In Vivo Determination of Knee Kinematics for Japanese Subjects Having Either a Low Contact Stress Rotating Platform or an Anteroposterior Glide Total Knee Arthroplasty

Takehiko Sugita, MD,* Katsumi Sato, MD,† Richard D. Komistek, PhD, ‡§ Mohamed R. Mahfouz, PhD,‡§ Ikuo Maeda, MD,* and Tokuhisa Sano, MD*

Abstract: The objective of this study was to work with a consecutive series of patients having Hospital for Special Surgery scores higher than 90 to evaluate kinematic patterns, under in vivo conditions, for 20 Japanese subjects implanted with 2 different mobile-bearing (MB) total knee arthroplasties (TKAs). Femorotibial contact paths for the medial and lateral condyles were then determined using a computer-automated model-fitting technique. This present study has shown that kinematic patterns for subjects having 2 different MB TKA designs differed but were not statistically different. Subjects implanted with a rotating platform (RP) MB TKA experienced minimal anteroposterior (AP) motion and larger axial rotation (RP). Subjects implanted with an anterior glide MB TKA experienced both femoral rotation and femoral translation (AP glide). There was minimal variability in the kinematic patterns for subjects implanted with an RP, whereas subjects implanted with an AP glide experienced more variable kinematic patterns. **Key words:** total knee arthroplasty, in vivo, fluoroscopy, kinematics.

Controversy remains in total knee arthroplasty (TKA) as to whether a surgeon should preserve or sacrifice the posterior cruciate ligament (PCL) [1,2]. Clinical follow-up studies have reported excellent results for both implant types [3-8]. Previous in vivo kinematic studies have shown differences in gait and deep knee bend activities for subjects having either a posterior cruciate–retaining (PCR) or a posterior cruciate–sacrificing (PCS) TKA [2,9-12]. To date, most experimental studies of knee kinematics have involved cadaveric [13-22] in vitro analyses or have not tested knees in a weight-bearing mode [23-29]. Others have used exoskeletal linkages and skin markers that permit error due to undesired motions between markers and the underlying bone.

More recently, fluoroscopy has been used to determine in vivo knee kinematics. Using fluoroscopy, researchers at the University of Tennessee, Knoxville, previously from the Rocky Mountain Musculoskeletal Research Laboratory, have analyzed American subjects having either a fixed-bearing PCR TKA, [9,10,30-32] posterior-stabilized (PS) TKA [9,32], and rotating platform (RP) TKA or a mobile-bearing (MB) TKA [31]. Although kinematic studies have been conducted on either fixed-bearing TKA or MB TKA, a study with a consecutive series of patients has not been conducted

*From the *Department of Orthopedics, Tohoku University, Sendai, Japan; †Department of Orthopaedics, Tohoku Rosai Hospital, Sendai, Japan; ‡Department of Biomedical Engineering, University of Tennessee, Knoxville, Tennessee, and §Bioengineering Laboratory, Oak Ridge National Laboratory, Oak Ridge, Tennessee.*
Submitted April 30, 2001; accepted August 31, 2004.
Benefits or funds were received in partial or total support of the research material described in this article from Depuy International.
Reprint requests: Richard D. Komistek, PhD, Biomedical Engineering Department, University of Tennessee, 313 Perkins Hall, Knoxville, TN 37996-2030.

0883-5403/04/2002-0004$30.00/0
doi:10.1016/j.arth.2004.10.008

Table 1. Patient Demographics

	M/F	Age (y)	Weight (kg)	Height (cm)	Preop range of motion (°)	Postop range of motion* (°)	Preop HSS score	Postop HSS score
AP Glide	2:8	74	59	74	120	112	53	97
RP	10 (F)	70	60	70	111	103	55	95
Student *t* test (*P*)		.1	.95	.54	.21	.15	.57	.27

*Postoperative range of motion was performed under weight-bearing conditions.

to determine if there is a significant difference between an MB TKA that is free to rotate (low contact stress [LCS] RP, polyethylene is free to rotate) and an MB TKA that is free to translate and rotate (LCS universal anteroposterior [AP] glide, polyethylene is free to translate and rotate). Also, in vivo kinematics, which could be compared with subsequent postoperative results, has not yet been evaluated early postoperatively. The objective of this consecutive-subject series study was to determine if there are any in vivo kinematic differences for subjects implanted with an MB TKA that preserves the PCL and allows both bearing rotation and translation (LCS APG TKA) vs an MB TKA that sacrifices the PCL and allows bearing rotation but does not permit translation (LCS RP TKA). Both prostheses analyzed in this study have similar femoral geometries and similar conformities between the femoral and polyethylene components.

Methods

Early postoperative knee kinematics was assessed for 20 subjects implanted with either an LCS universal PCS RP TKA or a universal APG (DePuy International, Leeds, England) MB TKA. Ten subjects were implanted with an RP TKA; another 10, with an APG TKA. Clinical data revealed no statistical difference between the subjects in the 2 groups ($P > .1$; Table 1). All TKAs were judged clinically successful (Hospital for Special Surgery scores >90), with no ligamentous laxity or pain. Because one of the main clinical criteria was subjects having an HSS score higher than 90, the 20 subjects chosen for this study were selected from an overall group of 32 subjects. Therefore, 12 subjects did not meet the inclusion criteria because their HSS scores were lower than 90. All subjects were either patients of Dr Takehiko Sugita (Tohoku University Hospital) or of Dr Katsumi Sato (Tohoku Rosai Hospital), and the only difference in surgical technique for the analyzed TKA was that the PCL was sacrificed for subjects having an RP TKA whereas the PCL was preserved for subjects having an APG TKA. The APG TKA was designed to allow for polyethylene translation and rotation and the RP was designed for polyethylene rotation (Fig. 1).

Two surgeons that had a similar experience with each MB implant type were chosen for this study. A

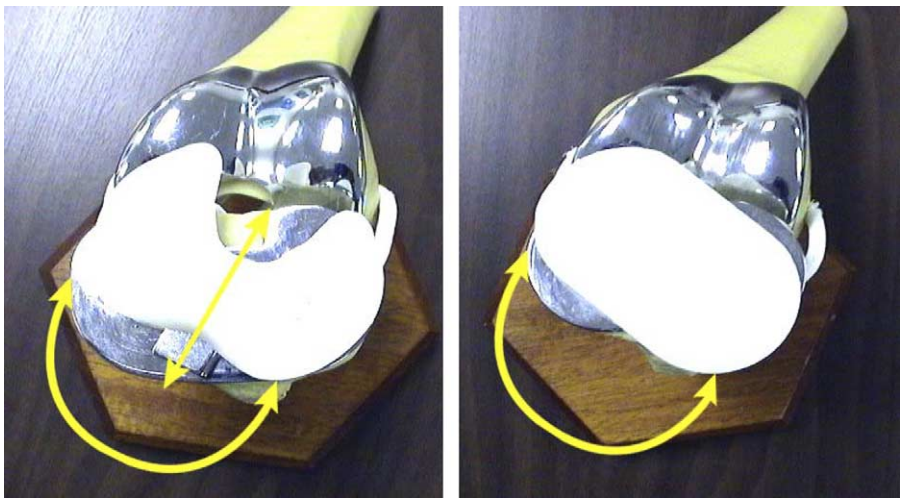

Fig. 1. Pictures of an APG implant (left) and an LCS RP implant (right).