



Supplementary Material

10.1302/2633-1462.44.BJO-2023-0023.R1

Knee coordinate system definition

Rotations and translations of the tibia relative to the femur were expressed using a knee coordinate system adapted from the convention described by Grood and Suntay.¹ The axes comprising the knee coordinate system were based on the geometries of the femoral component and tibial tray of the total knee arthroplasty design that was used in this study (Persona; Zimmer Biomet, USA).

We based the medial-lateral (ML) axis of the knee coordinate system on the geometry of the femoral component. The orientation of this axis was defined to be the cross product of the planes fit to the posterior and distal faces of the femoral component (Figure a). These planes were identified using reverse engineering software (Geomagic Wrap 3D Systems, USA). The ML axis was directed medially for left knees and laterally for right knees.

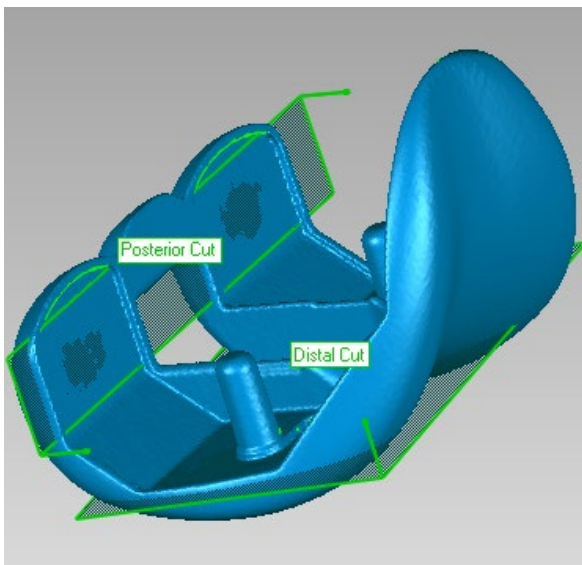


Fig a. Planes fitting the posterior face (Posterior Cut) and distal face (Distal Cut) of the femoral component.

The origin of the coordinate system fixed to the femoral component was centered within the femoral box in the axial plane (Figure ba). The origin was located midway between the line connecting the tips of the lugs. Proximally, the origin was located within a transverse plane positioned midway between the proximal-most and distal-most aspects of the posterior cut (Figures bb to bd).

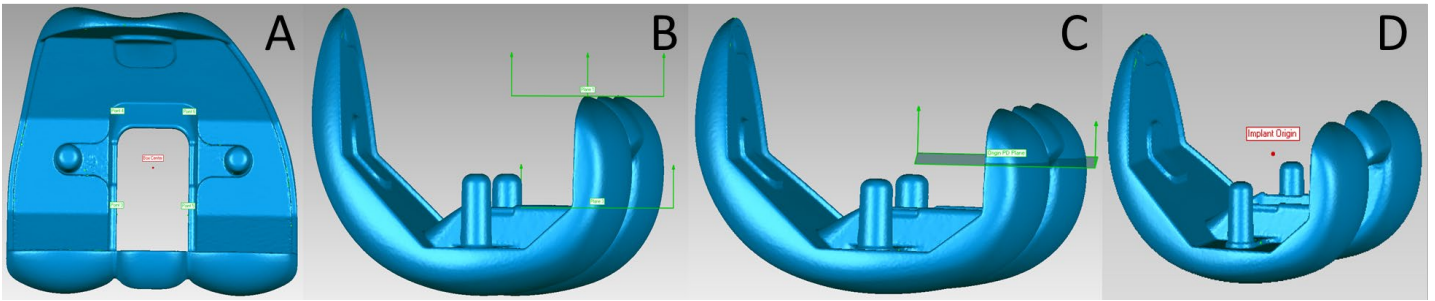


Fig b. Definition of the origin of the coordinate system fixed to the femoral component. a) The center of the femoral box (box centre). b) The planes defining the proximal and distal most aspects of the posterior cut. c) The plane midway between the proximal and distal most aspects of the posterior cut. d) The origin of the coordinate system fixed to the femoral component (implant origin).

We based the proximal-distal (PD) axis of the knee coordinate system on the geometry of the tibial tray. This axis was oriented perpendicular to a plane fit to the proximal face of the tibial tray (Figure ca; tibial axial plane). The PD axis was directed distally for both left and right knees. The origin of the coordinate system fixed to the tibial component was centered within the tibial tray. Specifically, the origin was located at the bisection of the line connecting the medial and lateral points along the outer edge of the tray where the thickness of the rim increased (Figure cb; Tibia_Left, Tibia_Right).

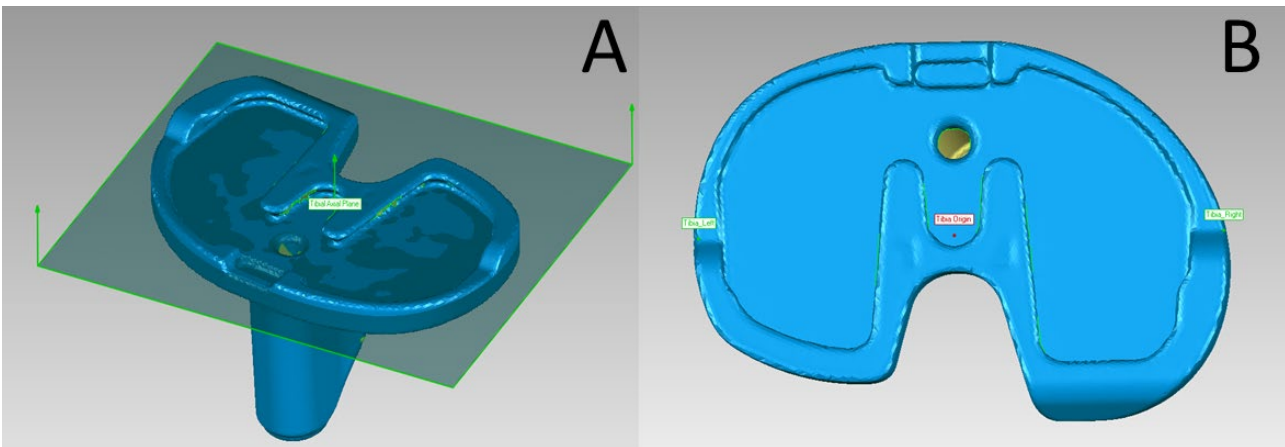


Fig c. Definition of the origin of the coordinate system fixed to the tibial component. a) The axial plane (tibial axial plane) matched the proximal face of the tibial tray. b) The origin of the tibial component bisected the medial (tibia_right) and lateral (tibia_left) points along the outer edge of the tray where the thickness of the rim increased.

We set the anterior-posterior (AP) axis of the knee coordinate system as the common perpendicular of the ML and PD axes. The AP axis was directed posteriorly for both left and right knees. Flexion-extension, internal/external rotation, and abduction and adduction were directed about the ML, PD, and AP axes described above. ML, PD, and AP translations were

expressed as the projection of the vector defined by the origins of the femoral and tibial components onto each corresponding anatomical direction.

Reference

1. **Good ES, Suntay WJ.** A joint coordinate system for the clinical description of three-dimensional motions: application to the knee. *J Biomech Eng.* 1983 May;105(2):136-144.