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Original Research Article

THREE-DIMENSIONAL CT MORPHOMETRY OF THE TIBIAL PLATEAU AND ITS IMPLICATIONS FOR ACL RECONSTRUCTION TUNNEL PLACEMENT

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ABSTRACT

Background: Accurate tunnel placement is the most critical determinant of success in anterior cruciate ligament (ACL) reconstruction. Malposition of the tibial tunnel is a well-known cause of graft impingement, instability, early graft failure, and revision surgery. The tibial plateau demonstrates population-specific anatomic variation that influences optimal tunnel orientation and safe drilling corridors. Three-dimensional computed tomography (3D-CT) allows highly precise morphometric assessment of the tibial plateau, yet Indian population-based data remain limited. The aim is to perform a detailed 3D-CT morphometric analysis of the tibial plateau in an Indian population and determine its implications for accurate tibial tunnel placement in ACL reconstruction.

Materials and Methods: A prospective cross-sectional study was conducted for 14 months, during which 156 adult subjects undergoing knee CT scans for non-ligamentous indications were consecutively enrolled. A sample size of 132, calculated using morphometric SD values and precision-based estimates, was increased to 156 to account for sub-grouping and image exclusions. High-resolution 3D-CT reconstructions were used to measure tibial plateau parameters including medial and lateral plateau width, anteroposterior (AP) depth, tibial slope (medial, lateral, and global), intercondylar eminence dimensions, ACL tibial footprint size and coordinates, safe drilling angles, and the relationship between tunnel trajectory and posterior cortex thickness. Morphometric correlations were analysed to define optimal tunnel entry points and angles for standard ACL grafts.

Results: The tibial plateau demonstrated considerable anatomic variability across individuals. The lateral plateau exhibited greater posterior slope than the medial plateau, significantly influencing tunnel trajectory. The native ACL tibial footprint was found consistently anterior to the medial tibial spine and demonstrated a mean AP distance of 42–45% from the anterior cortex. Posterior cortex thickness and slope-modified AP depth defined the safe limits for tunnel angulation without blowout. Regression analysis showed that tibial slope, plateau width, and mediolateral eminence position were the strongest predictors of ideal tunnel placement coordinates. The study provides evidence-based morphometric guidance for optimizing tibial tunnel entry points, depth, and angulation during ACL reconstruction in the Indian population.

Conclusion: Three-dimensional CT morphometry of the tibial plateau reveals significant anatomical variations that directly affect safe and accurate tibial tunnel placement during ACL reconstruction. Understanding population-specific plateau geometry enhances surgical decision making, minimizes the risk of cortical breaches, and supports improved graft biomechanics. Incorporating 3D-CT–based morphometric references into preoperative planning can substantially improve the precision and outcomes of ACL reconstruction.

Keywords: ACL reconstruction; tibial plateau; 3D-CT morphometry; tibial tunnel placement; posterior cortex blowout; ACL tibial footprint; knee anatomy.

INTRODUCTION

Anterior cruciate ligament (ACL) reconstruction is one of the most commonly performed arthroscopic procedures worldwide, and precise tibial tunnel placement remains a critical determinant of graft function, long-term stability, and surgical success.[1] Malposition of the tibial tunnel is a major cause of graft failure, leading to impingement against the intercondylar roof, persistent laxity, altered graft biomechanics, and the need for revision surgery. An optimal tunnel must replicate the native ACL tibial footprint, maintain the correct sagittal and coronal orientation, and avoid posterior cortex blowout, all of which depend on accurate interpretation of tibial plateau anatomy.[2]

The tibial plateau demonstrates substantial inter-individual and population-specific anatomical variability. Differences in plateau width, anteroposterior depth, posterior tibial slope (PTS), intercondylar eminence geometry, and ACL footprint dimensions significantly influence the safe zone for tibial tunnel entry and drilling trajectory.[3] Western anatomical norms and templating guides often do not adequately reflect the morphometry of Asian and Indian populations, who tend to exhibit smaller plateau dimensions and variable slopes. These variations can directly affect tunnel placement accuracy when standard guidelines are applied without population-specific morphometric calibration.[4]

Three-dimensional computed tomography (3D-CT) has emerged as the most reliable imaging modality for detailed assessment of bony morphology, offering enhanced accuracy compared with plain radiographs or conventional CT. Precise 3D reconstruction enables millimeter-level quantification of plateau geometry, eminence position, cortical thickness, and ACL footprint coordinates. Such detailed morphometric mapping is invaluable for refining tunnel placement guidelines and ensuring that surgical techniques are adapted to the native anatomy of the population being treated.[5,6]

Despite the widespread use of ACL reconstruction in India, comprehensive 3D-CT-based morphometric data of the tibial plateau remain scarce. There is a definitive need to establish normative anatomical parameters that directly support tunnel placement decisions, minimize surgical errors, and improve graft biomechanics.[7]

Therefore, it is of interest to perform a three-dimensional CT morphometric analysis of the tibial plateau and evaluate its implications for optimal tibial tunnel placement in ACL reconstruction.

MATERIALS AND METHODS

Study Design: A prospective cross-sectional morphometric study was conducted to quantitatively evaluate three-dimensional tibial plateau anatomy and determine its implications for tibial tunnel placement during ACL reconstruction.

Study Setting and Duration: The study was carried out in the Department of Orthopaedics and Radiology of a tertiary-care teaching hospital in India over 14 months (January 2023 – February 2024).

Sample Size Determination: Sample size was calculated to estimate mean tibial plateau morphometric parameters (e.g., anteroposterior depth, posterior tibial slope) with adequate precision using the standard formula for continuous variables:

$$n = \frac{Z_{\alpha/2}^2 \cdot \sigma^2}{d^2}$$

Where:

- Z_(α/2)=1.96for 95% confidence
- σ=3.8" mm" (standard deviation of tibial plateau AP depth from previous morphometric data)

d=0.65" mm" (acceptable absolute precision)

$$n = \frac{(1.96)^2 \times (3.8)^2}{(0.65)^2} \approx 132$$

To ensure adequate subgroup analysis, compensate for image exclusions, and enhance statistical power, the final sample size was increased to 156 adults (156 tibiae).

Study Population: Consecutive adult patients undergoing CT scans of the knee for non-ligamentous orthopedic indications (trauma screening without plateau involvement, patellar disorders, suspected meniscal pathology, or preoperative planning) were screened for inclusion.

Inclusion Criteria

- Age 18–65 years
- No previous ligament reconstruction
- Normal tibial plateau contour without fractures or deformity
- High-quality CT imaging suitable for 3D reconstruction

Exclusion Criteria

- Tibial plateau fractures
- Osteoarthritis grade ≥ 2 (Kellgren–Lawrence)
- Any tumor, infection, or deformity altering proximal tibial morphology
- Prior ligament or bony surgery around the knee
- CT scans with artefacts or incomplete visualization

CT Imaging Protocol

All subjects underwent standardized knee CT scans using a 128-slice multidetector CT scanner:

- Slice thickness: 1.0–1.25 mm
- Matrix: 512 × 512
- Field of view: optimized for proximal tibia
- Kernel: bone algorithm
- Reconstructions: sagittal, coronal, axial, and 3D-volume rendered models

3D Reconstruction and Measurement Method

High-resolution 3D models were generated using dedicated workstation software (PACS-integrated 3D reconstruction suite). All morphometric measurements were performed on the 3D surface model using calibrated digital tools.

Each measurement was taken independently by two orthopedic surgeons; the mean value was used for analysis.

Morphometric Parameters Assessed

1. Tibial Plateau Dimensions

- Medial plateau width (MPW)
- Lateral plateau width (LPW)
- Total tibial plateau width (TPW)
- Anteroposterior depth of medial plateau (MAPD)
- Anteroposterior depth of lateral plateau (LAPD)
- Overall AP tibial depth

2. Posterior Tibial Slope (PTS)

Measured using the proximal tibial anatomical axis:

- Medial posterior tibial slope
- Lateral posterior tibial slope
- Global posterior tibial slope

3. Intercondylar Eminence and Spine Morphometry

- Height of medial and lateral tibial spines
- Interspinous distance
- Eminence apex position relative to plateau boundaries

4. ACL Tibial Footprint Morphometry

- Footprint length, width, and area
- Centroid coordinates relative to:
  - anterior tibial cortex
  - medial tibial spine
  - posteromedial quadrant of plateau
- AP percentage distance (from anterior rim)
- ML percentage distance (from medial plateau border)

5. Tunnel-related Measurements

- Safe tunnel entry point coordinates
- Safe sagittal and coronal tunnel angulation
- Distance from tunnel trajectory to posterior cortex
- Posterior cortex thickness at risk zones
- Maximum permissible tunnel diameter
- Interference screw safe zone

Data Collection Process: All measurements were recorded in a pre-designed data sheet. Discrepancies >1.5 mm between observers were re-evaluated jointly to ensure accuracy. Reliability was assessed using intraclass correlation coefficients (ICC).

Outcome Measures

Primary Outcomes

- Normative 3D-CT morphometry of tibial plateau
- Native ACL tibial footprint location
- Safe tibial tunnel coordinates and angulation

Secondary Outcomes

- Predictive anatomical parameters influencing tunnel placement
- Risk assessment for posterior cortical breach

Statistical Analysis

Data were analysed using appropriate statistical software:

- Continuous variables: mean ± SD
- Categorical variables: frequencies and percentages
- Correlation analysis: Pearson's correlation
- Group comparisons: independent t-test or ANOVA
- Regression analysis to identify predictors of tunnel placement
- ICC used to determine measurement reliability
- Statistical significance defined as $P < 0.05$

Ethical Approval: The study received approval from the Institutional Ethics Committee, and informed consent was obtained from all participants prior to imaging analysis.

RESULTS

Results Overview

A total of 156 tibial plateaus from 156 adult subjects were analysed using high-resolution 3D-CT reconstructions. Considerable anatomical variability was observed in both medial and lateral plateau dimensions. The lateral tibial plateau consistently demonstrated a higher posterior tibial slope compared with the medial plateau, influencing tunnel trajectory and posterior wall safety margins. The native ACL tibial footprint showed a predictable but population-specific pattern, lying anterior to the medial tibial spine and occupying approximately 42–45% of the anteroposterior depth from the anterior cortex. Mediolateral footprint positioning also varied significantly among individuals. Posterior cortex thickness and modified anteroposterior depth changed according to tibial slope, directly affecting allowable tunnel angulation before posterior blowout risk increased. Strong correlations were found between tibial plateau width, posterior tibial slope, and footprint coordinates and the determination of optimal tunnel entry points. Regression analysis identified lateral posterior tibial slope, interspinous distance, and AP footprint percentages as significant predictors of safe drilling angles. Interobserver reliability for all measurements was excellent. Overall, the morphometric findings provide robust anatomical guidance for precise tibial tunnel creation during ACL reconstruction in this population.

Table 1: Demographic characteristics of the study population (n = 156)

Variable	Category	Number (%)
Age (years)	18–30	46 (29.5%)
	31–45	58 (37.2%)
	>45	52 (33.3%)
Sex	Male	92 (59.0%)

	Female	64 (41.0%)

This table presents the demographic distribution of included subjects.

Table 2: Tibial plateau compartmental widths (n = 156)

Parameter	Mean ± SD (mm)
Medial plateau width (MPW)	28.4 ± 2.6
Lateral plateau width (LPW)	26.7 ± 2.5
Total plateau width	55.1 ± 3.8

This table summarises medial, lateral, and total plateau widths.

Table 3: Anteroposterior (AP) depth of tibial plateau

Parameter	Mean ± SD (mm)
Medial AP depth (MAPD)	44.2 ± 3.9
Lateral AP depth (LAPD)	40.7 ± 3.6
Global AP depth	42.4 ± 3.7

This table outlines AP dimensions of medial and lateral compartments.

Table 4: Posterior tibial slope (PTS) measurements

Slope Type	Mean ± SD (°)
Medial PTS	7.8 ± 2.1
Lateral PTS	10.6 ± 2.4
Global PTS	9.2 ± 2.3

This table details posterior tibial slope values.

Table 5: Intercondylar eminence and spine morphometry

Parameter	Mean ± SD (mm)
Medial spine height	17.3 ± 2.2
Lateral spine height	15.9 ± 2.1
Interspinous distance	22.6 ± 2.8

This table characterizes tibial spine dimensions.

Table 6: ACL tibial footprint morphology (n = 156)

Parameter	Mean ± SD
Footprint length (mm)	12.6 ± 1.8
Footprint width (mm)	9.2 ± 1.5
Footprint area (mm²)	92.1 ± 14.7

This table describes footprint dimensions and area.

Table 7: ACL tibial footprint coordinates

Parameter	Mean ± SD (%)
AP position (% from anterior cortex)	43.4 ± 3.9
ML position (% from medial plateau border)	47.6 ± 4.1

This table reports AP and ML percentage positions.

Table 8: Posterior cortex thickness and safe drilling depth

Parameter	Mean ± SD (mm)
Posterior cortex thickness	8.4 ± 1.3
Maximum safe tunnel depth	34.6 ± 3.5

This table presents posterior wall thickness parameters.

Table 9: Safe tibial tunnel angulation (sagittal and coronal planes)

Plane	Mean Safe Angle (°)
Sagittal plane	52.3 ± 4.2
Coronal plane	12.6 ± 2.1

This table outlines recommended tunnel angles.

Table 10: Correlation analysis of morphometric determinants of tunnel placement

Parameter	Correlation (r)	P-value
Lateral PTS → sagittal angle	0.68	<0.001
AP footprint (%) → entry point	0.63	<0.001
Interspinous distance → ML angle	0.52	<0.001
Cortex thickness → maximum depth	0.59	<0.001

This table demonstrates correlations between morphometry and tunnel parameters.

Table 11: Multivariate regression predictors of ideal tunnel coordinates

Predictor	β-Coefficient	P-value

Lateral PTS	0.41	<0.001
AP footprint position	0.33	<0.001
Medial AP depth	0.26	0.002
Interspinous distance	0.21	0.008

This table identifies independent predictors.

Table 12: Interobserver reliability (Intraclass correlation coefficients)

Parameter	ICC
PTS	0.94
AP depth	0.92
Footprint coordinates	0.90
Tunnel angles	0.93

This table verifies measurement reproducibility.

[Table 1] summarises demographic characteristics, showing a balanced distribution across ages and sexes, establishing a representative adult population for morphometric evaluation. [Table 2] outlines medial and lateral plateau widths, revealing marked compartmental differences, which influence mediolateral tunnel entry positioning. [Table 3] demonstrates variations in AP depth between compartments, emphasizing the need to adjust tunnel depth to anatomical differences and avoid anterior or posterior misplacement. [Table 4] highlights posterior tibial slope differences, particularly the steeper lateral slope, which strongly affects sagittal tunnel angle selection. [Table 5] characterizes intercondylar eminence morphology, underscoring its significance in determining tunnel mediolateral orientation relative to tibial spines. [Table 6] details ACL footprint size variations, indicating the intrinsic variability of native graft footprint dimensions across individuals. [Table 7] identifies footprint centroid coordinates, showing consistent anterior positioning at approximately 43% AP depth and ~48% ML width, critical for anatomical tunnel placement. [Table 8] presents posterior cortex thickness and safe drilling depth, defining boundaries that prevent posterior wall blowout. [Table 9] specifies safe sagittal and coronal drilling angles, providing numerical guidance for tunnel orientation to minimize graft impingement. [Table 10] demonstrates strong correlations between morphometric variables and tunnel parameters, particularly lateral PTS and AP footprint percentage. [Table 11] identifies independent predictors of optimal tunnel coordinates through multivariate analysis, highlighting key factors guiding anatomical planning. Table 12 confirms excellent interobserver reliability, validating the reproducibility and accuracy of the 3D-CT measurement protocol.

DISCUSSION

This study presents a comprehensive three-dimensional CT–based morphometric assessment of the tibial plateau in an adult Indian population and establishes its implications for anatomical tibial tunnel placement during anterior cruciate ligament (ACL) reconstruction.[8] The detailed analysis of plateau geometry, posterior tibial slope, intercondylar eminence morphology, and ACL tibial footprint coordinates provides crucial insights for optimizing tunnel positioning, reducing technical errors, and improving surgical outcomes.[9]

The demographic distribution of the study population was consistent with the age group most likely to undergo knee imaging and ACL-related orthopedic assessments, lending clinical relevance to the findings. The tibial plateau width and anteroposterior (AP) depth demonstrated considerable anatomic variability across individuals.[10,11] The medial plateau was consistently broader and deeper than the lateral plateau, which aligns with known biomechanical and structural differences between the compartments. These dimensional differences are clinically significant, as they influence the mediolateral entry point of the tibial tunnel and the maximum safe depth of drilling.[12]

Posterior tibial slope (PTS) emerged as an influential morphometric parameter in this study. The lateral slope was significantly steeper than the medial slope, a finding consistent with established anatomical studies. This difference is critically important because tunnel trajectory must account for slope variations to prevent graft impingement against the intercondylar roof.[13] A steeper lateral PTS demands a more vertically oriented tunnel, whereas a flatter slope allows greater angulation without increasing the risk of posterior wall blowout. The positive correlation between lateral PTS and safe sagittal drilling angle observed in this study supports the need for slope-adjusted tunnel orientation.[14]

The intercondylar eminence and tibial spines also demonstrated variable morphology, which plays a central role in defining anatomical tunnel mediolateral orientation. The interspinous distance influences the ML entry point and helps ensure that tunnel placement replicates the native ACL tibial footprint rather than approaching the anteromedial or anterolateral tibial spine excessively. These findings reaffirm the commonly used anatomical landmarks for ACL reconstruction while providing population-specific precision.[15]

The ACL tibial footprint morphometry and coordinates form the core of anatomical ACL reconstruction. In this study, the footprint was consistently located anterior to the medial tibial spine, at approximately 42–45% of AP depth from the anterior cortex, findings that align well with cadaveric studies and international literature.[16] The

ML footprint position at roughly 48% of plateau width underscores the central positioning of the ACL tibial insertion, ensuring that tunnel placement should neither be excessively medial nor lateral. The footprint dimensions further highlight the need for accurate re-creation of graft footprint size to improve rotational stability and graft integration.[17]

Posterior cortex thickness and safe drilling depth values derived from 3D-CT analysis are highly practical for surgical planning. A posterior cortex thickness of approximately 8–9 mm and a safe drilling depth of 34–35 mm provides clear guidelines to prevent posterior wall blowout, one of the most feared technical complications in ACL reconstruction. These numerical thresholds offer quantifiable safety margins that can be integrated into intraoperative decision-making.[18]

Correlation and regression analyses further validated key morphometric predictors of tunnel placement. The strongest determinants included lateral PTS, AP footprint percentage, interspinous distance, and medial AP depth. These variables collectively defined the ideal sagittal and coronal tunnel angles, entry points, and trajectories.[19] The findings reinforce that tunnel placement should be individualized based on morphological parameters rather than relying on fixed universal guidelines.

The interobserver reliability results demonstrated excellent reproducibility of measurements, indicating that the 3D-CT morphometric methodology is robust and suitable for clinical and research applications. High ICC values across all major parameters confirm the reliability of 3D-based analysis for planning anatomical ACL reconstruction.[20]

The strengths of this study include a well-calculated sample size, rigorous inclusion criteria, high-resolution 3D imaging, and a comprehensive parameter set addressing both bony geometry and footprint characteristics. However, its single-centre design may limit generalizability across diverse ethnic groups within India. Additionally, ligamentous and cartilaginous morphology were not included in the analysis, although the focus of this research was bony architecture relevant to tunnel placement.

Overall, the study provides clinically valuable morphometric data that can serve as a population-specific reference for ACL reconstruction. The findings highlight the importance of incorporating detailed tibial plateau morphometry particularly AP footprint location, posterior tibial slope, and posterior cortical thickness into preoperative templating and intraoperative navigation. Such tailored planning can minimize complications, improve graft biomechanics, and enhance long-term outcomes in ACL reconstruction.

CONCLUSION

This study demonstrates that three-dimensional CT morphometry provides highly accurate and clinically relevant insights into tibial plateau anatomy that directly influence tibial tunnel placement in ACL reconstruction. Significant anatomical variability was observed in posterior tibial slope, plateau dimensions, intercondylar eminence morphology, and ACL tibial footprint coordinates. The lateral tibial slope was consistently steeper than the medial slope, altering tunnel trajectory requirements. The ACL tibial footprint was reliably located at approximately 42–45% of the anteroposterior depth and 47–48% of the mediolateral width, offering precise anatomical guidance. Posterior cortex thickness and slope-adjusted AP depth provided clear safety margins for preventing posterior wall blowout. Key morphometric factors including lateral PTS, AP footprint percentage, and interspinous distance emerged as major predictors of ideal tunnel coordinates. Incorporating 3D-CT–based anatomical references into preoperative planning can enhance tunnel accuracy, minimize complications, and improve graft biomechanics in ACL reconstruction.

Limitations

1. This was a single-centre study, which may not fully represent morphometric variations across different ethnic or regional populations within India.
2. The study included only bony morphometric analysis; ligamentous and cartilaginous structures were not evaluated.
3. CT scans were obtained from patients imaged for clinical reasons and not exclusively healthy volunteers, although cases with deformity or pathology were excluded.
4. Tunnel placement was not assessed intraoperatively; only anatomical predictors were analysed.
5. Radiation exposure inherent to CT imaging limits applicability in purely research-based volunteer studies.

Recommendations

1. ACL reconstruction should incorporate patient-specific morphometric assessment rather than relying solely on universal tunnel placement landmarks.
2. Preoperative 3D-CT mapping may be considered in revision cases, anatomical variants, or complex knees to avoid tunnel malposition.
3. Emphasis should be placed on the relationship between posterior tibial slope and sagittal tunnel angle selection to minimize graft impingement.
4. Further multicentric studies across varied Indian populations are recommended to establish comprehensive normative datasets.
5. Integration of AI-assisted morphometry and 3D navigation systems may further improve tunnel accuracy and surgical outcomes.

REFERENCES

1. Montreuil J, Saleh J, Cresson T, De Guise JA, Lavoie F. Tibial Tunnel Placement in ACL Reconstruction Using a Novel Grid and Biplanar Stereo radiographic Imaging. Orthop J Sports Med. 2021 Mar 11;9(3):2325967121989369. doi:

10.1177/2325967121989369. PMID: 34250158; PMCID: PMC8239338.

2. Petersen W, Tillmann B. Anatomie und Funktion des vorderen Kreuzbandes [Anatomy and function of the anterior cruciate ligament]. Orthopade. 2002 Aug;31(8):710-8. German. doi: 10.1007/s00132-002-0330-0. PMID: 12426749.
3. Nicodeme JD, Löcherbach C, Jolles BM. Tibial tunnel placement in posterior cruciate ligament reconstruction: a systematic review. Knee Surg Sports Traumatol Arthrosc. 2014 Jul;22(7):1556-62. doi: 10.1007/s00167-013-2563-3. Epub 2013 Jun 16. PMID: 23771349; PMCID: PMC4059945.
4. Iriuchishima T, Goto B. Tibial Spine Location Influences Tibial Tunnel Placement in Anatomical Single-Bundle Anterior Cruciate Ligament Reconstruction. J Knee Surg. 2022 Feb;35(3):294-298. doi: 10.1055/s-0040-1713736. Epub 2020 Jul 8. PMID: 32643780.
5. Xu Y, Ao Y, Wang J, Yu J, Cui G. Relation of tunnel enlargement and tunnel placement after single-bundle anterior cruciate ligament reconstruction. Arthroscopy. 2011 Jul;27(7):923-32. doi: 10.1016/j.arthro.2011.02.020. Epub 2011 May 31. PMID: 21621372.
6. Cremer P, Peltier A, Maubisson L, Neyret P, Lustig S, Servien E. Positioning of the Tibial Tunnel After Single-Bundle ACL Primary Reconstruction on 3D CT scans: A New Method. Arthrosc Sports Med Rehabil. 2020 Oct 9;2(5):e615-e622. doi: 10.1016/j.asmr.2020.07.011. PMID: 33135002; PMCID: PMC7588642.
7. Buzzi R, Zaccherotti G, Giron F, Aglietti P. The relationship between the intercondylar roof and the tibial plateau with the knee in extension: relevance for tibial tunnel placement in anterior cruciate ligament reconstruction. Arthroscopy. 1999 Sep;15(6):625-31. doi: 10.1053/ar.1999.v15.015062. PMID: 10495179.
8. Khalfayan EE, Sharkey PF, Alexander AH, Bruckner JD, Bynum EB. The relationship between tunnel placement and clinical results after anterior cruciate ligament reconstruction. Am J Sports Med. 1996 May-Jun;24(3):335-41. doi: 10.1177/036354659602400315. PMID: 8734885.
9. Keller TC, Tompkins M, Economopoulos K, Milewski MD, Gaskin C, Brockmeier S, Hart J, Miller MD. Tibial tunnel placement accuracy during anterior cruciate ligament reconstruction: independent femoral versus transtibial femoral tunnel drilling techniques. Arthroscopy. 2014 Sep;30(9):1116-23. doi: 10.1016/j.arthro.2014.04.004. Epub 2014 Jun 4. PMID: 24907026.
10. Nema SK, Balaji G, Akkilagunta S, Menon J, Poduval M, Patro D. Radiologic assessment of femoral and tibial tunnel placement based on anatomic landmarks in arthroscopic single bundle anterior cruciate ligament reconstruction. Indian J Orthop. 2017 May-Jun;51(3):286-291. doi: 10.4103/ortho.IJOrtho_219_16. PMID: 28566780; PMCID: PMC5439314.
11. Werner BC, Burrus MT, Gwathmey FW, Miller MD. A prospective evaluation of the anterior horn of the lateral meniscus as a landmark for tibial tunnel placement in anterior cruciate ligament (ACL) reconstruction. Knee. 2016 Jun;23(3):478-81. doi: 10.1016/j.knee.2015.10.009. Epub 2015 Nov 6. PMID: 26549778.
12. Büyükdoğan K, Laidlaw MS, Fox MA, Kew ME, Miller MD. Effect of Tibial Tunnel Placement Using the Lateral Meniscus as a Landmark on Clinical Outcomes of Anatomic Single-Bundle Anterior Cruciate Ligament Reconstruction. Am J Sports Med. 2021 May;49(6):1451-1459. doi: 10.1177/0363546521999672. Epub 2021 Apr 8. PMID: 33830836.
13. Morgan CD, Kalman VR, Grawl DM. Definitive landmarks for reproducible tibial tunnel placement in anterior cruciate ligament reconstruction. Arthroscopy. 1995 Jun;11(3):275-88. doi: 10.1016/0749-8063(95)90003-9. PMID: 7632302.
14. Vermesan D, Inchingolo F, Patrascu JM, Trocan I, Prejbeanu R, Florescu S, Damian G, Benagiano V, Abbinante A, Caprio M, Cagiano R, Haragus H. Anterior cruciate ligament reconstruction and determination of tunnel size and graft obliquity. Eur Rev Med Pharmacol Sci. 2015;19(3):357-64. PMID: 25720703.
15. Hinterwimmer S, Mehl J. Kombination von VKB-Ersatzplastik und hoher tibialer Umstellungsosteotomie [Combination of ACL-replacement and high tibial osteotomy]. Oper Orthop Traumatol. 2014 Feb;26(1):43-55. German. doi: 10.1007/s00064-013-0269-9. Epub 2014 Feb 9. PMID: 24553688.
16. Wolf BR, Ramme AJ, Wright RW, Brophy RH, McCarty EC, Vidal AR, Parker RD, Andrish JT, Amendola A; MOON Knee Group. Variability in ACL tunnel placement: observational clinical study of surgeon ACL tunnel variability. Am J Sports Med. 2013 Jun;41(6):1265-73. doi: 10.1177/0363546513483271. Epub 2013 Apr 25. PMID: 23618702.
17. Leiter JR, de Korompay N, Macdonald L, McRae S, Froese W, Macdonald PB. Reliability of tunnel angle in ACL reconstruction: two-dimensional versus three-dimensional guide technique. Knee Surg Sports Traumatol Arthrosc. 2011 Aug;19(8):1258-64. doi: 10.1007/s00167-011-1397-0. Epub 2011 Feb 3. PMID: 21290110.
18. Miller MD, Gerdeman AC, Miller CD, Hart JM, Gaskin CM, Golish SR, Clancy WG Jr. The effects of extra-articular starting point and transtibial femoral drilling on the intra-articular aperture of the tibial tunnel in ACL reconstruction. Am J Sports Med. 2010 Apr;38(4):707-12. doi: 10.1177/0363546509351818. Epub 2010 Feb 17. PMID: 20164306.
19. Ahn JH, Jeong HJ, Ko CS, Ko TS, Kim JH. Three-dimensional reconstruction computed tomography evaluation of tunnel location during single-bundle anterior cruciate ligament reconstruction: a comparison of transtibial and 2-incision tibial tunnel-independent techniques. Clin Orthop Surg. 2013 Mar;5(1):26-35. doi: 10.4055/cios.2013.5.1.26. Epub 2013 Feb 20. PMID: 23467279; PMCID: PMC3582868.
20. Hosseini A, Lodhia P, Van de Velde SK, Asnis PD, Zarins B, Gill TJ, Li G. Tunnel position and graft orientation in failed anterior cruciate ligament reconstruction: a clinical and imaging analysis. Int Orthop. 2012 Apr;36(4):845-52. doi: 10.1007/s00264-011-1333-4. Epub 2011 Aug 9. PMID: 21826407; PMCID: PMC3311801..