

# Anterior Cruciate Ligament Tear in a 7-Year-Old Athlete

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## Abstract

We present the case study of a 7-year-old boy with an initial partial anterior cruciate ligament (ACL) tear. Initially, this patient was treated conservatively due to his age and immature skeletal structure. He returned to competitive sports, but reinjured the knee resulting in a complete ACL tear. The purpose of this paper is to outline the incidence, mechanism of injury, treatment and prevention of ACL injuries in the pediatric population. Evaluation of the injury and treatment options, including complex reconstruction will be presented via a case study approach and review of the literature. The focus of this review for treatment of ACL tear was in those younger than 14 years.

case of ACL reconstruction; the growing anatomy of the skeletally immature patient must be considered.

Traditional ACL reconstruction involves drilling holes for graft placement across both the distal femur and the proximal tibia. Graft placement becomes an issue in the growing patient because approximately 65% of total growth from the lower extremity comes from the growth plates about the knees: 37% from the distal femoral physis and 28% from the proximal tibial physis.<sup>10,11</sup> There is continuing debate about timing, graft choice, technique, and graft placement for ACL reconstruction in pediatric patients who have most of their growth ahead of them.

In this article, we report the case of a 7-year-old boy with an ACL tear. We also outline the incidence, mechanism of injury, management, and prevention of ACL injuries in the pediatric population. Injury evaluation and management options, including complex reconstruction, are presented through a case study approach and a review of the literature.

The patient and his family provided written informed consent for print and electronic publication of this case report.

## Case Report

A 7-year-old boy was presented by his mother to a pediatric orthopedic clinic with left knee pain. He had been injured during a baseball game 5 days earlier. He reported sliding into a base and catching his left foot under it, which caused the knee to twist. Pain and swelling in the knee were immediate. Weight-bearing produced significant discomfort and the boy had a notable limp. On the day of the injury, radiographs obtained at an outside emergency department showed no fracture or dislocation, and the boy was discharged home. However, he continued to have left knee pain, especially with full extension and weight-bearing.

On initial physical examination in the orthopedic clinic, the patient appeared healthy. Focused examination of the left knee revealed a mild effusion with decreased range of motion (ROM) and significant pain during full flexion. There was tenderness to palpation along the lateral joint line. The posterior drawer test was negative and there was no laxity on the Lachman test or pivot shift test. The patient was stable on the varus and valgus stress tests. Radiographs, which included 3 views of the knee and 2 of the ankle, showed a large knee effusion but no obvious fracture or dislocation.

After 2 weeks, the patient returned to the clinic for follow-

Between 35 million and 44 million children and adolescents participate in organized sports in the United States annually.<sup>1-4</sup> Sports injuries are increasingly common in young athletes. More than 3.5 million adolescents under age 14 and 2 million students of high school age incur a sports injury severe enough to warrant medical treatment.<sup>3,5,6</sup> Anterior cruciate ligament (ACL) tears are among the sports injuries that have increased in incidence in the young athlete population over the past 20 years.<sup>4,5,7</sup> ACL tears are thought to occur in 250,000 to 300,000 patients per year.<sup>3</sup>

Until a decade ago, ACL injuries in patients up to 11 years were considered rare. However, an increased incidence of ACL tears was identified in both boys and girls older than 11.<sup>4</sup> The increase in sports injuries in young athletes over the past few decades is thought to be related to higher rates of participation, earlier sports specialization, increased intensity of play, year-round training, poor conditioning, participation on multiple teams or in multiple sports in one season, and competing at a much younger age.<sup>3-5,7-9</sup> With younger children's participation in athletics on the rise, the issue of age must be given special attention during sports injury management. This is especially important in the

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up physical examination, which again showed a moderate effusion and decreased left knee ROM. Compared with the right ACL, the left ACL showed questionable increased laxity on the Lachman test. As before, the posterior drawer test was negative and the patient was stable on the varus and valgus stress tests. The laxity finding prompted magnetic resonance imaging (MRI) to rule out internal derangement. MRI showed a partial left knee ACL tear with some fibers intact and a lateral femoral condyle contusion. Given the patient's skeletal immaturity, nonoperative management per the study by Kocher and colleagues<sup>12</sup> was recommended.

The patient underwent a course of physical therapy to improve ROM, with a focus on strengthening the quadriceps and hamstring muscles. He was fitted with a hinged knee brace to limit the extremes of motion and was instructed to use crutches and remain non-weight-bearing until the next follow-up. At that follow-up, 2 months after initiation of physical therapy, he tolerated walking but continued to use the brace to prevent excessive motion. On examination, he had full left knee ROM, mild laxity on the Lachman test, and a normal pivot shift test. On the basis of these findings, the brace and the crutches were discontinued. Physical therapy would be extended until all of the therapist's goals were met. Activity restrictions were lifted given the patient's full left knee ROM, returned strength, and almost completed course of physical therapy.

Approximately 1 year later, the patient returned to clinic

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“Sport-specific injury rates vary considerably, but sports that involve jumping, sprinting, and pivoting have a common ACL injury mechanism, and it is associated with the highest injury risks,” according to previous research.

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after reinjuring the left knee while playing tackle football. He reported that the knee was going out on him and that pain and instability were increasing with activity, football in particular. Focused examination of the left knee revealed full ROM and no effusion. A grade 3 Lachman test and a positive pivot shift test demonstrated increased laxity of the left knee joint. The finding of increased instability prompted repeat MRI, which showed a complete ACL tear with no other abnormalities.

The patient and his family were informed about management options. Given the patient's skeletal immaturity and the risk for growth abnormalities after traditional ACL reconstruction, the first management option was to discontinue all sports until the patient reached skeletal maturity, at which time traditional ACL reconstruction could be performed. The second option was to undergo physeal-sparing ACL reconstruction,

but this also carried the risk for growth abnormalities. The family chose physeal-sparing surgery, which included rerouting the iliotibial band through the knee and under the inner meniscal ligament.

One month after the repeat injury, the patient (8 years 9 months old now) underwent left physeal-sparing ACL reconstruction with an iliotibial band autograft. After surgery, he was placed in a ROM knee brace for a total of 6 weeks, with motion restricted to 0° to 30° for 2 weeks, then 0° to 60° for 2 weeks, and finally 0° to 90° for 2 weeks. For 6 more weeks, he remained toe-touch weight-bearing with crutches and continued using the knee brace. Physical therapy began after the first postoperative clinic visit. After surgery, the patient did well and had no notable complications. At the time of this publication, he has returned to full play with no limitations.

### Review of the Literature

Research on the frequency and cause of ACL injuries has increased over the past decade. During this period, 3 studies (2004, 2008, 2009) on the incidence of ACL reconstruction were reported,<sup>13-15</sup> only 1 specifically in the pediatric population.<sup>13</sup> In the 2004 study,<sup>13</sup> an insurance data set for the period 1995 to 1999 was analyzed to determine the incidence of soccer injuries in youth between age 5 and 18. Six million players were included in the cohort. ACL injuries accounted for 6.7% of the total number of injuries and for 30.8% of all knee injury claims. In the 2008 study,<sup>14</sup> conducted in a health maintenance organization setting over the period 2001 to 2005, the highest incidence of ACL reconstruction (total rate, 29.6 per 100,000 members) was found in women between age 14 and 17; there was no age limit in this study. In the 2009 study,<sup>15</sup> which examined the population of New Zealand for knee injuries, including ACL tears, the rate of ACL reconstruction over a 5-year period was 36.9 per 100,000 person-years. This study also found that 65% of ACL injuries occurred during sports or recreational activities.

Sport-specific injury rates vary considerably, but sports that involve jumping, sprinting, and pivoting have a common ACL injury mechanism, and it is associated with the highest injury risks.<sup>16</sup> Men athletes have the highest injury risk in hockey, basketball, rugby, soccer, and football, and women athletes in gymnastics, basketball, and soccer.<sup>16,17</sup> Cross-country running, baseball, and softball have a high injury rate for both men and women, likely related to the repetitive movements involved.<sup>17</sup> Most knee injuries result from noncontact mechanisms in both men and women.<sup>5,6,18-20</sup>

In 2003, Dorizas and Stanitski<sup>21</sup> reported that ACL injuries are uncommon in skeletally immature patients and noted the limited literature on diagnosis and management of these injuries in this population. With more young people participating in sports activities, however, reports of ACL tears are becoming more common.<sup>22</sup> Approximately 0.5% to 3% of the 250,000 to 300,000 annual ACL tears are reported as skeletally immature.<sup>3</sup> The association between ACL tears and other intra-articular injuries is well known. Up to 70% of patients have associated meniscus tears and 46% have articular cartilage injuries.<sup>4,23</sup>

Management of these injuries in patients who have significant growth remaining is still controversial.<sup>8,20-22</sup>

In 2002, management guidelines for partial ACL tears in skeletally immature patients were published after a study was conducted in patients with partial ACL tears, both skeletally mature and immature.<sup>12</sup> Nonoperative management involved both use of a hinged knee brace to prevent excessive extension for 12 weeks and toe-touch weight-bearing for 6 to 8 weeks. Physical therapy was initiated to focus on hamstring strength and return to play. At 3 months, patients were wearing an ACL knee brace as they returned to sports/play. As noted in the present case report, this nonoperative protocol was followed during management of our patient's partial ACL tear. Of the patients treated nonoperatively in the 2002 study, 31% eventually required ACL reconstruction because of either instability or reinjury during sports/play, and all were found to have a complete ACL tear during the surgery.

More recent literature reviews of management of ACL tears in skeletally immature patients have shown the continuing rise in the number of skeletally immature patients with ACL tears.<sup>3,7-9,11,21</sup> Nonoperative treatment for skeletally immature patients with partial or complete ACL tears remains controversial, as the requirement for activity modification and bracing can be difficult to manage.<sup>7,11</sup> A large majority of pediatric patients' usual daily activities involves running and playing, which should be restricted during conservative management. A disadvantage of nonoperative management is the difficulty in maintaining activity restrictions. In addition, the functional instability of the knee joint carries a risk for injury to meniscal and articular cartilage, which leads to the development of degenerative joint disease.<sup>4,8,9,11,24</sup> In comparison, the disadvantages of surgical management in skeletally immature patients most severely include growth disturbance.<sup>8</sup>

With interest and participation in competitive sports increasing in our youth, there has been a predictable increase in their injury rates.<sup>11</sup> The Centers for Disease Control and Prevention estimated that half of all sports injuries may be preventable with education and use of protective equipment.<sup>6</sup> Injuries should not be considered an inevitable part of sports and play, given the possibility of prevention.<sup>5</sup> We recommend that injury prevention be incorporated into education and behavior changes, environmental interventions, and enforcement or legislative interventions. As we continue to investigate ACL injury prevention, we must make it a priority to minimize effects on our young patients' health-related quality of life.<sup>8</sup>

## Discussion

As the best way to manage skeletally immature partial ACL tears is still being worked out, for now we should continue to follow the 2002 guidelines.<sup>12</sup>

We discovered in our case report and literature review that patients who return to activity with partial ACL tears risk further injury. Further injury may have long-term complications. Research is needed on use of skeletally immature ACL reconstruction techniques, with follow-up over the long term. In addition, the recommendation for conservative management

should be examined in the current sports culture. Incidence and injury causation, specifically in pediatric populations, require further investigation. Increased use of injury-tracking databases and injury prevention interventions is also needed in order to address the rise in sports injuries in our youth.

At this time, whenever treatment is being considered for a skeletally immature patient with an ACL tear, partial or complete, the main objective should be to regain a functional, stable knee that will allow the patient to resume his or her usual daily activities.<sup>3,9</sup>

The safest and most effective ACL reconstruction technique for skeletally immature patients is still evolving, and support for both nonoperative and operative management can be found in the current literature. The majority of the data supports surgical reconstruction for patients with complete tears or knee instability.<sup>3</sup> When a treatment plan is being developed for a skeletally immature patient, it is important to consider preservation of the meniscus and the stability of the knee.<sup>7</sup> At this time, given the lack of randomized control trials and insufficient data, there is no consensus regarding the risks of early ACL reconstruction versus nonoperative management.

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