Juvenile Osteochondritis Dissecans of the Knee Shows Early Evidence of Radiologic Irregularity

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Introduction

The etiology and development of juvenile osteochondritis dissecans (JOCD) of the knee remain heavily debated[1]. Since the initial description by Franz König suggesting an inflammatory process[2], the definition of OCD has evolved into our current understanding of the disease as "a focal idiopathic alteration of subchondral bone with risk for instability and disruption of overlying articular cartilage that may result in premature osteoarthritis" [1,3,4]. The precise underlying pathophysiology for the development of JOCD remain unknown and is likely multifactorial, including genetic predisposition, vascular insufficiency, trauma, and bone fragility with non-specific histologic findings showing changes that resemble fracture non-healing. Nonetheless, providers should ideally be able to identify early disease with the goal of intervening before a lesion becomes unstable. While it is common for providers to look at old imaging studies in the clinic, to the authors' knowledge there are no reports investigating the timeline of lesion development in those patients later confirmed to have diagnosis of JOCD. This study aimed to determine the radiologic presence of JOCD lesions up to a decade prior to diagnosis.

Methods

Records at a single pediatric orthopaedic hospital between 2012-2020 were retrospectively reviewed for patients diagnosed with JOCD of the knee who also had imaging studies of the lower extremity performed >1 year prior to the establishment of a JOCD diagnosis. Only patients with both MRI and radiographic studies of the lower extremity at the time of diagnosis of JOCD of the affected knee were included. The search resulted in 24 patients that were included in the present study. 8 patients were excluded for poor visualization on early imaging of the affected knee and 2 patients were excluded for carrying a diagnosis other than JOCD upon further review[5]. Investigators carefully examined the early studies for any irregularities in the anatomic area of the later JOCD lesion, including lucency or sclerotic margin on plain radiographs and hypointense signal in subchondral bone on T1-weighted MRI sequences or subchondral bone edema on fluid-sensitive MRI sequences. Mann-Whitney U tests were performed to evaluate the difference in time to presentation and age at early imaging between patients with early images that showed irregularity and patients with early images that were normal.

Results

18 lesions in 14 patients (5 female) were included. Lesion location and imaging details are presented in Table 1.

All 18 lesions had early plain radiographs and 5 also had early MRI. 2 patients had multiple plain radiographs. The mean age at diagnosis was 12.5 years (range 6.4-17.7) and the mean interval between early imaging and diagnosis was 4.4 years (range 2.3-7.8). 36% (5/14) of all patients had early radiologic irregularities in the area of a later diagnosed JOCD lesion. 5/20 early radiographs and 1/5 early MRIs (Figure 1) had radiographic irregularities in the area of the later diagnosed lesion. All irregularities visible on plain radiographs were subtle lucency in a similar location and geometric pattern to the later diagnosed lesion (Figure 2). No difference was observed in time from imaging to diagnosis ($p=0.156$) or age at early imaging ($p=0.069$) between patients with images that showed irregularity and patients with normal images.

Discussion

Multiple classification schemes have attempted to radiologically stage knee OCD lesion progression [6–10]. Suggestions for the earliest possible imaging findings of OCD include focal subchondral lucency with sclerotic margins using radiographs or subchondral bone bruise, edema, and thickened articular cartilage with low signal changes using MRI [6,10,11].

Table 1: Lesion location and early imaging

ID	Sex	Age (diagnosis)	OCD Location	Side	Imaging Type	Indication	Age (imaging)	Early Evidence?	Description
1	M	15.0	MFC	L	XR	limp, heel pain	12.3	Y	lucency
			MFC	R	XR	limp, heel pain	12.3	N	
2	F	13.3	LFC	R	XR	pain, swelling	7.4	N	
3	M	12.0	MFC	R	XR	limp	4.2	N	
4	F	12.4	LFC	R	XR	pain	7.0	N	
					XR	distal femur fracture	9.9	Y	lucency
5	F	9.0	Tibial Plateau	R	XR	pain, swelling	5.7	N	
			Tibial Plateau	L	XR	pain, swelling	5.7	N	
6	M	17.7	LFC	R	XR	pain, swelling	12.9	N	
					MR	pain, swelling	12.9	N	
7	F	10.4	LFC	R	XR	unknown	4.4	N	
					XR	postop meniscectomy	8.2	N	
					MR	meniscal tear	7.7	N	
8	F	12.3	MFC	L	XR	pain, buckling	6.2	N	
					MR	pain, buckling	6.2	N	
9	M	13.3	LFC	R	XR	osteochondroma	10.5	N	
			MFC	R	XR	osteochondroma	10.5	Y	lucency
10	M	12.9	LFC	R	XR	postop meniscectomy	7.4	Y	lucency, sclerosis
					MR	meniscal tear	5.7	N	
11	M	6.4	MFC	R	XR	tibia/fibula fractures	1.2	N	
12	M	14.6	LFC	L	XR	skeletal survey	9.8	N	
13	M	9.1	LFC	R	XR	pain, limp	5.5	N	
			LFC	L	XR	pain, limp	5.5	N	
14	M	12.5	LFC	R	XR	postop meniscectomy	8.9	Y	lucency
					MR	postop meniscectomy	8.5	Y	hypointense T1 signal

MFC denotes medial femoral condyle, LFC denotes lateral femoral condyle, XR denotes radiograph, MR denotes MRI.

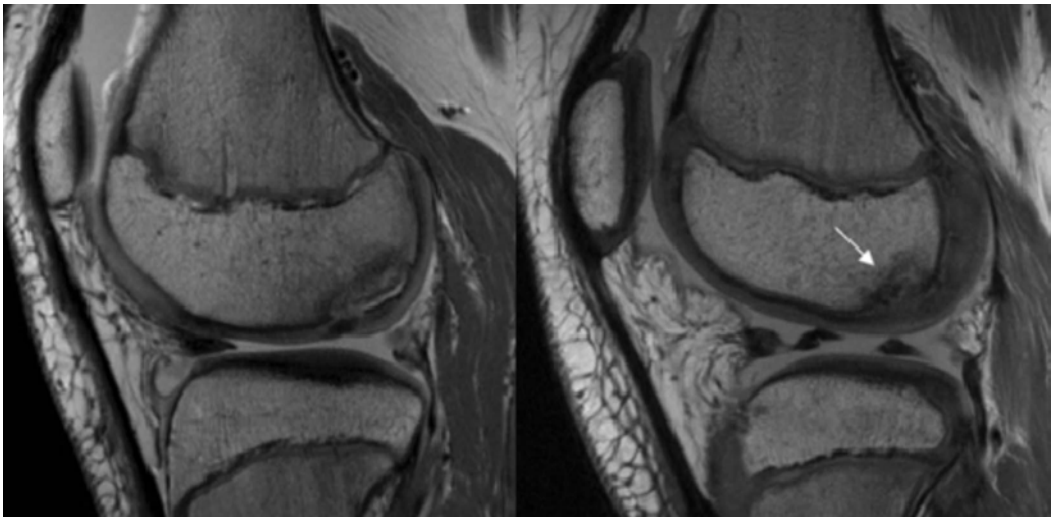

Figure 1. Sagittal PD images of the right knee of patient 14 diagnosed with OCD of the lateral femoral condyle at age 12 (left). Early images performed at age 8 (right) showing hypointense signal (arrow) in the area of the later diagnosed OCD lesion.

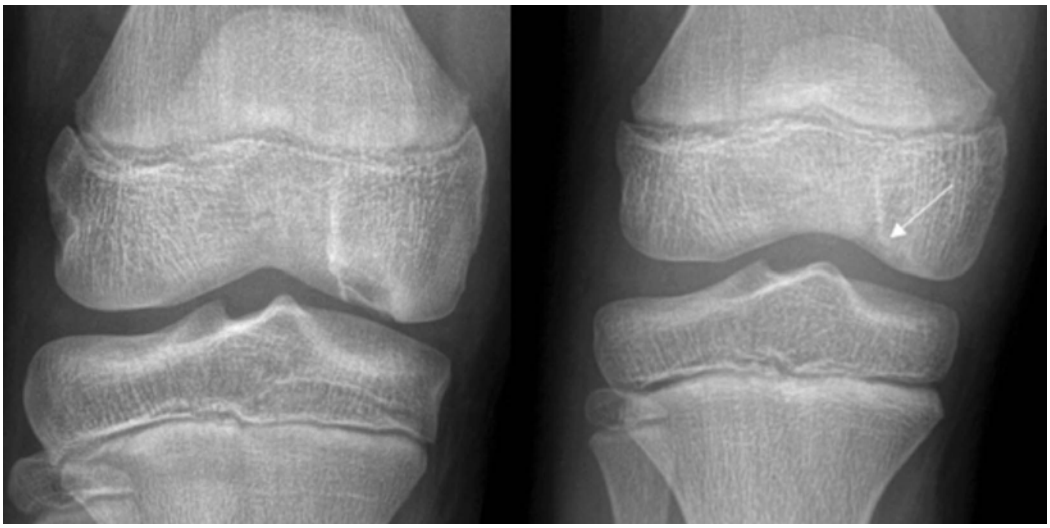

Figure 2. AP views of the right knee of a patient diagnosed with OCD of the medial femoral condyle at age 15 (left). Radiographs performed at age 12 (right) for a limp and heel pain show a subtle lucecny (arrow) in the area of the later diagnosed OCD lesion.

However, many of these studies examine patients at the time of diagnosis who likely went on to be treated. Thus, providing little insight into the radiologic development and evolution of untreated lesions. Here, we found that 36% of patients had radiologic irregularities in the location of the later diagnosed JOCD of the knee. Given these findings, and keeping in mind that JOCD has been partially attributed to prior trauma[12], providers evaluating post-traumatic radiographs of a pediatric patient should pay close attention to the subchondral bone of the knee to look for radiologic irregularities and early signs of JOCD. The most common finding was a subtle lucency on plain radiographs in the exact area of the future JOCD lesion. These incidental irregularities may then be followed with the aim of initiating early nonoperative treatment, when appropriate, and preventing lesion instability if JOCD develops[13,14]. We found no difference in time to diagnosis or age at early imaging between patients with imaging that showed irregularity and patients with normal imaging. Together, this data suggests that the rate of progression from irregularity to diagnosis of JOCD may vary between patients, rather than follow a predictable timeline.

While we show that radiologic irregularities can be visible for years prior to diagnosis, we could not provide evidence to support a JOCD tissue of origin. Studies using advanced imaging with 9.4-T MRI and histologic specimens provide some evidence for vascular insufficiency of the epiphyseal cartilage[15–17]. Other studies support the hypothesis that JOCD of the knee results from dysfunction of endochondral ossification in the maturing femoral condyles[18–20].

This study was limited by the small sample size and the potential for confirmation bias as early images were reviewed. We attempted to mitigate this bias by confirming evidence of early lesions with the senior author. Further studies are needed to fully map the early radiologic development of OCD of the knee.

Conclusion

More than one in three patients diagnosed with OCD of the knee may show early incidental radiologic irregularities in the location of the later diagnosed JOCD. Careful attention should be awarded to the subchondral bone as providers evaluate knee imaging of children who present with a lower extremity complaint.

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