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Case Series

Return to Play and Long-Term Participation Following ACL Reconstruction in Elite Handball Players

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Abstract

Purpose: The consequences of Anterior Cruciate Ligament (ACL) injury and subsequent reconstruction in handball players are understudied. The aim of the present study is to present the effects of ACL reconstruction exclusively on handball players regarding return to play.

Methods: Fourteen knees with an ACL tear in twelve patients were included in the study. Nine injuries (64.3%) occurred during games, and five (35.7%) during training. The mechanism of injury was non-contact in 64.3% of cases. All cases were treated with a hamstrings autograft.

Results: The athletes returned to unrestricted full team training in a mean of 7.7 months. Return to competitive play was achieved in twelve of the fourteen cases (85.7%) in a mean time of 9.6 months post-operatively. Nine of the athletes that returned to play (75%75%) reached the same level of competition as before injury. At a mean follow-up of 37.1 months post-operatively, 58.3% 58.3% of the players included in the study and 70%70% of those that returned to play were still active players; all playing at their pre-injury competition level. There was one recurrence of an ACL tear (7.1%), while two athletes (14.2%) had a contralateral ACL rupture during the follow-up period. All athletes - including the ones that quitted - had excellent knee scores at the latest follow-up. IKDC mean score was 94.7, Lysholm mean score was 95, EuroQoL mean score was 100, and KOOS mean score was 97.3.

Conclusions: A high proportion of elite handball players can return to play following ACL reconstruction with a low rate of recurrence. However, not all players can stay in the sport for long and this should be kept in mind when an ACL tear occurs.

Keywords: Anterior cruciate ligament reconstruction; Career length; Handball players; Level of competition; Return to play

Introduction

Handball is one of the most popular team sports in Europe. It is a quick, physical game, that includes a lot of body contact, direction changes, jumping and single leg landing all performed at high intensity. All of these movements predispose the athlete and especially the athlete's knee to injury, and it is true that handball is associated with a high injury rate. It has been reported that injuries in handball occur at a rate of 8.3-12.1/1000 game hours and at a rate of 0.6-3.4/1000 training hours [1,2]. In particular, side-cutting movements and one-legged landing manoeuvres that are common in handball create a high external knee valgus moment that has been shown to predispose the knee to Anterior Cruciate Ligament (ACL) tear [3-6]. Female handball players are more likely to sustain an ACL injury compared to their male counterparts, and the overall rate of ACL injury in handball is 0.86 injuries for female and 0.24 for male players per 1000 hours of exposure [7,8]. ACL injuries are of particular interest because they can be a devastating injury for the health and the career of an athlete. Surgery is required, followed by a long rehabilitation process; it can be 6 to 12 months until the athlete can return to sports, and this return is not guaranteed. Return to sports also does not always mean return to preinjury level of competition. Ardern et al reported a 63% return to preinjury level of play and a 44% return to competitive sports in a systematic review of athletes among various sports [9], and although return to sports for elite athletes is higher (83%) [10], these numbers suggest that not all athletes can maintain a successful career following an ACL injury. There is also a high risk for graft failure and recurrence of the injury (4.5-11%) or for a new similar injury on the contralateral knee (6-30%) following return to sports after ACL reconstruction (ACLR) [11-13]. Data in the aforementioned studies come from various sports, mainly soccer. Although handball is a popular sport in Europe it lags behind compared to other sports regarding evidence-based medicine. As of February 2023, scientific publications included in PubMed exceed 15000 for soccer, 6000 for basketball and 2500 for volleyball, while for handball the number is less than 1600. Regarding ACL there are 800 studies for soccer, 350 for basketball and only around 100 for handball, although ACL injuries are quite common in handball. The aim of the present study is to present our experience regarding the consequences that an ACL injury and reconstruction has in competitive handball players, regarding time to return to training and games, as well as performance and career length thereafter, thus adding to the knowledge regarding this devastating injury in the sport of handball.

Methods

Criteria for inclusion in the study were: athletes involved in high-level competitive handball (Tegner score >7), ACL injury verified by an MRI followed by ACL reconstruction performed in our institute from 2016 to 2020, minimum follow-up of 12 months post return to play or decision to stop playing following reconstruction if that occurred earlier. Exclusion criteria were revision ACL reconstruction, and inadequate follow-up. All patients were routinely followed-up at 3, 6, 12 weeks, every month between 3-12 months and yearly thereafter post-operatively. A last follow-up was performed for the purposes of the current study. The data recorded included epidemiologic information of the patient (age, gender, sport position), the injury (affected side, injury during game or training, mechanism of injury, other concomitant knee lesions), and the treatment (time from injury to operation, type of graft used, rehabilitation protocol followed). Information collected also included whether the patient returned to play and the timeframe of the return, at which level he/she returned, whether that level of competition was sustained, whether he/she is still playing and if not, the reason for quitting. Information on subsequent injuries on the ipsilateral or contralateral knee were also recorded, as well as performance scores including IKDC, KOOS, Lysholm score, and EuroQoL.

All patients were treated by the same orthopaedic surgeon (IT) with a quadruple hamstrings graft using a button technique for femoral stabilization, and an absorbable screw for tibial stabilization. Rehabilitation focused early on full active knee extension, patellar mobilization, quadriceps function, full weight bearing and ROM, followed by close kinetic chain exercises and a comprehensive dynamic functional movement program, with emphasis on strengthening of femur vastus medialis in women. They were cleared to return to unrestricted competitive training, only after certain criteria were met: evidence of graft maturation in MRI, performance of at least 90% of the contralateral leg in single-legged hop tests (single hop, triple cross-over hop, triple hop, and 6-meter timed hop tests), and both isokinetic and isotonic training that were tested on the Cybex Norm 770 (Henley HealthCare, Medway, MA, USA). Return to play (RtP) was defined as returning to play in an actual game, either pre-season or regular season. Return to running, return to on-field individual training , return to unrestricted training with the team, and return to the level of competition that the athlete had before injury were also recorded and defined as described. Statistical analysis was performed using Excel (Microsoft, WA, USA).

Results

Seventeen knees in fourteen handball players were treated in our institution with ACL reconstruction during the study period. Three were excluded from the study - two because they were revision cases, and one because of inadequate follow-up. Overall, fourteen knees in twelve patients were included in the study. There were seven male and five female athletes. The mean

age at time of injury was 19.1 years ($SD \pm 2.3, range\ 14 - 32$). There were 9 right, and 5 left knees affected; in 8 case it was the dominant leg affected and in 6 the non-dominant. Regarding the position there were 4 inter, 3 pivot, 1 playmaker, 1 winger and 3 keepers involved. Nine injuries (64.3%) occurred during games, and five (35.7%) during training. The mechanism of injury was non-contact in nine cases (64.3%) and contact in five (35.7%). In six cases (42.9%) there was a concomitant lateral meniscus injury, and in two of these cases an associated medial collateral ligament (MCL) injury. Surgery was performed in a mean 3.1 weeks ($SD \pm 1.8, range\ 1 - 13$) following injury. The meniscus tear was treated with suturing in all cases, while the MCL injury was treated conservatively. Mean follow-up was 37.1 months post-operatively ($SD \pm 8.8, range\ 9 - 70$) or 26.9 months post-return to play ($SD \pm 10.7, range\ 1 - 60$). The athletes returned to running in a mean of 11 weeks ($SD \pm 2.4, range\ 8 - 22$) , and to on-field individual training in a mean of 22.2 weeks ($SD \pm 4.1, range\ 13 - 39$). Return to unrestricted full team training was achieved in a mean of 7.7 months ($SD \pm 1.2, range\ 4 - 12$).

In twelve of the fourteen cases (85.7%) the athlete returned to play in a mean time of 9.6 months post-operatively ($SD \pm 1.3, range\ 6 - 14$). One athlete who was 32 years old at the time of injury elected to retire right after the operation, while another who had ACLR on the contralateral knee two years earlier, returned to full team training at 8 months post-operatively, but elected to retire before participating in any competitive game. Of the twelve cases that the handball player returned to play, nine (75%) returned to the same level of play as before injury. Currently seven of the twelve players included in the study (58.3%), and seven of the ten that returned to play are still active players, and they are all playing at their pre-injury competition level. Four of the five players that quitted mentioned personal reasons for doing so (two before returning to play, one at two months and the other at 28 months after return to play), while one had chondral and meniscus injuries in both knees 36 months following return to play and quitted because of that. There was one recurrence of an ACL injury in the cohort (7.1%) right after return to play at 9 months post-operatively. The athlete was re-operated and is still playing at the same level as before the initial injury. Another two athletes (14.2%) had a contralateral ACL rupture at 3 and 13 months after returning to play from the initial operation. Another athlete, as aforementioned, had chondral and meniscus injuries in both knees 36 months following return to play, and had to be operated for it. All athletes - including the ones that quitted - had excellent knee scores at the latest follow-up. IKDC mean score was 94.7 ($SD \pm 2.7, range\ 85 - 100$), Lysholm mean score was 95 ($SD \pm 2.3, range\ 91 - 100$), EuroQoL mean score was 100, and KOOS mean score was 97.3 ($SD \pm 1.3, range\ 93 - 100$).

Discussion

The present study found that ACL injuries in handball occur more commonly in games (64.3% of our cohort) and with a non-contact mechanism (64.3% of cases). A high proportion of the injured athletes (85.7%) returned to play in a mean time of 9.6 months post-operatively ($SD \pm 1.3$), while return to on-field individual training was achieved in a mean of 22.2 weeks. Seventy-five percent of the athletes that returned to play reached the same level of competition as before injury. At a mean follow-up of 37.1 months post-operatively, only seven of the twelve players included in the study (58.3%), and seven of the ten that returned to play (70%) are still active players; all playing at their pre-injury competition level. Two athletes (14.2%) had a contralateral ACL rupture, and one had a re-injury of the ipsilateral ACL (7.1%) during the follow-up period.

Methodological Considerations

The main limitation of the present study is the small sample size, that makes conclusions vulnerable to sample bias. However, it is not always easy to have a large sample when uncommon injuries like ACL tears are involved, especially in countries where handball has a small to moderate popularity, like Greece where the study was conducted. This, nevertheless, should not diminish the usefulness of such studies. Most studies come from countries where handball is one of the most popular sports. Knowing whether things are different or not in countries with less athletes should also be considered as valuable information. Furthermore, meta-analyses that provide us with the most reliable evidence, require multiple studies in order to draw useful conclusions, and we could only identify one other study reporting return to play after ACLR exclusively on handball players. Another limitation of the present study is that the mean follow-up period was 37 months. Studies on career length following ACL reconstruction would be more useful if they followed the patients all the way to the time they stop their careers for whatever reason. This of course is not always feasible, and we believe that information on how things have evolved three years post-operatively is also of value. We intend to continue the follow-up of the present cohort of athletes in the future.

ACL Injury Characteristics

Female handball athletes are 6-10 times more likely to sustain an ACL tear compared to male athletes [7,8,11,14]. Injuries in handball occur much more often during games than during training (8.3-12.1 injuries/1000 game hours vs. 0.6-3.4 injuries/1000

training hours), and the same is true for ACL tears [1,2]. In about two thirds of cases there is a non-contact mechanism of injury causing the ACL tear (68.5%) and this finding is similar between genders [15]. There is also no difference between dominant and non-dominant leg in ACL injury rates (and biomechanical studies support this finding [3,16]. The present study supports most of these findings, as 64.3% of ACL tears occurred during games, in 64.3% of cases there was a non-contact injury mechanism, and the affected leg was the dominant in eight cases and the non-dominant in six. The only finding in our study contradicting literature was that there were more male than female injured athletes (7 vs. 5), but on one hand the sample is too small for statistical conclusions, and on the other hand handball is more popular between males in Greece, which could explain this finding.

Return To Play Following ACL Reconstruction

Not all athletes can maintain a successful career following an ACL injury. Elite athletes return to sports at a rate of 83% [10,11], Things are even worse when non-elite athletes are included; the systematic review of Ardern et al reported a 63% return to preinjury level of play and a 44% return to competitive sports [9]. This data comes from studies including athletes form various sports. In soccer up to 98.2% of elite players return to play [17,18], but for American football the rate is around 70% [19,20]. We could only identify one study in literature dedicated to handball players after ACL reconstruction, and the RtP rate was 58% [21]. Our study found an 85.7% RtP rate among handball players, which is much higher, but in terms with the reported RtP rate of elite athletes in various sports during the last decade, and perhaps the time that the study of Myklebust et al took place almost twenty years ago could explain this difference. Another study with a high proportion of handball players (79 in a cohort of 217 athletes from pivot sports) reported a combined 83% RtP rate, which is closer to our findings [11]. RtP is usually achieved within 6-12 months post-operatively in different sports with basketball and American football athletes taking the most time [10,18,20]. The athletes in our study returned to play in a mean time of 9.6 months post-operatively ($SD \pm 1.3, range\ 6-14$), while return to on-field individual training was achieved in a mean of 22.2 weeks ($SD \pm 4.1, range\ 13-39$), $SD \pm 4.1, range\ 13-39$), and return to unrestricted full team training in a mean of 7.7 months ($SD \pm 1.2, range\ 4-12$) $SD \pm 1.2, range\ 4-12$).

Level of Play Following Rtp and Career Length

While RtP is relatively high following ACL reconstruction - especially among elite players, not all players return to their preinjury level of play, nor can they sustain the competition level that they reach. In the present study 75% of the athletes that returned to play reached the same level of competition as before injury. At a mean follow-up of 37.1 months post-operatively, 58.3% of the players included in the study and 70% of those that returned to play were still active players; all playing at their pre-injury competition level. Lindanger et al reported an 83% RtP rate among pivot sport players (with about 1/3 of them handball players), but only 53% returned to preinjury level [11]. In soccer, while elite players almost always return to playing (98%), at 3 years post-op 85.8% are still playing, with only 65% at the highest level [18], and at 5 years post-op 63% are still playing with only 41% maintaining the same level [17]. Deterioration in performance has also been reported [17], although we did not attempt to measure this in our study.

It is noteworthy however, that the reasons for quitting playing are not always clear. Lindanger et al questioned 217 pivot sport athletes (79 of them handball players) 22-30 years after ACL reconstruction. Eighty-three percent of them returned to play, and 14% of those that did not return stated that the reason was unrelated to their knee. Similarly, 48% of the study population finally stopped playing for reasons unrelated to knee issues, while only 32% of male and 21% of female athletes mentioned the injured knee as the reason for playing at a lower level or eventually quitting the sport [11]. In our study none of the two players that did not return to play, and only one of the five players that had quitted after returning to play at the final follow-up (20%), mentioned the knee as the reason for doing so. However, it is not always easy to demarcate the reasons leading to a decision. One of the two athletes that did not return to play mentioned age as the factor for quitting as he was 35 years old at the time of injury, but he was a goalkeeper, and goalkeepers play longer than players in other positions, so if it were not for the injury, maybe he would not have quitted at that time. Another important factor for players returning to action after ACL reconstruction that is highlighted recently is the fear of re-injury, which has a huge impact on return to play and performance thereafter. Lindanger et al reported fear of re-injury in 10% of those that returned to play and 45% of those that did not return. In our study no player reported fear of reinjury, but we did not use a specific questionnaire focused on this subject [11].

Injury Recurrence

Tear of the graft is a dreadful complication of ACL reconstruction. Athletes that have sustained an ACL tear are also considered vulnerable to a similar injury in the contralateral knee. In our cohort one female athlete had a re-injury of the ipsilateral ACL (7.1%), and two male athletes (14.2%) had a contralateral ACL rupture during the follow-up period. Data form the Norwegian ACL registry showed a graft revision rate of 6.1% in 3010 handball players treated with ACL reconstruction [14]. However, longer follow-up as in the study of Lindanger et al (median 25 years follow-up) reveals higher numbers (11%

revision rate and 30% contralateral knee injury) [11]. A systematic review in various other sports reported a revision rate of 8% and a contralateral injury rate of 12%, but the follow-up time was not discussed [22].

Clinical Scores

All athletes - including the ones that quitted - had excellent knee scores at the latest follow-up. IKDC mean score was 94.7 , Lysholm mean score was 95, KOOS mean score was 97.3, and EuroQoL mean score was 100. This should be expected for players that had returned and were playing at the same level; they would not have coped otherwise. However, it is useful information for the ones that had quitted, as ACL injury has been associated with long-term development of Osteoarthritis (OA) [11]. Of course, the follow-up period in the present study is too small for OA to occur, but knee function even for those that have stopped playing should be monitored.

Conclusions

An ACL tear can be a devastating injury for an athlete career-wise. The consequences of ACL injury and subsequent reconstruction in handball players are understudied. The present study is one of the very few studies focused exclusively on handball players returning to play from ACL reconstruction. A high proportion of the injured athletes (85.7%) returned to play in a mean time of 9.6 months post-operatively, with 75% of them returning at the same level of competition as before injury. However, not all players can stay in the sport. At a mean follow-up of 37.1 months post-operatively, only 58.3% of the players included were still active players. There is a considerable variation on performance after ACL reconstruction, that depends on the type of sport and on the specific position of the player. This should be kept in mind, and more focus should be directed to neuromuscular training programs that have shown to prevent ACL injuries at least in female elite handball players [23,24].

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