The Location of Femoral and Tibial Tunnels in Males and Females after Anterior Cruciate Ligament Reconstruction and its Correlation with the Functional Outcome

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Abstract

Objective: The purpose of this study was to visualize and quantify the position of bone tunnels in anterior cruciate ligament reconstruction with use of novel methods applied to three-dimensional computed tomographic reconstruction images and its impact on functional outcome post-operatively.

Methods: This is a prospective cohort study of 50 patients of ACL tear injury. Patient who were operated for ACL reconstruction were followed up for 6 months and post-operative status assessed based on Tegner and Lysholm scoring, three dimensional CT scan of the operated knee to decide tunnel placement.

Results: In our study, out of 50 patients enrolled, 35 were males and 15 were females which shows ACL injury is almost twice more common in males than females. Age of the patients ranged from 23 years to 42 years, average age being, 30 years. Thus proving ACL injury is more common in younger and active age group. Out of 50 patients, 40 had improvement as compared to pre-op status whereas 10 patients had complaint of persistent symptoms post-operatively.

Conclusion: ACL tear is more common in males as compared to females and young, active people are affected commonly. Tunnel placement plays an important role in post-operative rehabilitation of the patients but it's not the only factor playing role.

Keywords: ACL reconstruction, Tunnel placement, Functional Outcome.

Background

Characterization of the insertion site anatomy in anterior cruciate ligament reconstruction has recently received increased attention in the literature, coinciding with a growing interest in anatomic reconstruction. The purpose of this study was to visualize and quantify the position of bone tunnels in anterior cruciate ligament reconstruction with use of novel methods applied to three-dimensional computed tomographic reconstruction images and its impact on functional outcome post-operatively.

Methods

This is a prospective cohort study of 50 patients of ACL tear injury. Patient who were operated for ACL reconstruction were followed up for 6 months and post-operative status assessed based on Tegner and Lysholm scoring, three dimensional CT scan of the operated knee to decide tunnel placement.

There is some evidence that graft placement aligned with native insertion sites results in superior clinical outcomes. A careful review of recently published articles, however, suggests that there is still no consensus regarding appropriate tunnel placement in anatomic anterior cruciate ligament reconstruction(1).

To characterize the anterior cruciate ligament footprint with its two bundles, a profound knowledge of the anterior cruciate ligament anatomy and its surrounding structures is necessary. Soft-tissue remnants from the anteromedial and posterolateral bundles, and anatomic structures such as the anterior horn of the lateral meniscus and the posterior cruciate ligament, are essential landmarks for anterior cruciate ligament bone-tunnel placement. Furthermore, topographical osseous anatomic landmarks that have recently been identified, such as the lateral intercondylar ridge and lateral bifurcate ridge on the femoral side and the tibial spine, the medial and lateral intercondylar tubercles, and the anterior intertubercular ridge on the tibia are utilized to guide bone-tunnel placement(2). Importantly, these latter structures are readily visualized on three dimensional computed tomography reconstruction scans, making them ideal reference points for the evaluation of tunnel position. By combining three-dimensional imaging with meticulous, arthroscopic dissection, it is anticipated that anatomic anteromedial and posterolateral tunnel positions relative to osseous morphological landmarks can be identified arthroscopically. The purpose of this study was to evaluate the position of anatomically tunnels on three-dimensional computed tomography models in males and females. We hope that the results may be used as a clinical guide for surgeons to evaluate tunnel position. Tunnel Position assessed by 2 methods.

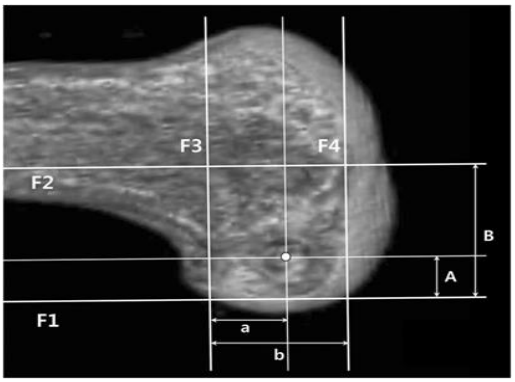

Fig. 1: Anatomic Coordinate Axes Method

The rationale for this anatomical method was to design a three dimensional assessment of femoral tunnel position relative to structures that can be visualized arthroscopically through the medial portal. Thus, the measurements derived from three-dimensional computed tomography models could be applied during arthroscopy as a guide to anatomical tunnel placement. In our study, tToimprove visualization of the medial wall of the lateral femoral condyle, the medial condyle was removed from the three-dimensional computed tomography model at the most anterior aspect of the distal notch. A true medial view of the femur (perpendicular to the medial-lateral femoral axis) was established at 90 of knee flexion, allowing standardized visualization of the medial wall of the lateral condyle (see Fig. 4). The tunnel positions were determined in the posterior to anterior and proximal-to-distal directions, parallel to the respective anatomical axes. More specifically, posterior-to-anterior positions were calculated as percentages of the distance from the line (Fig. 1) running through the posterior border of the medial wall of the lateral condyle to the line (Fig. 2) running through the most anterior point of the notch. Proximal-to-distal positions were calculated as percentages of the distance from the line (Fig. 3) running through the proximal border of the notch to the line (Fig. 4) running through the distal point of the notch roof.

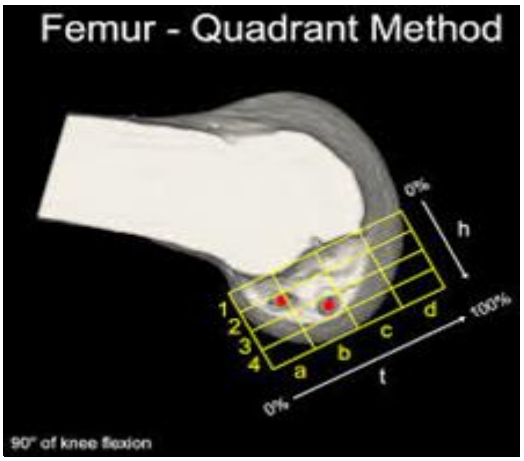

Fig. 2: Quadrant Method

On radiographs, the grid is aligned with the Blumensaat line, which is a projection of the femoral notch roof on the radiograph. However, since no such line exists on a three dimensional computed tomography model, the most anterior edge of the femoral notch roof was chosen as the reference for the grid alignment. The segments of the grid along the Blumensaat line (t) were labeled from A to D. The segments of the grid perpendicular to the Blumensaat line (h) were labeled from 1 to 4.

Observation and Analysis

All the patients enrolled in our study had tunnel placement properly behind blumensaat line in males and females both. Out of 50 patients enrolled, 40 patients had improvement in post-operative status following ACL reconstruction whereas 10 patients had persistent complaint of knee instability post-operatively.

Table 1: Out of 50 patients, 35 were male patients whereas 15 were female patients

Sex	Number of patients
Male	35
Female	15

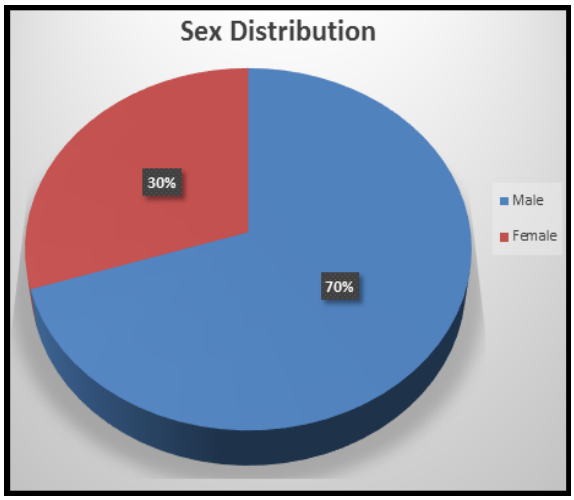

Fig. 3

Age of patients ranged from 23 years to 42 years indicating that ACL injury is common in younger age group.

In our study, average Tegner and Lysholm score pre-operatively was 58.6 (Poor) which improved to 78.6 (Fair) post-operatively.

Table 2

Tegner and Lysholm score	
Pre-op score	Post-op score
58.6	76.4

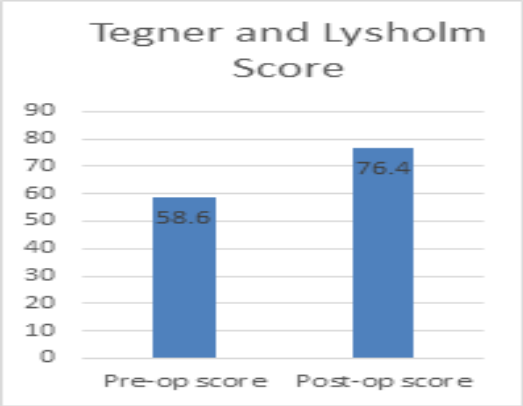

Fig. 4

Despite no difference observed in tunnel placement between males and females, post-operative Tegner and Lysholm scoring showed more improvement in female patients as shown below in table and chart.

Table 3

Sex	Pre-op	Post-op
Females	61	89.5
Males	57.6	71.2

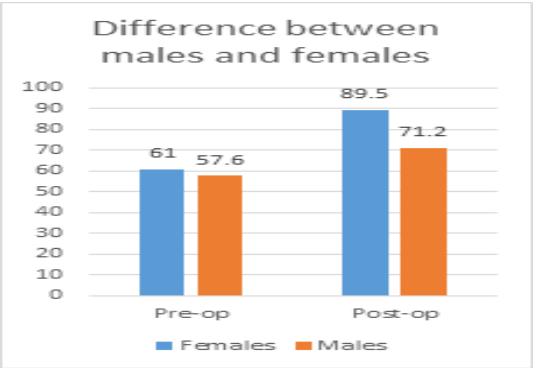

Fig. 5

All the patients had proper placement of tunnel with screw holding its proper position post-operatively at 6 months.

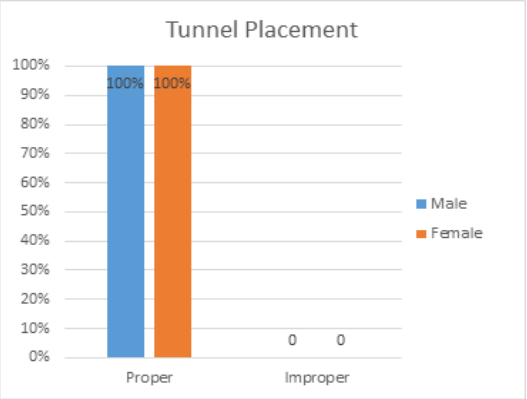

Fig. 6

Results and Discussion

This is a prospective cohort study of 50 patients of ACL tear injury who were operated by ACL reconstruction procedure. Patients were followed-up for 6 months and post-operative status assessed based on Tegner and Lysholm scoring and three dimensional CT scan. 3D CT scan was used mainly to assess the tunnel placement and hold of screw post-operatively.

In our study, out of 50 patients enrolled, 35 were males and 15 were females which shows ACL injury is almost twice more common in males than females.

Age of the patients ranged from 23 years to 42 years, average age being, 30 years. Thus proving ACL injury is more common in younger and active age group.

Out of 50 patients, 40 had improvement as compared to pre-op status whereas 10 patients had complaint of persistent symptoms post-operatively. No patient reported worsening of symptoms post-operatively. All the patients had proper placement of tunnels as assessed by post-operative 3D CT scans. 10 patients who had persistent symptoms postoperatively were unable to follow their exercise schedule emphasizing the role of physiotherapy in rehabilitation. Average improvement in Tegner and Lysholm scoring was more in female group in our study as compared to males, the reason for which remains to be established yet. This bias may be due to less number of female patients in our study. Average improvement in males was 13.6 whereas average improvement in females were 28.5 in our study.

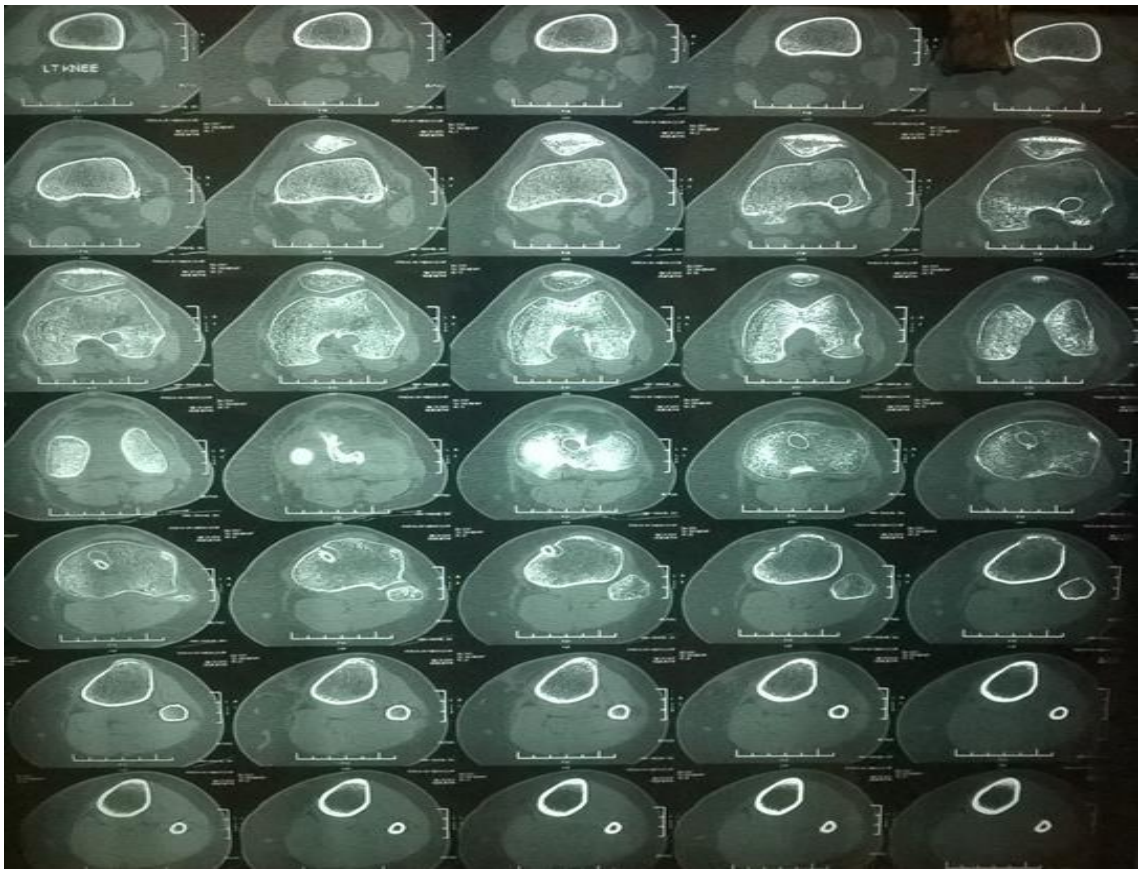
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Fig. 7: 3D CT scan (post-operative) Case-1

Conclusion

ACL tear is more common in males as compared to females and young, active people are affected commonly. Tunnel placement plays an important role in post-operative rehabilitation of the patients operated but it's not the only factor playing role. As observed in our study, despite proper tunnel placements, few patients did not have significant improvement post-operatively and also female group had better post-operative results than male group. Thus, post-operative exercises and rehabilitation program and other factors also play major in overall outcome of surgery. Larger database and long term follow up is required to establish role of tunnel placement and other factors in outcome of ACL reconstruction surgery.

References

1. Campbell's Operative Orthopaedics, 12th edition.
2. Manual of arthroscopic surgery, Michael Strobel.