

A descriptive study of Relationship between Post Tibial slope and Anterior-Cruciate Ligament Injury (ACL)

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Received: 02-5-2021 / Revised: 20-06-2021 / Accepted: 31-07-2021

Abstract

Background: Anterior cruciate ligament is most commonly involved in traumatic knee injuries. Among the various risk factors, posterior tibial slope is the Anatomical risk factor studied most for repair of this injury. Para Tibial Slope(PTS) both lateral and Medial are studied enormously to find the cause of Anterior Cruciate Ligament(ACL) injury. **Material and methods:** A Pilot study was conducted and sample size determined after obtaining Ethical clearance from the Institute. Posterior Tibial Slope measured Among the patient with Symptomatic knee injury patient by Digital Radiograph and MRI studies. Data analysed using software to sought association of ACL Injury and variance in posterior tibial slope. **Results:** The mean duration of illness (time between trauma and reporting of MRI to be done) was 7 ± 3.3 months with minimum 2 and maximum of 12 months. This is because many patients have treated outside before attending our tertiary care institution and mainly those who are unsatisfied with outside treatment, attended our institution and also because of tertiary care center hospital MRI is free so waiting time is usually very long. **Conclusion:** Increased posterior tibial slope (Radiologically measured) and Increased Lateral and medial para-tibial slope, its Average(MRI measured) has definite relationship with ACL injury.

Keywords: ACL, PTS(Posterior Tibial Slope), PITS(Posterior inferior tibial slope).

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Introduction

Knee is the largest hinge joint of body. This joint very easily injured not only in sports persons but also to common people. Along its attachment most common ligament to be injured is Anterior Cruciate Ligament in a traumatic knee. Numerous risk factors have been proposed for anterior cruciate ligament (ACL) injuries. [1] Commonly, these factors are classified into 4 categories: environmental, anatomic, hormonal, and Neuro-muscular. While anatomic risk factors are typically the hardest to modify, their identification remains important for further advancement of preventative measures and treatment of these Injuries. [2] Posterior tibial slope (PTS) has been proposed as a potential risk factor for ACL injury. Biomechanical analysis of the knee has revealed that the degree of PTS may be an important contributing factor to the AP stability of the knee. Past studies have found a correlation between increased PTS and increased anterior translation of the knee in cadaver models. These findings are corroborated by kinematic evidence demonstrating that larger PTS results in increased anterior Tibial translation and ACL force in active gait. The medial and lateral PTS are not necessarily identical in one given knee and differences of as much as 27° have been reported in cadaveric studies. [3] The slope varies widely, It may vary with age, squatting habit, between sexes, or there may be no sexual dimorphism Slope of medial and lateral plateau may differ significantly and slope also differs on radiograph due to change in measurement methods. [4] A recent study recommended separate assessment of the medial and lateral plateau PTS because patients with ACL rupture were seen to have a greater slope on the lateral plateau. The PTS is defined on a

lateral radiograph by the angle between perpendicular to the longitudinal axis of the bone and tangent to the medial and the lateral plateaus. [5] Although the biomechanical importance of the PTS is known the studies that have using plain radiographs only to Characterize PTS examined the relationship between PTS and ACL injury have Provided inconclusive and sometimes contradictory results. Various longitudinal axes have been defined and the mean angle is reportedly between 4°-14°. However, in Indian population the mean radiographic angle 6° to 24°. A high error in measurement resulting from a rotated tibia during lateral radiograph imaging may be misleading. [6] The lateral PTS has been considered an important anatomic reference landmark and guide for restoration of the natural PTS in TKA but discrimination between the plateaus is difficult with radiography and methods using three-dimensional computed reconstructions are time-consuming and complex. [7] Studies that Have used magnetic resonance imaging (MRI) to more thoroughly characterize tibial geometry, found that PTS on the lateral tibial plateau, but not on the medial tibial plateau, may be correlated with ACL injury. A recent meta-analysis showed that both medial and lateral PTS are associated with ACL injury regardless of sex. [8] An increased Posterior tibial slope is associated with ACL rupture. A higher pivot-shift grade is associated with an increased degree of posterior tibial slope and also anterior tibial translation. One recent study measured the differences between the medial and lateral PTS on MRI in patients with ACL rupture, but an additional radiograph was needed for the longitudinal axis determination. [9]

Material and methods

This is Descriptive and systemic random sampling study is conducted patients attending OPD with knee trauma in the Dept. of Orthopaedics in R.G KAR Medical College and Hospital.

Inclusion criteria: No history of osteoarthritis, No history of rheumatoid arthritis, No history of prior surgery on the knee of interest.

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Exclusion criteria: Diagnosis of patellofemoral syndrome.

All patients undergo following Radiograph: digital X-RAY (AGFA TXD-600) of affected knee to be taken in 100% magnification. True lateral view is identified by merging both condyles of femur as well as tibia. For measurement, we follow dejour and bonnin 1994 [10] described method. The diaphyseal axis of tibia was drawn between two points equidistant between the anterior and posterior border of tibia. The 1st one just below the tibial tubercle and the other one 10 cm below that, one reference line was drawn perpendicular to this at the level of tibiofemoral joint. The inclination of tibia drawn from the most superior point of the tibial plateau. The angle of this inclination line to the reference line is defined as radiological tibial slope.

MRI: MRI images (GE HEALTHCARE SURT 1000 XL1 1.5 tesla) from patients were analyzed using imaging software (all measurements are made using DIACOM image viewer software and jivex DIACOM image viewing software). Tibial slope measurements are obtained using the method previously described by Hudek et al [11] in 2009.

Statistical Analysis

Data of all patients were tabulated in Microsoft excel 2016 sheet and statistical analysis was done using IBM SPSS version 25. Normality testing was done for all continuous data like age, duration of illness, posterior tibial slope using Shapiro-Wilk test.

Continuous data were summarized with mean and standard deviation for parametric data and median and interquartile range for non-parametric data. Categorical measures like sex and presence or absence of ACL tear was summarizing with proportions. The

continuous variables were compared between the ACL injury present and absent group using unpaired t-test. Association between X ray and MRI slope values were tested by paired t-test. Statistical significance was defined as $P < .05$ and all tests were 2-sided. Cut-off value for tibial slope for predicting ACL tear was calculated by ROC analysis using Youden index.

Result

The range of age of patient is 15yrs-55yrs with mean age 30.2 ± 9.1 yrs. unpaired t-test showed no significant difference in these patients. There are 12 females and 60 males in the study with male to female ratio 5:1. Chi-square test showed no difference in distribution among male and female patients.

The mean duration of illness (time between trauma and reporting of MRI to be done) was 7 ± 3.3 months with minimum 2 and maximum of 12 months. This is because many patients have treated outside before attending our tertiary care institution and mainly those who are unsatisfied with outside treatment, attended our institution and also because of tertiary care center hospital MRI is free so waiting time is usually very long. Among those 72 subjects 46 (64%) had MRI confirmed ACL tear and 26 (34%) subjects had no tear. Rudresh S Halwar et al [12] showed incidence of MRI confirmed ACL tear in 111 patients to be 68.5%. In those 72 subjects 31 (43%) had injury to left side and 41 (57%) had injury to right side, among the left sided injured knee 24 patients had MRI confirmed ACL tear, and on right side injured patients 22 patients had MRI confirmed ACL tear.

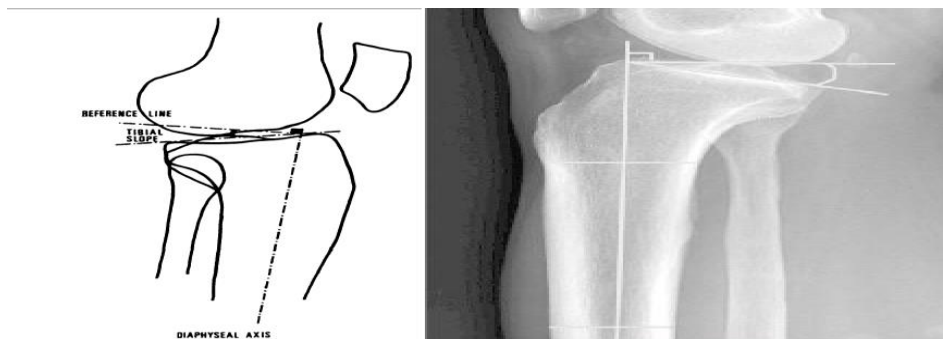


Fig 1: X - ray angle determination



Fig 2: Tibial axis determination

Discussion

The posterior tibial slope measured in digital x-ray, though defining posterior tibial slope on digital x-ray is a tough job and not free from errors many studies using only x-ray have contradicting results. The mean Posterior tibial slope on X-ray was 12.1 degrees and mean difference was 3.7 degrees between ACL tear (13.4°) and non-tear groups (9.7°) which was found to be significant by t-test. Cut-off for >9.3 degrees on X-ray was found to be predictive of ACL injury

with sensitivity of 93.5% and 53.2% specificity Brandon et al [13] found female ACL-insufficient patients had a significantly greater Posterior-inferior tibial slope (PITS) ($12.0^\circ \pm 3.5^\circ$) than their negative controls ($8.6^\circ \pm 2.7^\circ$). Male ACL insufficient patients had a significantly greater PITS ($10.8^\circ \pm 3.9^\circ$) than their negative controls ($8.4^\circ \pm 3.4^\circ$). In the isolated ACL-insufficient patients, the high-grade pivot-shift patient group had a statistically significantly greater PITS ($11.10^\circ \pm 3.85^\circ$) than the low-grade pivot-shift patient

group ($9.19^\circ \pm 3.58^\circ$). Hohman et al [14] showed mean for non-injured male and female mean PITS 5.80 ± 3.1 , 5.0 ± 3.4 respectively and mean PITS of injured male and female are 5.5 ± 3.4 and 6.7 ± 3.7 . Sonnery-Cottet B et al [15] mean PTS was significantly higher in case group than in control 10.1° (SD 3.3) versus 7.52° (SD 2.13), respectively; $p < 0.001$. Todd et al [16] showed subjects in the noncontact ACL group had significantly greater slope angles ($9.39^\circ \pm 2.58^\circ$) than did control subjects ($8.50^\circ \pm 2.67^\circ$) ($P = .003$). The posterior tibial slope measured in MRI had three parameters (1). Medial posterior tibial slope (mps), (2). Lateral posterior tibial slope (lps) and (3). average slope, which is the average of mps and lps.

Mps- The mean medial posterior slope was 8.3 degrees and it was significantly less for non-ACL tear (6.1 degrees) than for ACL tear (9.5 degrees), cutoff value 5.6 degrees was found to be differentiating between presence and absence of ACL tear in MRI with 92.9% sensitivity and 53.8% specificity. Aswini T et al [17] found positive correlation between mps and Acl injury, with mps without tear $7.2 \pm 3.7^\circ$ and mps in Acl injury patients to be $9.3 \pm 3^\circ$.

Lps- The mean lateral posterior slope was 7.3 degrees and it was significantly less in those without ACL tear in MRI than those with tear (4.1 vs 9.2 degrees) cutoff value 6.4 degrees was found to be differentiating between presence and absence of ACL tear in MRI with 84.8% sensitivity and 87.7% specificity. Aswini T et al [18] found positive correlation between lps and acl injury, with lps without tear $5.7 \pm 2.5^\circ$ and lps in acl injury patients to be 7.09 ± 3.47 . Hasemi et al [19] showed mean for non-injured male and female mean lps 5.40 ± 2.77 , 7.03 ± 3.07 respectively and mean lps of injured male and female are 7.22 ± 2.71 and 8.44 ± 2.82 . Stijak I 2007 [20] comparison of the tibial slope on lateral tibial plateau in both the groups (case and control) conclude that the difference was significant ($P < 0.01$). The tibial slope on the medial tibial plateau in the two groups was not significant. The average tibial slope on lateral tibial plateau in the examined group was 7.52° (from 0 to 13°), and the medial was slightly lower at 5.24° (from -1 to 12°). The value of the tibial slope on lateral tibial plateau in the control group was 4.36° (from -2 to 9°), whereas the tibial slope on the medial tibial plateau had a value of 6.58° (from 0 to 13°). In comparison to mps with lps correlation with ACL tear found more with lps than mps by roc curve analysis. Hasemi j et al [21] found steep lps as risk factor both men and women and mps only risk factor for men. Waiwaiole a et al [22] comparison demonstrated that the study group had significantly greater values for lateral PTS ($6^\circ \pm 4^\circ$); $P < .001$ and medial PTS ($7^\circ \pm 4^\circ$); $P < .002$ compared with controls ($5^\circ \pm 3^\circ$ and $5^\circ \pm 4^\circ$, respectively). Average- the average of medial and lateral posterior slope was calculated in MRI and was found to be 7.8 degrees. It was also significantly less for those with ACL tear than those without (5.1 vs 9.3 degrees) cutoff value 6.5 degrees was found to be differentiating between presence and absence of ACL tear in MRI with 91.3% sensitivity and 84.6% specificity [22]

Conclusion

Increased posterior tibial slope (x-ray measured), medial posterior slope (mps), lateral posterior slope (lps) and average slope (MRI measured) all are potential risk factors of ACL injury. Age and sex of individuals are not risk factor.

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Conflict of Interest: Nil Source of support: Nil