	0 (0)	N/A
	No	5 (100)	8 (100)	