



Anterior Cruciate Ligament Injuries before Maturation: Surgical Complications

Babagoltabar Samakoush H^{1*} and Norasteh AA²

¹Faculty of Physical Education and Sport Sciences, University of Guilan, Iran

²Department of Corrective Exercise and sport Injuries, University of guilan, Iran

***Corresponding author:** Hamed Babagoltabar Samakoush, PHD Student in Physical Education and Sport Sciences (Sport Injuries & Corrective Exercises), Faculty of Physical Education and Sport Sciences, University of Guilan, Rasht, Iran, Tel: 09115871408; Email: hb.sama@yahoo.com

Mini Review

Volume 3 Issue 3

Received Date: September 08, 2020

Published Date: September 23, 2020

DOI: 10.23880/aphot-16000162

Abstract

Understanding the cause of ACL injury and its difficulties, especially before maturity, remains unknown. However, several studies have examined its prevalence in different countries and the complications of surgery in the few years after reconstruction and presented different results. According to the results of various studies in this study, a general explanation was given regarding ACL damage before puberty and complications caused by surgery in this period.

Keywords: Ligament Injuries; Sports; Population; National Hospital

Introduction

Children and adolescent participation in organized sports is widespread and gaining in popularity in countries [1], with children now often beginning participation at a younger age and competing at a higher level [2]. In addition, greater demands are being placed on youth athletes, through increased training, sports specialization, and an emphasis on year-round competitive play [2]. Taken together, these factors have led to an increase in the diagnosis of sports-specific injuries in children and adolescents [1-3]. Anterior Cruciate Ligament (ACL) injury to the knee, particularly in children and adolescents, has been the focus of recent media and scholarly attention [4]. This is not surprising given that ACL injury causes significant discomfort and disability and may also result in the long-term in reduced levels of physical activity and contribute to obesity [5], thus negating the potential benefits of sports participation for children and adolescents. In addition, ACL injuries have the potential for adverse long-term health outcomes, such as an increased risk of degenerative arthritis and escalation of health care costs [6,7]. Therefore, the aim of this study was to evaluate the prevalence of anterior cruciate ligament injury and its

complications in immature athletes.

Discussion

Anterior cruciate ligament (ACL) injuries are thought to be rare in children and adolescents and are more commonly seen as types of tibia injuries. But a recent surveillance study found that ACL injuries accounted for almost a quarter of all high school knee injuries [8].

A relatively new study using data from the US National Database found a significant increase in physical injuries to children and adolescents as well as in ACL reconstructions. Interestingly, the increase in ACL injuries in children and adolescents seems to be significantly greater than the increase observed in the adult population [9].

Numerous studies have been conducted on the prevalence of ACL injury in the pre-adolescent age range. A total of 8215 injuries were reported (3340 females, 4875 males) which were divided into three categories of general injuries, knee injury and ACL injury. 22% of injuries were related to the knee (30% in women and 22% in men). ACL injury accounted

for 31% of knee injuries (37% female and 24% male). The minimum age for ACL injury was 5 years old. The ratio of the knee injury to kidney injury increased with age. Compared to men, women showed a higher proportion of knee injuries/all injuries and a higher ratio of ACL injuries/all injuries. This study shows that ACL injury occurs in soccer players who are musculoskeletal immature, and women appear to be at increased risk for ACL and knee injuries compared to men, even when they are musculoskeletal immature [10].

In a 10-year study from 2005 to 2015 and in the age range of 5 to 14 years, a total of 320 ACL injuries were reported, the highest rate of which (96.9%) was in the age range of 10 to 14 years and sports activities 6/56% of ACL injuries. 52.5% of ACL injuries in women were caused by participating in ball sports, while 35.4% of ACL injuries in men were caused by participating in ball sports [2]. Another study in the United States between 2000 and 2009 found that ACL injury was 6.3% of reported injuries in the age range of 5 to 12 years and 10.6% in the age range of 13 to 17 years [11]. In a study that examined the prevalence of injury in women and men in the age range of 6 to 18 years, the highest prevalence of ACL injury was found for women at the age of 16 and for men at the age of 17 years. There was no significant difference between men and women [12]. In another review, Takashi, et al. [13] in Japan examined anterior cruciate ligament (ACL) injuries among high school athletes over a 10-year period. Young athletes (12 to 18 years old) belonging to sports clubs in junior high schools (grades 7 to 9) and high schools (grades 10 to 12) were the focus of this study. The total number of ACL injuries during the 10-year period was 30,458, with an incidence of 0.81 per 1,000 athletes per year. Among those with ACL injuries, the ratio of girls to boys was 2.8 and the prevalence of injuries in girls was higher than boys (1.36 vs. 0.48). Athletes in the 11th grade showed the highest rate of ACL injuries. Another study in Finland by Weitz, et al. [14] examined the prevalence of anterior cruciate ligament injury in people under 18 years of age. This study examined the data of the Finnish National Hospital from 1997 to 2014. This study examined the data of the Finnish National Hospital from 1997 to 2014. Samples of this study included 19961205 residents of Finland with injuries less than 18 years. The results showed that 4725 people from the study population suffered from an ACL injury. In general, it was found that in boys aged 15-13 years, the increase in ACL injury was 59% and in boys aged 16 to 17 years, this increase was 44%. The results of this study showed that ACL injury is not a minor injury in children and its prevalence in children has increased over the past 15 years.

A 20-year study (1990-2009) conducted by the State of New York found that ACL reconstruction was eight times higher in 18-15-year-olds than in 11-14-year-olds [3]. In another study conducted between 2007 and 2011, individuals

aged 10 to 14 years reported an 18.9% increase in ACL rupture and 26.7% ACL reconstruction during this period [9]. Another study in Australia reported a significant linear increase in ACL reconstruction in men aged 14-14 between July 2003 and June 2008 [4]. The study also found that ACL regeneration increased rapidly during adolescence and early adulthood and then gradually decreased [4]. In another study, it was stated that the rate of ACL reconstruction per 100,000 population aged 3 to 20 years has been steadily increasing over the past 20 years, increasing from 17.6 in 1990 to 50.9 per 100,000 in 2009. The peak age for ACL reconstruction in 2009 was 17 years. In 2009, the youngest age at which ACL reconstruction was performed was 9 years old. The rate of ACL reconstruction in male patients was about 15% higher than female patients and ACL reconstruction in patients with private health insurance was 6 times higher than patients registered in the hospital [3]. Also, in a review study conducted in the United States in 2014, it was stated that the age of ACL regeneration increased among all age groups, which was 924% in patients under 15 years of age [15]. In this regard, in the field of reoperation following ACL reconstruction Astur, et al. [16] in a retrospective study from 2001 to 2016 in three age groups under 16 years, 16 to 18 years, and more than 18 years showed in the first community (Under 16 years old) out of 61 ACL surgeries, 15 people (24.6%), in the second group (16 to 18 years old) out of 57 people who underwent ACL surgery, 10 cases (17.5%) and in the third community (above 18 years) Out of 1258 surgeries, 116 cases (9.2%) required reoperation.

Secondary injuries are a particular concern in patients with anterior cruciate ligament (ACL) injuries. Risk of re-rupture, complications of the surgery, and premature osteoarthritis are among these concerns [16-18].

Reducing the risk of secondary knee injuries is therefore an important goal for the treatment of ACL injuries in children. Numerous studies have described an increased risk of the secondary meniscus and cartilage injury with a non-surgical treatment approach or delay in surgical treatment [19]. In this regard, it was stated that the rate of cross-ACL rupture after reconstruction is from 4% to 42%. Pre-pubertal patients are at greater risk than adults, possibly due to inherent anatomical differences with biomechanical and neuromuscular changes [20]. Other Scandinavian re-injury studies have shown that adolescents are 2.5 to 3.5 times more likely to be at risk than adults (in three categories: under 13, 13 to 15, and 15 to 18). ACL rupture is after surgery, which is equal to 12 to 35% of the recurrence rate [21,22].

In a study in which Dekker, et al. [17] examined the factors influencing re-rupture following ACL surgery in people under 18 years of age, they reported a 32% recurrence of ACL injury in this study. (Age, sex, growth

plate position, tibia movement, notch width index), surgical features (a type of transplant, surgical technique), recovery measures (time to return to exercise, duration of physical therapy) and type of exercise before and after surgery (Primary and secondary sports, number of sports), time to return to sports was the only predictor of recurrent ACL injury. It was also stated that athletes return to exercise at a high rate (91%) before maturation, after ACL reconstruction, which is less likely to cause them to participate in preschool sports, less fear of returning to activity in younger athletes, or Better neuromuscular flexibility before puberty, which is an important factor in the recurrence of the injury, which was probably reported in this study as a delay in the return of quadriceps and hamstring strength and neuromuscular control in adolescents after ACL reconstruction. One of the unexpected findings of this study was that, unlike the time to return to exercise, the duration of physiotherapy did not predict further injuries. This may indicate that a safe return to exercise requires not only sufficient strength and neuromuscular control but also a period of biological recovery that is not affected by participation in rehabilitation. In fact, some experts suggest that it may take 2 years for the knee to fully recover from ACL damage and regeneration [23], which has been described as knee homeostasis [24]. In fact, there is evidence that returning to exercise before the knee is biologically recovered from an ACL injury may increase the risk of osteoarthritis, possibly leading to reduced cartilage flexibility, inflammatory cytokines, and impaired muscle strength. It is related to the knee [25]. Although in the study of Dicker, et al. [17] the time of return to exercise was reported as an effective factor in causing re-injury, several studies showed no effect on early return to exercise (less than 6 months) on the rate of rupture and functional outcomes [26,27]. In contrast, another study showed that intense early activity leads to ligament strain and potential knee instability [28].

In general, postoperative surgical studies are recommended for individuals before maturation [22]. However, the evidence to support this is scarce. In a longitudinal study that lasted for 9.5 years, Ekas, et al. [29] examined the complications of ACL reconstruction in 47 people after puberty. In this study, forty-three patients underwent active rehabilitation without ACL reconstruction. 4 patients were treated with initial ACL reconstruction. In the final follow-up, 27 patients (57%) underwent ACL reconstruction, of which 14 patients had knee weakness (prevalence, 30%), and 9 of them had weakness in the injury area. Sixteen of the injured had a new injury to a healthy meniscus (34% incidence). In 17 patients, the results showed repair of the injured meniscus. The final MRI results showed cartilage injuries in the index knee of 13 patients (28%) and contralateral injuries in 8 patients (2 meniscus injuries, 5 cartilage injuries, and 1 fracture). In two patients the

difference in leg length was more than 15 mm and in 3 patients an increase in the valgus angle of more than 5 degrees was observed in the injured leg. Overall, the results of this study showed that the incidence of new meniscus rupture after ACL injury in children was 34% at a mean follow-up of 9.5 years. At the final follow-up, 27 patients (57%) had normal ligaments and none of them had knee osteoarthritis. Early active rehabilitation, ongoing follow-up, and delayed surgery if necessary may be a safe and appropriate treatment option for some pediatric ACL injuries.

In summary, it is important to note that the underlying risk of ACL regeneration in the musculoskeletal immature population using conventional adult techniques with transphyseal tibia and femur is a factor in developmental disorders during this period [30,31]. Differences in limb length or angular deformities following surgery may cause more problematic functional defects for the young athlete [32]. Also, increased meniscus injuries due to before maturation surgery may lead to osteoporosis changes throughout life [33]. Based on the background of studies, it is suggested that conservative management of ACL injuries in an athlete with braces, rehabilitation, and correction of functional activities is the preferred treatment and ACL reconstruction should be performed after skeletal maturity [9,30]. However, several studies have shown poor results with this method of active patients, because increased regeneration time is associated with an increased risk of irreversible meniscus rupture and lateral duct internal lesions [34-37]. Based on this, it seems difficult to decide whether surgical treatment should be performed after ACL injury in the pre-pubertal period or whether surgery should be delayed until after maturation, and to answer this question more studies are needed in this area.

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