

Differing prosthetic alignment and femoral component sizing among three computer assisted CT-free navigation systems in TKA

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Introduction: Computer-assisted navigation systems have been developed to improve the accuracy of osteotomy and implantation in relation to the mechanical axis in total knee arthroplasty (TKA). Although the usefulness of these systems has been reported by several authors, navigation has not reported to improve patient satisfaction or clinical results despite the added alignment accuracy, higher expense, and operative time at midterm follow-up. The problems or black box of the use of navigation systems have received little attention. One of them is the different definition of bony landmark, especially the knee center in the sagittal plane, where the recommendations of each company's engineer may be different. Therefore, the purpose of the current study was to compare the postoperative alignment and sizing of femoral prosthesis among patients performed by 3 different navigation systems.

Materials & Methods: Recently, 15 posterior stabilized TKAs (Triathlon; Stryker; Mahwah, NJ, USA) were performed for varus osteoarthritic patients in 2011 using a CT-free navigation system (Stryker Navigation System). The results of this study group were retrospectively compared in sagittal alignment and sizing of the femoral prosthesis with those in groups of 30 posterior stabilized TKAs (Press-fit Condylar prosthesis; DePuy, Tokyo, Japan) using another CT-free navigation system (VectorVision) performed between 2002 and 2006 and 30 cruciate-retaining TKAs (E.motion; B. Braun Aesculap, Tuttlingen, Germany) using a CT-free navigation system (OrthoPilot v 4.2) between 2006 and 2009.

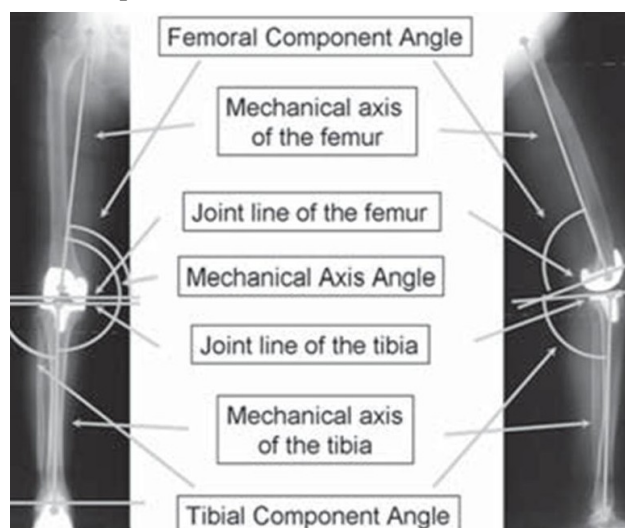
Prosthetic implantation technique

(Femoral component)

Two different mechanical axes (mechanical axis 1 and mechanical axis 2) are defined to determine the relationship between the femoral component and the distal femur. Mechanical axis 1 is the line connecting the femoral head center to knee center, a point 1 cm anterior to the distal end of Blumensaat's line (a line extending through the intercondylar notch on a lateral view of the knee). Mechanical axis 2 is the line connecting the femoral head center to the knee center, a point identified 65% posteriorly on the line between the anterior cortex and the most prominent point of the posterior medial femoral condyle.

In the OrthoPilot group, the femoral component is implanted perpendicular to mechanical axis 2.

In the VectorVision group, the femoral component is implanted perpendicular to mechanical axis 1.



In the Stryker group, based on the preliminary data showing different femoral component alignment and sizing in the sagittal plane [1], we performed 2D-3D matching by 3D Digital Template System (Athena, Soft Cube, Osaka, Japan) and measured the angle between mechanical axis 1 and the appropriate femoral component to avoid anterior notch preoperatively. The femoral component was implanted at the angle to mechanical axis 1.

(Tibial component)

The proximal tibial osteotomy was performed with 3° posterior inclination in the sagittal plane in all groups.

Radiographic evaluation

Several parameters were measured on postoperative AP and lateral long-leg weight-bearing radiographs for each patient. Radiographs were taken with the patient standing, trying to take weight equally on both feet, with the knee in maximum extension and facing the radiograph tube. Five radiographic parameters of the component positioning angle were measured based on 4 reference lines (Figure1). The mechanical axis 1 was used as the mechanical axis of the femur in the sagittal plane

In the second part of the study, we compared both the pre- and postoperative AP dimension of the femoral condyle and prosthesis in 3 different navigation groups using lateral radiographs.

Results:

(Sagittal Plane Alignment)

The sagittal femoral component angle was $86.0^{\circ} \pm 1.4^{\circ}$ in the Orthopilot group, $90.0^{\circ} \pm 2.0^{\circ}$ in the VectorVision group and $87.4^{\circ} \pm 2.5^{\circ}$ in Stryker group. The sagittal femoral component angle in the VectorVision group is significantly larger than that in the Orthopilot group and that in the Stryker group. The sagittal tibial component angle was $84.4^{\circ} \pm 1.9^{\circ}$ in the Orthopilot group, $85.0^{\circ} \pm 3.2^{\circ}$ in the VectorVision group and $87.5^{\circ} \pm 2.4^{\circ}$ in Stryker group with no significant difference.

(Anteroposterior Dimension of the Femoral Condyle)

The preoperative AP dimensions of the femoral condyle were 62.4 ± 3.7 mm in the OrthoPilot group and 62.4 ± 4.4 mm in the Vector Vision group and 63.6 ± 6.2 mm in the Stryker group. And the postoperative values were 62.6 ± 3.9 mm in the OrthoPilot group, 64.7 ± 4.1 mm in the Vector Vision group and 64.5 ± 4.3 mm in Stryker group. In the comparison between pre- and postoperative values, postoperative values in the VectorVision group were significantly larger than the preoperative values, but no significant difference existed in the OrthoPilot group and Stryker group. Thus, the size of the selected femoral component in the VectorVision group tended to increase postoperatively compared with preoperative femoral condyle.

(Coronal Plane Alignment)

Mechanical axis angle, femoral component angle and tibial component angle in the coronal plane showed no significant differences among the groups.

Discussion: In the current study, we confirmed that the first series of the navigation; Vector Vision group showed neutral implantation to mechanical axis 1 (extended implantation to mechanical axis 2) compared to the other groups, resulting in larger size of femoral component to avoid anterior notch creation. Based on the different knee center from the others, the second series of navigation; Orthopilot group showed flexed implantation to mechanical axis 1 (neutral implantation to mechanical axis 2), keeping antero-posterior dimension of the femoral condyle. Based on the preliminary data and careful preoperative planning with 2D-3D matching, the latest series of the navigation; Stryker group showed flexed implantation to mechanical axis 1 and retained antero-posterior dimension of the femoral condyle despite of implantation to mechanical axis 1.

Conclusion: Surgeons should take into account the type of navigation system and the size of the femoral component when using a navigation system.

References

1. Matsumoto T, Kubo S, Muratsu H, Tsumura N, Ishida K, Matsushita T, Takayama K, Sasaki H, Oka S, Kurosaka M, Kuroda R. Differing prosthetic alignment and femoral component sizing between 2 computer-assisted CT-free navigation system in TKA. Orthopedics 34(12): e860-5, 2011.