The Fluoroscopic Analysis of The Medial-Pivot Total Knee Arthroplasty (TKA)
for Subjects with Severe Valgus knee Deformities

INTRODUCTION:
Numerous TKA designs have been introduced to reproduce the kinematics of healthy knees. The ADVANCE Medial-Pivot Knee, features a ball-in-socket medial bearing with a less conforming lateral trough, is designed to create medial compartment stability with mobility of the lateral compartment.

However, previous studies have not indicated if the medial-pivot kinematics is replicated postoperatively for subjects with valgus knee deformities.

The purpose of this study is to investigate in vivo kinematics for arthritic subjects with severe valgus deformities during deep knee bending and compare the kinematics of pre and postoperative knees.

METHODS:
The three-dimensional (3-D) in vivo kinematics were assessed for 7 subjects who were implanted with the ADVANCE medial-pivot TKA (Wright Medical Technology, Arlington, TN). All subjects exhibited severe valgus deformities with advanced roentgenographic grades (Kellgren Lawrence Grades IV) and the mean femorotibial angle (FTA) was 157.0±7.5° (mean±SD). Subjects included 7 female and the mean age at surgery was 73.7 years (65 to 79 years). All surgeries were performed by the single surgeon group with consistent and reproducible techniques for balancing flexion and extension gap and tension of collateral ligaments. Clinical outcomes were judged successful in all cases. The study design was approved by the institutional review board and all participants provided informed consent.

Preoperatively, each subject was asked to perform a weight-bearing deep knee bend to maximum flexion under radiographic surveillance in the sagittal plane. The 3-D bone models of the femur and tibia, generated by segmentation from CT images, were projected onto the radiographic images and their 3-D positions and orientations were determined using image matching software "Knee motion" (LEXI Corporation, Tokyo, Japan) (Figure 1a).

Postoperatively, a kinematic analysis of the implanted knees was performed using a single-plane shape-matching technique. Radiographs were digitized and processed to delineate the prosthetic components from surrounding tissues. The in vivo component relationships were then ascertained from a comparison with manufacturer-supplied, computer-generated geometric models of the prosthesis. The in vivo positions and orientations of the components were determined from computer matching of the digitized radiographs (Figure 1b).

We evaluated the following parameters: maximum flexion angle, tibiofemoral rotation, anteroposterior (AP) contact positions and translation of the medial and lateral condyles of femurs.

RESULT (Table 1)
Maximum flexion averaged 112.1±31.3° preoperatively and 115.6±11.4° at one month postoperative (p=0.78).

Preoperatively, 5 of 7 subjects experienced external tibial rotation from full extension to maximum flexion and 2 subject exhibited internal rotation from mid flexion to terminal flexion.

Postoperatively, in contrast, all subjects showed internal rotation patterns and there was a statistically significant difference in tibial rotation from full extension to maximum flexion between the preoperative (-4.7±7.6°) and postoperative examinations (4.8±3.1°) (p=0.01).

Preoperatively, 5 of 7 subjects exhibited posterior femoral translation patterns and the average condylar translation was greater in the medial condyle than in the lateral condyle, 6.9±9.7mm and 3.9±13.8mm, respectively (p=0.23) and 4 knees exhibited paradoxical anterior translations during mid-flexion.

Postoperatively, small amount of posterior translation of the lateral condyle and anterior translation of the medial condyle were confirmed in most subjects, averaging 1.7±1.6mm and -2.2±1.5mm, respectively (p=0.01).

DISCUSSION:
According to previous reports, flexion of the nonarthritic healthy knee is associated with posterior rollback of the femoral condyle and internal rotation of the tibia. In the present study, subjects exhibited small posterior femoral translation associated with external tibial rotation, which were different from patterns previously reported for normal knees (1). Our results were more similar to recent reports on the kinematics of osteoarthritic knees, which demonstrate loss of normal rollback and internal rotation (2,3).

Postoperatively, flexion performance was restored without significant instability. Although most subjects exhibited reduced posterior rollback and axial internal rotation associated with paradoxical motion of the medial condyle, these kinematic patterns seem to be more physiological than those of preoperative ones.

These observations suggest that a Medial-Pivot TKA design providing adequate AP stability for the subject with severe valgus deformity.

REFERENCES:

In addition, medial condylar positions in extension were slightly more posterior and lateral condylar positions were more anterior postoperatively, however not statistically significant (p=0.041, p=0.66).