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Epidemiology of Anterior Cruciate Ligament Injuries – A Hospital-Based Cross-Sectional Study

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Abstract

Introduction: Anterior cruciate ligament (ACL) injuries with rapidly increasing incidence in our country are disabling to an individual both economically and monetarily, as their management is not only expensive but also has influence on the loss of number of working days of the individual. The natural history of ACL injuries which is not completely understood can have implications in treatment, management decisions, as well as patient counseling.

Materials and Methods: The objectives were to study the prevalence of ACL injuries among patients with knee injuries attending to our hospital and to assess factors associated with ACL injuries including selected demographic variables and other predisposing factors. We studied all patients (103) knee injuries seeking outpatient services at a tertiary care hospital over a period of 2 years. They were evaluated using a standardized questionnaire regarding the details of the injury followed by detailed general physical examination.

Results: We found that males in the age group of 21–30 years with normal body mass index (BMI) were most commonly affected, road traffic accident involving two wheelers being the predominant mode of injury. Majority of ACL injuries occurred on uneven surface during rainy season and they were of indirect in nature. The affected patients lead a sedentary lifestyle with highest frequency among graduates.

Conclusions: We found relatively high incidence of ACL injuries in graduate, middle-aged males with normal BMI. Most patients had poor awareness of ACL injuries and their implications. Majority of the patients had restriction in activities of daily living on self-assessment, which has significant bearing on patients economic and social well-being, we also notice consistent reporting of magnetic resonance imaging to match the clinical examination of lateral meniscal injury more than medial meniscus injury.

Keywords: Anterior cruciate ligament injuries, Epidemiology, Demography, Sex ratio, Road traffic accident, Lifestyle.

Introduction

The functional importance of the anterior cruciate ligament (ACL) has been identified, disputed, and reemphasized over the past few years [1]. ACL injuries are disabling to the individual. There is a rapid rise in the incidence of these injuries in our country, the management of which is costly and also has influence on the loss of number of working days of the individual. However, there are only few studies available in the literature on epidemiology of these injuries making comparisons difficult. This study was an attempt to bridge that gap.

Incidence of ACL recorded in the United States of America is 100,000–200,000/year [2].

Most of the available literature is based on Western studies, and multiethnic studies in Asian countries performed in different settings [3]. These results cannot be extrapolated completely to Indian subcontinent. However, only few studies on ACL injuries are available with relevance to the Indian subcontinent.

To the best of our knowledge, there are no prospective Indian studies available on epidemiology of ACL injuries. Most of the Indian studies available are retrospective, done on smaller number of patients with limited variables.

The objectives of our study was to report the incidence of ACL injuries attending our hospital and to assess various factors associated with ACL injuries including selected demographic variables and other predisposing factors.

Materials and Methods

This study was conducted after obtaining the Institutional Ethical Committee approval. This study was conducted over a period of 2 years between 2006 and 2008.

We analyzed all patients with knee injuries who presented to our department of orthopedic surgery during the study period. Those patients fulfilling

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the selection criteria were included in the study and our inclusion criteria included all the patients with acute or chronic knee injuries, and all those who have had a history of surgeries and reinjuries were excluded from the study.

A total of 103 patients who satisfied the inclusion criteria were analyzed. All those patients who fulfilled the inclusion criteria participated in an informed consent process. They were administered a standardized questionnaire pertinent to the details of the injury which was taken, followed by detailed general physical examination, standardized clinical tests for the injuries around the knee with the details of the radiological investigations such as X-rays and magnetic resonance imaging (MRI) were also taken into consideration.

The statistical significance of the incidences was compared with already known incidences in similar population subgroups using Z test, 95% confidence levels were calculated for all the incidence rates. For the quantitative parameters which were normally distributed, mean with standard deviation was used to describe the data. For not normal distribution, median/mode was used to describe. P < 0.005 was considered as statistically significant.

Results

During the study period, we had a total of 157,600 patients attending our orthopedic outpatient and emergency department. Among these, 1853 had knee injuries and 103 patients with primary ACL injuries consented to be a part of our study.

We report an incidence of 5.59% ACL injuries per 100 knee injury cases (95% confidence interval of 5–7). There was male preponderance with male:female ratio of 9:1. The mean age was 29.26 years with the range of 18–60 years and the average body mass index (BMI) of 24.02 kg/m2. Majority of our study population were literate with 75.7% of them having completed their undergraduation.

Among the study population, 83 patients (80.6%) led a sedentary lifestyle; while 20 patients (19.4%) had an active lifestyle. Among patients with sedentary lifestyle, 26 patients (31.1%) were software engineers followed by students amounting to 22 patients (26.5%). About 9.6% (8 patients) were supervisors, 5 patients (6.0%) were priests, while 3 patients (3.6%) each belonged to homemaker managers, health-care professionals. Two patients each amounting to 2.4% of the study population were found to be nurses, businessmen, and contractors. Fifty-seven attender, shopkeeper, religious sister, accountant, teacher, carpenter, and tailor each constituted 1 patient (1.2%) among the sedentary study population.

Among, 20 patients with an active lifestyle, 6 patients (30%) were employees, 4 (20%) were manual laborers and workers each, while policemen, laborer, security guard, and agriculturist amounting to 1 patient each constituted 5% of the non-sedentary population with 81 of them having no awareness of the injury or the likely implications of the ACL injury.

We also notice a seasonal variations in injuries were 44 cases sustained injury during rainy season with an incidence of 43 cases per 100 knee injuries and 95% confidence interval was at 33–52/100 cases of ACL injuries, 24 cases (23.3%) sustained injury during summer time, 23 cases sustained injury during winter, 11 cases (10.68%) did not remember the season of injury, and 1 case (0.97%) sustained injury during spring (Table 1).

Road traffic injuries (road traffic accident [RTA]) constituted the common mechanism of injury which amounted to 53 cases (51.45%). Among the RTA cases, two-wheeler accidents accounted for 94.33% (50%) of cases. The sports-related injury constituted for 31 cases (30.09%) in whom 21 (67.74%) cases were due to contact sports and 10 (32.25%) were due to non-contact

Table 1: Demographic evaluation

Parameters	Average	Results
Incidence		6 per 100 knee injury
Age (years)	Mean – 29.26	66% – 21-30,
	(Range 18 – 60)	17.4% – 31-40,
		7.7% – 41-50,
		5.8% – 11-20, and
		2.9% – 51-60
Sex		Male: 89%
		Female: 11%
Body mass index (BMI in Kg/M^2)	24.02	66 – Normal (18.5–24.9);
	(Range: 16.46–32.85)	31 – Overweight (25.0–29.9) 02 – Obese (30.0–34.9)
		04 – Underweight (<18.5)
Occupation	98% literate	02 – Postgraduated
		78 – Undergraduated
		12 – Finished college
		09 – Completed schooling
		02 – Not educated
Lifestyle		83 – Sedentary
		20 – Non-sedentary
Season		44 – Rainy Season
		24 – Summer time
		23 – Winter
		11 – Could not Recall
		01 – Spring
Awareness about ACL injury		22 – Patients had awareness
		81 – Patients had no awareness
Implications of ACL injury		19 – Had implications
		76 – No implication

sporting injury. Miscellaneous injuries constituted the rest 19 cases amounting to 18.45% of the study population among whom slip and fall at home, industrial accidents like concrete roof collapse, were the predominant mode of injuries (Fig. 1).

The nature of injury was indirect in nature which amounted to (80) 77.67% and direct injuries accounted for (23) 19.42% of the study population. The type surface was analyzed which showed that 46 cases (44.67%) had sustained injury on the even surface and 54 cases (52.43%) on uneven surface, and 3 patients could not recall the surface of the injury.

The clinical presentation to hospital following injury showed a mean of 148.51 days with 17 (17.51%) of cases coming immediately to the hospital, 33 (32.03%) within 4 weeks, 32 (31.06%) within 1–6 months, 12 (11.65%) within 6 months–1 year, and 9 (8.73%) presented after 1 year and had right knee was involved in 53 cases and 50 cases had left knee injury.

Chief complaints at the time of injury among the study population were predominantly pain in 99 (96.11%) of cases, 77 (74.75%) patients had swelling on and off, 28 (27.2%) noted instability at the time of injury, and 56 (54.36%) came with instability symptoms at the time of presentation and 3 (2.91%) cases had locked knee (Table 2).

Among these patients, 30 patients (29%) received pre-operative ACL protocol while 73 patients (71%) did not receive pre-operative ACL protocol.

Ninety-two patients (89.32%) had received treatment following the injury, 38 patients (40.8%) were immobilized in cylinder back slab; 19 patients (18.6%) immobilized in knee brace while 18 patients (17.65%) received crepe bandage and analgesics as initial treatment. Those remaining 18 patients (17.65%) received native treatment from osteopaths.

We noticed that 99 patients (96.11%) complained of restriction in activities of daily living while 4 patients (3.88%) could carry out daily activities normally based on self-assessed disability by the patients. Furthermore, 68 patients (66.01%) were noted with wasting of muscles involving thigh component, 90 patients (87.4%) had restriction of knee joint movements, and 19 patients (18.44%) had extensor lag on functional assessment.

On clinical examination, 98 patients (95.14%) were Lachman positive while anterior drawer test was found to be positive in 85 patients (82.5%) and pivot shift test was positive in 28 patients (27.18%) when it was performed in the outpatient department (OPD)/emergency room (ER). However in 63 patients (61.2%), it was tested positive when performed under anesthesia.

In our study population, 55 patients (53.4%) had suspected medial meniscus injury on clinical examination. Among these 55 patients, 54 patients (98.18%) were reported to have medial meniscal injury on MRI and 43 patients (78.18%) had medial meniscal injury confirmed by diagnostic arthroscopy. Seven patients (6.8%) were suspected to have lateral meniscus injury clinically and 16 patients (15.53%) were reported to have lateral meniscus injury on MRI. Among these 16 patients diagnosed on MRI, 14 patients (87.5%) had lateral meniscus injury confirmed by diagnostic arthroscopy. Sixteen patients (15.53%) were suspected to have medial collateral ligament injury clinically. Among these 16 patients, 9 patients (56.25%) were reported with this injury on MRI and 2 patients (12.5%) were confirmed to have medial collateral ligament injury on diagnostic arthroscopy. Five patients (4.85%) were suspected to have lateral collateral ligament injury on clinical examination. Among these 5 patients, 2 patients (40%) were reported to have lateral collateral ligament injury after MRI scan and no patients were found to have this injury on arthroscopy (Fig. 2).

Types of meniscus injuries among the study population showed involvement of posterior horn tear of the medial meniscus in 22 patients (51.2%) as the most common injury pattern (Figs. 3 and 4).

Radiographic analysis of ACL injuries among the study population which included X-rays and MRI scans. Among the study population of 103 patients, 101 patients had undergone MRI scan, 76 patients (75.24%) had ACL tear involving the femoral attachment; 23 patients (22.8%) patients had mid substance tear involving ACL while 2 patients (1.98%) had ACL tear involving the tibial attachment and they were also associated with inferior pole patella fracture in 3 cases, Segond's fracture in 2 cases, 2 have osteochondral fracture, and 1 had tibial spine avulsion fracture.

Table 2: Clinical presentation

Clinical symptoms	Presentation (cases)
Pain and swelling	45
Pain, swelling, and instability	42
Pain and instability	12
Instability and swelling	3
Instability alone	1

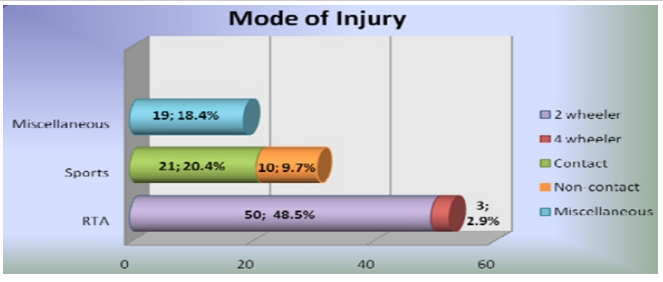

Figure 1: Mode of injury.

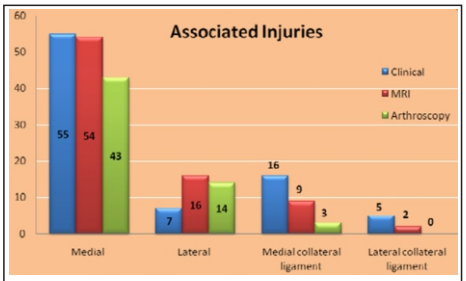

Figure 2: Associated meniscal and ligament injuries.

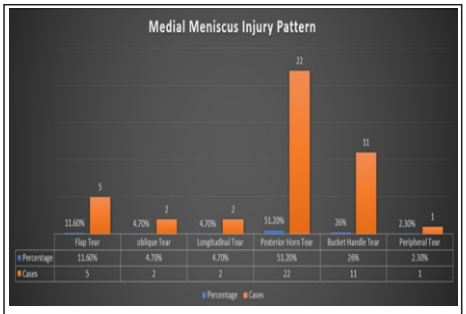

Figure 3: Pattern of medial meniscus tear.

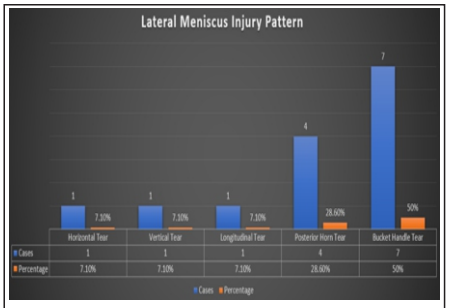

Figure 4: Pattern of lateral meniscus tear.

Discussion

Epidemiologic studies and analysis performed by different investigators in different settings have unraveled interesting facts regarding epidemiological parameters of ACL injuries. When comparing these studies, it would be ideal that one could relate to both the groups. The existing studies available are mainly western studies, where the data are available on sports-related ACL injuries. The data are available on incidence rates in general population, to which our data were compared, and the subsequent analysis was done.

In this prospective study, we studied 1853 patients with knee injuries, among which 103 patients were diagnosed with ACL injuries. We found that general incidence in the patients attending our hospital was 6 cases per 100 knee injuries. This was found to be higher than the reported incidence rates in existing studies. Marshall et al. reported an incidence of 1/2500 population ACL injuries [4]. Another reported incidence by Beynnon et al. and Griffin et al. reported 1/3500 population [5, 6], while Nielsen et al. reported incidence rate of 0.3/1000 population [7]. This was found to be statistically significant in our study. This reflects that it is indeed a common ligament to get injured in knee injuries which reflects larger population base in our country which would warrant a careful assessment of all knee injuries by attending frontline doctors.

The incidence rate in our study showed a male preponderance with a male:female ratio of 9:1. The existing literature reports a higher incidence rate in female population at 0.39/1000 population. Furthermore, it states that female sex has a 6–8 times higher chance of ACL injuries than males in view of the anatomical variation of the femoral condyles and the intercondylar notch [8]. Chan et al. reported high rate of ACL injuries in males at 81.2% which was similar to the studies done in the Asian population [3, 9], Beynnon et al. reported incidence of ACL injuries 9.7/1000 population of females [5]. We found that the higher incidence rates of ACL injuries reported in our study were found to be statistically significant. This significant difference in the incidence could probably be attributed to the fact that in India, traditionally, males are perceived more active than the females. Due to the cultural differences in the subcontinent, males are generally more active in sports-related activities, most of the time they are the bread winners in the family. This is an ever changing trend due to globalization and changes in legislation to bring in parity and gender equality, it requires further evaluation in the coming years as the risk factors for ACL injury are more in females as compared by the systematic review [10, 11].

In our study, we found higher incidence in the age group of 21–30 years, which amounted to a total of 68 cases (66.01%). The highest reported incidence of ACL injury was in the age group of 15–25 years which accounted for 33% of the study group and least in 51–60 years age group 3 cases (2%).(4) This could probably be due to the fact that this age group is more active in their participation in sports and related activities.

Most of our patients presented to us within 1 month of injury; a total of 33 patients (32.01%) presented within 4 weeks. Thirty-two patients making 31% of our study population presented after 1 month but within 6 months of injury. About 8.7% presented after 1 year of injury. In this variable, we did not have data to compare with other studies. The late presentation shows the poor knowledge and implications involved with ACL injury.

In our study, patients presented within 6 month's time, which goes on to say that these injuries are so disabling for our patients that they sought attention early. Mode of injuries noted in our study, 53 ACL injuries (51.45%) were due to RTA. Three cases were due four-wheeler injuries (2.9%). Fifty cases were due to two-wheeler injuries which comprised 48% of the cases.

The existing literature reports ACL injuries in mainly sports-related activities and this was contrary to our study which reports its mainly in RTA's. This finding was found to be statistically significant. RTAs were found to be more common in our study, due to overpopulation, crowded roads, and suboptimal infrastructure. The situation was aggravated by the rapid proliferation of vehicles, both two wheelers and four wheelers, beyond the stage where the roads can accommodate. Last but not the least, fast life among the youth could also be a contributory factor.

Thirty-one cases (30.1%) were due to sports-related injuries among which 21

cases (20.3%) were due contact sports, 10 cases (9.7%) were due to non-contact mechanism. Non-contact injuries were described to be more commonly associated with ACL injuries in the literature, 70% of cases were due to non-contact mechanism as described by Haim et al. In our study, we found that 67.7% of sports-related ACL injuries were due to contact sports.

We noted predominantly indirect nature of injuries in our series which constituted 80 cases (77.67%) of the study population. For this variable, we did not have data to compare with other studies hence statistical significance of which could not be calculated. However, most of the injury patterns noticed was due to RTAs, which may indicate that indirect injury mechanism was more common. Here, knee joint may be subjected to rotational, angulation, or combination of any these forces which could predispose to ACL injuries.

We also noticed that in 54 cases (52.4%), injuries occurred on uneven surfaces while 46 cases (44.66%) had injuries on even surface. The existing literature comparing the association between surfaces and risk of ACL injuries have mostly studied injuries occurring on wooden floors and artificial floor. These studies were done on sports-related population by Olsen et al. [13, 14]. These data could not be compared with our study since most of our patients were injured due to RTAs therefore on natural surfaces.

We also analyzed seasonal trends in ACL injuries presenting to our institution and we did notice that 44 cases (42.72%) among 103 happened during rainy season, while 24 cases (23.3%) sustained injury during summertime. In literature, Orchard et al. studied the weather conditions influencing the risk of ACL injuries in Australian Football League (AFL). They have found that low water evaporation and high rainfall significantly lower the risk of ACL injuries in AFL footballers. It is due to softening of the ground, which lowers shoe-surface traction [15]. These data could not be compared in our study since the setting for our study was different; here, mode of injuries noticed was more in RTAs. However, we do infer that roads are more slippery during rainy season which predisposes to slip and falls. Our study has shown that most of the ACL injuries happened in well-educated population, a total of 78 patients comprising (75.7%) were either graduates or doing graduation. Even though we cannot draw any comparisons with any other available literature for this variable, it is data for future studies to compare with. This variable was used to make sure if they can understand ACL injury implications and its pros and cons, which will further influence the know-how of ACL injuries.

Our analysis on occupation and its relation to ACL injuries showed that 84 cases (81.55%) among 103 were found to be in patients with sedentary lifestyle. Nineteen cases (18.45%) were found to be in patients with non-sedentary lifestyle. Haim et al. have stated that ACL injuries are common especially in young individuals who participate in sports activities associated with pivoting, decelerating, and jumping [12].

We noticed that 45 patients (43.7%) had pain and swelling as complaints at the time of presenting to hospital, 42 patients (40.77%) had pain, swelling, and instability at the time of presenting to hospital, 1 patient (0.97%) had pain alone, and 1 patient (0.97%) had instability alone. Ninety-two patients (89.3%) of 103 patients were attended to by a physician at the time of injury of in due course. Ten patients (9.7%) did not receive any treatment. Although majority of our patients were attended by physician or surgeon, 57 patients (61.95%) were diagnosed or explained to have ACL injury at the time of initial presentation. Rest were diagnosed to have minor sprains involving the knee joints which subsequently diagnosed as ACL tear. Noyes et al. in their study, they have reported that 6.8% of patient's only diagnosis of ACL injury made at the time of presentation [16].

In this study, 99 patients had restricted activity of daily living. We also made an attempt to study the awareness and implications of ACL injuries. Patients were asked simple yes or no questions to ascertain awareness while implications were recorded as stated by the patient. These data show that 22 patients (32.35%) had some understanding about these injuries before they sustained the injury. Twenty-seven patients (26.21%) understood the implication of the ACL injuries. The patients who were aware of these injuries and its implication were well educated and pursuing jobs in software industry.

Our study concerning the association of BMI and ACL injuries, was not in agreement with the study of Uhorchak et al. who have stated that it is more common in patients with higher than normal BMI [17]. Our study found that 66 patients (64.07%) had normal BMI, 33 patients (32.03%) were overweight. This could be due to the fact that majority of Indians are of thin built as compared to their Western counterparts.

Our patients underwent a thorough physical examination and found that 98 patients (95.14%) had positive Lachman test which is a good screening test to rule out ACL tear, especially in acute setting. Anterior drawer test, which is another supportive test, used in diagnosing ACL injuries was found to be positive in 85% of patients (82.5%). Both these tests were done on the patients as pain tolerated, in the OPD/emergency department. Pivot shift test was found to be positive in 28 patients (27.18%) when performed in the OPD/emergency department. Since pivot shift test being a painful test it was mostly performed under anesthesia in operating room and it was found to be positive in 63 patients (61.2%). A positive result for the pivot shift test is the best for ruling in a ruptured ACL

ligament.

Most common associated injuries noticed were the meniscal injuries, 55 patients (53.4%) were suspected to have medial meniscus injury clinically among which 54 (98.18%) had MRI images confirming the diagnosis, finally, 43 patients (78.18%) had confirmed medial meniscus injury. Most common medial meniscus injury noticed was posterior horn tear in 22 cases (51.1%). Seven patients (6.8%) were suspected to have lateral meniscus injury clinically and 16 patients (15.53%) were reported to have lateral meniscus injury after MRI, out of these 14 patients (87.5%) had lateral meniscus injury confirmed by diagnostic arthroscopy. Bucket handle tear was the most common type of injury noticed which comprised 50% of cases (7) patients.

Functional assessment of these patients, 68 patients (66.01%) had wasting of muscles involving thigh component, 90 patients (87.4%) had restriction of knee joint movements, and 19 patients (18.44%) had extensor lag. These are important determinants in rehabilitation of the patients.

Conclusions

We found relatively high incidence of ACL injuries in graduate, middle-aged males with normal BMI. Most patients had poor awareness of ACL injuries and their implications. Majority of the patients had restriction in activities of daily living on self-assessment, which has significant bearing on patients economic and social well-being, we also notice consistent reporting of MRI to match the clinical examination of lateral meniscal injury more than medial meniscus injury.

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