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Original Research Article

Study of tibial ACL footprint in patients undergoing ACL reconstruction-correlation between pre-op MRI and intra-op measurements using arthroscopic ruler

Nandeesh S[1,*], Ambrish Sharma[1], Raju K P[1] and Sumit Kumar[1]

[1] Department of Orthopaedics, BGS Global Institute of Medical Science, Kengeri, Bangalore-560060
* Correspondence: drs.nandeesh@hotmail.com

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Abstract: Background: Currently measuring the preoperative size of the ACL tibial footprint. Length on sagittal MRI view is measured as the most anterior and most posterior portion of the ACL tibial attachment. To have an accurate measurement for the size of an ACL footprint, the ability to accurately identify the insertion site on MRI is important.
Methodology: 20 patients with ACL tear were included in the study.
Results: The mean age of the study participants was found to be 29.35+6.507 years. The mean weight of the study participants was found to be 75.55+12.84. The mean pre-op Tibial footprint of the study participants was found to be 12.54+2.24. The mean intra-op Tibial footprint of the study participants was found to be 12.87+1.53. The correlation was found to be statistically significant between the pre-op findings and the intra-op findings.
Conclusion: Tibial foot print length measured preoperatively on MRI can be used as a strong predictor for actual tibial length which can be helpful for prior planning of ACL reconstruction to improve the outcome.

Keywords: Anterior cruciate ligament; tibial footprint; ACL reconstruction; MRI.

1. Introduction

The largest and likely most complex joint in the human body is the knee. It is prone to injury because it is located between the two longest lever arms of the skeleton because of the huge moments that can be transmitted to it from stresses applied at great distances to the ligaments and capsular structures that support the structural strength of the joint [1]. The anterior cruciate ligament is the most frequently injured ligament, and the knee joint is the most frequently injured of all the joints [2]. The high-speed vehicle damage of today and the active lifestyle of athletes have increased knee ligament injury. Together with the other ligaments, the capsule, the muscles, and the bone, the anterior cruciate ligament serves as the pivot for the functional alignment and stability of the knee [3,4].

The most frequent and serious ligamentous damage to the knee joint is an anterior cruciate ligament (ACL) tear [5]. As the main stabiliser of the knee joint against anterior translation of the tibia on the femur, the ACL is essential in limiting rotation and valgus stress. Knee instability is caused by a deficiency in the anterior cruciate ligament. Due to this impairment, there is a higher risk of meniscus intra-articular damage, repeat injuries, and osteoarthritis [6].

ACL injury has become more significant in today's world of football, motorcycles, improved fitness awareness, and intensely competitive sports. Following a knee hyperextension injury, the ACL ruptures first. The knee's coordinated rolling and gliding motion is disrupted when the ACL is torn, leading to an uneven weight distribution through the knee joint [7,8]. The fundamental objective of ACL reconstruction is to restore knee joint stability. The three main categories of surgical ACL reconstruction techniques are intra-articular, extra-articular and mixed, employing either autogenous or synthetic material. However, there is no one optimum method to fix the chronic ligament laxity brought on by the injury. The two autografts that are most frequently employed for improved functional results are combination of semitendinosus and gracilis hamstring tendon grafts and bone patellar tendon graft.

SB ACL reconstruction has been frequently used since arthroscopic ACL reconstruction began. But recently, it was believed that when reconstructing the SB ACL, the native PL bundle's anatomical and biomechanical characteristics weren't taken into adequate consideration [9–13]. Hence, the DB ACL reconstruction came up considering that it would closely mimic the anatomical and functional properties of native ACL [14]. Few biomechanical studies even showed that the PL bundle reconstruction in DB-ACL reconstruction provides more anterior as well as rotational stability [15–17]. Therefore, a detailed knowledge of the size and shape of the tibial footprints of the two ACL bundles is of great importance. Although measuring the size of the ACL tibial footprint on MRI is commonly used for preoperative planning of ACL reconstruction, the accuracy of such measurement has not yet been well investigated [18,19].

This study was undertaken to forecast the size of the ACL footprint before surgery in order to choose the best surgical approach and graft.

2. Materials and methods

This cross-sectional study was conducted at the Department of Orthopaedics of BGS Medical College and Research Hospital, Bangalore after getting clearance from the institutional ethical committee. Duration of the study was for 18 months. The sample size taken for the study was 20 patients. In and out patients >18 years and patients having associated ligament injuries were included in the study. Patient less than 18 years, having history of suffering from Myocardial Infarction(MI) less than 6 months, psychiatric illness, head injury, epilepsy, uncontrolled diabetes, hypertension, associated intra-articular fractures in the knee or arthritis of the knee joint, duration between MRI and arthroscopic reconstruction more than 3 months and contraindicated for MRI (patient having pacemaker and implant in situ) were excluded from the study. Written informed consent was taken from the study participants before collecting the data. A pre-tested, semi-structured questionnaire was used to collect information on socio-demographic variables and history by interview method. Relevant Laboratory and Radiological investigations were done.

The data was collected and compiled in MS Excel. Descriptive statistics has been used to present the data. To analyse the data SPSS (Version 26.0) was used.

3. Results

[Table 1] 35% of research participants were between the ages of 31 and 35, whereas 25% were between the ages of 26 and 30. The study's participants' average ages were determined to be 29.35 + 6.507 years.

Table 1. Age of the study participants

Age	Frequency	Percent
17-20 years	2	10
21-25 years	3	15
26-30 years	5	25
31-35 years	7	35
36-40 years	3	15
Mean	29.35+6.507	

[Table 2] 55% were affected on the right side and 45% were affected on the left side. 65% of the study participants did not have any associated injuries. 25% had medial meniscus tear and 5% had lateral meniscus tear and 5% had both PCL and MCL tear. [Figure 1]

Table 2. Side affected

Side	Frequency	Percent
Left	9	45
Rright	11	55

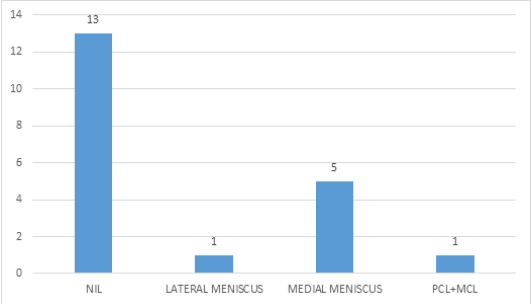

Figure 1. Associated injuries

[Table 3] The study's participants' average weight was determined to be 75.55 + 12.84.

Table 3. Mean weight

	Minimum	Maximum	Mean	Std. Deviation
Mean weight	50	93	75.55	12.845

[Table 4] The average pre-op tibial footprint among research participants was 12.54 + 2.24. The average intra-operative Tibial footprint of research participants was 12.87+1.53.

Table 4. Tibial foot print

Tibial foot print	Minimum	Maximum	Mean	Std. deviation
Preop	9.0	19.0	12.545	2.2463
Intra OP	10.0	16.0	12.875	1.5379

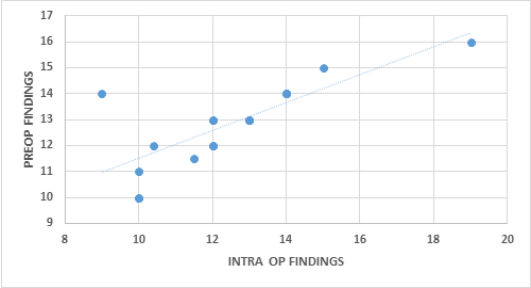

Figure 2. Correlation of tibial foot print

The preoperative findings and the intraoperative findings have a positive correlation, as can be seen in the picture above. The correlation between the pre-op findings and the intra-op findings was shown to be statistically significant, [Figure 2].

[Table 5] Pre- and intra-operative mean findings for men were 12.67 + 2.37 and 12.91 + 1.66, respectively. The mean pre- and post-operative outcomes for male patients were determined to be 11.80+1.31 and 12.66+0.57, respectively. It was not demonstrated that gender and the pre-op and post-op data had a statistically meaningful relationship.

Table 5. Tibial foot print with gender

Gender		Preop	Intra OP
Male	Mean	12.676	12.912
	N	17	17
	S D	2.3779	1.6605
Female	Mean	11.800	12.667
	N	3	3
	S D	1.3115	0.5774
P value		0.548	0.807

[Table 6]. The mean pre-op and intra-op findings among males was found to be 12.72+1.52 and 12.83+1.50 respectively. The mean pre-op and intra-op findings among males was found to be 12.40+2.77 and 12.90+1.64 respectively. The association was not found to be statistically significant between the side affected and the pre-op and post-op findings.

Table 6. Tibial foot print with affected side

Affected side		Preop	Intra OP
LEFT	MEAN	12.722	12.833
	N	9	9
	S D	1.5230	1.5000
RIGHT	MEAN	12.400	12.909
	N	11	11
	S D	2.7713	1.6404
P value		0.759	0.916

[Table 7] The mean pre-op and intra-op findings among study participants with associated injuries is given in the above table. The association was not found to be statistically significant between the associated injuries and the pre-op and post-op findings.

Table 7. Tibial foot print with associated injuries

Associated injuries		Preop	Intra OP
Nil	Mean	13.269	13.115
	N	13	13
	S D	2.3149	1.6602
Lateral meniscus	Mean	10.400	12.000
	N	1	1
	S D	.	.
Medial meniscus	Mean	11.000	12.400
	N	5	5
	S D	1.4142	1.5166
PCL+MCL	Mean	13.000	13.000
	N	1	1
	S D	.	.
P value		0.200	0.800

4. Discussion

The present study was undertaken to assess the correlation between pre-operative tibial foot print length on MRI and intraoperative foot print length which is the actual length.

The study had a total of 20 participants. 25% of participants were between the ages of 26 and 30 whereas 35% were in this age range between 31 and 35. The average age of the study's participants was found to be 29.35 + 6.507 years. In research that was older than ours, by Raja *et al.*, [20] and Park *et al.*, [21], the mean age was 35 years and 67.9 6.8 years. 85% of the individuals in the study were men, and 45% and 55% of the right sides of their bodies, respectively, were affected.

25% had medial meniscus tear and 5% had lateral meniscus tear and 5% had both PCL and MCL tear. The mean weight of our study participants was found to be 75.55+12.84 which was more compared to a study by Raja *et al.*, [20]. in which it was 62.3 $\pm$ 9.0 kg.

The mean pre-op Tibial footprint of the study participants was found to be 12.54+2.24. The mean intra-op Tibial footprint of the study participants was found to be 12.87+1.53. Pre-op findings positively correlated with the intra-op findings. The correlation was found to be statistically significant between the pre-op findings and the intra-op findings with an r value of 0.788 and P<0.00001.

In a study by Kim *et al.*, [22], the ACL tibial footprint's measured length on MRI and its actual length were 12.4 mm (range, 9.7-15.3 mm) and 13.8 (10.6-17.8) (P.001), respectively, and there was a significant connection between the two measurements (r =0.904, P 0.001). The results of this investigation were comparable to those of the current study.

The mean pre-op and intra-op findings among males was found to be 12.67+2.37 and 12.91+1.66 respectively. The mean pre-op and intra-op findings among females was found to be 11.80+1.31 and 12.66+0.57 respectively. The association was not found to be statistically significant between gender and the pre-op and post-op findings. In a study by Kim *et al.*, [22]. length on MRI and its actual length for men was 12.6 mm (range,10.9-15.3 mm) and 14.2 (12.3-17.8) (P < 0.001); for women it was 12.4 mm (range, 9.7-14.5 mm) and 13.7 (10.6-15.8) (P <0.001), the results of this investigation were in contrast to the findings of the current study, which revealed no correlation between either gender and length. There was no statistically significant correlation between the relevant injuries and the pre-op and post-op data. Only sporadically has the size of the ACL's tibial footprint been used in research to estimate the ACL's actual size.

The sagittal MRI view of the ACL fovea was used to quantify the length of the ACL tibial footprint in a study by Ichiba *et al.*, [23], but the accuracy of the size of the ACL fovea on the sagittal MRI view was not examined by examining the relationship with its real size in that investigation.

Han *et al.*, [24] looked at the precision of the 3-dimensional MRI measurement of the ACL tibial footprint. According to the findings of this study, the length and width of the tibial footprint on 3-dimensional MRI demonstrated strong agreements with the real length and width in cadaveric dissection.

In a research by Guenther *et al.*, [25], the area of the ACL tibial insertion site was measured intraoperatively and there was good agreement between the two methods. These results support the notion that the size of the ACL tibial footprint on MRI may serve as a useful metric for estimating the real size of the ligament. ACL tibial footprint real length was only partially predicted by research.

In a recent study, Park *et al.*, [26] found that the ACL tibial foot print length could be predicted by tibial length, with a reasonable coefficient of determination (R2 = 0.44), among patient height, weight, leg length, femur length, tibial length, and size of the proximal end of the tibia. These results are consistent with our theory that preoperative MRI measurement of the ACL tibial footprint length can aid in predicting its actual length.

5. Conclusion

From the above study, we conclude that tibial foot print length measured preoperatively on MRI can be used as a strong predictor for actual tibial length which can be helpful for prior planning of ACL reconstruction to improve the outcome.

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