

Early Clinical Outcomes and Functional Assessments for the 3D Knee™ Total Knee Arthroplasty

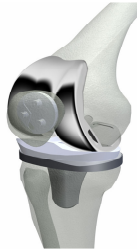
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Introduction

Contemporary total knee arthroplasty (TKA) provides reliable pain relief and restoration of moderate function for patients suffering from severe joint degeneration. Outcomes are typically good, but patients sometimes lack adequate range of motion and strength. Many studies have demonstrated a link between prosthesis design and patient function^{1,2,3} and newer TKA designs attempt to incorporate these findings to help patients quickly regain and improve their knee function after surgery

Based on *in vivo* kinematic studies and retrieved implant analysis, the 3D Knee™ prosthesis (Encore Medical, Austin, TX) was designed with the goals of providing better patient strength, improved range of motion, and enhanced durability (Figure 1). This report summarizes early clinical and functional outcomes of patients receiving the 3D Knee™ and characterizes durability on retrieved prostheses.

Figure 1. The 3D Knee™ is a fixed-bearing total knee prosthesis. It incorporates a hemispherical lateral condyle and tibial articulation to provide definitive AP translational control while freely allowing axial rotation, essentially an 'ACL substituting' articulation. The femoral component has a wider medial condyle to provide greater contact area and the posterior condyles are shaped to provide maximum posterior condylar offset late in the flexion arc.



Methods

Subjects for these IRB-approved studies were recruited from 407 consecutive TKA operated from 2001 to 2006 by the same surgeon. There were 185 male and 222 female patients with an average age of 73±9 years and BMI of 28±5 at index surgery. All patients received the same cemented, fixed-bearing 'ACL-substituting' 3D Knee™ TKA with the PCL maintained with a bone block on the proximal tibia.

Clinical Outcomes – The first 100 3D Knee™ TKA in 86 patients with minimum 3 years of follow-up were evaluated using Knee Society Scores, range of motion measurements (Figure 2), and radiographic review.

Retrieval Analysis – Four (1%) polyethylene tibial inserts were obtained during reoperation for infection (2), hemarthrosis (1), and adhesive capsulitis (1) after 6 to 13 months of *in vivo* function. Damage patterns on retrieved inserts were measured using optical microscopy and calibrated digital imaging techniques.

Stability and Range of Motion– AP knee joint stability and passive range of motion was assessed in 19 patients with 21 3D Knee™ TKA after an average of 31±5 months follow-up (Figure 2). The unilateral TKA and normal contralateral knees without arthritis were compared.

Dynamic Function (Gait Lab) – Ten patients with unilateral 3D Knee™ TKA were studied using a motion capture system, force platforms, and surface electromyography during free-speed walking, stair ascent/descent, and stepping onto and over a 20 cm box (Figure 3). Full body kinematics and lower extremity kinetics were analyzed.

Dynamic Range of Motion (Fluoroscopy) –Twenty 3D Knee™ TKA in 16 patients were studied during a maximum kneeling activity using fluoroscopy (Figure 3). Lateral fluoroscopic images were acquired and the components' 3D position and orientation were determined using shape matching techniques.



Figure 2. Range of motion was measured using a goniometer. Total AP stability was measured as relative tibial-femoral displacement at 30° and 75° of flexion using the KT 2000 arthrometer.

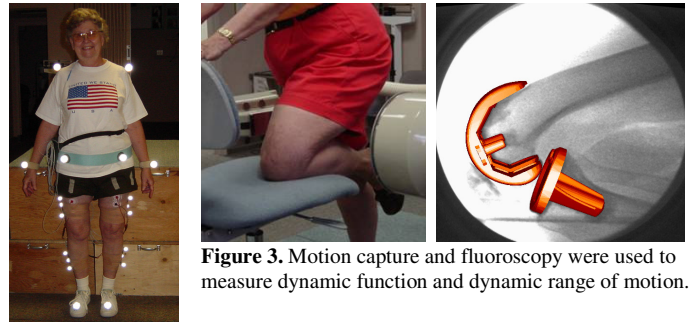


Figure 3. Motion capture and fluoroscopy were used to measure dynamic function and dynamic range of motion.

Results

Clinical Outcomes - Knee scores averaged 96±7 (pain) and 95±12 (function) at an average of 3.2±0.7 (range, 2 to 5) years follow-up. Passive flexion averaged 122°±10°, with 70% of the TKA achieving >120° flexion. Seven TKA had 2-4 mm wide radiolucent lines.

Retrieval Analysis –The dominant wear mode was burnishing, with some scratching and pitting. None of the inserts had delamination.

Stability and Range of Motion –Total AP displacement averaged 6.7±4.7 mm at 30° and 6.5±3.3 mm at 75° for the TKA and 9.2±2.8 mm at 30° and 7.1±2.4 mm at 75° for the normal knees. Knee flexion was not significantly different between the TKA (123°±7°) and normal knees (130°±11°) in the same patients.

Dynamic Function – There were no significant differences in knee kinematics during the functional activities. Peak flexion moments (dynamic strength) for the TKA averaged 79%, 80% and 85% of the patients' contralateral normal knees during gait, stair-climbing and step-over tasks, respectively. The operated knees exhibited reduced lateral hamstrings activity during the ascent phase of the step-over task.

Dynamic Range of Motion – Maximum skeletal flexion averaged 131°±13° (range, 109°-160°) during the kneeling activity. Tibial internal rotation averaged 10°±4°, and posterior condylar rollback averaged -2±4mm medially and -10±4mm laterally.

Discussion

Early results with this fixed-bearing PCL-retaining TKA are encouraging. Clinical scores and complication rates are equivalent or better than experienced with previous prostheses in the same clinic. The retrieved polyethylene inserts show good early durability. Patient strength during demanding dynamic activities is equivalent to the strongest TKA reported in the literature,² and significantly better than values reported for other prostheses.⁴

The 3D Knee™ is designed to enhance flexion by better controlling AP movement and providing increased posterior condylar offset late in the flexion arc. Maximum flexion with this PCL-retaining TKA is equivalent to the best performing posterior-stabilized TKA in North American patients.⁵ The 3D Knee™ TKA are as stable, or more stable, than the contralateral normal knees in the same patients. Knee joint stability is maintained within the 5-10 mm range of AP displacement considered desirable for satisfactory outcome and unimpaired TKA function.^{6,7} Furthermore, this fixed-bearing prosthesis with 'ACL-substitution' has proven beneficial for accommodating the wide range of joint laxity that occurs with different surgical techniques.⁸

References

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Acknowledgements

The authors thank numerous clinical (Lewjack Dorrance, Dr. Yoshinori Ishii, Hiroshi Kiga Dr. Yoshikazu Matsuda) and technical (James Coburn, Kim Mitchell) collaborators. These studies were sponsored by The BioMotion Foundation with grant support from Encore Medical, L.P.