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Acute Traumatic Knee Effusions in Children and Adolescents

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Summary: A prospective analysis was completed during a 6-month period to identify all patients, age 18 years or younger, who presented for evaluation of their knee effusion. There were 44 injured knees in 44 patients. There were a total of 55 diagnoses: 16 (29%) anterior cruciate ligament (ACL) injuries, 16 (29%) meniscal tears, 14 (25%) patellofemoral subluxations or dislocations, 3 (5%) medial collateral ligament sprains, 2 (4%) patellar osteochondral fractures, 2 (4%) retinacular injuries, 1 (2%) posterior cruciate ligament rupture, and 1 (2%) tibial eminence fracture. Girls had 11 of the 14 patellofemoral injuries; 58% of the girls had effusions secondary to patellofemoral pathology compared with 12% of the boys. Boys had 10 of the 16 meniscal tears and 13 of the 16 ACL tears. Fifty-two percent of boys had an injury to the ACL and 44% had an injury to a meniscus. In contrast, 16% of girls had an ACL injury and 32% had meniscal tears. ACL injuries, meniscal tears, and patellofemoral pathology accounted for 87% (48/55) of the diagnoses. Girls were more likely to have patellofemoral pathology; boys were more likely to have ACL and meniscal tears. **Key Words:** Adolescent knee injuries—Knee effusions—Knee hemarthroses—Pediatric knee injuries.

During the past 20 years, there has been a progressive increase in the number of young people participating in organized sports (3,21). With the increase in sports participation, more young athletes are presenting for diagnosis and treatment of musculoskeletal injuries. In pediatric athletes, the knee is the most frequent site of sports-related injury (21).

The complexity of the knee joint can make diagnosis difficult, even under optimal conditions. Primary evaluation of traumatic knee injuries in the pediatric patient has been shown to be diagnostically challenging (15,29). This is partly because of age-dependent psychosocial issues and the added complexity of the immature knee joint. One must consider additional diagnoses that are unique, or at least more common, in patients with immature skeletons (e.g., distal femoral physeal/metaphyseal fractures, proximal tibial physeal/metaphyseal fractures, tibial eminence fractures). However, a high level of diagnostic accuracy has been shown to be possible by those skilled in this area (26).

To identify the cause of the traumatic knee effusion, the clinician needs to perform a detailed examination and must have a thorough understanding of knee joint anatomy with its potential diagnoses. Few published reports deal with the evaluation and diagnosis of acute knee injuries in children and adolescents. A series by Stanitski et al. (27) reported anterior cruciate ligament (ACL) tears in 47%, isolated meniscal tears in 30%, combined ACL/meniscal injuries in 16%, and osteochondral injuries in 7%. In contrast, a series by Bergstrom et al. (4) of 30 knees identified 15 collateral ligament sprains, 13 ACL ruptures, 10 patellofemoral injuries, 5 meniscal tears, 4 posterior cruciate ligament (PCL) injuries, 4 arcuate ligament tears, and 2 popliteus tears. The wide variation in the frequencies of these diagnoses makes it difficult to create a list of potential diagnoses. A comprehensive knowledge of the possible and most likely diagnoses should improve patient care by allowing more rapid diagnosis with the minimum of radiologic and invasive interventions.

This report describes the presentation and diagnosis of traumatic knee effusion in children and adolescents. Emphasis was placed on injury history, clinical presentation, and final diagnosis.

MATERIALS AND METHODS

A prospective analysis was completed during a 6-month period from July 1, 1999 to December 31, 1999 to identify all patients who presented for evaluation of acute, traumatic knee effusions. Knee effusions were evaluated in an outpatient office setting by a pediatric fellowship-trained orthopaedic surgeon. Inclusion criteria were age 0 to 18 years and acute onset of knee effusion secondary to a known acute knee injury. Exclusion criteria included atraumatic knee effusions, previous ip-

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silateral knee surgery, and a history of inflammatory arthropathy.

At the primary evaluation, all patients underwent a routine clinical and radiographic knee evaluation. A routine four-view radiographic series was completed in all patients (anteroposterior, lateral, notch, and Merchant's views). Patellar subluxation was defined as the lateral margin of the patella projecting lateral to the femoral trochlear edge on Merchant's views. Patellar tilt was assessed on Merchant's views.

The presence of an intra-articular effusion was determined by clinical evaluation. To assess for an effusion, the patient was placed in the supine position with the knee in full extension. The suprapatellar pouch was manually compressed, forcing the joint effusion distally to the level of the patella and patellar tendon. Ballottement of fluid medially and laterally was classified as an effusion, referencing the contralateral knee as normal for each patient. A mild effusion was a small amount at joint fluid not visually discernible and only detected manually. A moderate effusion was easy to visualize, causing the peripatellar areas to lose normal bony contours. A large effusion was defined as a tense joint space with a ballottable patella.

After the criteria for inclusion were established, the remainder of each patient's care was influenced only by the working diagnosis. All knee injuries were managed by the attending surgeon according to that surgeon's preferred method of diagnosis and treatment. There were no established treatment protocols to influence the delivery of care. Additional radiographic assessment (i.e., magnetic resonance imaging [MRI] scan) was left to the discretion of the treating physician. Surgical interventions were performed after the final diagnoses were established, if clinically indicated. Patients were followed-up clinically until resolution of symptoms and/or until completion of their postoperative care. Patients were contacted by phone or examined in the office to verify resolution of knee symptoms and return to normal athletics/activities.

RESULTS

Forty-four patients with 44 knees were identified who satisfied the criteria for inclusion. There were 25 boys and 19 girls. There were 18 left knees and 26 right knees. Mean age at injury was 14 years 8 months (range 8 years 3 months to 18 years 0 months). There were six patients younger than 13 years. Follow-up averaged 21 months (range 16–26). Follow-up was by phone in 38 patients and by office visits in six patients. Prospective data collected focused on patient demographics, sport and injury mechanism, postinjury symptoms (development of effusion <6 hours after injury, "pop" at time of injury, ability to bear weight, and instability and mechanical symptoms), clinical examination, radiologic studies, and operative findings.

Mean time from injury to initial orthopaedic evaluation was 17 days (range 1–190). Twenty-eight patients (64%) reported hearing a "pop" at the time of injury, and all patients had immediate pain at injury with knee swelling less than 6 hours after injury. At the primary evaluation, knee effusions were noted in all patients: mild in 10, moderate in 20, and large in 14. Documented activity at the time of knee injury was football in nine, soccer in nine, activities of daily living in five, cheerleading in four, hockey in two, volleyball in two, bicycling in two, physical education class in two, and nine in various sporting activities.

The plain radiographic series was normal in 35 and abnormal in nine. Patellofemoral findings (patellar tilt, patellar subluxation, or osteochondral loose body) were documented in seven of the 14 knees with patellofemoral dislocation or subluxation episodes. One Segond's fracture (1 of 16 ACL injuries) and one tibial eminence fracture were the other abnormal findings on the plain radiograph series. MRI scans were obtained in 29 of the 44 knees (66%), typically for working diagnoses of ACL injury, meniscal injury, intra-articular fracture, and loose bodies. All meniscal tears, those associated with ACL tears and the isolated injuries, were identified preoperatively and confirmed intraoperatively. Only two of the 14 patellofemoral injuries underwent MRI examinations, both for presumed osteochondral loose bodies.

The 44 knees had a total of 55 diagnoses: 16 ACL injuries (36% of the knees), 16 meniscal tears (36%), 14 patellofemoral subluxations or dislocations (32%), 3 medial collateral ligament (MCL) sprains (7%), 2 patellar osteochondral fractures (5%), 2 retinacular contusions (5%), 1 PCL injury (2%), and 1 tibial eminence fracture (2%). Sixteen meniscal tears were identified, seven involving the medial meniscus and nine involving the lateral meniscus. Thirty-eight percent of the meniscal tears (one medial, three lateral, and one both) had an associated ACL tear. Of the 16 ACL injuries identified, 75% were complete injuries and 25% were partial injuries. Thirty-one percent of the ACL tears ($n = 5$) had an associated meniscal tear (two medial and four lateral); the remaining 69% were isolated injuries. No injury was seen exclusively in one age group or gender, nor were any trends identified.

In the 44 knees, the mechanism of injury was an indirect cause in 30 and direct in 14. An indirect mechanism was responsible for nine of the 16 ACL injuries, 10 of the 16 meniscal tears, and 12 of the 14 patellofemoral injuries. The classic "pop" at the time of injury was reported in 10 of the 16 ACL injuries and in 12 of the 14 patellofemoral injuries. Combined, ACL tears and patellofemoral injuries represented 26 of 33 knees (79%) that "popped" at the time of injury.

Analysis of the injuries revealed some gender differences. Boys had 10 of the 16 meniscal tears and 13 of the 16 ACL tears. Overall, 52% of boys had an effusion caused by an ACL injury, and 44% of boys had an injury caused by meniscus. In contrast, girls had six meniscal tears (32% prevalence) and three ACL injuries (16% prevalence). In contrast, 11 of the 14 patellofemoral injuries were in girls. Overall, 58% of girls had an effusion secondary to patellofemoral pathology, compared with 12% of boys (3 of 25 patients). Four of the five knee

injuries in patients with a history of previous knee problems were caused by patellofemoral pathology.

Breakdown of injuries by sports participation at the time of injury demonstrated subtle differences. Injuries during football participation (n = 9) were six ACL tears, five meniscal tears, two MCL sprains, and one PCL tear. There were no patellofemoral subluxation or dislocation episodes. Injuries during soccer participation (n = 9) were three ACL tears, two meniscal tears, one MCL sprain, and three patellofemoral injuries. When injuries during cheerleading activities and activities of daily living (n = 9) were combined, there were two ACL tears, one meniscal tear, and six patellofemoral injuries. Surgical management was performed in 21 knees: 10 ACL reconstructions (all complete injuries), six partial meniscectomies (4 lateral, 2 medial), five meniscal repairs (3 medial, 2 lateral), four patellar realignments with two loose body removals, and one tibial eminence fracture (open reduction and screw fixation). Undoubtedly, with longer follow-up more knees will undergo surgical management, such as the two complete ACL tears treated nonoperatively.

All patients at last contact had returned to full activities, and there were no changes in the final diagnosis for any patient.

DISCUSSION

For this report, the term "traumatic knee effusion" was chosen as the clinical description of the patient presentation instead "traumatic knee hemarthroses." In the clinical setting, knee effusions are classically assumed to be hemarthroses if they are traumatic in origin and occur within several hours after injury. Because none of the knees underwent arthrocentesis, a decision was made to simply describe the clinical presentation of this problem instead of assuming all were hemarthroses. The significance of this entity in the adult or pediatric patient, and whether called an acute traumatic knee "effusion" or "hemarthrosis," is well documented and often represents an important injury (5,6,8,9,18,19,23,27,29). The findings of this study concur, with 21 of the 44 knees undergoing surgical management.

To those familiar with the care of the pediatric patient, the difficulty of diagnosing pediatric musculoskeletal conditions is well known. Diagnosis of the acute pediatric knee injury can be challenging because of multiple factors (2,16). Young patients may not remember the mechanism of injury; they frequently have difficulty detailing their joint problems, and they unknowingly limit the accuracy of the knee examination through lack of cooperation or inconsistent verbal responses (5). The accuracy of preoperative knee diagnoses is lowest in the preadolescent age group (18%–55%) (10,15,28,29). Adolescents are slightly better, with preoperative diagnoses being accurate 44% to 70% of the time (10,15, 28,29).

During the past 30 years, improvements in the care of knee injuries have occurred because of the significant basic research and clinical investigations that have been performed during that time period. The advent of knee arthroscopy has arguably been the single most important tool in advancing the understanding of the knee joint; it is an unparalleled tool for surgical care of intra-articular pathology. Knee arthroscopy has been shown to be a safe diagnostic and therapeutic technique in children and adolescents (2,10,19,22,27,29,32). Some have advocated its use in the pediatric patient as a diagnostic tool for all knee hemarthroses, because of concerns about a significant intra-articular knee injury (2,4,9,16). Knee arthroscopy has also been advocated for the difficult examination (2), to alleviate parental or patient anxiety (28), and for all patellar dislocations (2,29).

Unfortunately, the widespread use of knee arthroscopy for knee problems in the younger age groups has led to a significant number of "normal" arthroscopies. Harilainen (14) reported on arthroscopies of new-onset knee hemarthroses and found only 66% of arthroscopies were "useful or very useful"; 34% were found to be "useless". Eiskjaer (9) found a normal knee arthroscopy in 23% of children with acute knee hemarthrosis; in another 38%, no surgically treatable lesion was encountered during arthroscopy. The universal acceptance of arthroscopy and its ease of use may have diminished its stature as a diagnostic and therapeutic tool. In fact, some do not consider knee arthroscopy to be a surgical procedure: "Unnecessary surgery was avoided in these children because a different diagnosis was made or the treatment was accomplished through the arthroscope" (32). In this study, the overall rate of surgery was 48%, which is significantly less than the surgical rate in adults (8), with 20 of the 21 surgeries including arthroscopy. Routine use of knee arthroscopy should not replace a thorough physical and radiographic examination for acute knee injuries (26).

One of the main reasons for more limited use of knee arthroscopy in acute knee effusions is because of the advances in radiologic imaging, specifically MRI. The use of MRI has significantly improved the nonsurgical diagnosis of knee injuries (17). However, interpretation of MRI scans of the knee, adult and pediatric, can be inaccurate (11,24,27). In children and adolescents, the accuracy of knee MRIs is undergoing scrutiny, with more inaccuracies documented in the youngest patients (20,27,33). In general, MRI should be used only after a careful history and physical examination have been performed (27,31). In this series of patients, though not specifically quantified, the physical examination typically was effective in determining most of the final diagnoses (25). The judicious use of MRI enabled the detection of associated lesions (meniscal tears, osteochondral injuries) not easily identified during office evaluation and confirmation of suspected diagnoses. Physical examination and MRI scans were effective in determining the correct diagnoses in all patients, thereby preventing any arthroscopies from being performed solely for diagnostic purposes.

In this study, ACL injuries, meniscal tears, and patellofemoral pathology accounted for 48 of the 55 diagnoses. The frequencies of the major diagnoses, and their

interrelationship, were within the ranges reported in previous studies (1,2,4,9,12,13,16,19,27,29–32). One difference was the presence of osteochondral injuries or loose bodies in knees with patellofemoral pathology. Previous reports have identified osteochondral injuries or loose bodies in 29% to 70% of pediatric patients with patellofemoral pathology, with only 26% to 36% of these diagnosed preoperatively (2,19,29). In this study, only four of the 14 knees with patellar dislocation or subluxation episodes underwent surgical management (all patellar realignments). Preoperatively, loose bodies were identified in two of those four knees; the other two knees had pristine patellofemoral articulations without visualizable cartilage injuries. Because routine MRI scans and diagnostic knee arthroscopies were not performed, some articular cartilage injuries were undoubtedly not identified. The lack of persistent symptoms at the patellofemoral joint and the lack of mechanical symptoms indicated that no clinically significant lesion was missed.

Gender differences were documented within this series. Girls were more likely to have patellofemoral pathology; boys were more likely to have ACL and meniscal tears. The reason for this difference is not clear. Patellofemoral problems are more common in females than males (7), and the greater number of girls in this study with patellofemoral problems cannot explain the four-fold greater frequency of ACL injuries in boys. In my experience, there are three- to four-times more girls presenting with ACL tears than boys. The most likely cause for this is that the study data were collected during football season. DeHaven and Lintner (7) reported that football was the most common sport in which injury occurred, producing more than 12-times the number of injuries than the second most common activity, basketball. The sampling bias during the 6-month collection period is the most likely explanation for the frequency distribution; collection of information during a longer time period (for example, 12 or 18 months) presumably would correct this discrepancy.

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