DOI: https://doi.org/10.53350/pjmhs221611017

ORIGINAL ARTICLE

Tibial and Femoral Bone Tunnel Position after Arthroscopic Reconstruction of the Anterior Cruciate Ligament: A Retrospective Study

SAEED ULLAH[1], ASFANDYAR[2], MUHAMMED FARHAN FARHAT[3]
[1]Saeed ullah, Head of Orthopedic Department, ZKS Catogary C Hospital Matta Swat Pakistan.
[2]Asfandyar, Assistan Professor Orthopedic, Pakistan Institute of Medical Sciences Islamabad Pakistan.
[3]Muhammed Farhan, Medical Officer Orthopedic, Pakistan Institute of Medical Sciences Islamabad Pakistan.
Coressponding author: Saeed ullah, Email: drsaeedullahmerzi@gmail.com

ABSTRACT

Aim: To assess the tibial and femoral bone tunnel position after arthroscopic reconstruction of the anterior cruciate ligament

Study design: Retrospective study

Place and duration: This Study was conducted at ZKS Catogary C Hospital Matta Swat Pakistan from January 2020 to Januray 2021.

Methodology: In this study, total 52 patients were included. The tunnel position after anterior cruciate ligament (ACL) reconstruction was determined using a three-dimensional CT scan. SPSS software version 23 used to identify the relation between tunnel positions and ACL reconstruction outcomes.

Results: The radiological evaluation indicated that the average length of the femoral tunnel is 43.75 ± 3.2 mm, and the tibial tunnel is 23 ± 4.6 mm. All the bones were anatomically positioned. The coronal and sagittal angles of the tibial and femoral tunnel were 24.7 ± 3.4; 53.2 ± 2.9 degrees and 28.7 ± 3.3; 42.6 ± 2.8 degrees respectively. The X- and Y-axis values of the femoral and tibial tunnel were 26.7 ± 3.8 mm; 43.6 ± 6.5 mm and 46.7 ± 2.8 mm; 32.2 ± 4.6 mm respectively.

Conclusion: There was a significant positive correlation between the sagittal angle of the tibial tunnel to the medial axis and femoral tunnel to the Y-axis indicating that the tibial sagittal angle is a correspondent of the intra-articular femoral tunnel behind the resident's ridge. In conclusion, these findings may lead to a better and safe surgical procedure with improved clinical outcomes in terms of knee kinematics and risk of complications.

Keywords: femoral bone tunnel position, anterior cruciate ligament, arthroscopic reconstruction

INTRODUCTION

Anterior cruciate ligament (ACL) injury is considered the most common type of ligament injury in the knee. The ACL injuries are more frequent in young individuals and affect 70 per 100,000 individuals per year. The ACL is covered by synovial fluid and has decreased vascularization; therefore, it has a slow healing rate. Therefore, surgical procedures are considered one of the most convenient treatment approaches for ACL injury (1). The surgical ACL reconstruction technique involved the implantation of tendon graft through tibial and femoral tunnels. The correct anatomical position of the tunnel after the ACL reconstruction is crucial for the proper functioning of the knee joint (2).

Transtibal (TT) technique is the most commonly used procedure in ACL reconstruction and provides long-term better outcomes. However, the TT process involves constant drilling, which can result in nonanatomic placement. A cadaveric study conducted by Chung et al., 2016 reported TT technique was feasible for ACL reconstruction and did not mention any after-surgery complications (7).

Indecorous position of tunnel is the primary reason for ACL reconstruction failure. It can result in poor flexion and elongated draft because of increased exposure to high traction force (2,3). Approximately 85 % of surgical failures are due to malpositioning of the tibia and femur tunnel (5). Formation of the femoral tunnel at a distance from the native position of ACL can result in excessive pressure on the graft resulting in the failure of the surgical procedure. If the tibial tunnel is placed too anteriorly, it can result in pressure on the tendon and graft tear. The positioning of the tibial tunnel too posteriorly can cause the failure of the tunnel to regulate laxity (6). Along with the position of tunnels, the length of tunnels is another crucial element for the success of ACL reconstruction. It is identified through the literature that the proper position of the tendon with the tunnel surface is curcial for the bone-tendon union. Radiographic techniques are used approaches to diagnose the ACL injury and the status of ACL after reconstruction (4).

The present study aimed to identify the location of the tibia and femur during and after ACL reconstruction and impact of tibia and femur positioning on the outcomes of ACL reconstruction.

METHODOLOGY

This retrospective study was conducted at ZKS Catogary C Hospital Matta Swat Pakistan from January 2020 to Januray 2021, after getting approval from institutional review committee. Since it was a retrospective study, so the need for informed consent was relinquish. A total of 52 patients who had ACL injury were included in this study. Diagnosis of ACL injury was made by X-ray or CT scan by surgeon or radiologist. Patients with rotatory instability, obesity, osteoarthritis, and fractures in the femur or tibia were excluded from this study. ACL reconstruction was performed by the TT technique.

The ACL reconstruction was done by using general anesthesia. To extract the semitendinosus tendon of same side, a tendon harvester was used. Both ends of the

harvested graft were sutured and by using a device tunnel was inserted. The polyester tape was used to join the structures. The remnant of femur bone was removed to create a tunnel. The remnant of tibial ACL was removed, and ACL was inserted at anteriomedial bundle. A tibial tunnel was made having diameter of 8-9 mm.

After one week of surgery CT scan of all patients were performed to analyze the femur and tibia tunnel position. A multidetector CT scan captured standard axial, sagittal, and three-dimensional images. QM. 15,16 was used to draw X and Y coordinates on captured images. The association between the ridge and the femur position and tibia tunnel was also evaluated.

All the statistical analyses was performed using Statistical software for the social sciences (SPSS) version 23.0. All the quantitative data was expressed as mean ± standard deviation. Effect modifiers like age, gender, BMI and duration of injury were controlled through stratification and post-stratification. The p value of <0.05 was kept significant.

RESULTS

The mean length of the femoral tunnel was 43.75 ± 3.2 mm (range = 38 – 47 mm) with the suspensory fixation device 29.0 ± 2.8 mm long (range = 17 – 35 mm). The tunnel position and measurements were evaluated by 3D computed tomography. Both the tibial and femoral tunnels were behind the ridge. The average X- and Y- axis values of tibial and femoral tunnel measured by 3D computed tomography images and summarized in table 1. There is no complication observed in any patient thus, indicating that the tibial and femoral tunnel was a safe and reproducible method. In the coronal view, the femoral tunnel angle was found at 28.7 ± 3.3 degrees to the femoral axis, and in the sagittal view, the angle of the tunnel was 42.6 ± 2.8 degrees (As shown in Table 2).

The mean length of the tibial tunnel was 23 ± 4.6 mm and located at a mean distance of 8.7 ± 1.5 mm medial from the tibial axis. The tibial tunnel was located at the angle of 24.7 ± 3.4 degrees in coronal view while in sagittal view, it is found at the angle of 53.2 ± 2.9 degrees. There is no case observed with complications regarding the tibial cartilage injury or tibial tunnel inference with the collateral ligament indicating that the tibial tunnel is favorable at this position. There was a strong positive correlation that was found between the sagittal angle of the tibial tunnel relative to the tibial medial axis and the femoral tunnel

Table 1: Tibial and femoral tunnel position evaluated by 3D-Computed Tomography

Parameters	X-value	Y-value
Tibia	46.7 ± 2.8	32.2 ± 4.6
Femur	26.7 ± 3.8	43.6 ± 6.5

Table 2: Tibial and femoral angle relative to their respective axis in coronal and sagittal view

Parameters	Sagittal (Degree)	Coronal (Degree)
Tibial angle	53.2 ± 2.9	24.7 ± 3.4
Femoral angle	42.6 ± 2.8	28.7 ± 3.3

DISCUSSION

In this study, the single-bundle trans-tibial ACL reconstruction was evaluated and measured by 3D computed tomography to identify the accurate tunnel position in ACL reconstruction and restore the native kinematic of the knee. They showed a strong positive correlation between the sagittal angle of the tibial tunnel with respective axis and femoral tunnel on the Y-axis and indicated that this position of the tunnel is favorable and compatible in single-bundle transtibial ACL reconstruction.

The tibial tunnel position is a critical step in the TT technique of ACL reconstruction (8). Chung et al reported that transtibial femoral tunnel anchored with the tip of intercondylar roof area at 10 or 11 o'clock position with an unexposed resident's ridge and ACL remnant (9). Another study reported the resident's ridge as a reliable and consistent anatomical structure for the femoral ACL insertion (10). All these findings are consistent with our findings indicating that the femoral tunnel should be located just behind the resident's ridges. However, there are still some conflicts regarding the residential's ridges as it has great dimensional variations (11). Our study is also consistent with another study that reported the femoral and tibial tunnel created between the anteromedial and posterolateral ACL footprints located behind the resident's ridge (12, 13).

Using QM analysis of 3D-CT images, the tibial tunnel position concerning the tibial axis and medial tibial joint line was evaluated and it is confirmed that tibial tunnel was not interfering with the medial collateral ligament. These results were consistent with the study reported by Kopf et al that TT ACL reconstruction is more reliable when implanted at the native site guided by the resident's ridge (14). These results indicated that it was a safe, reliable, and reproducible surgical procedure with little to no risk of complications.

This study has several limitations. The inter observational variations in radiological measurements are not accessible as the small variation in angle measurement may lead to devasting change. It is not possible to measure the angle in 3D images, the angles were only measured in 2D radiological images. This surgical procedure is only applicable to single-bundle ACL reconstruction and cannot apply to double-bundle anatomic ACL reconstruction. To the best of our knowledge, this study is a forward step that clarifies the femoral and tibial tunnel position behind the resident's ridge. However, there is still needed to elaborate the surgical procedure of ACL reconstruction to yield the best clinical outcomes. Besides all these limitations, this study has some wonderful strengths. These data opened a new window in orthopedic research and provide a reference tunnel position that may lead to the exploration of better and safe surgical procedures in future clinical studies. The SB-TT ACL reconstruction was performed by multiple surgeons that reduced the likelihood bias and make the findings more generalized in orthopedic research. Interestingly, consistent findings were obtained among multiple surgeons utilizing the same surgical technique.

CONCLUSION

From the above results, it is concluded that TT-SB ACL reconstruction of the knee provide a better anatomical position and clinical outcomes when the femoral tunnel was created just behind the resident's ridge and the tibial tunnel was created at a distance of 8.7 mm from the tibial axis at

an average coronal and sagittal angle of 24.7 ± 3.4 and 53.2 ± 2.9 degrees respectively. These tibial and femoral tunnel position was found as safe, favorable, and more kinematics tunnel position of TT ACL reconstruction.

Permission: It was taken from the ethical review committee of the institute
Funding source: None
Conflict of interest: None

REFERENCES

1. Ducouret E, Loriaut P, Boyer P, Perozziello A, Pesquer L, Mounayer C, Dallaudiere B. Tunnel positioning assessment after anterior cruciate ligament reconstruction at 12 months: comparison between 3D CT and 3D MRI. A pilot study. Orthopaedics & Traumatology: Surgery & Research. 2017 Oct 1;103(6):937-42.
2. Chen Y, Chua KH, Singh A, Tan JH, Chen X, Tan SH, Tai BC, Lingaraj K. Outcome of single-bundle hamstring anterior cruciate ligament reconstruction using the anteromedial versus the transtibial technique: a systematic review and meta-analysis. Arthroscopy: the Journal Of Arthroscopic & Related Surgery. 2015 Sep 1;31(9):1784-94.
3. Osti M, Krawinkel A, Ostermann M, Hoffelner T, Benedetto KP. Femoral and tibial graft tunnel parameters after transtibial, anteromedial portal, and outside-in single-bundle anterior cruciate ligament reconstruction. The American journal of sports medicine. 2015 Sep;43(9):2250-8.
4. van Eck CF, Wong AK, Irrgang JJ, Fu FH, Tashman S. The effects of limb alignment on anterior cruciate ligament graft tunnel positions estimated from plain radiographs. Knee Surgery, Sports Traumatology, Arthroscopy. 2012 May 1;20(5):979-85.
5. Haasper C, Kopf S, Lorenz S, Middleton KK, Tashman S, Fu FH. Influence of tibial rotation on tibial tunnel position measurements using lateral fluoroscopy in anterior cruciate ligament reconstruction. Knee Surgery, Sports Traumatology, Arthroscopy. 2015 Mar;23(3):649-54.
6. Karlsson J, Irrgang JJ, van Eck CF, Samuelsson K, Mejia HA, Fu FH. Anatomic single-and double-bundle anterior cruciate ligament reconstruction, part 2: clinical application of surgical technique. The American journal of sports medicine. 2011 Sep;39(9):2016-26.
7. Chung JY, Ha CW, Lee DH, Park YG, Park YB, Awe SI. Anatomic placement of the femoral tunnel by a modified transtibial technique using a large-offset femoral tunnel guide: A cadaveric study. The Knee. 2016 Aug 1;23(4):659-65.
8. Robert HE, Bouguennec N, Vogeli D, Berton E, Bowen M. Coverage of the anterior cruciate ligament femoral footprint using 3 different approaches in single-bundle reconstruction: a cadaveric study analyzed by 3-dimensional computed tomography. Am J Sports Med. 2013;41(10):2375-83.
9. Das A, Yadav CS, Gamanagatti S, Pandey RM, Mittal R. Arthroscopic and 3D CT Scan Evaluation of Femoral Footprint of the Anterior Cruciate Ligament in Chronic ACL Deficient Knees. J Knee Surg. 2019;32(6):584-8.
10. Bhattacharyya R, Ker A, Fogg Q, Spencer SJ, Joseph J. Lateral Intercondylar Ridge: Is it a reliable landmark for femoral ACL insertion?: An anatomical study. Int J Surg. 2018;50:55-9.
11. Tsukada S, Fujishiro H, Watanabe K, Nimura A, Mochizuki T, Mahakkanukrauh P, et al. Anatomic variations of the lateral intercondylar ridge: relationship to the anterior margin of the anterior cruciate ligament. Am J Sports Med. 2014;42(5):1110-7.
12. Youm YS, Cho SD, Eo J, Lee KJ, Jung KH, Cha JR. 3D CT analysis of femoral and tibial tunnel positions after modified transtibial single bundle ACL reconstruction with varus and internal rotation of the tibia. Knee. 2013;20(4):272-6.
13. Sadoghi P, Kröpfl A, Jansson V, Müller PE, Pietschmann MF, Fischmeister MF. Impact of tibial and femoral tunnel position on clinical results after anterior cruciate ligament reconstruction. Arthroscopy. 2011;27(3):355-64.
14. Kopf S, Forsythe B, Wong AK, Tashman S, Anderst W, Irrgang JJ, et al. Nonanatomic tunnel position in traditional transtibial single-bundle anterior cruciate ligament reconstruction evaluated by three-dimensional computed tomography. J Bone Joint Surg Am. 2010;92(6):1427-31.