A New Method for Accurately Predicting the Femoral ACL Footprint Using Bony Landmarks : A Cadaver Study

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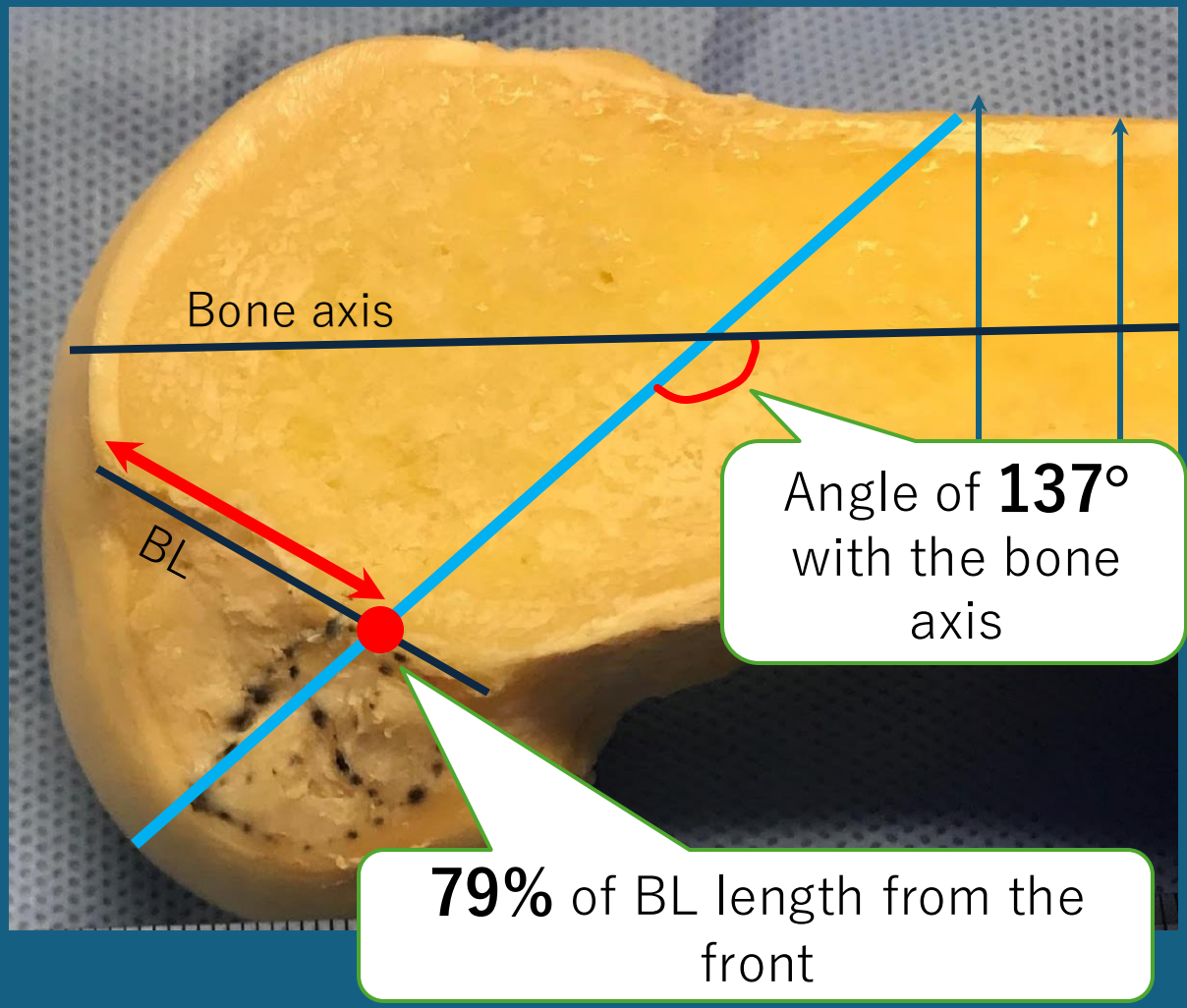
INTRODUCTION

Precise determination of the bone tunnel position is crucial in anatomical anterior cruciate ligament (ACL) reconstruction.

Previous studies have reported that the intercondylar ridge (ICR), a widely utilized intraoperative indicator, forms an average angle of 137° with the femoral bony axis [1] and passes through 79% of Blumensaat's line (BL) from the anterior edge [2].

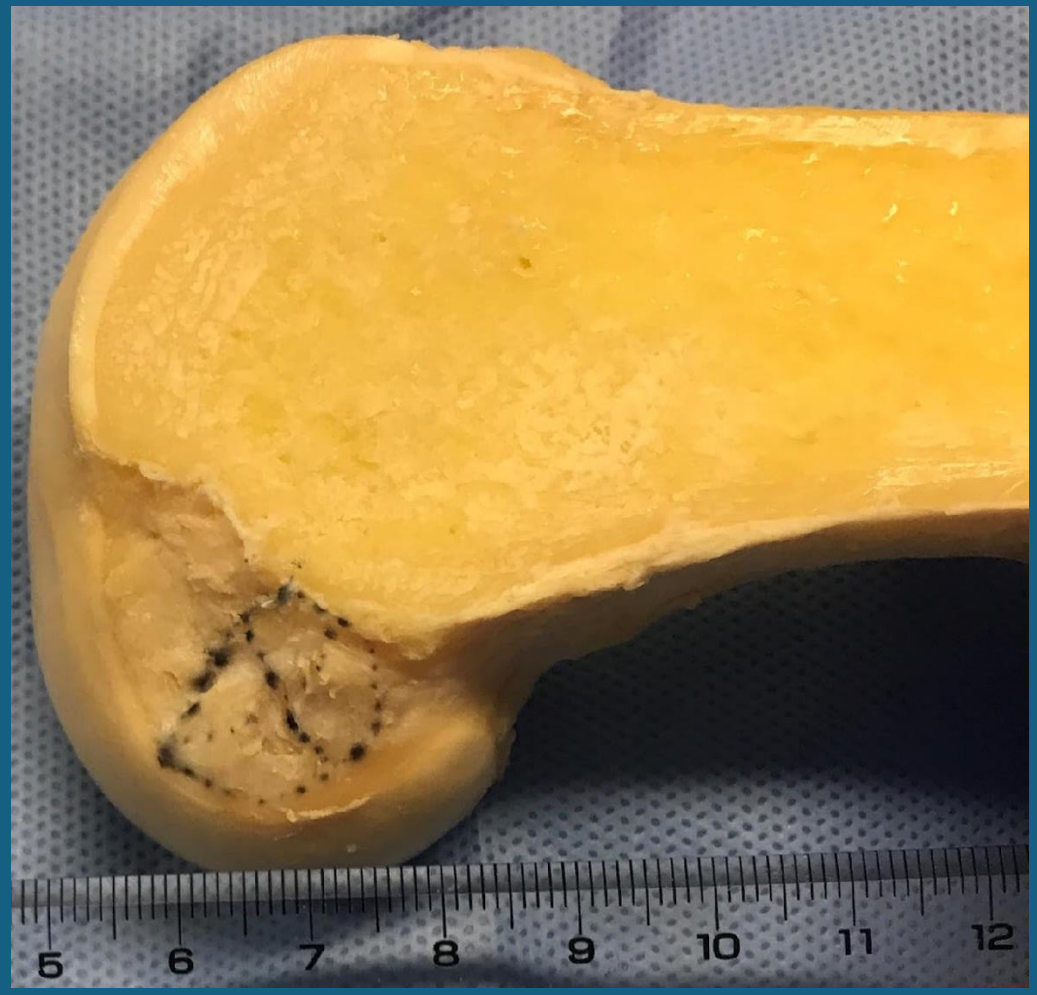


INTRODUCTION

This study aimed to validate the accuracy of the ACL femoral footprint predicted from these bony landmarks and to identify the optimal bony axis angle and position on the BL that best approximates the actual ACL femoral footprint for Japanese individuals .

MATERIALS

- Fifty formalin-fixed cadaveric knees (19 male, 31 female; mean age 82 years, range 53-98) were examined.
- Cases with severe osteoarthritis were excluded.
- The femur was bisected sagittally, and the femoral ACL footprint was marked and digitally photographed.

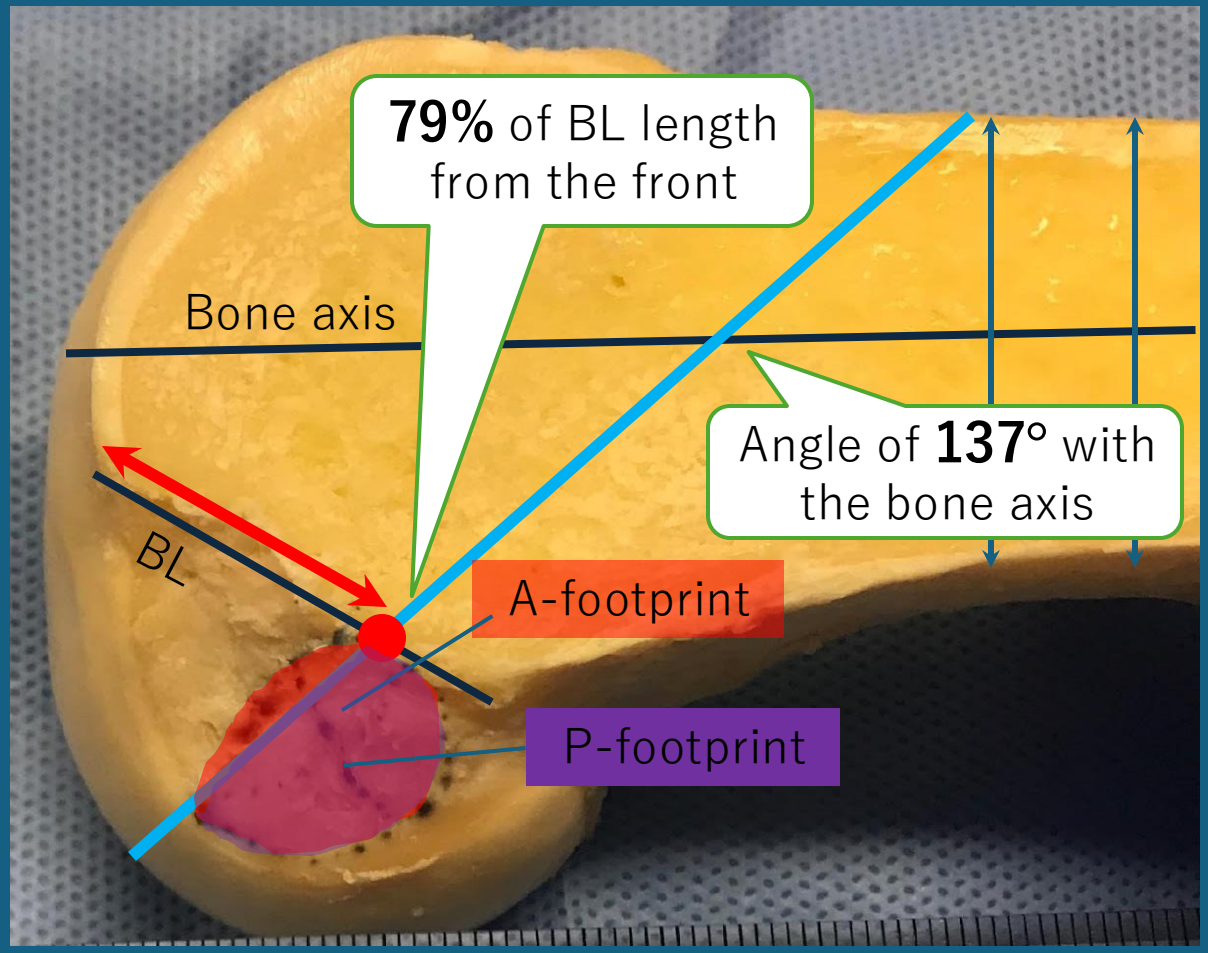


METHODS 1

Image analysis was performed using ImageJ (National Institute of Health) to measure the actual footprint area (A-footprint).

The area of the lateral wall of the femoral intercondylar notch (predicted footprint, P-footprint) posterior to the line forming a 137° angle with the femoral bony axis and passing through 79% of the BL from the anterior edge was measured.

The coverage of the P-footprint to the A-footprint was calculated (P-footprint/A-footprint × 100 %).



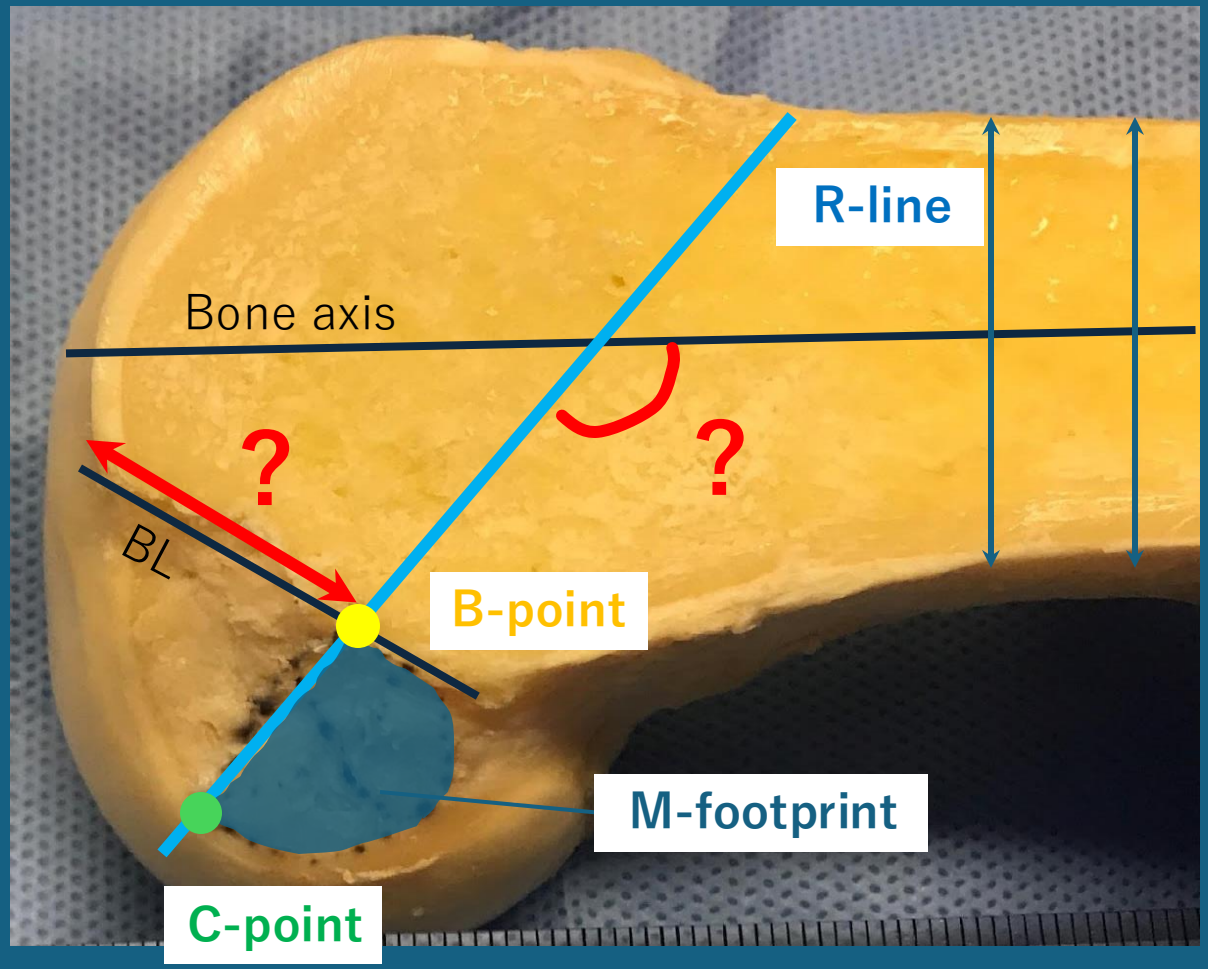
METHODS 2

To achieve a more anatomical footprint measurement, we measured the contact position of the actual footprint with the BL, the angle between the footprint and the bone axis, and the area using the following method. We then compared the M-footprint area with the A-footprint.

The B-point was defined as the contact point between the BL and the A-footprint, and the C-point was the anterior contact point between the A-footprint and the cartilage edge.

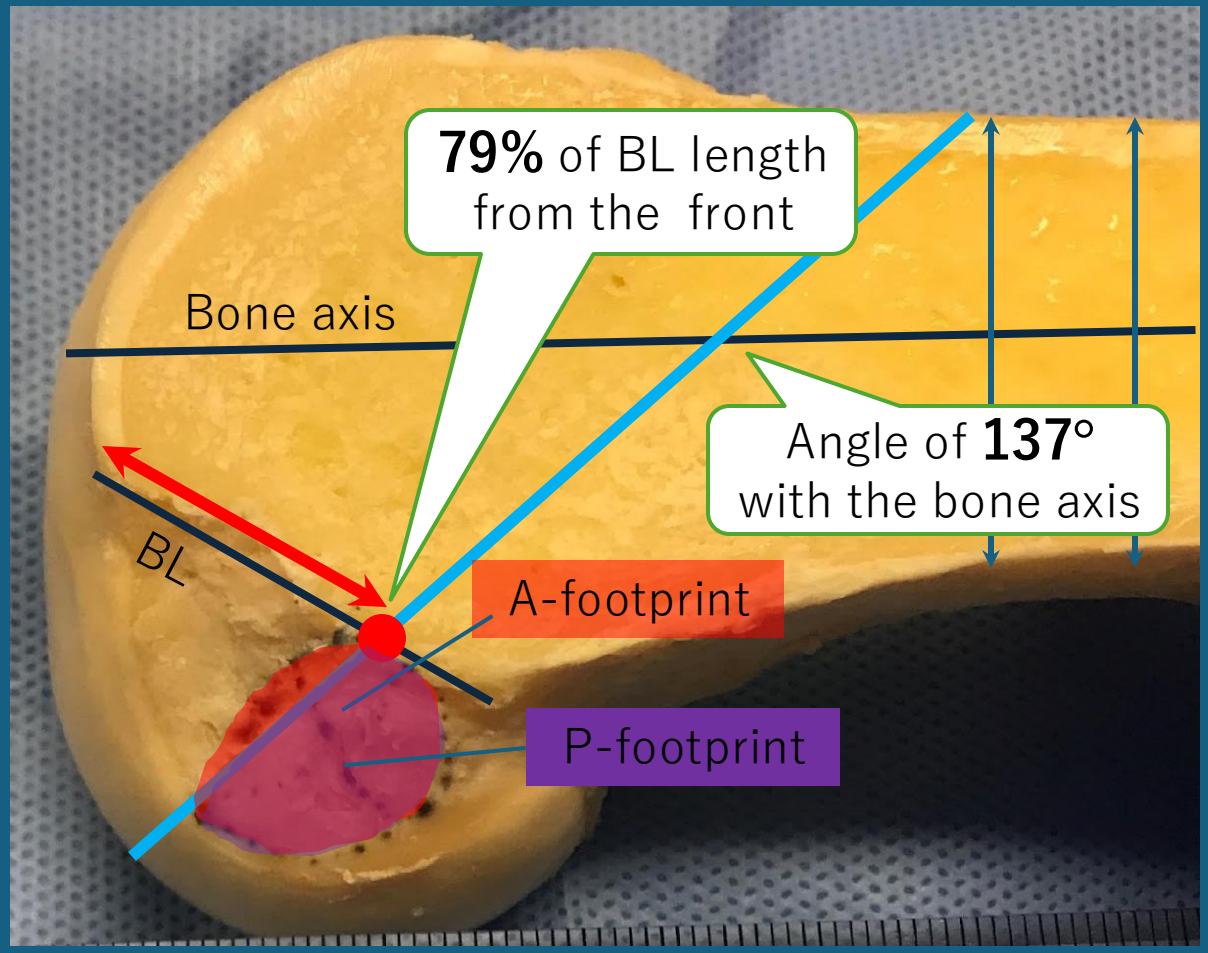
The R-line, passing through the B-point and C-point, was used to measure the distance (%) from the anterior end of the BL to its crossing point and the angle with the bone axis.

The M-footprint was calculated using these values, and its coverage relative to the A-footprint was evaluated.



RESULTS 1

The mean coverage of the P-footprint was 71.8% (±9.6).

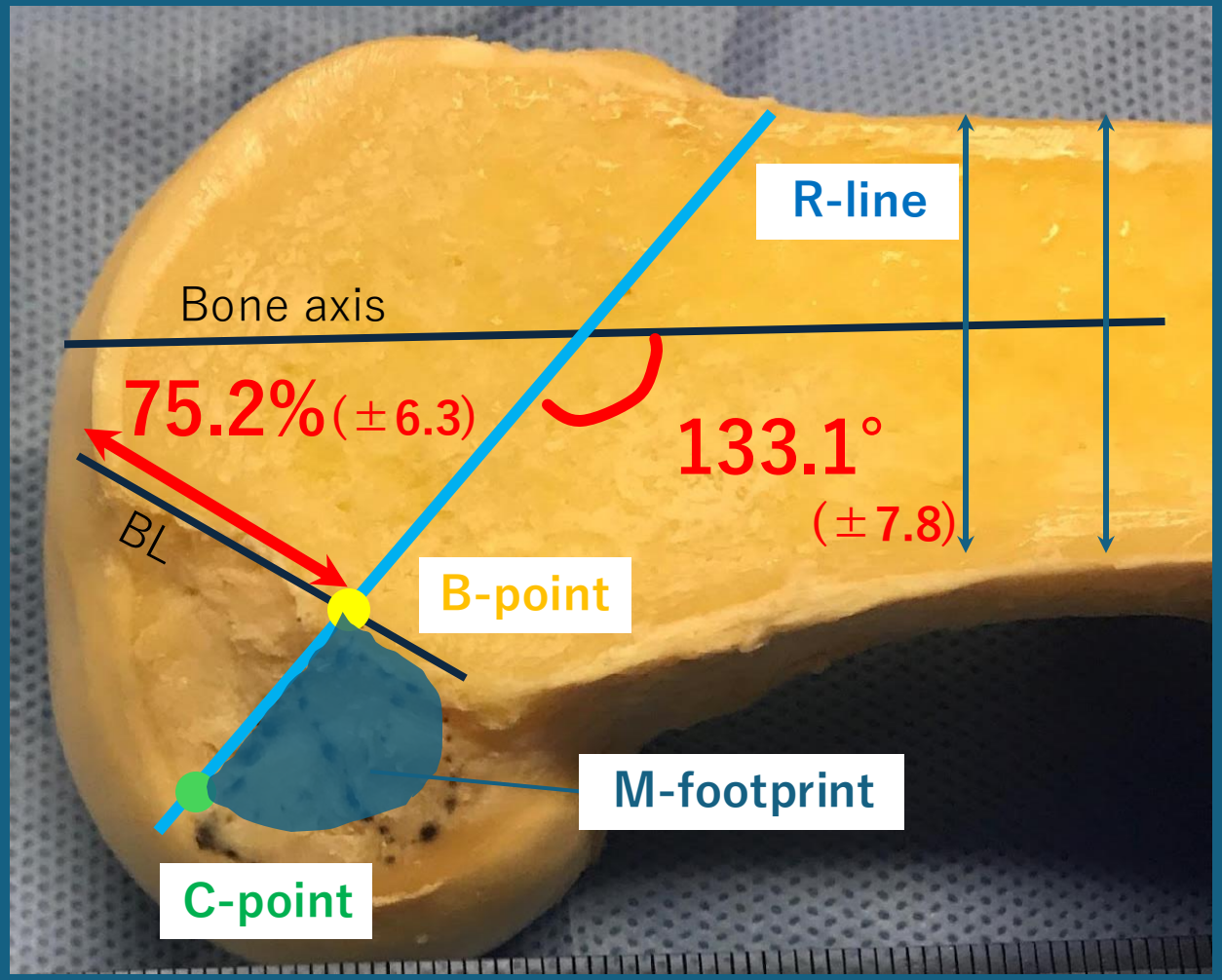


RESULTS 2

The B-point was located at 75.2% (±6.3) from the anterior edge of the BL.
The R-line formed an angle of 133.1° (±7.8) with the femoral axis.

The coverage of the M-footprint, calculated using these values, was 84.85% (±7.16), which was significantly higher than that of the P-footprint (P<0.001).

	P-footprint	A-footprint	P-value
Coverage of the A-footprint (%)	71.8(±9.6)	84.85(±7.16)	<0.001



DISCUSSION

This is the first study to predict the ACL attachment site from bony landmarks using Japanese cadaveric knees. Using new landmarks (B-point, R-line), the coverage rate of the ACL attachment site predicted from images was approximately 85%, indicating good accuracy.

Compared to previous reports, the B-point was 4% more anterior on the BL, and the R-line was inclined 4° toward flexion. This is thought to result from racial differences in femoral bone morphology, with East Asians having a smaller anterior-posterior length than Caucasians [3].

These results may serve as a guideline for creating bone tunnels in ACL reconstruction.

LIMITATIONS

- Small sample size.
- Limited to Japanese individuals.
- Measurements were performed by a single examiner.
- The anterior edge of the ACL footprint is not a straight line.

CONCLUSION

The findings of this study suggest that the M-footprint method provides a more precise estimation of the ACL femoral footprint compared to the *P*-footprint method for Japanese individuals. For optimal bone tunnel placement during ACL reconstruction, creating the bone tunnel posterior to the R-line is recommended.

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