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## ORIGINAL RESEARCH

# To measure the tibial and femoral footprint of ACL in Indian patients (with and without ACL injury) using MRI of normal patients, during (ACLR) and during TKR

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**ABSTRACT**

**Aim: To measure the tibial and femoral footprint of ACL in Indian patients (with and without ACL injury) using MRI of normal patients, during (ACLR) and during TKR.**

**Materials and Methods: The present prospective study was conducted at PD HINDUJA hospital and medical research center, Mumbai from March 2015 to November 2015 among 100 patients of Indian origin undergoing arthroscopy, TKR and MRI in our hospital. We have taken three separate patients group undergoing different procedure related to knee i.e. Group 1 (Arthroscopic ACL reconstruction), Group 2 (Total knee replacement) and Group 3 (Diagnostic MRI). As MRI are done in extension of knee, femoral footprint was in vertically oval plane, so calculating length of maximum Supero-inferior measurement on MRI sequence of femoral footprint was giving us length of femoral footprint. All above-mentioned readings were added in tabular form in excel sheet master chart and was statistically analyzed using SPSS software version 24.**

**Results: In group 1, it was seen that height and weight has positive correlation with tibial footprint length, width and femoral footprint. In group 2, it was seen that age, height and weight has positive correlation with tibial footprint length. This shows height is showing weak correlation coefficient. In group 3, height and tibial footprint size was having significant p value of 0.011 and weight was also having significant p value of 0.030.**

**Conclusion: Indian mean ACL tibial footprint length is 14.3+/-1.3mm, ACL tibial width is 10.53 +/-1.18mm and ACL femoral length is 16.4 +/-2.7mm. Height is constantly associated with ACL footprint dimensions. Indian Male can be considered for double bundle ACLR, while in females single bundle ACLR is better option but final decision has to be individualized.**

**Keywords: ACL, ACLR, Tibia, MRI**

## INTRODUCTION

Anterior cruciate ligament is one of the most important stabilizers of knee. ACL is the primary restraint to anterior tibial displacement, accounting for approximately 85% of anterior drawer test when knee is 90 degrees flexed. Injury to the anterior cruciate ligament (ACL) is very common orthopedic sports injury comes across in orthopedic practice. Due to its nature, various treating modalities and techniques have been evolved. In earlier days of surgical treatment, ACL reconstruction was done by single bundle graft but later it was proposed that, in order to mimic native ACL constructing two bundles would be beneficial. Double bundle ACL will have improved biomechanical rotational and anteroposterior stability due to fiber's arrangement of graft(1,2).

Clinically, double bundle reconstruction can produce better short term outcomes with regards to rotational and anteroposterior instability than single bundle reconstruction (3,4). However some of the recent researches have shown that outcomes of double bundle are at par with that of single bundle reconstruction(5,6). Although double bundle is technically demanding procedure and having high learning curve, it also has some disadvantages as it leads to increased tunnel widening, which further leads to possible instability and decreased bone stock so revision of ACL difficult (7,8). Hence proper preoperative analysis and patient selection for specific procedure is demanded.

Importance of size of footprint of ACL is considered when we have to opt between single bundle vs double bundle ACL reconstruction and for selecting optimum graft size. Recent studies have shown that small tibial footprint will not allow to create double tunnels.(9) Size of footprint will depend upon general anatomical structure of person.

Present study is aimed at measuring the tibial and femoral footprint of ACL in Indian patients (with and without ACL injury) using MRI of normal patients, during arthroscopic ACL reconstruction (ACLR) and during total knee replacement (TKR). By this study we are trying to establish the parameters of Indian patients, as none of the literature studies have performed any investigation on Indian patients regarding footprint of ACL. These parameters will help us to select appropriate surgical procedure in Indian patients by individualising our own parameters rather than following laid down parameters by study done on different set of patients of different ethnicity and general body structure.

## MATERIALS AND METHODS

The present prospective study was conducted at PD HINDUJA hospital and medical research center, Mumbaifrom March 2015 to November 2015 among patient of Indian origin undergoing arthroscopy, TKR and MRI in our hospital.

## SAMPLE SIZE

For the sample size,

$\alpha = 0.05$, $\beta = 0.1$

Mean in known population ($\mu 0$) = 15mm

Standard Deviation ($\sigma$)= +/- 3mm

Null Hypothesis value ($\mu 1$) = 14mm

Based on these conditions the sample size was considered as **95 patients** at95% confidence level & 90% power and rounded up to **100 patients**.

## INCLUSION CRITERIA

1. Patients of Indian origin
2. Patient undergoing arthroscopic ACL reconstruction
3. Patient undergoing TKR
4. Patients undergoing diagnostic MRI of knee

5. Patient of either sex with age 18yrs to 75 yrs.

**EXCLUSION CRITERIA**

1. In MRI group patient with complete or partial tear of ACL are excluded
2. Previously operated ACL reconstruction
3. Patients undergoing revision TKR
4. History of any intraarticular fracture in knee
5. Any infective condition, malignancy of knee
6. For MRI and TKR groups any pathology affecting ACL
7. Severely osteoarthritic knee with osteophytes

**METHODOLOGY**

We have taken three separate patients group undergoing different procedure related to knee.

**GROUP 1 (ARTHROSCOPIC ACL RECONSTRUCTION)**

In this group of patients, patients were undergoing arthroscopic ACL reconstruction procedure for diagnosis of ACL tear of knee. During surgery, arthroscopic portal were made for visualization with arthroscopic camera and simultaneous instrumentation. In both the measurement knee was kept 90 degrees flexed.

With established technique called ‘ Ruler technique’ by Charlie Brown et al (10) both the femoral and tibial footprints were measured. Ruler Technique uses all standard AM, AL and AAM portal and measurement was done with standardized flexible TRUKOR gauge by smith and nephew company.

**FEMORAL FOOTPRINT**

After confirming diagnosis of ACL tear, remnant of ACL was shaved off with arthroscopic shaver till margin of femoral and tibial footprint was visible. Keeping knee flexed to 90 degrees, TRUKOR gauge curved at about 45 degrees at approx. 20mm to accommodate inside and simultaneously it was not obscuring view of camera and instrumentation from AAM portal. Distal end of ruler was positioned in notch where distal tip was laying at most deepest portion of femoral footprint, which was just beneath articular margin where it borders articular surface. By this method measurement was taken at a point where maximum deep to shallow length of femoral footprint was present.

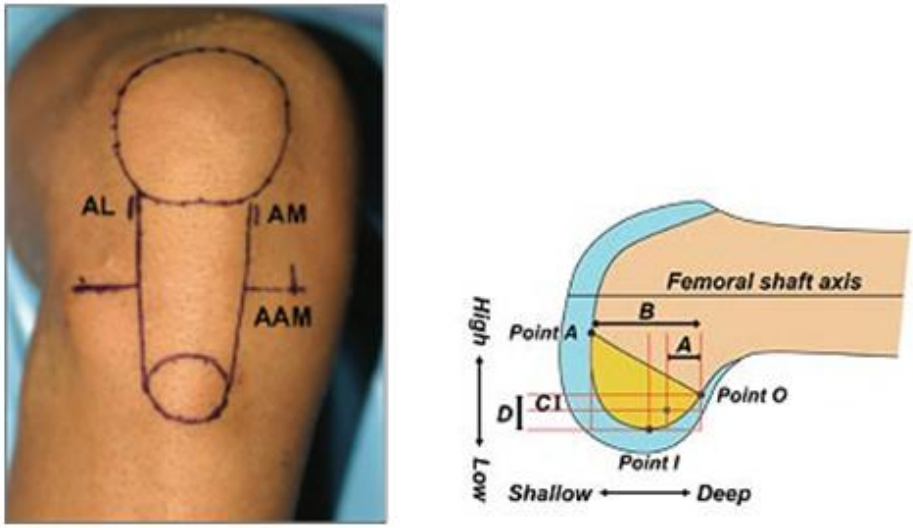


**Figure 1: Here the arthroscopic portals are shown: AL: Anterolateral, AM: Anteromedial, AAM: Accessory Medial Portal, Relation of footprint shown when knee is 90 degrees flexed.**

**TIBIAL FOOTPRINT**

For tibial footprint knee was kept flexed to position of 90 degrees. Footprint of ACL was shaved off with shaver till remnant fibers were visualized. TRUKOR gauge was passed from AAM portal and measurement of length of tibial footprint was done which was longest measurement of footprint, which was similar to but not necessarily coincides with anteroposterior axis. Width of tibial footprint was maximum measurement obtained perpendicular to length of tibial footprint.

**GROUP 2 (TOTAL KNEE REPLACEMENT)**

In this group patients who were planned to undergo Total knee replacement surgery were included. In this method all surgical steps were done as per routine TKR without altering any step. In total knee replacement it is necessary to take tibial and femoral cuts to fix new prosthesis over it. Tibial cut was taken after application jig to tibia. In this process we got cut section of articular surface of tibial bearing footprint of ACL along with meniscal attachment. On resected tibial cuts, we cleared all meniscal attachment and synovium surrounding fibers of ACL so as to delineate tibial footprint. In this method it was possible only to measure tibial footprint. Femoral footprint measurement was not possible technically.

**TIBIAL FOOTPRINT**

On resected tibial specimen after clearing all soft tissue attachments tibial footprint were separated and marked. Here we have measured two parameters of footprint.

1.Length – it was longest measurement of tibial footprint, which coincide, but not necessarily in anteroposterior axis.

2. Width – it was longest measurement of tibial footprint perpendicular to length of footprint.

**GROUP 3 (DIAGNOSTIC MRI OF PATIENTS)**

In this group patients who were not having ACL deficient knee were included so that anatomical pattern and radiological image of intact ACL footprint can be measured, anatomical details and images of which was not clear in ACL deficient knee.

All patients underwent standardized knee protocol of MRI for detection of pathology. MRI was performed by in single machine of: 3 T Philips Ingnesia, for this method sagittal and coronal images was used for tibial and femoral footprint measurement. All images were seen and analyzed for measurements by single observer, scans having evidence of ACL pathology, any prior surgery were excluded. Using digital image viewing software with digital metric scale all measurements were taken.

**TIBIAL FOOTPRINT AND OTHER MEASUREMENTS**

After selecting MRI with all mentioned criteria, in tibial footprint following measurements were taken:

1. **Length:** For calculating length of footprint, T2 weighted films of MRI were selected having maximum length of tibial footprint. With help of image viewing software, using Digital metric scale Anteroposterior diameter of tibia was measured by line drawing from anterior edge of tibia near articulating margin just proximal to tibial tubercle up to, posteriorly point at the level of origin of PCL.

Then in sagittal plane two points were fixed, first was anterior most point of insertion tibial footprint and second was posterior most point of insertion of tibial footprint. Then considering this two point as reference points two perpendiculars was drawn to the articulating surface of tibial plateau along long axis of tibia, which was intersecting Anteroposterior line drawn to measure AP diameter of tibia. So we got following set of values

a) Total anteroposterior diameter of tibia (AP)
b) Distance of anterior articular surface to anterior most insertion of tibial footprint (AB1)
c) Distance of anterior articular surface to posterior most insertion tibial footprint (AB2)
d) Distance between B1and B2 was length of footprint(57)

All above measurements were expressed in percentage of sagittal depth of tibial surface occupancy.

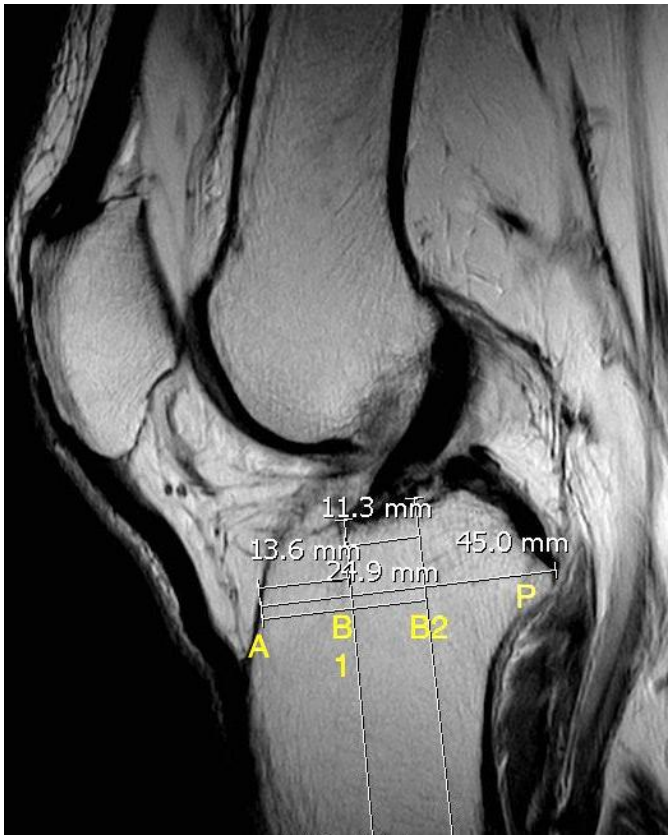


**Figure 2: A: anterior point at tibial articular margin proximal to tibial tubercle, B1: perpendicular to tibial plateau from anterior most point of Tibial footprint of ACL, B2: perpendicular to tibial plateau from posterior most point of Tibial footprint of ACL, P: posterior point at level of origin of PCL**

**TIBIAL FOOTPRINT WIDTH**

For calculating width of tibial footprint, coronal section of T2 weighted images weres used. In these images width was calculated as maximum mediolateral measurement of ACL in intercondylar notch near tibial insertion.

**FEMORAL FOOTPRINT LENGTH**

In T2 weighted coronal images as we go posteriorly from tibial footprint, fibers of ACL go Supero-lateral to insert on lateral femoral condyle on medial surface. This image of femoral footprint was selected on sequence of MRI with maximum dimension of footprint length. As we know oval femoral footprint changes orientation from horizontal in flexion to vertically oval when knee is kept in extension. As MRI are done in extension of knee, femoral footprint was in vertically oval plane, so calculating length of maximum Supero-inferior measurement on MRI sequence of femoral footprint was giving us length of femoral footprint.

All above-mentioned readings were added in tabular form in excel sheet master chart and was statistically analyzed using SPSS software version 24.

## RESULTS

Patients included were almost in proportion of 1:1 with respect to male to female. In-group 1 of arthroscopy average age was 29.03 yrs. with range of 20 -38 yrs. In-group 2 of TKR average age was 63.65 yrs. with range of 50-74 yrs. In-group 3 of MRI average was 44.35 yrs. with range of 18-69 yrs.

**Table 1: Group Wise Distribution of Patients**

| Method | N | |
|---|---|---|
| | Male | Female |
| 1. Arthroscopy | 21 | 11 |
| 2. TKR | 14 | 20 |
| 3. MRI | 13 | 21 |

**Table 2: Variables of physical characteristics associated with ACL femoral footprint length in group 1**

| Femoral footprint length | | N=32 | p value byMann – Whitney test |
|---|---|---|---|
| Age | >=14 | 26 | 0.266 |
| | <14 | 6 | |
| Height | >=14 | 26 | |
| | <14 | 6 | 0.153 |
| Weight | >=14 | 26 | 0.007 |
| | <14 | 6 | |
| Female | >=14 | 6 | 0.011 |
| | <14 | 5 | |
| Male | >=14 | 20 | |
| | <14 | 1 | |
| Left Knee | >=14 | 14 | 0.16 |
| | <14 | 3 | |
| Right Knee | >=14 | 16 | |
| | <14 | 1 | |

P value shows significant difference when we consider gender and femoral footprint length. P value was significant when compared femoral footprint with weight, <0.01. It was not significant with age and height with non-significant p value. There was non-significant p value while comparing knee examined and femoral footprint (table 2). It is seen that height and weight has positive correlation with tibial footprint length, width and femoral footprint. Correlation coefficient is suggestive of strong if value is >0.75. Moderate if coefficient is 075-0.40 and weak if value is <0.40. Thus all above parameters have moderate strength of correlation.

**Table 3: Variables of physical characteristics associated with ACL femoral footprint length in group 2**

| Femoral footprint length | | N=34 | p value by Mann – Whitney test |
|---|---|---|---|
| Age | >=14 | 26 | 0.015 |
| | <14 | 8 | |
| Height | >=14 | 26 | 0.028 |
| | <14 | 8 | |
| Weight | >=14 | 26 | 0.046 |
| | <14 | 8 | |

| | | | |
|---|---|---|---|
| Female | >=14 | 18 | 0.042 |
| | <14 | 2 | |
| Male | >=14 | 8 | |
| | <14 | 6 | |
| Left Knee | >=14 | 13 | 0.69 |
| | <14 | 3 | |
| Right Knee | >=14 | 13 | |
| | <14 | 5 | |

Here from the analysis, tibial footprint has significant difference with age, height and weight of patient. P value was significant while comparing patients having tibial footprint size above 14 mm and gender male. There was no significant association in knee examined for tibial footprint size variability (table 3). It is seen that age, height and weight has positive correlation with tibial footprint length. Correlation coefficient is suggestive of strong correlation if >0.75. Moderate if coefficient is 075-0.40 and weak if value is <0.40. This shows height is showing weak correlation coefficient.

**Table 4: Variables of physical characteristics associated with ACL femoral footprint length in group 3**

| Femoral footprint length | | N=34 | p value by Mann – Whitney test |
|---|---|---|---|
| Age | >=14 | 15 | 0.98 |
| | <14 | 19 | |
| Height | >=14 | 15 | |
| | <14 | 19 | 0.011 |
| Weight | >=14 | 15 | 0.030 |
| | <14 | 19 | |
| Female | >=14 | 6 | 0.033 |
| | <14 | 15 | |
| Male | >=14 | 9 | |
| | <14 | 4 | |
| Left Knee | >=14 | 6 | 0.38 |
| | <14 | 11 | |
| Right Knee | >=14 | 9 | |
| | <14 | 8 | |

Height and tibial footprint size was having significant p value of 0.011 and weight was also having significant p value of 0.030. Age was having non-significant p value. Gender and tibial footprint length had significant difference of p value. No any predilection was present with knee examined and tibial footprint size (table 4).

**Table 5: Findings on MRI Measurements**

| | AP | AB1 | AB1 in% | AB2 | AB 2 in % | ACL Central position | ACL Central position in % |
|---|---|---|---|---|---|---|---|
| Mean | 46.98 | 13.36 | 28.381 | 26.99 | 57.435 | 20.09 | 42.73 |
| S.D. | 3.56 | 2.16 | 3.754 | 3.17 | 4.973 | 2.53 | 4.13 |
| Min | 39.20 | 9.50 | 21.253 | 21.20 | 48.770 | 15.45 | 34.56 |
| Max | 53.90 | 18.60 | 37.126 | 33.70 | 67.265 | 25.85 | 51.60 |

## DISCUSSION

Very few studies exist about footprint of ACL in Asian population. In whatever present literature we have, they have studied few aspects about the ACL dimensions by direct measurements either by cadaveric knee or in TKR or in MRI. With the background of literature studies, we are trying to find out association of physique of Indian patients and ACL footprint dimensions. In one of the studies by **Kulkamthom et al** it was documented that average tibial footprint length was 15.36 mm as per the in 77 cadaveric knees of Thai population (11). In other study conducted on Japanese patients by sagittal sections of MRI by **Ichiba et al.**(12) ACL tibial foot print was 15.2 mm with the distribution of population having footprint length < 14 mm was 28%. One of the studies conducted on Asian female population by **Park et al** (13)while doing TKR found out the tibial foot print to be 13.8 mm and width of 9.8 mm, the proportion of population having tibial footprint < 14 mm was higher, it was 53.5%.

In our study, the average of the tibial footprint length and width from all three methods is 14.32 mm and 10.32 mm respectively. Femoral footprint length was measured in two groups of arthroscopy and MRI, which was 16.39 mm. In our study we have also analyzed the pattern of meniscal tear involvement while taking the measurement of ACL footprint. We found that involvement of both meniscal tear was commonly seen in elderly population and involvement of lateral meniscus is seen in younger population. Medial Meniscal tear is seen more pronouncedly in degenerative knee conditions like osteoarthritis of the knees.

In our study we took cut off of 14mm for both tibial and femoral footprint. This was based on various studies and metaanalysis. Siebold et al (9) in his study about tibial and femoral footprint of ACL has set the parameters about double bundle ACLR. In this study he proposed, tibial square model in which minimum anteroposterior length required for separate AM and PL tibial tunnel placement is 14mm while in femoral footprint it was 14 to 15 mm for double bundle placement.

## IN GROUP 1 ARTHROSCOPY

In this group, we measured the femoral and tibial footprint with method described earlier in all the patients undergoing arthroscopic ACL reconstruction. We found that ACL tibial footprint length was 14.65 mm with the 97% of the values were in the range of 13mm to 16.99 mm. **Kopf et al (14)** found this value in arthroscopically measured study group to be 17+/-2mm. In our method group this value is significantly lower as compared to study conducted on patients of other ethnic origin.

By this method we found that, tibial footprint of ACL is having statistically significant relation with height and weight with p value <0.01. In relation with age the P value was non-significant. In previous studies, **Ichiba et al**(11) found that there was positive correlation existing between height, weight with tibial footprint. **Kopf et al**(14) found weak association between these parameter.

Tibial footprint and gender has shown statistically significance in two groups with p value of <0.012, suggesting male population has significantly greater footprint dimensions. It was supported by study conducted by **Siebold et al**(9). Tibial footprint does not show any specific significance of difference between right and left knees examined. Right and left knee showed similar pattern of tibial footprint. This finding was similar to study performed by **Dargel et al**(15).

Tibial footprint width in this study group was 10.28mm. With 40.6% measurements were in-group 10mm-10.99.mm. This finding was in line with **Siebold et al (9)**where they found width to be 10+/- 2mm.

Femoral footprint in this group showed the pattern in which 59.4% measurements were in range of 14mm-16.99mm, with mean of 15.18mm. In study performed by **Siebold et**

**al**(9)they found that femoral footprint length was 15+/-3mm. As per study done by **Kopf et al**(14) length of footprint was 16.5+/- 2mm. This is suggestive of Indian patients examined in this group has smaller femoral footprint as compared to western population.

**IN GROUP 2, TOTAL KNEE ARTHROPLASTY**

In this group, we studied patients undergoing total knee replacement. While doing the surgery, after the tibial cut we have taken measurements of tibial footprint of ACL as described earlier. In current study, the average tibial footprint length was 14.88 mm with 58.8 % of the values were in the range of 14 mm to 16.99mm. **Park et al**(13) did the similar study in Asian females undergoing total knee replacement surgeries-the average footprint length was 13.8 mm. One study by **Kulkamthom et al** (11)done on 77 cadaveric knees of population, it was found that the average femoral tibial attachment was 15.36mm. Another study conducted on Japanese population **Ichiba et al**(12) reports average tibial footprint length as 15.2mm. Our study results are comparable with the other studies conducted on Asian population, which is significantly higher than the results of **Park et al (13)** as his study includes only female population.

Tibial footprint length is having statistically significant difference when age, height and weight are taken into considerations with the "p" values being 0.015, 0.028 and 0.046 respectively. This finding is consistent with the findings of **Ichiba et al.**(12) Tibial footprint length shows statistically significant difference with gender with the "p" value of 0.042 suggesting males have greater footprint dimensions. These findings are consistent with the results of **Siebold et al (9), Ichiba et al (12) and Kulkamthom et al (11).**

Tibial footprint length and side of knee examined did not give any conclusive significant difference. This finding is correlating with **Ichiba et al.**(12)

**IN GROUP 3 MRI**

In this group, we studied patients undergoing MRI and have compared results. MRI was done for diagnostic purpose in patients and those who have Non ACL deficient knee are included and measured as per the methodology described earlier. In current study the average tibial footprint length was 13.45mm with 44.1% values were in range from 13-14.99mm. **Ichiba et al**(12) conducted a study with the use of sagittal sections of MRI in 100 Japanese patients and found that footprint of ACL in male was 15.2mm with 28% being <14 mm. In our this method of MRI, percentage of population having tibial length below 14mm was 55.8% whereas in method group 2 of total knee replacement it was 23.6% and in methodology Group1 it was only 18.8%. Hence showing a differential distribution of tibial footprint length in different groups. This difference could be attributed to non-randomized hospital based population, which may not be complete representative of whole population. **Staubli et al**(16) performed MRA in 35 patients with intact ACL and found that average ACL tibial footprint length was 16.5mm.

The physical characteristics of the patients associated with tibial footprint length in this method showed a significant difference of p values with respect to height and weight values being 0.011 and 0.030 respectively. Age was showing no significant difference with a p value of 0.986. These findings are consistent with other two method groups of our study. Tibial footprint dimensions and gender show statically significant difference in two groups with the p values being 0.033. These findings are consistent with **Ichiba et al (12), Siebold et al (9) and Kulkamthom et al (11)** studies.Tibial footprint length and knee examined did not give any conclusive significant difference. This finding is correlating with **Ichiba et al**. (12) The mean of tibial footprint width in our study is 10.26mm and 50 % of values were ranging from 10 -10.99mm. This is almost comparable with study conducted by **Park et al**(13)where it was 9.8mm. It is also consistent with **Siebold et al**(9) where it was 10+/-1mm.

From this comparison, we can analyse that sagittal sections of MRI showing all these measurements of or study are comparable with other published studies of western population. The absolute values in current study are less than western studies conducted but when expressed in terms of percentage, it was comparable to respective counterpart. As per established literature by **Amis et al**(17) goal for placement of tibial guide pin should be 41-44% on Amis jacob line which corresponds to centre of tibial ACL insertion. In our study we found centre of tibial ACL insertion to be at 42.1 +/- 4%, that is similar to results of Amis et al study. By this measurements surgeons can plan where to guide tibial guide pin for tibial tunnel placement to reach centre of ACL during preoperative course in primary ACL and revision ACL reconstruction.

**Table 6: Comparison of all three group findings**

| Method | | Tibial footprint Length (mm) | Tibial footprint Width (mm) | Femoral footprint length (mm) |
|---|---|---|---|---|
| 1. Arthroscopy | Mean | 14.66 | 10.28 | 15.19 |
| | S.D | 1.12 | .99 | 2.29 |
| | Minimum | 13.00 | 9.00 | 11.00 |
| | Maximum | 17.00 | 13.00 | 21.00 |
| 2. TKR | Mean | 14.88 | 11.03 | |
| | S.D. | 2.04 | 1.42 | |
| | Minimum | 11.00 | 9.00 | |
| | Maximum | 20.00 | 15.00 | |
| 3. MRI | Mean | 13.46 | 10.26 | 17.53 |
| | S.D. | 1.94 | .91 | 2.76 |
| | Minimum | 10.40 | 8.80 | 9.30 |
| | Maximum | 19.40 | 12.60 | 20.70 |

The average femoral footprint length in group 1 of arthroscopic ACLR was 15.19 mm with direct measurement while in group of MRI its value was higher as 17.53 mm. MRI was done in non ACLD knee while Arthroscopy was done in patient of ACL tear. From this difference of value, we can hypothesize that smaller femoral footprint of ACL can be associating factor that can lead to rupture of ACL and patients with intact ACL were having longer footprint so might be protective phenomenon from ACL tear. Testing this hypothesis require altogether different study of randomized large sample size.

From this it can be seen that Indian patients physique is smaller than western patients, which has positive correlation to smaller dimension of tibial footprint. Values obtained by current study are similar to study done on other studies conducted on Asian populations. Femoral footprint length in our study was longer than other Asian population data. From differentiation done on basis of gender it is clearly seen that male have larger tibial footprint dimension than females.

## LIMITATIONS

- The measures were obtained only by one observer; we did not evaluate the intra- and inter-observer variability, and thus the results are less generalizable
- We have included hospital based sample size of patients; we recommend to have randomized large sample size for study to generalize results to population.
- In method group 2 of Total knee replacement, we could not measure femoral footprint length due to inadequate exposure and technically problem.

## CONCLUSION

- Indian mean ACL tibial footprint length is 14.3+/-1.3mm, ACL tibial width is 10.53 +/-1.18mm and ACL femoral length is 16.4 +/-2.7mm.
- Indian patient has small ACL tibial footprint dimensions than western population.
- Male have significantly larger ACL tibial footprint.
- Height is constantly associated with ACL footprint dimensions.
- Indian Male can be considered for double bundle ACLR, while in females single bundle ACLR is better option but final decision has to be individualized.

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