Postoperative Functional Assessment for Total Knee Arthroplasty using Medial Pivot Concept

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PURPOSE:
Recently, total knee arthroplasty (TKA) has been generalized as an operation that achieves excellent clinical results. However, younger and more demanding patients require even greater implant longevity and functional performance, and there are many variations in the prosthesis design.

Banks et al have been reported that the kinematic outcome from TKA varies with the prosthesis design: the CR and mobile types of TKA provide lateral pivot motion, whereas the PS type provides medial pivot motion. Schmidt et al have been reported that the Medial Pivot type TKA has reproduced medial pivot motion.

We assessed the postoperative function of two types of medial pivot type TKA in vivo in order to determine if medial pivot motion is reproduced.

METHODS:
The subjects were 16 osteoarthritis patients undergoing TKA in 16 joints. TKA was performed with the ADVANCE Medial Pivot Knee System (ADVANCE TKA) made by WRIGHT MEDICAL Technology in 8 joints (Fig.1), and with the FINE Total Knee System CR type (FINE TKA) made by NAKASHIMA MEDICAL in JAPAN in 8 joints (Fig.2).

The posterior cruciate ligament was preserved in all cases. The ADVANCE TKA femoral component has a constant sagittal radius of curvature extending from full extension to 90 degrees of flexion. The spherical medial femoral condyle pivots about the matching spherical depression on the tibial insert, while 15 degrees of rotation around the medial pivot is allowed with an accurate path on the lateral plateau. This “ball in socket” medial pivot mechanism maximizes medial congruency while providing controlled A-P translation on the lateral plateau.

The FINE TKA is designed with a 3-degree step of the joint line in order to reconstruct the anatomic geometry. This system has an asymmetrical design between the medial and lateral femoral condyle, the medial femoral condyle designed to be 3 degrees larger than the lateral femoral condyle. In comparison, the tibial insert is designed in such a manner that the medial plateau is lower than the lateral plateau by 3 degrees. By incorporating the 3 degrees joint line step into the TKA prosthesis design, the anatomical geometry and posterior condyle offset is rebuilt. The tibial insert is designed to conform to the medial plateau. The lateral plateau is designed with a posterior slope, so that it adopts the tibial internal rotation through medial pivot motion.

The kinematic postoperative functional assessment was performed in the 16 patients using a 3D-to-2D model registration technique. The kinematic postoperative functional assessment of these two TKA prosthesis models was generally recognized. Therefore, the ADVANCE TKA demonstrated the medial pivot pattern; tibial external rotation was shown in early stages of flexion, and tibial internal rotation was shown with flexion up to 90 degrees.

In the FINE TKA, the average contact point on the medial plateau showed a 0.9 mm femoral roll back from 0 to 30 degrees of flexion, 0.9 mm femoral roll forward from 30 to 70 degrees of flexion, and femoral roll back from 80 to 90 degrees of flexion. The average tibial contact point on the lateral plateau, however, showed femoral roll back at a constant rate from 0 to 90 degrees of flexion, with 9 mm of femoral rollback at 90 degrees of flexion. The average tibial rotational angle was 0.5 degrees at 0 degree of flexion, and after reaching 1.7 degrees of internal rotation at 20 degrees of flexion, an approximately constant rate of tibial internal rotation was shown, with 16.9 degrees of internal rotation was shown at 90 degrees of flexion.

In every case, tibial internal rotation was generally accepted. From these results, the FINE TKA showed the medial pivot pattern; tibial internal rotation was shown with flexion up to 90 degrees.

RESULTS:
In the ADVANCE TKA, the average contact point on the medial plateau of the tibiofemoral motion was constant from extension to flexion. In the lateral plateau, the average contact point showed a 1.1 mm femoral roll forward with flexion to 20 degrees and a 3.9 mm femoral roll back with flexion to 90 degrees. The average tibial rotational angle was 2.7 degrees of tibial internal rotation at 0 degrees of flexion, 0.3 degrees of tibial external rotation from 0 to 20 degrees of flexion, and 8.2 degrees of tibial internal rotation with flexion up to 90 degrees. In every case, although a distributed trend could be seen in the internal rotational position set at 0 degrees, tibial internal rotation was reproducible.

In the FINE TKA, the average contact point on the medial plateau showed a 0.9 mm femoral roll back from 0 to 30 degrees of flexion, 0.9 mm femoral roll forward from 30 to 70 degrees of flexion, and femoral roll back from 80 to 90 degrees of flexion. The average contact point on the lateral plateau, however, showed femoral roll back at a constant rate from 0 to 90 degrees of flexion, with 9 mm of femoral rollback at 90 degrees of flexion. The average tibial rotational angle was 0.5 degrees at 0 degree of flexion, and after reaching 1.7 degrees of internal rotation at 20 degrees of flexion, an approximately constant rate of tibial internal rotation was shown, with 16.9 degrees of internal rotation was shown at 90 degrees of flexion.

CONCLUSIONS:
The kinematic postoperative functional assessment of these two prosthesis designs was performed in vivo. In both designs, internal rotation by medial pivot motion was observed. The difference in the results is due to the different design of the two types of TKA prosthesis.

REFERENCES: