Size of the Tibial Footprint of Anterior Cruciate Ligament: MRI Study

Bibek Basukala, MBBS, MS; Amit Joshi, MBBS, MS; Nagmani Singh, MBBS, MS; Rohit Bista, MBBS, MS; Ishor Pradhan, MBBS, MS

AKB Centre for Arthroscopy, Sports Injury and Rehabilitation Centre, Department of Orthopedic, B & B Hospital, Gwarko, Lalitpur, Nepal

Address of correspondence:

Bibek Basukala, MBBS, MS

Department of Orthopedic, B & B Hospital, Gwarko, Lalitpur, Nepal

Email: biksvivek@gmail.com

Introduction: Anatomic ACL reconstruction (ACLR) is the surgical treatment for an ACL tear. Every individual is different and so is their ACL thus one size will not fit all. There is a concept of individualized ACLR. The occupancy of adequate footprint area by the graft has been a major determinant of individualized ACLR. For adequate representation, 50-70 % of the footprint must be covered by the graft. This is usually managed with single-bundle ACLR in footprint size 16 mm or less whereas a size more than 16 mm requires double-bundle ACLR. Many techniques have been described for the measurement of footprint size. Preoperative MRI measurements have shown comparable results with intraoperative direct measurement of footprint. A study of similar nature in our population is lacking. Thus, the aim of this study was to find out the footprint size in our patient population.

Methods: This was a MRI-based study. A total of 230 knee MRIs done for various indications were selected for the study. 15 of those MRIs were excluded as the footprint was not measurable or ACL had intrinsic pathology. Sagittal T2 weighted image showing the largest portion of the ACL footprint of the tibia was selected for the study. A line was drawn from most anterior and posterior points of the footprint parallel to the tibial plateau. Measurement was done using Radiant Dicom viewer and recorded. Analysis was done using SPSS 23.

Results: Out of a total of 215 cases, the mean footprint of our population was found to be 14.1 mm with a range of 10.8 - 17.6 mm. The footprint was found to be smaller in the female population compared to males (13.6 mm vs 14.7 mm) and this difference was found to be statistically significant.

Conclusion: The average footprint size of our study population is 14.1 mm. The size of the footprint is significantly smaller in females compared to males.

Keywords: anterior cruciate ligament, footprint, individualised ACLR.

Individualized anatomic ACL reconstruction has been established as a standard of care for individuals with an ACL tear. The concept behind individualized reconstruction is every individual is different and so is their ACL. So, one size won't fit all and it is necessary to change various parameters like the size of the graft, placement of the graft, number of bundles to reconstruct according to the preoperative and intraoperative evaluation of torn ACL.[1,2] One of the very important determinants in individualized ACLR is the size of the tibial footprint which will guide the size of the graft to be used during the reconstruction. Freddie Fu has recommended that graft should occupy 50-70% of the tibial footprint for better clinical results. Among various dimensions of footprint, the anteroposterior length of the footprint has been the most consistent measure.[1,3] Guidelines and tables for optimal graft sizes have been given in accordance with this variable. Length >16 mm will need double-bundle ACL reconstruction and single-bundle ACL reconstruction will be sufficient in footprint <16mm.[4] Multiple studies have been published which measured the length of tibial footprint with different results. Both preoperative and intraoperative measurements have been studied and compared.[5] Kim et al showed that preoperative measurement of the length of footprint in MRI correlates well with intraoperative management and recommended MRI measurement of footprint dimension for preoperative planning.[6] Also, it has been shown that the size of ACL differs from the size of the knee which has been reflected in the size of ACL footprint too. Studies from the Asian population reported a smaller footprint compared to the western population.[7,8] We do not have data showing the footprint length of the Nepalese population. With this study, we aim to achieve the average footprint size of the Nepalese population.

Methods

Random 230 MRI of knee done for various indications which were performed in single-center with same machine (1.5 tesla) with same settings were retrieved. While selecting age less than 10 years and more than 60 years were not included. All the images were evaluated at first to see the ACL footprint. Those with mucoid degeneration of ACL, osteophytes around footprint, showing signs of past trauma or surgery were excluded from the study. After exclusion, 215 cases were included for further evaluation of ACL footprint. We used RadiAnt Dicom viewer for measurement **(Figure 1)**. To measure the exact length of the tibial footprint, a sagittal image showing the largest exposure of the ACL fibers at the tibial attachment site was chosen. The length of the ACL tibial footprint was measured as the distance from the most anterior to the most posterior fibers of the ACL tibial attachment. The anteroposterior length was done parallel to the tibial plateau **(Figure 1)**. The sequence used was a proton density-weighted sagittal image. Results were recorded

Figure 1: RadiAnt dicom viewer. Anteroposterial length of ACL footprint measured with the line parallel to tibial plateau joining most anterior and posterior point of footprint

in Microsoft excel and further analysis was done with SPSS.

Results

Out of a total of 215 cases, the mean anteroposterior length of the tibial footprint of ACL was found to be 14.1 mm with range 10.8 - 18.8 mm **(Figure 2)**.

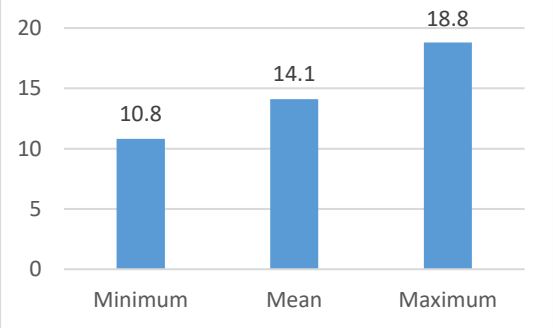

Figure 2: Size of tibial footprint

The footprint was found to be smaller in the female population compared to males (13.6 mm vs 14.7 mm) and this difference was found to be statistically significant **(Figure 3)**.

The mean age of chosen patients was 24.3 years (range 15 – 58 years). The majority were male comprising 52% of the total.

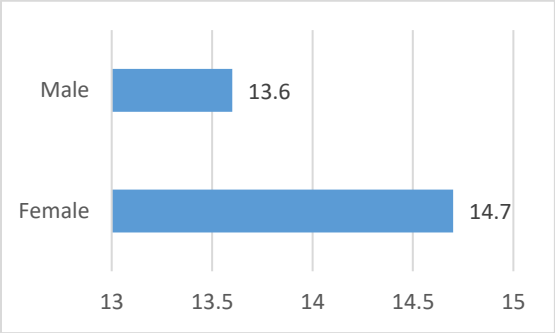

Figure 3: Male vs Female

Discussion

Freddie Fu with his multiple research popularized the concept of individualized anatomical ACL reconstruction. According to him, anatomical ACLR means functional restoration of ACL in its native dimension, collagen orientation, and insertion sites.[1,2,9,10] Insertion sites (footprint location and size) is a very important determinant for successful reconstruction according to Fu et al. Adequate representation of ACL footprint according to the studies is to cover at least 50-70% of the total footprint. Accordingly, the algorithms and

tables have been described for individualized anatomic ACL reconstruction with reference to the size of a tibial footprint. Anatomical studies of ACL have shown that ACL is the widest at the tibial insertion site. The femoral footprint comprises up to 70% of the area of tibial insertion and the substance of ACL constitutes only about 50% of tibial insertion. This shows that the tibial insertion footprint is the single most important measurement required for preoperative planning of individualized ACLR.[4,10] Anteroposterior length along with mediolateral width and area of the footprint has been studied in various studies both preoperatively with MRI and with intraoperative direct measurement. Anteroposterior length of the footprint is one of the most consistent variables that is measured preoperatively with MRI. Mediolateral width measurement requires oblique sequences which is not the usual sequence of MRI of the knee also like the shape of the tibial footprint is variable the measurement of the area also is not a consistent MRI variable to measure the dimension of the tibial footprint of ACL.[5,7,8]

In this research we also measured the anteroposterior length of the tibial footprint of ACL, we followed the technique used by Kim et al.[7] Average length of tibial footprint in our study is 14.1 mm which is similar to the study by Kim et al. They reported average length of 12.4 mm. Park et al,[7] similar size of the footprint was reported in Chinese study too by Feilong li et al.[11] in contrast studies from western population reports larger footprint.[12] This may be because of smaller knees in the Asian population which will have ACL with smaller dimensions.

Our study also shows a shorter length of footprint in females compared to the male population which was found to be statistically significant. This finding is similar to many published Asian and western literature. If we follow the principles of individualized anatomical ACLR, considering the average size of footprint in our population being 14.1 mm, we can safely make a conclusion that most of the Nepalese population won't be needing double-bundle ACLR and the optimal size of graft comes around 8-9 mm diameter. Still, it's always preferable to have a preoperative MRI measurement of footprint and make individualized decisions on graft size.

Conclusion

The average size of the tibial footprint of ACL in our study is 14.1 mm (range 10.8 – 17.6 mm). The footprint is shorter in females. Preoperative measurement of anteroposterior length of the tibial footprint is an easy and helpful tool for preoperative planning of individualized anatomical ACL reconstruction.

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