

Original Research Article

Radiographic evaluation of posterior tibial slope in ACL deficient Indian patients

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ABSTRACT

Background: There are several studies which have investigated various osseous morphologic characteristics as they relate to ACL injury. Tibial slope, notch width, and notch width index are some. However, there does not appear to be consensus across studies. The aim of this study was to validate association between posterior tibial slope (PTS) and ACL injury in an ACL deficient knee of Indian patients.

Methods: This retrospective cum prospective study was done at a tertiary hospital from June 2017 to May 2018. 40 patients were included. Inclusion criteria were documented evidence of ACL tear to the affected knee; no history of osteoarthritis; no history of rheumatoid arthritis; patients voluntarily consented for the use of their radiographs for the study. The assessment was completed with a true lateral view of the knee with full length leg and ankle. The functional tibial slope as described by Julliard et al was used to determine the PTS. The mean and standard deviation (SD) for medial PTS were measured. Demographic data like age, sex were collected and entered into a database.

Results: 95% of patients were male. Mean age was 29.25. The mean PTS was 13.037 which is reasonably high as compared to normal while the standard deviation was 4.487 reflecting large amount of variation.

Conclusions: Increased posterior tibial slope can be concluded as a significant risk factor in ACL injury which corroborates the findings of various previously published studies. The findings presented may help identify patients who are at greater risk of ACL injury.

Keywords: ACL injury, Posterior tibial slope

INTRODUCTION

The annual incidence of revision anterior cruciate ligament (ACL) reconstruction (ACLR) continues to rise.¹ It is estimated that 200,000 ACLRs are performed annually in the United States, with reported revision rates ranging from 1% to 13%.¹ Reconstruction of the ACL is a reliable procedure, with 90% of patients reporting improvement in functional outcomes following surgery.² Numerous factors have been incriminated to increase risk of failure following ACL reconstruction. These factors are broadly classified as extrinsic or intrinsic. Intrinsic factors such as an increased posterior tibial slope (PTS)

or a narrow intercondylar notch are not routinely addressed during ACL revision surgery.^{3,4}

Posterior tibial slope is defined as posterior inclination of tibia with respect to longitudinal axis of the tibia. Tibial slope is not static and changes from birth until skeletal maturity as at birth, tibial slope is approximately 25° degrees but decreases until skeletal growth is completed.⁵ At maturity, tibial slope ranges from 0° to 20° degrees, and the absolute value depends on the population group. There is no standard and accepted technique for measuring the tibial slope. Several methods have been described to measure tibial slope like direct cadaveric

measurements, CT based, MRI based or even routine radiograph based.⁶ They all depend on the angle between the tangent to the medial plateau and the perpendicular direction to various anatomical references like: tibial proximal anatomical axis, tibial shaft anatomical axis, posterior tibial cortex, fibular proximal anatomical axis, fibular shaft axis, and anterior tibial cortex.

Various studies have corroborated association between high PTS and risk of ACL injury in an adult.^{7,8,9} But there are few who found nothing to substantiate the association.¹⁰ Dejour and Bonnin reported that for every 10° increase in slope, an additional 6 mm of anterior tibial translation can be expected in both the ACL – intact and the ACL- deficient knee.¹¹ During stance phase of gait, vertical shearing forces across tibio-femoral joint are converted into anteriorly directed tibial translational force. The ACL serves as the primary restraint to anterior translation and as the PTS increases, a greater force is applied to the ACL (or graft reconstruction) Vduring functional loading and gradually induce stretching and rupture of ligament.¹²⁻¹⁴ Webb and colleagues determined that patients with a PTS 12° or greater as measured on lateral radiographs had 5 times greater odds of subsequent ACL injury after reconstruction and had an ACL reinjury rate of 59% in their series.¹⁵ Studies have found that every degree increase in lateral tibial slope was associated with a 32% increase in the risk of an ACL injury.

Literature has limited data scrutinising relationship between posterior tibial slope and ACL injury in an ACL deficient knee of Indian patients. The aim of the study is to validate association between ACL injury and posterior tibial slope using radiographic method in Indian patients.

METHODS

This retrospective cum prospective study was conducted over a period of 1 year from June 2017 to May 2018 in Department of Orthopaedics, All India Institute of Medical Sciences Patna with a cohort of 40 patients. Inclusion criteria were: (1) documented evidence of ACL tear to the affected knee (2) no history of osteoarthritis (3) no history of rheumatoid arthritis (4) patients voluntarily consented for the use of their radiographs for the study.

The assessment was completed with a true lateral view of the knee with full length leg and ankle. For true lateral view, femoral condyles must be superimposed as for measurement of posterior tibial slope the distance between the posterior edges of femoral condyles should be less than <5 mm. The functional tibial slope as described by Julliard et al was used to determine the PTS, which is the angle between the tangent to the medial tibial plateau and the lateral mechanical axis of the leg (Figure 1).¹⁶ This is considered to be the most suitable, as it uses the full length of the tibia and relates to its mechanical axis. The data collected from medical records

department provided patients age, sex, and surgery performed if any.



Figure 1: Radiograph of full length True lateral view of leg with knee and ankle: posterior tibial slope is the angle formed by perpendicular to the mechanical axis of tibia with the tangent to the medial tibial plateau.

Statistical analysis

The subjects (n=40) with age ranging from 17 years to 45 years were distributed into 4 age intervals ≤20, 21-30, 31-40 and >40. Tibial slope mean for individual age intervals were calculated along with mean of total subjects. P value was measured between and within the various groups. Mean of posterior tibial slope in male and females were calculated and P value measured. Finally Pearson correlation between age and tibial slope calculated.

RESULTS

95% of patients were male (Table 1). Mean age was 29.25. The mean PTS of all subjects was 13.037 which is reasonably high as compared to normal while the

standard deviation was 4.487 reflecting large amount of variation (Table 2). The trend in the mean PTS value with advancing age was evaluated using a line graph. Analysis of mean PTS with various age groups showed a trend of first decline with slight increase in 31-40 years and again decline with p value 0.655, not significant (Figure 2).

Table 1: Sex distribution.

Gender	Number of Patients	Percentage (%)
Male	38	95
Female	2	5

Table 2: Statistical analysis depicting age based number of patients, mean and standard deviation.

Age (in years)	Number of patients	Mean	Standard deviation
<=20	8	14.250	3.284
21-30	18	12.638	5.161
31-40	12	13.333	4.499
>40	2	10.000	.0000
Total	40	13.037	4.487

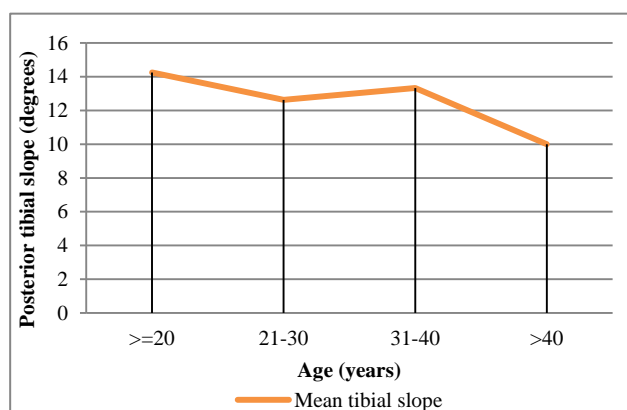


Figure 2: Slope changes with advancing age.

Table 3: Statistical analysis depicting gender based number of patients, mean and standard deviation.

Gender	Number of patients	Mean	Standard deviation
Tibial slope			
Male	38	12.986	4.595
Female	2	14.000	1.4

38 patients were male and mean PTS was 12.98 while with 2 females in cohort the mean was 14.00 (Table 3). The P value for the two gender based groups was 0.760 which is statistically not significant. Pearson correlation (r value) between age and tibial slope was -0.178 which indicates that the two variables are perfectly negatively linearly related. P value for the correlation between age and tibial slope was 0.271 which is not statistically significant (Table 4).

Table 4: Statistical analysis depicting correlation results.

	Tibial slope	Age
Tibial slope		
Pearson correlation (r value)	1	-0.178
Sig.(2 tailed) (p value)		0.271
N	40	40
Age		
Pearson correlation	-0.178	1
Sig. (2 tailed)	0.271	
N	40	40

DISCUSSION

Among various risk factors which have been proposed with ACL injury, modifiable risk factors are the ones which must be identified. Posterior tibial slope is one of the modifiable risk factors which has been studied extensively recently. Normal value of posterior tibial slope is 7-10° and higher the tibial slope more will be the anterior translation of tibia thereby putting more strain on ACL.¹⁷

In our study Tibial slope decreases as age advances with subtle increase in 31-40 years age group and again decline. Study done by Muthuuri concluded that the slope decreases with osteoarthritic degeneration.¹⁸ However Chiur et al concluded that osteoarthritis increases the slope by two to three degrees.¹⁹ As age advances tibial slope is also affected but a larger study is required to establish whether the slope increases or decreases.

Measurements based on lateral radiographs yielded 10±3° tibial slopes.¹¹ In our study, the mean tibial slope was found to be about 13° which is consistent with findings in literature. Study done by Şenışık et al found tibial slope to be 13° which is what even our study found.²⁰ Risk factors for ACL injury is multifactorial but literature has demonstrated a relationship between increased PTS and ACL injury which can be explained by the potential biomechanical and kinematic implications of an increased tibial slope over ACL.²¹⁻²⁴

The findings presented in this study are clinically pertinent as they can help to identify people who may be at an increased risk of an ACL injury and also those who are at high risk for re-injury after ACL reconstruction thereby reducing incidence of ACL injury and subsequent development of secondary Osteoarthritis. Although prevention programs have been shown to be effective in reducing the risk of an ACL injury, their cost-effectiveness is still inconclusive.²⁵⁻²⁷

This study has some limitations which has to be pointed out.

- Sample size is small

- Conventional radiography as a tool to measure tibial slope is inferior to CT or MRI based measurements.

CONCLUSION

Increased posterior tibial slope can be concluded as a significant risk factor in ACL injury which corroborates the findings of various previously published studies. The findings presented may help identify patients who are at greater risk of ACL injury.

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Ethical approval: The study was approved by the institutional ethics committee

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