DOI: 10.7860/IJARS/2018/36805:2423

Original Article

Anatomy Section

Is Anterior Cruciate Ligament Tear Common at Tibial or Femoral End?

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ABSTRACT

Introduction: Anterior Cruciate Ligament (ACL) is considered as very important ligament for knee joint to maintain the knee stability. But their recurrent injuries lead to study its structure, attachment and its function for reconstructive surgical procedures. Over the past decades, several studies have shown inconclusive evidence on gender predisposition to ACL injury.

Aim: To determine if anterior cruciate ligament tear is common at tibial or femoral end, and to find out if there is any gender based difference in the incidence of ACL tear.

Material and Methods: This retro-prospective cohort study was conducted in the Departments of Anatomy and Radio-Diagnosis from August 2012 – August 2016. The cases above 18 years who required Magnetic Resonance Imaging (MRI) of knee for ACL tear were selected for this study. A total of 100 patients were included in the study. The data was presented as frequencies and proportions, mean and standard deviations. Difference in distribution based on gender and anatomical site was tested using chi square test. Statistical significance (p-value) was considered at 0.05 levels.

Results: Total of 86 males and 14 females were included, Average age of cases included in the study in male 34.99±10.4 and in female was 39.57±12.41 of the 100 cases. ACL injury at femoral end was significantly more compared at tibial end (Femoral end 59% vs. Tibial end 41%, p-value = 0.01). There was trend of male predilection towards femoral end detachment and female predilection towards tibial detachment and these observations were statistically significant (Femoral end: Male (62.8%Vs Female 35.7% p-value = 0.06) Tibial end: Male (37.2% vs. Female 64.3%, p-value=0.06).

Conclusion: Our study shows the higher incidence of ACL tear or detachment at femoral than tibial end of the ligament. The anterior cruciate ligament tear need reconstructive surgical procedure to preserve the permanent function of the knee with long duration of remedial treatment.

Keywords: Anterior cruciate ligament, Knee injury, Magnetic resonance imaging

INTRODUCTION

The knee joint has two strong intra-capsular but extra-synovial ligaments namely, anterior and posterior cruciate ligaments. ACL is attached in the anterior intercondylar area of tibial bone and lateral to the medial tibial eminence blending with the anterior horn of the lateral meniscus. It ascends postero laterally and is attached into the postero-medial aspect of lateral condyle of femur. [1]. The primary objective of the study is to determine if ACL tear is common at tibial or femoral end and the secondary objective is to determine the gender based difference in the incidence of ACL tear.

MATERIALS AND METHODS

This prospective study was conducted in collaboration with the Departments of Radio-Diagnosis and Anatomy from August 2012-August 2016, at Pondicherry Institute of Medical Sciences (P.I.M.S), Pondicherry, India. The Ethics Committee of the Pondicherry Institute of Medical Sciences approved this study. Written informed consent was obtained from the patients undergoing MRI evaluation for ACL tear. Patients with diseases like Synovitis, Posterior cruciate ligament and Meniscal tear of knee joint other than ACL tear were excluded from the study, individuals both male and female above 18 years of age who underwent MRI for ACL tear were included for the study.

The MRI was evaluated by a radiologist who commented upon the sites of ACL detachment as to whether it is femoral or tibial. A total of 100 patients were included in the study.

STATISTICAL ANALYSIS

The data was presented as frequencies and proportions, mean and standard deviations. Difference in distribution based on gender and anatomical site were tested using chi-square test, p-value less than 0.05 was considered to be statistically significant.

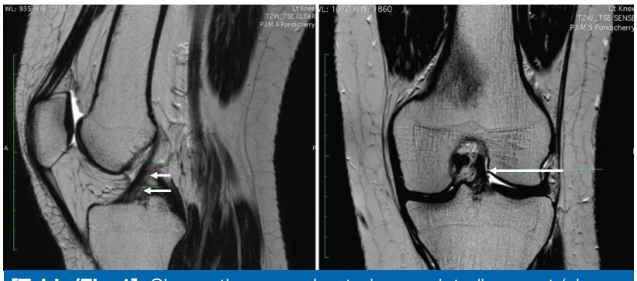
RESULTS

A total of 86 males and 14 females were included in the study. The average age was 34.99±10.4 years in males and 39.57±12.41years in females. ACL injury at the femoral end (59%) was more frequent compared to the tibial end (41%) with a p value of 0.01. There was a significant trend of male predilection towards femoral end detachment (male 62.8% vs female 35.7%; p-value = 0.06) and female predilection towards tibial end detachment (male 37.2% vs female 64.3%; p-value = 0.06).

DISCUSSION

In a case control study by Park JS et al., in 2012, [2] it was observed that the incidence of ACL tear was more common in males/females. The authors report that the females who has the diminutive Notch Width (NW) and Notch Width Index (NWI) tend to have higher possibility of ACL injuries. In our study it was observed the females were more prone for ACL injury than men.

Araujo P et al., reported that MRI was very valuable in anatomic ACL reconstruction [3]. We observed that the MRI was helpful to identify the detachment of ACL in tibial or femoral end and might be useful for accurate managing of ACL reconstruction by arthroscopy [Table/Fig-1].



[Table/Fig-1]: Shows the normal anterior cruciate ligament (shown by the arrow) in T2W sagittal and T2W coronal images

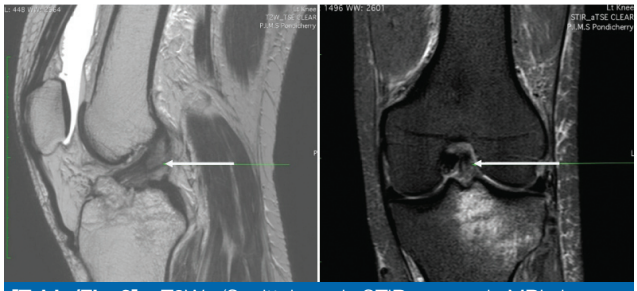
Khodair SA et al., studied the relationship of distal femoral morphormetry with ACL injury using MRI. The results of their study advised that there were significant differences in Notch Width (NW) and Bicondylar Notch Width (BCW) between males and females but there was no significant difference in respect to Notch Index (NI). They also stated that the patients with small NI and NW are at high risk for ACL injuries [4].

Carola F van Eck et al., studied the femoral intercondylar notch and found that patient's height influenced the notch shape. They mentioned that the females had a smaller notch width at the base and middle of the notch [5].

Study by Kevin O et al., suggested that an increased anterior directed shear force on the tibia correlated with higher incidence of ACL injury [6]. Studies have also identified an increased postero-inferior directed tibial rise and low medial depth of the tibial area of stability, as significant risk factors for ACL injury [6].

While a few studies have proposed the decreased ACL volume as a major risk factor for ACL injury. A few other studies have proposed that generalized joint laxity could also be a potential risk factor for ACL injury. Prior ACL injury and reconstruction had been implicated as risk factors for future knee injury [7].

The study done by Walden M et.al in 2006 suggested that the persons who already had anterior cruciate ligament surgical procedure for ACL repair they may have the risk for reinjures and also for contralateral knee injuries [8]. We observed that in males, tear of the femoral attachment of ACL was more common than the tibial end [Table/Fig-2].



[Table/Fig-2]: T2W (Sagittal and STIR coronal MRI images show oedematous anterior cruciate ligament (arrow) appearing hyperintense on T2W and STIR sequences with an avulsion fracture at its tibial end. Bone contusions are seen in the proximal part of tibia appearing hyperintense on STIR sequence.

We took another study for the morphormetry of bundles of anterior cruciate ligament and we observed the femoral attachment was narrow than the tibial attachment.

The hormonal and genetic factors have been linked to ACL injury. Studies have suggested an increase in risk of ACL rupture in the preovulatory phase of menstrual cycle [9-13]. We have observed the ACL injury in female patients were common between the age group 25-50 years.

Yoon JP et al., studied about prediction of ACL injury by MRI. One hundred and fifty patients with complete ACL tear included for the study. To calculate the MRI findings of ACL tear they used the double logistic regression equations. So using this calculation method the possibility of ACL injury was calculated in six weeks, three months, and one year of duration with accuracies of 82.1%, 89.4%, and 89.4%. [14].

Ruiter SJ et al., studied about restoration of rotational stability by anatomically oriented ACL graft and transtibial ACL graft. [15]. According to Ng WH et al., the MRI provides a much more accurate assessment of ACL injury and also for the other associated ACL injuries [16].

Siegel L et al., studied the ACL injuries and mentioned that ACL injuries might result in the premature end of athletic careers and serious disability in non-athletes [17]. Lin SH et al., studied the connection of ACL injury with knee osteoarthritis and total knee replacement surgeries. This study was conducted in

Taiwan population. They suggested that the osteoarthritis (OA) develop after traumatic knee injury, but it gives way to lower occurrence of OA development and total knee replacement. The authors were advising that the patients should undergo reconstruction of ACL at the earliest to lower the risk in future [Table/Fig-3] [18].

OTHER INTEREST

This study is part of a Ph.D thesis and the Principal Investicator of the study is Sakkarai Jayagndhi and the Supervisors are Dr. Virender Kumar Nim and Dr. M. Mohan Kumar.

Author (Year)	Objectives	Result	Present study
Park JS et al., (2012)	ACL tear was more common in males/females.	Females with small notch width (NW) and notch width index (NWI) in MRI have more possibility for ACL injuries.	The females were more prone for ACL injury than men.
Araujo P et al. (2013)	Optimize the use of MRI in anatomic ACL reconstruction.	MRI was very valuable in anatomic ACL reconstruction.	MRI was helpful to identify the detachment of ACL in tibial or femoral end and might be useful for accurately managing of ACL reconstruction by arthroscopy.
Khodair SA et al.(2014)	Morphometrics with anterior cruciate ligament injury using MRI.	Small NI and NW are at high risk for ACL injuries.	-
Carola F. van Eck et al.(2010)	Femoral intercondylar notch shape and dimensions in ACL-injured patients.	Females had a smaller notch width at the base and middle of the notch.	-
Kevin O et al.(2015)	ACL injury Current Understanding of Risk Factors.	Increased anterior directed shear force on the tibia correlated with higher incidence of ACL injury.	-
Beynnon B et al.(2014)	Risk of non contact anterior cruciate ligament injury.	ACL volume as a major risk factor for ACL injury.	-
Walden M et al 2006	Risk of new knee injury in elite footballers with previous ACL injury.	Those had ACL surgical procedure for ACL repair might may have the risk for reinjures and also for contralateral knee injuries	_
Slauterbeck JR et al (2002)	The Menstrual Cycle, Sex Hormones, and ACL Injury.	ACL rupture in the preovulatory phase of menstrual cycle	ACL injury was observed between the age of 25-50 years of females patients
Present study (012-2016)	1.ACL tear common at tibial or femoral end 2.Gender based difference in ACL tear	1. 59% of ACL tear at femoral and 49% at tibial end. 2. In males ACL tear was more common at femoral than the tibial end.	-

[Table/Fig-3]: Comparison between the present study with other studies related to anterior cruciate ligament injury.

LIMITATION

The small sample size with respect to female subject could be a limitation for the study.

CONCLUSION

MRI plays an important role in the diagnosis of ACL tear. Our study observed that the ACL tear was more frequent at femoral end compared to tibial end. In this study the overall injury of ACL was observed in females than males. And the femoral end of ACL was more frequently injured in males and the tibial end of ACL more commonly in females. The results of this study will be very helpful in planning gender based neuromuscular training programs to avoid ACL tears in athletics.

ACKNOWLEDGEMENTS

I would like to thank Dr.Renu G' Boy Varghese, Director – Principal, P.I.M.S, Dr.Moses Ambrose, Pathology P.I.M.S, Dr.R.Rajalakshmi, Physiology, IGMC&RI Pondicherry, Dr.Suman Verma, Anatomy, JIPMER, Dr.Kalaiselvi, Community Medicine, P.I.M.S, Department of Radio diagnosis and Department of Anatomy, P.I.M.S.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Publishing: **Oct 01, 2018**