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Original Article

Acute anterior cruciate ligament injuries in multisport elite players: Demography, association, and pattern in different sports

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ABSTRACT

Background: Anterior cruciate ligament (ACL) tear rates are known to vary from sport to sport. To the best of our knowledge, the relationship of ACL injury with different sports is not reported earlier. The objective of the present study is to investigate the association of ACL injury with different sports and to document various associated ligamentous, meniscal, and chondral lesions of the knee.

Materials and methods: Descriptive epidemiological study was carried out in a tertiary care center over a 10-year period. Data were collected of the 638 ACL injured elite sportspersons operated by us. Percentage of ACL injuries and other associated injuries of the knee in different games was calculated. Chi-square test was applied to analyze the relationship between injuries of the specific structures of knee and sports played. *p* values less than 0.05 were considered to be statistically significant with a confidence interval of 95%.

Results: Kabaddi and football constituted the highest percentage (61%) of ACL injuries. Associated injuries were 10 posterior cruciate ligament tears, 11 posterolateral corner injuries, three medial collateral ligament tears, 390 meniscal tears (206 medial, 184 lateral), 201 femoral/tibial condylar lesions (128 medial, 40 lateral femoral condyle and 17 medial, 16 lateral tibial condyle), and two common peroneal nerve injuries. Lateral meniscal tears in kabaddi and medial femoral condylar lesions in badminton were significantly higher.

Conclusions: Kabaddi resulted in higher number of ACL injuries and other associated injuries to the knee. Further investigation is required to ascertain high-risk factors for such injuries.

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1. Introduction

Anterior cruciate ligament (ACL) injuries of the knee are commonly seen injuries in various contact sports – kabaddi,

football, basketball, handball, wrestling, hockey, and noncontact sports, such as badminton, cricket, gymnastics, and volleyball.^{1–5} The incidence and pattern of the ACL injury vary with the type of sports activity, age, and gender.^{6–10} Continuation of sports activity in the presence of ACL injury predisposes

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for secondary injury to the intra-articular structures of the knee.¹¹

Some studies have reported the incidence and prevalence of knee injuries in different sports without mention of specific structures in the knee joint.¹²⁻¹⁵ Others have focused on the incidence and rate of ACL injury in individual sports and a few on the comparison between two or more sports.¹⁶⁻²⁰ Most of the previous studies have reported on the overall occurrence of the meniscal and chondral injuries of the knee associated with the ACL injury and a few on the sports-specific meniscal injuries associated with ACL tears.²¹⁻²³ Till date, only four epidemiological studies have presented specific data about the incidence and pattern of the ACL injury in multiple sports activities.^{4,7,23,24}

However, in the current literature, we were unable to find any study that has analyzed the cohort of ACL injured sportspersons to ascertain the relationship of ACL injury as well as injury of the internal structures of the knee joint in various sports.

The purpose of our study was to investigate the association of ACL injury with different sports in general, and more specifically to study the occurrence of various ligamentous, meniscal, chondral, and neurovascular lesions of the knee in ACL injured knees in various sports, so that the severity of knee injury in specific sports could be ascertained.

2. Materials and methods

This is a prospective study carried out in a tertiary care center over a period of 10 years from January 2005 to April 2015. We included all the patients attending our sports injury clinic for ACL reconstructive surgery. The demographic data of all the patients, type of sport played by them, and intraoperative findings were recorded in a predesigned pro forma.

We included all the patients who presented between 1 and 42 days (6 weeks) of the ACL injury and excluded those injuries that occurred apart from any sporting activity and patients who reported after a delay of 42 days. We performed a detailed clinical examination regarding pain, swelling, range of motion, and specific tests – anterior drawer test, pivot shift test, and Lachman test. MRI was done in all the patients. Quantitative assessment was done using KT-1000 knee arthrometer to document the level of instability. Data were then analyzed using SPSS version 17.0. Mean age of the patients and percentage of all ACL injuries and associated injuries of the knee in different sports were calculated. Chi-square test was then applied to analyze the relationship between different sports played, resulting in ACL injury and the associated injuries of the knee. For comparing the association of the associating injuries in different sports, we separately analyzed the data for eight sports and excluded all those sports with ACL injuries less than 15 in number.

3. Results

The total number of patients was 638. Average time from injury (TFI) was 24 days. Age of the patients varied from 13 to 41 years (mean age 24.9 ± 5.7 years). All the sports participants

were elite athletes. Out of 638 players, 449 (70.4%) were in the age group of 18–27 years. There were 600 (94%) ACL tears in males as compared to 38 (6%) in females. Left knee, 365 patients (57.2%), sustained more injuries as compared to the right knee, 273 patients (42.8%).

Kabaddi accounted for the highest number of ACL injuries, 285 patients (44.7%), followed by other sports (Tables 1 and 2). The mean value of side-to-side difference of KT-1000 was highest in kabaddi (mean 7.2 mm, range 6–9 mm). In the rest of the games, the mean difference was 6.5 mm (range 5–7 mm).

Other associated injuries, which have accompanied ACL injuries, were as follows: 10 (1.6%) posterior cruciate ligament (PCL) tears, three (0.5%) medial collateral ligament (MCL) tears (grade 3), 11 (1.7%) complete posterolateral corner (PLC) injuries, and two (0.31%) complete common peroneal nerve (CPN) palsies. These associated injuries were diagnosed on the basis of clinical examination and MRI. The PCL and PLC injuries were managed by performing respective reconstructive surgeries at the time of ACL reconstruction only. Both the peroneal nerve palsies were seen in the patients suffering from PLC injuries and the peroneal nerve neurolysis was done at the time of PLC reconstruction. Of these, one patient showed complete recovery while the other patient required a subsequent tibialis posterior tendon transfer. The MCL injuries showed full recovery with a hinged brace for 6 weeks after ACL reconstruction. A total of 390 (61.1%) meniscal tears were seen, out of which, 206 (32.3%) were medial meniscal tears and 184 (28.8%) lateral meniscal tears; no statistical significant difference was found between medial and lateral meniscal tears ($\chi^2 = 1.79$, $df = 1$, $p = .18$). 201 (31.5%) chondral lesions of the femoral/tibial condyles were observed. Chondral damage of the medial femoral condyle was seen in 128 (20.1%) patients and lateral femoral condyle in 40 (6.3%) patients. The difference between medial and lateral condylar chondral damage was found to be highly statistically significant ($\chi^2 = 53.08$, $df = 1$, $p = .0001$). Chondral damage of the medial tibial condyle was seen in 17 (2.7%) patients and lateral tibial condyle in 16 (2.5%) patients; the difference was not statistically significant ($\chi^2 = 0.031$, $df = 1$, $p = .86$).

When eight sports (Table 3) with ACL injuries more than 15 in number were analyzed, kabaddi players were found to suffer the highest percentage of lateral meniscal tears (36.5%), which was statistically significant ($\chi^2 = 15.89$, $df = 7$, $p = .026$). The chondral damage of the medial femoral condyle was observed to be the maximum in the badminton players (29.4%), which was statistically significant ($\chi^2 = 18.31$, $df = 7$, $p = .011$) as compared to other sports.

When sports with the highest number of ACL injuries, kabaddi 285 (44.7%) and football 104 (16.3%), were analyzed for knowing the difference between the associated injuries, kabaddi players were found to be highly associated with the injury of the lateral meniscus ($\chi^2 = 6.21$, $df = 1$, $p = .013$) and chondral damage of the medial femoral condyle ($\chi^2 = 5.75$, $df = 1$, $p = .016$) as compared to the football players (Table 4).

4. Discussion

ACL injuries are one of the most frequent injuries of the knee joint, which pose serious physical and economic burden on the

Table 1 – ACL injuries and associated ligamentous and nerve injuries of knee in different sports.

Sports	ACL injuries	Associated ligamentous and nerve injuries			
		MCL	PCL	PLC	Common peroneal nerve palsy
Kabaddi	285 (44.7%)	1 (0.4%)	4 (1.4%)	10 (3.5%)	2 (0.7%)
Football	104 (16.3%)	0	1 (1.0%)	1 (1%)	0
Athletics	54 (8.5%)	1 (1.9%)	2 (3.7%)	0	0
Cricket	41 (6.4%)	0	0	0	0
Volleyball	34 (5.3%)	0	1 (2.9%)	0	0
Basketball	31 (4.9%)	0	0	0	0
Wrestling	23 (3.6%)	1 (4.3%)	2 (8.7%)	0	0
Badminton	17 (2.7%)	0	0	0	0
Boxing	4 (0.6%)	0	0	0	0
Karate	2 (0.3%)	0	0	0	0
Taekwondo	3 (0.5%)	0	0	0	0
Weight lifting	3 (0.5%)	0	0	0	0
Gymnastics	8 (1.3%)	0	0	0	0
Handball	5 (0.8%)	0	0	0	0
Hockey	9 (1.4%)	0	0	0	0
Judo	6 (0.9%)	0	0	0	0
Tugwar	1 (0.2%)	0	0	0	0
Ultimate frisbee	1 (0.2%)	0	0	0	0
Skating hockey	1 (0.2%)	0	0	0	0
Skiing	1 (0.2%)	0	0	0	0
Squash	1 (0.2%)	0	0	0	0
Swimming	1 (0.2%)	0	0	0	0
Kho-kho	1 (0.2%)	0	0	0	0
Kick boxing	1 (0.2%)	0	0	0	0
Lawn tennis	1 (0.2%)	0	0	0	0
Total	638 (100%)	3 (0.5%)	10 (1.6%)	11 (1.7%)	2 (0.31%)

Table 2 – Associated meniscal and chondral lesions of knee in different sports.

Sports	Associated meniscal and chondral injuries					
	Medial meniscus	Lateral meniscus	Medial femoral condyle	Lateral femoral condyle	Medial tibial condyle	Lateral tibial condyle
Kabaddi	94 (33.0%)	104 (36.5%)	74 (26%)	21 (7.4%)	12 (4.2%)	8 (2.8%)
Football	33 (31.7%)	24 (23.1%)	15 (14.4%)	6 (5.8%)	2 (1.9%)	1 (1.0%)
Athletics	16 (29.6%)	15 (27.8%)	6 (11.1%)	4 (7.4%)	2 (3.7%)	1 (1.9%)
Cricket	11 (26.8%)	6 (14.6%)	3 (7.3%)	1 (2.4%)	0	1 (2.4%)
Volleyball	15 (44.1%)	10 (29.4%)	8 (23.5%)	3 (8.8%)	0	2 (5.9%)
Basketball	13 (41.9%)	9 (29.0%)	3 (9.7%)	1 (3.2%)	0	0
Wrestling	8 (34.8%)	4 (17.4%)	5 (21.7%)	1 (4.3%)	1 (4.3%)	1 (4.3%)
Badminton	6 (35.3%)	3 (17.6%)	5 (29.4%)	1 (5.9%)	0	0
Boxing	1 (25.0%)	1 (25.0%)	0	0	0	0
Karate	0	0	0	0	0	1 (50.0%)
Taekwondo	2 (66.7%)	0	2 (66.7%)	0	0	0
Weight lifting	1 (33.3%)	0	0	0	0	0
Gymnastics	0	0	0	0	0	0
Handball	1 (20.0%)	1 (20.0%)	2 (40.0%)	1 (20.0%)	0	0
Hockey	1 (11.1%)	3 (33.3%)	1 (11.1%)	0	0	0
Judo	1 (16.7%)	2 (33.3%)	2 (33.3%)	1 (16.7%)	0	0
Tugwar	0	0	0	0	0	0
Ultimate frisbee	1 (100%)	1 (100%)	1 (100%)	0	0	0
Skating hockey	1 (100%)	0	1 (100%)	0	0	0
Skiing	0	0	0	0	0	0
Squash	0	0	0	0	0	0
Swimming	0	0	0	0	0	0
Kho-kho	0	0	0	0	0	0
Kick boxing	0	1 (100%)	0	0	0	1 (100%)
Lawn tennis	1 (100%)	0	0	0	0	0
Total	206 (32.3%)	184 (28.8%)	128 (20.1%)	40 (6.3%)	17 (2.7%)	16 (2.5%)

Table 3 – Relationship between eight sports (kabaddi, football, athletics, cricket, volleyball, basketball, badminton, and wrestling) and associated injuries of the knee.

Associated injuries	Chi-square test values (χ^2)	'p' value
Medial meniscii	4.12	.77
Lateral meniscii	15.89	.026*
Medial femoral condyle	18.31	.011*
Lateral femoral condyle	2.68	.91
Medial tibial condyle	6.09	.53
Lateral tibial condyle	4.54	.72

* $p < 0.05$.

Table 4 – Relationship between kabaddi, football, and associated injuries of the knee.

Associated injuries	Chi-square test values (χ^2)	'p' value
Medial meniscii	0.054	.82
Lateral meniscii	6.21	.013*
Medial femoral condyle	5.75	.016*
Lateral femoral condyle	0.30	.58
Medial tibial condyle	1.15	.28
Lateral tibial condyle	1.15	.28

* $p < 0.05$.

players. These injuries often require expensive surgical treatment followed by the extensive long-term rehabilitation.²⁵ Severity of the ACL injury varies with different games. Thus, we used the opportunity of studying the association of ACL injury with different sports in elite players to know as to which sport is more prone to cause ACL injury and which sport causes more severe injury to the associated structures of the knee joint.

We analyzed the relationship of associated injuries of the knee with individual sports in addition to the overall occurrence in our study, in order to ascertain that as to which sport poses risk of injury to the associated structures of the knee. Thus, our study is unique in reporting the association of acute ACL injury to the other structures of the knee in individual sports.

In our study, we included only those patients who reported within 42 days of an ACL injury. The chronic ACL injury (>6 weeks duration) patients are reported to have more associated injuries due to repeated episodes of pivoting, so in order to avoid the bias of chronic ACL injury on the injury of associated structures.²⁶ We excluded patients with more than a delay of 42 days.

Previously, the incidence and prevalence of knee injuries in kabaddi has been reported to be higher by various authors.^{5,13,27} However, there was no specific mention of ACL injury in kabaddi. Our study revealed that kabaddi players sustained the highest percentage, 44.7%, of ACL injuries. Furthermore, the mean side-to-side difference of KT-1000 was observed to be highest in kabaddi (mean 7.2 mm, range 6–9 mm) as compared to the remaining games. In the rest of the games, the mean difference was 6.5 mm (range 5–7 mm). Additionally, kabaddi was the only game that was observed by us to result in

statistically significant number of lateral meniscal tears (104), PLC injuries (10), and CPN palsies (2). The occurrence of PLC injury and CPN palsy in kabaddi indicates that the severity of trauma in kabaddi is significantly higher. Thus, our study can be a landmark study, which has highlighted the exponential risk of high-energy knee injuries in kabaddi. It is a known fact that kabaddi involves contact with opponents and contact with the uneven ground, which can result in knee injuries.⁵ It also involves pivoting, sudden turning, and acceleration and deceleration of the knee joint, and all these movements predispose for ACL injury. But the occurrence of multiligament injury and injury to the CPN highlights a new observation that the energy involved in the causation of the ACL injury in kabaddi is significantly higher. We feel that such an alarming number of ACL injuries and serious injuries of the other structures of the knee in kabaddi players are a matter of concern, which needs further investigation and insight by conduction of on-field structured studies to investigate the specific actions of the players that can cause such serious injuries.

Football players sustained the second highest number of ACL injuries, 104 (16.3%). It also involves indulgence of player in contact with another player and kicking and torsional movements of the leg, which predispose for ACL injury in this sport. In previous multisport studies, football accounted for the highest number of reported ACL knee injuries.^{4,7} These authors, however, did not include kabaddi in their study. In our study, the occurrence of ACL injuries in kabaddi was almost three times (kabaddi – 44.7% and football – 16.3%) as compared to the football players.

Our study showed that the athletic activities – running and long/high jumping – constituted 8.5% of all ACL injuries. The mechanism of injury in majority (89%) of our athletes was fall and contact with the uneven ground while running and jumping. Although Devereaux and Lachmann²⁸ has earlier reported the occurrence of knee injuries to be 20% and 23%, in short distance and long distance running, respectively, they have not specifically mentioned about the ACL injury in their study. Furthermore, athletic jumping has not been highlighted as a causative factor for ACL injury in any of the previous studies. Thus, our study is also the first study that has reported the occurrence of ACL injury specifically in athletic running and jumping.

Cricket constituted 6.4% of all ACL injuries in our study. 73% of cricket players got injured while diving to field the ball, 25% were injured while bowling, and 2% while batting. Stretch,³ in a longitudinal study on cricket injuries, reported that injuries sustained by the knee were 18.5% of all injuries. However, their study has not mentioned about the ACL injuries specifically.

Our study reported that 5.3% of all ACL injuries occurred in volleyball players, followed by 4.9% in basketball players, 3.6% in wrestlers, 2.7% in badminton players, 1.4% in hockey players, and 1.3% in gymnasts. From this finding of our study, we observed that there is less association of ACL injuries with these sports as compared to kabaddi and football. This observation is consistent with the findings of Majewski et al., who have documented ACL injuries in multiple sports observed by them over a period of 10 years in their clinic.²³ The ACL injuries reported by them were as follows: 3% in volleyball, 2.1% in basketball, 1% in badminton, and 1% in gymnastics. In another study by Kilcoyne et al., only 34 ACL injuries were

reported in basketball players out of all 341 ACL injuries, which was relatively low and similar to our observation.²⁹ Hootman et al. showed in their epidemiological study that ACL injuries accounted for 1.5% and 1.6% of all injuries in wrestlers and women field hockey players, respectively.⁴

We have studied the data of eight sports (with more than 15 ACL injuries) separately, excluding the remaining sports with lesser number of ACL injuries, because by calculating the percentage of associated injuries in sports with lesser number of ACL injuries, we ran the risk of having bias of falsely higher percentages.

In the eight sports that had more than 15 ACL injuries, lateral meniscal tears were found to be statistically higher than the medial meniscal tears ($p < 0.05$). This is contrary to the observation of Kilcoyne et al. who have reported more tears of the medial meniscus in association with the ACL injury.²⁹ However, these authors have included meniscal tears even in those sports where the number of the ACL injuries was too small and even one. When we included all the sports in the cumulative manner irrespective of the number of ACL tears, medial meniscal tears, 206 (32.3%), were observed to be marginally higher than the lateral meniscal tears, 184 (28.8%). Another study on the sports specific meniscal injuries reported to have more cases of medial meniscal tears (32.7%) than lateral meniscal tears (15.1%) with ACL injuries.²³ However, Smith and Barrett have noted marginally higher incidence of lateral meniscal tears than the medial meniscal tears associated with ACL tear in acutely injured knee in their study.³⁰ However, they have included even nonsports persons in their study.

In our study, chondral damage of the medial femoral condyle was statistically higher than the lateral femoral condyle ($\chi^2 = 53.08$, $p = .0001$). Other chondral lesions included damage of the medial tibial condyle, 17 (2.7%), and lateral tibial condyle, 16 (2.5%). 72.1% of the chondral lesions were located in the medial tibio-femoral compartment. Overall, we observed 201 (31.5%) chondral damage lesions. Tandogan et al. have observed that 19% of the knees with ACL tears had chondral damage and the medial tibio-femoral compartment showed more chondral damage than the lateral compartment.²¹ However, their study was not confined to the acute sports injuries. They included even those patients who suffered sports injuries 360 months back. Inclusion of the chronic cases does not show the actual occurrence of chondral damage at the time of original sports injury. The higher occurrence of chondral damage (31.5%) in our study as compared to the 19% chondral damage in their study may be attributed to the fact that they have not included kabaddi in their study; we have observed in our study that kabaddi poses the highest risk of injury to the structures of the knee joint. Thus, to the best of our knowledge, ours is the only study that has reflected the contribution of sports as a cause of chondral damage.

When considering two sports with the highest number of ACL injuries (kabaddi and football), we analyzed that the highest association of lateral meniscal tear ($\chi^2 = 6.21$, $p = .013$) and chondral damage of the medial femoral condyle ($\chi^2 = 5.75$, $p = .016$) was found with kabaddi when compared with football.

Male players sustained more number of ACL injuries, 600 (94%), as compared to females, 38 (6%), in our study. Previous

studies have shown higher number of ACL injuries among female participants.^{8–10} The lower number of females in our study could be due the greater involvement of the male players in contact sports and risk taking behavior, especially in our country. This is in agreement with the study by Gianotti et al.,²⁴ which has shown similar results.

5. Conclusion

Kabaddi players suffered from maximum number of ACL injuries and injuries of the other associated structures of the knee. Whether it is due to the poor ground condition, poor body conditioning, or faulty rules of the game needs to be elucidated. Thus, further investigation should be carried out to analyze various factors responsible for the higher risk of ACL injuries and other serious injuries to the associated structures of the knee in sports participants. This will enable better prevention to avoid long break in the career of players.

Secondarily, we are of the opinion that further research is also warranted to investigate the association of ACL injury in different sports focusing on the identification of specific risk factors associated with each sport, so that more specific ACL-targeted protective programs could be designed according to the individual game.

Conflicts of interest

The authors have none to declare.

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