ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2018/105–110/$2.00/©JCCA 2018

Adolescent knee pain: fracture or normal? A case report.

Melissa Corso, BSc, MSc, DC[1]
Scott Howitt, BA, CK, MSc, DC, FRCCSS(C), FCCPOR[1]

Background: *Knee injuries are the second to fourth most common injuries in youth soccer. In this population, sprains/strains, fractures and contusions are most common. Due to variations in the developing skeleton, it can be difficult to rule out fractures.*

Case Summary: *We present a case of a 13-year-old presenting to the emergency department (ED) with patellar pain after pivoting during a soccer game. After radiographic clearance, he was allowed to return to sport. Following another fall and ED visit, his full leg was casted. He presented to a chiropractor after cast removal, who made recommendations for progressive rehabilitation owing to the lack of evidence for fracture on radiographs.*

Summary: *We suggest a thorough history, physical and Ottawa knee rules to determine whether*

Contexte : *Les blessures au genou viennent au deuxième, troisième et quatrième rang des blessures courantes chez les jeunes joueurs de soccer. Dans cette population, les foulures ou entorses, les fractures et les contusions sont très fréquentes. En raison des variances de développement du squelette, il peut être difficile d'écarter les fractures.*

Résumé de cas : *On présente le cas d'un jeune de 13 ans admis dans un service des urgences (SU) en raison d'une douleur au genou apparue à la suite d'une torsion durant une partie de soccer. Après avoir constaté une absence d'anomalies sur les clichés radiographiques, on a autorisé le patient à jouer de nouveau au soccer. Mais l'automne suivant, lorsque ce patient a été admis de nouveau au SU, on a lui mis toute la jambe dans le plâtre. Il a consulté un chiropraticien après le retrait de son plâtre. Comme il n'y a avait aucun signe de fracture sur les radiographies, le chiropraticien lui a recommandé de suivre un programme de rééducation progressive.*

Résumé : *On recommande un examen minutieux des antécédents, un examen physique et l'utilisation des*

[1] Division of Graduate Studies, Canadian Memorial Chiropractic College

Corresponding Author:
Melissa Corso
Canadian Memorial Chiropractic College, 6100 Leslie Street, North York, ON M2H 3J1
Tel: 416-482-2340 ext. 501
E-mail: mcorso@cmcc.ca

No other affiliations to report. No disclaimers to report. No sources of support to report.
The patient involved in the case has provided consent for it to be used in a case report.

radiographs are indicated in the management of a pediatric knee injury. Due to normal skeletal variance, we recommend bilateral radiographs and if findings are ambiguous, consultation with a radiologist to confirm clinical suspicions.

(JCCA. 2018;62(2):105-110)

KEY WORDS: chiropractic, knee pain, adolescent, normal variant

règles d'Ottawa pour le diagnostic des pathologies du genou pour savoir si la prise de radiographies est pertinente dans la prise en charge des blessures au genou chez l'enfant. En raison des variantes anatomiques de la normale, on recommande la prise de radiographies bilatéralement et si les résultats d'examen sont ambigus, la consultation d'un radiologue pour confirmer les soupçons.

(JCCA. 2018;62(2):105-110)

MOTS CLÉS : chiropratique, douleur au genou, adolescent, variante de la normale

Introduction

The prevalence of reported pediatric knee injuries in soccer players varies in the literature. In a study by Rossler *et al*., knee injuries were the second most common injuries in children playing soccer after the ankle.[1] While Kerr *et al*. report that knee injuries are the fourth most common in youth and adolescent soccer players, after head/face, ankle and hand/wrist injuries.[2]

Epidemiological studies identify that 14 to 17 year olds tend to sustain more injuries than younger age groups and males tend to be injured more often than females.[2–4] Therefore, it appears that maturation and sex may have an effect on the incidence and type of injury. For example, youth who have not reached full skeletal maturation seem to have more fractures, and fewer strains and sprains, as well as more upper body injuries compared to older age groups who have reached full maturity.[1] Males had a greater proportion of fractures and lacerations, whereas females had a higher proportion of concussions.[2]

In the pediatric population, the most common diagnoses were sprains/strains (30.5-34%), fractures (15.4-23%) and contusions (12.5-17.7%).[1–5] More than 50% of acute fractures were in the upper body and almost half of these were a direct result of a fall.[1] When looking at fractures alone, 62.5% occurred in the upper limbs, 35% in the lower limbs and 2.5% in the trunk (ribs).[1] Acute fractures had increasing incidence rates from younger to older players.[1,3,6] Sprains and strains tended to be more common in older age groups.[3] Similar prevalence were found in both sport teams and emergency department populations.[1]

In non-acute fractures, approximately 63% were growth related and involved the knee (Osgood-Schlatter syndrome) or the foot (Sever's disease).[1] The incidence of non-acute fractures peaked between 11 and 12 years old.[1] Osgood-Schlatter syndrome occurs at the tibial tuberosity where the apophyses cannot withstand the forces exerted by the quadriceps muscles.[7] This results in micro-avulsions of the quadriceps tendon insertion and may present as an enlarged tibial tuberosity.[7,8] The development of Sever's disease is similar to Osgood-Schlatter syndrome, differing in location, where it can be identified at the attachment of the Achilles tendon to the calcaneus.[7,9] Clinically, these conditions can be diagnosed with pain on palpation of the tendinous insertion, potentially an enlargement of the insertion and tension in the associated musculature due to the differential growth rate of the bones and muscles during maturation.[7] Specifically, the rectus femoris and hamstrings in Osgood-Schlatter syndrome, and the triceps surae in Sever's disease.[7] In addition, Sever's disease tends to present in boys between 8 to 12 years old, whereas Osgood-Schlatter syndrome tends to present comparatively later in adolescence.[7,8] Both of these conditions are aggravated by activity and relieved by rest.[7,8] Radiographic diagnosis is not recommended in the management of these conditions, however, they should be considered if pain is predominantly unilateral or pain is persistent.[7,9]

When a youth or adolescent patient presents with an injury, it is first important to gather information from the history and physical exam to inform in which case

radiographs would alter the clinical management.[10] It is also valuable to corroborate the mechanism of injury with coaches or parents who were present, which may provide more information than the youth athlete can recall. The Ottawa knee rules (OKR) and/or Pittsburgh decision rules (PDR) were developed to reduce the number of radiographs ordered and more accurately determine those in need of radiographs after acute knee injuries. In the adult population, the OKR are 100% sensitive to detect clinically significant fractures in adults with knee injuries.[6,11] The OKR recommend radiographs for patients with acute knee injury, and at least one of the following: older than 55 years, tenderness at the head of the fibula, isolated patellar tenderness, inability to flex the knee to 90 degrees, and inability to weight bear immediately and in the emergency room.[6,11] In children, the OKR were also 100% sensitive, with only a 42.8% specificity, using all criteria for those more than 55 years old.[10,11] The interobserver reliability was 0.85 overall, ranging from 0.62 in the youngest age group to 1.0 in the oldest.[11] This study even included Salter Harris type I and II fractures.[11] The PDR recommend radiographs for fall or blunt-trauma as mechanism of injury and age less than 12 or greater than 50 years old, or the same mechanism of injury with the inability to walk or weight bear four steps in the emergency department.[12] Sensitivity ranges from 77-100% and specificity ranges from 57-79%.[11,12,13] In a study comparing the OKR and PDR, they had similar sensitivities (85%), but the PDR had greater specificity, however in others, the OKR may have greater sensitivity.[12,14] The recommended normal series of radiographs are the anterior-posterior and lateral knee views.[10]

The purpose of this case report is to highlight the importance of using clinical information and radiographs to determine the appropriate plan of management in pediatric knee injuries. Specifically, recommending the use of the OKR or the PDR, bilateral radiographs if radiographs are warranted and getting a second opinion if needed.

Case Presentation

A 13-year old right-foot dominant male soccer player presented to a sports chiropractor (Fellow of the Royal College of Chiropractic Sports Sciences – Canada) complaining of right knee pain at the distal pole of the patella, most apparent to the patient when descending stairs. He presented six days after having a full-length leg plaster cast removed. Three and a half weeks prior to his visit to the chiropractor, he experienced a "popping" pain (10/10 using the Numeric Pain Rating Scale (NPRS)) during a directional change with the right leg planted while playing soccer. The pain was in the medial aspect of the right knee. He was assisted off the field, unable to weight bear, and was transported to the local emergency department (ED) by his parents. The ED radiographs prompted a referral to the fracture clinic for orthopaedic consultation due to a lucency identified in the inferior pole of the patella (Figure 1). Upon orthopaedic consultation, he was discharged, and immediately allowed to return to play, as this finding was deemed normal. Two and a half weeks after the initial injury, the athlete inadvertently fell onto his right knee, causing extreme pain. This prompted a return to the ED, another set of radiographs and a recommendation to cast the entire leg (foot to hip). The cast was subsequently removed after two weeks, with further recommendations to rest.

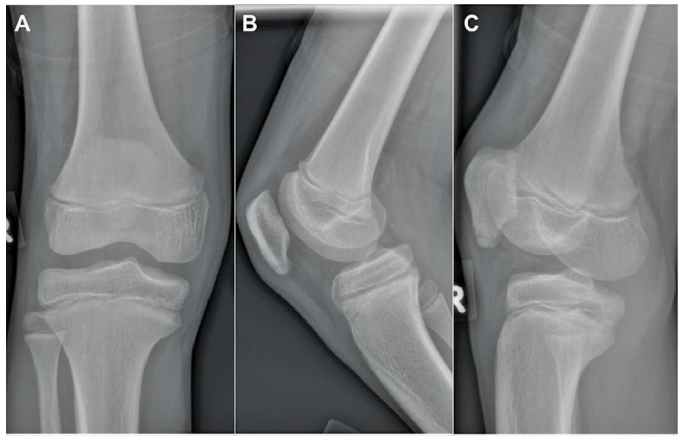

Figure 1.
Right knee radiographs from ED first visit.
A) AP knee B) Lateral knee
C) Oblique knee.

Upon presentation to the sports chiropractor, the right quadriceps was visibly atrophied (25.5 cm on the right, compared to 27 on the left, measured 4 cm above the patella). There was no swelling apparent on either the medial or lateral aspect of the patella, or at the tibial tuberosity. The patient was unable to squat beyond 90 degrees of knee flexion due to increasing pain and pressure around the patella, with valgus also noted during the

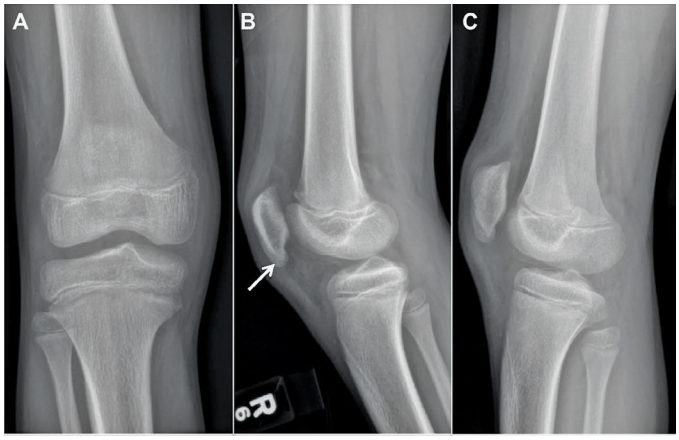

Figure 2.
Right knee radiographs from ED second visit. A) AP knee B) Lateral knee C) Oblique knee. Arrow indicates subcortical blurring.

movement. Meniscal orthopaedic testing was negative, including Thessaly's test, McMurray's and joint line tenderness. ACL laxity was noted bilaterally during anterior drawer and Lachman's tests. Posterior drawer, valgus and varus stress tests, and ligamentous palpation were all negative. Thomas test revealed quadriceps tightness bilaterally (right knee flexion at 120 degrees, and 110 degrees on the left), with hip flexor tone within normal limits. Upon palpation, there was exquisite tenderness at the inferior pole of the right patella (8/10 NPRS) with moderate tenderness in the middle of the patellar tendon and the tibial plateau (3-4/10 NPRS). The differential diagnoses of the sports chiropractor included right-sided Sinding-Larsen-Johansson disease, Osgood-Schlatter syndrome, patellar tendinopathy and the previously suspected patellar fracture.

Anterior-posterior and lateral radiographs were available from both visits to the ED. Upon review by the chiropractor, there was a high suspicion that the radiographs were normal for a boy of this age. Therefore, the chiropractor received a second opinion from a chiropractic radiologist, to ensure his recommendations to the patient were appropriate. Figure 1 includes radiographs from the patient's first visit to the ED and Figure 2 includes radiographs of the second visit to the ED.

The radiology report stated that bone density was adequate with unfused physes and apophyses. The cortices and trabeculae were intact. No widening of the physes or displaced apophyses were visualized. The patellar height was well maintained. The medial and lateral femorotibial joints and patellofemoral joints were well maintained. The Hoffa's fat pad was intact and no swelling of the suprapatellar recess was visualized. The radiologist's impressions were an unremarkable radiographic study of a skeletally immature right knee.

A clinical comment was included regarding the follow-up radiographic study of the right knee, showing slight cortical blurring at the anterior aspect of the inferior half of the patella with a faint subcortical oblique lucency. No adjacent soft tissue swelling was seen. This likely represents bony resorption secondary to bone contusion to this region. The faint irregular lucency at the inferior pole of the patella on the initial study was not present on the second study and as such, does not represent a non-displaced fracture.

Having ruled out a patellar fracture, the patient was given technical instruction for the squat movement patterns to reduce valgus stress and was encouraged to begin a progressive rehabilitative return to play program with his soccer club. This included box squats to 90 degrees and progressive lowering with reduced pain and progressive and regressive angular isometric loading contractions in 15° increments from a seated position. The patient was instructed to increase his protein intake to 5 servings of 20 grams of protein per day.[15–17] Three weeks after initial presentation to the sports chiropractor, the patient had a 0.5 cm discrepancy in girth of the quadriceps, was squatting to 130 degrees without pain, and demonstrated the ability to perform agility, speed and soccer specific activities without pain (including running figure eights, cutting, jumping, sprint and striking a soccer ball). The patient was cleared to resume soccer activities at this time.

Discussion

Patellar fractures are not a common injury in children. Only one percent of patellar fractures occur under the age of 15.[10] While patellar fractures can occur from direct and indirect mechanisms, direct forces through the patella are the most common cause.[10] The smaller prevalence of patellar injuries in the pediatric population is thought to be due to a smaller extensor muscle mass reducing the forces on the patella in indirect injuries and a cushioning effect of the surrounding cartilage in direct mechanisms.[10]

With regards to the clinical note by the chiropractic radiologist, showing slight cortical blurring at the anterior aspect of the inferior half of the patella suggesting bone resorption secondary to a bone contusion, this was made on the basis that bone being resorbed is much less dense than normal bone.[18] This is associated with the remodelling phase of bone.[18] When combined with clinical and radiographic findings, such as the lack of soft tissue swelling, clinically and radiographically, as well as the change in the cortical lucency first demonstrated on the radiograph, it was concluded that this finding was not associated with fracture, but likely to a bone contusion to the patella.

It is imperative to remember that the developing skeleton has a number of secondary growth centres that appear irregular upon visualization on radiographs.[10] To add to the complexity, not only can they be irregular, they can also be asymmetrical.[10] For example, irregularities in the lateral and medial epiphysis of the femur can be mistaken for pathologies such as osteochondritis or destructive processes, although they are a normal developmental stage.[10] Other normal findings include a notch or groove for the tendon of the popliteus on the lateral aspect of the lateral femoral condyle, specifically visible in adolescents, and the os fabella, a sesamoid bone in the gastrocnemius.[10] Therefore, we suggest that bilateral radiographs be taken if a fracture is suspected around a joint to determine the normal appearance of secondary growth centres of the involved bones.

There are many normal variants of the patella during development, as demonstrated in this case.[10] Ossification begins around three to five years of age, and begins as multiple centres that coalesce over time.[10] The initial ossification can appear granular or irregular, and may appear as radio-opaque densities in the soft tissues.[10] In addition, secondary ossification centres can be easily mistaken as fractures.[10] The most common ossification centre of the patella is of the superolateral corner, which is known as a bipartite patella if it remains unfused.[10] Other accessory ossification centres can also be found at the upper and lower poles of the patella, such as in the case presented, or on the medial or lateral borders.[10] These are often variable and asymmetric.[10]

Other ossification centres in the knee include the tibial tubercle, which begins to ossify between seven to nine years, beginning at the distal end, enlarging proximally and anteriorly.[10] The main tibial ossification proceeds in the opposite direction, down toward the tubercle.[10] Epiphyseal cartilage remains between these ossification centres until near physeal maturity.[10] On the occasion where the ossification centre appears prominent, irregular or fragmented, it may indicate a possible avulsion or the presence of Osgood-Schlatter's syndrome, however, it is more often than not, a normal variant of this region.[10] It is important to note that Osgood-Schlatter's syndrome must also be differentiated from Sinding-Larsen-Johansson syndrome, a traction apophysitis of the distal pole of the patella.[10] Sinding-Larsen-Johansson syndrome is characterized by pain at the inferior pole of the patella with fragmentation of or calcification at the pole upon imaging.[19] The prevalence of this condition is lower than Osgood-Schlatter's syndrome, ranging between two to five percent in healthy 10 to 14 year olds.[19] Radiographic changes of the inferior pole of the patella can often be difficult to discern due to the variants in ossification centre, emphasizing the need for bilateral radiographs to identify differences from the symptomatic to asymptomatic sides.[19,20] The physis of the proximal tibia is undulating in shape, appearing different on different radiograph views, which can be mistaken for an epiphyseal fracture.[10] Localized angulations in the physis appearing as depressions in the metaphysis, may also appear abnormal, but again, can be a normal developmental variant.[10] It is possible that areas of accessory ossification centres relating to the epiphysis and physis appear small and irregular and should not be mistaken for fractures.[10]

The differential diagnoses considered in this case included Sinding-Larsen-Johansson syndrome, driven by the age of the patient and location of the chief complaint at the inferior pole of the patella[10], Osgood-Schlatter syndrome, a common condition in the active pediatric population[1], patellar tendinopathy, due to the location of the pain, aggravating activities and demands of the sport (running, jumping and change in direction) and the previously suspected fracture. If a fracture is on the list of differential diagnoses, it is important to take the necessary steps to rule out its involvement, but also, to be sure it is a fracture, if this diagnosis is made. As demonstrated in this case, even two weeks of cast immobilization can have a significant impact on muscle atrophy, in an otherwise healthy young athlete. Evidence suggests that significant muscle atrophy can occur after five days of immobiliz-

ation.[21] A 3.5% loss in quadriceps cross-sectional area occurred after five days of immobilization, increasing to 8.4% loss after 14 days.[21] This is associated with a 9% and 22.9% decrease in quadriceps muscle strength after five and 14 days of immobilization, respectively.[21]

Summary

According to FIFA, as of 2006, soccer has at least 265 million participants worldwide.[22] Of these, approximately 22 million players are youth.[22] Depending on the source in the literature, knee injuries are the second to fourth most common injuries in youth and adolescent soccer players.[1,2] These knee injuries can range from acute fractures, non-acute fractures, to sprains and strains; the prevalence of which vary based on age and sex.[1–3,6] The OKR are an important tool that can be used to determine if the patient should have radiographs taken, which can help the clinician rule out fractures, or other serious injuries. Given the normal variance possible in this population, clinicians should be cautious in diagnosing normal findings as fractures, as this may have significant functional implications for the patient.[21] The use of bilateral radiographs, in addition to the history and physical examination should be used to inform their diagnoses. Given a situation where they may be unsure, it is always prudent to get a second opinion from a radiologist.

References

1. Rössler R, Junge A, Chomiak J, Dvorak J, Faude O. Soccer injuries in players aged 7 to 12 years. Am J Sports Med. 2016;44(2):309-317.
2. Kerr ZY, Pierpoint LA, Currie DW, Wasserman EB, Comstock RD. Epidemiologic comparisons of soccer-related injuries presenting to emergency departments and reported within high school and collegiate settings. Inj Epidemiol. 2017;4(1):19.
3. Adams AL, Schiff MA. Childhood soccer injuries treated in U.S. emergency departments. Acad Emerg Med. 2006;13(5):571-574.
4. Smith NA, Chounthirath T, Xiang H. Soccer-related injuries treated in emergency departments: 1990-2014. Pediatrics. 2016;138(4):e20160346-e20160346.
5. Leininger RE, Knox CL, Comstock RD. Epidemiology of 1.6 million pediatric soccer-related injuries presenting to US emergency departments from 1990 to 2003. Am J Sports Med. 2007;35(2):288-293.
6. Stiell IG, Greenberg GH, Wells GA, et al. Prospective validation of a decision rule for the use of radiography in acute knee injuries. J Am Med Assoc. 1996;275(8):611.
7. Launay F. Sports-related overuse injuries in children. Orthop Traumatol Surg Res. 2015;101(1):S139-S147.
8. Vaishya R, Azizi AT, Agarwal AK, Vijay V. Apophysitis of the tibial tuberosity (Osgood-Schlatter Disease): a review. Cureus. 2016;8(9).
9. Perhamre S, Lazowska D, Papageorgiou S, Lundin F, Kla M, Norlin R. Sever ' s injury a clinical diagnosis. 2013;103(5):361-368.
10. Baert AL, Knauth M, Sartor K. Imaging in Pediatric Skeletal Trauma. (Johnson KJ, Bache E, eds.). Springer; 2008.
11. Bulloch B, Neto G, Plint A, et al. Validation of the Ottawa Knee Rule in children: a multicenter study. Ann Emerg Med. 2003;42(1):48-55.
12. Cheung TC, Tank Y, Breederveld RS, Tuinebreijer WE, De Lange-De Klerk ESM, Derksen RJ. Diagnostic accuracy and reproducibility of the Ottawa Knee Rule vs the Pittsburgh Decision Rule. Am J Emerg Med. 2013;31(4):641-645.
13. El Ashry SR, El Gamal TA, Challagundla SR, Ntala CA, Nagy AM, Crane EO. X-rays for acute knee injuries: Pre- and post-Pittsburgh decision rules implementation. A district general hospital experience. Ortop Traumatol Rehabil. 2016;18(5):471-475.
14. Konan Sujith S, Zang TT, Tamimi N, Haddad FS. Can the Ottawa and Pittsburgh rules reduce requests for radiography in patients referred to acute knee clinics? Ann R Coll Surg Engl. 2013;95(3):188-191.
15. Kerksick CM, Arent S, Schoenfeld BJ, et al. International society of sports nutrition position stand: nutrient timing. J Int Soc Sports Nutr. 2017;14(1):1-21.
16. Thomas D. Nutrition and athletic performance. J Am Med Assoc. 2016;48(3):543-568.
17. Witard OC, Jackman SR, Breen L, Smith K, Selby A, Tipton KD. Myofibrillar muscle protein synthesis rates subsequent to a meal in response to increasing doses of whey protein at rest and after resistance exercise. Am J Clin Nutr. 2018; 99(1):86-95.
18. Mulligan ME. The "gray cortex": an early sign of stress fracture. Skeletal Radiol. 1995;24(3):201-203.
19. Iwamoto J, Takeda T, Sato Y, Matsumoto H. Radiographic abnormalities of the inferior pole of the patella in juvenile athletes. Keio J Med. 2009;58(1):50-53.
20. Gottsegen CJ, Eyer BA, White EA, Learch TJ, Forrester D. Avulsion fractures of the knee: imaging findings and clinical significance. Radiographics. 2008;90033(6):1755-1771.
21. Wall BT, Dirks ML, Snijders T, Senden JMG, Dolmans J, Van Loon LJC. Substantial skeletal muscle loss occurs during only 5 days of disuse. Acta Physiol. 2014;210(3):600-611.
22. FIFA C. FIFA Big Count 2006: 270 million people active in football. FIFA Commun Div Inf Serv. 2007;31:1-12.