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Does a new implant design with more physiological kinematics provide better results after knee arthroplasty?

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ABSTRACT

Background: Improved knee kinematics is one of the major goals to obtain better satisfaction after total knee arthroplasty. This study examined whether a guided motion knee design improves functional outcome and satisfaction as compared to a conventional design.
Methods: In a retrospective manner, from January 2005 to December 2008, patients with two different kinematic TKA designs were enrolled. The 150 patients were divided into two groups: guided motion group (77) with kinematic design (Journey) and control group (73) with no kinematic design (LCS). All the patients had the same surgical technique and postoperative protocols. The functional and radiographic results were interpreted with the Hospital for Special Surgery (HSS) knee score and WOMAC score.
Results: After a mean follow-up of 84.2 months, the guided motion group had higher mean postoperative range of motion ($p = 0.022$), functional status in the WOMAC function subscale ($p = 0.002$), but had higher residual pain in the WOMAC pain subscale ($p = 0.018$ and $p = 0.013$) and higher iliotibial band syndrome incidence (6.6% vs 0%; $p = 0.02$). There were no significant differences in HSS score between the two groups. No differences were seen between groups in patient satisfaction in the WOMAC total score ($p = 0.46$) and survival rate.
Conclusion: The guided motion design can improve functional status according to WOMAC but not to HSS knee scores. Poorer pain scores and no higher patient satisfaction were observed with this kinematic design.

1. Introduction

Achievement of good long-term clinical and functional results following total knee arthroplasty (TKA) depends on many factors, including adequate patient selection, choice of implant, use of an adequate surgical procedure, and adequate ligament balance [1]. Despite advances in relation to these factors, many studies suggest that only 82%–89% of patients are satisfied with TKA [2–4]. These studies suggest that TKA does not achieve its goals of eliminating pain and restoring function in all cases.

The conventional implant designs have shown abnormal and highly unpredictable kinematics, with the femoral component tending towards posterior subluxation in extension and paradoxical forward movement with flexion. Such abnormal kinematics contribute to reduce flexion, decrease quadriceps muscle efficiency, worsen functional prognosis, and increase anterior knee pain after TKA [5]. Changes introduced in the component geometry and implant modularity have improved surgical success. Some modern designs have added a degree of constriction, attempting to solve these problems with the contribution of "guided motion", which has been suggested to restore more normal and physiological kinematics. The most widely standardized design involves the use of a post that replaces the posterior cruciate ligament (PCL) (posterior stabilized (PS) implants).

Since PS designs were introduced in the early 1970s, many studies have shown them to be useful for reducing paradoxical roll-back [6–8], although they do not achieve complete normalization [7]. New designs recently launched into the market attempt to replace both cruciate ligaments (bi-cruciate stabilized (BCS) implants) with the main objective of reproducing normal knee kinematics and thereby affording better clinical and functional results with increased patient satisfaction after TKA [9].

The present study investigated whether the use of a new implant design which attempts to more faithfully reproduce physiological knee kinematics after TKA results in better middle- and long-term functional outcomes, and whether improved kinematic performance influences final patient satisfaction.

2. Material and methods

All patients gave their informed consent to participate before they were enrolled into the study. A retrospective clinical trial was conducted in compliance with the ethical standards of the Declaration of Helsinki established in 1964, as revised in 2013.

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A retrospective review of the prospectively collected data from the institution's hip and knee registry was performed. The population in this study consisted of patients who underwent primary TKA from January 2005 to December 2008, with a minimum follow-up period of two years. A total of 180 patients (180 knees) were enrolled into the study.

The inclusion criteria were knee pain and loss of function secondary to osteoarthritis amenable to prosthetic replacement surgery. After excluding patients with neurological disorders, avascular necrosis, history of infection of the affected knee, and individuals who refused participation, the final study sample consisted of 150 patients. Patients were divided into two groups according to type of implant used (conventional design or guided motion design). The type of implant was selected by the surgical teams — one of them trained in the use of the new design and the other in the use of the conventional model. Seventy-three patients were included in the conventional implant group, and 77 in the guided motion implant group. Patient inclusion flow chart is shown in Figure 1.

Two different designs were tested. A low contact stress system with mobile platforms (Low Contact Stress (LCS)® Complete™ RPS Knee System, DePuy Orthopaedics, Warsaw, IN, USA) was used in the conventional implant group (no guided motion), while the functional (guided motion) implant group received a bi-cruciate stabilized implant system (Journey®, Smith & Nephew, Memphis, TN, USA). Both implants were considered to be comparable for the treatment of knee osteoarthritis (Figures 2 and 3).

The surgical procedure used was similar in both groups. A tourniquet was used in all cases. A midline incision was made, followed by a standard medial parapatellar arthrotomy. Tibial osteotomy was performed perpendicular to the mechanical axis of the tibia, attempting to obtain seven degrees of posterior tilting for the LCS® and three degrees for the Journey® (as recommended by the manufacturers) in the sagittal plane using extramedullary guides. At the femoral level, a six degree valgus angle intramedullary alignment was made in all cases, after sectioning the anterior cruciate ligament (ACL) in the LCS® group and both cruciate ligaments in the Journey® group. In both systems, anterior reference was selected and between two sizes, bigger size was selected. If flexion gap was tight, a smaller femoral component was used. All components were cemented, and patellar replacement was not performed in any case. A rotary PE was used in the conventional implant group for preservation of the posterior cruciate ligament (all LCS prosthesis had functional posterior cruciate ligament), while a bi-stabilized PE was used in the guided motion implant group.

After surgery, all patients received intravenous cefazolin for 48 h (vancomycin in patients with beta-lactam allergy or known methicillin-resistant *Staphylococcus aureus* colonization) and low molecular weight heparin (enoxaparin 40 mg) on a prophylactic basis for four weeks after surgery. Early mobilization, physical therapy, and continuous passive motion were prescribed in all patients.

Clinical and radiographic evaluation was done in all cases. The Hospital for Special Surgery (HSS) scale [10] was applied before surgery, six weeks and six and 12 months after surgery, and annually thereafter. The knee joint motion range was measured by an assistant not directly related to the study using a goniometer and the standard references with the patient sitting [11]. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [12] scores were recorded before surgery and annually by the mentioned assistant.

Anteroposterior and lateral X-ray films were taken annually in the standing position, assessing the mechanical axis, height of the joint space and patellar height [13]. Osteolysis was defined as an expansive focal radiolucent area. Loosening was classified as confirmed (implant displacement), probable (complete radiolucencies > 2 mm), or possible (radiolucencies < 1 mm between 50% and 99% of the implant). Two observers unrelated to the surgical procedures performed all radiographic evaluations and measurements.

Normal distribution of study variables was confirmed using a Shapiro–Wilk test. Quantitative variables were expressed as the mean and range, while qualitative variables were reported as absolute numbers and percentages. Quantitative variables were compared using Student's t test for paired samples. Qualitative variables were in

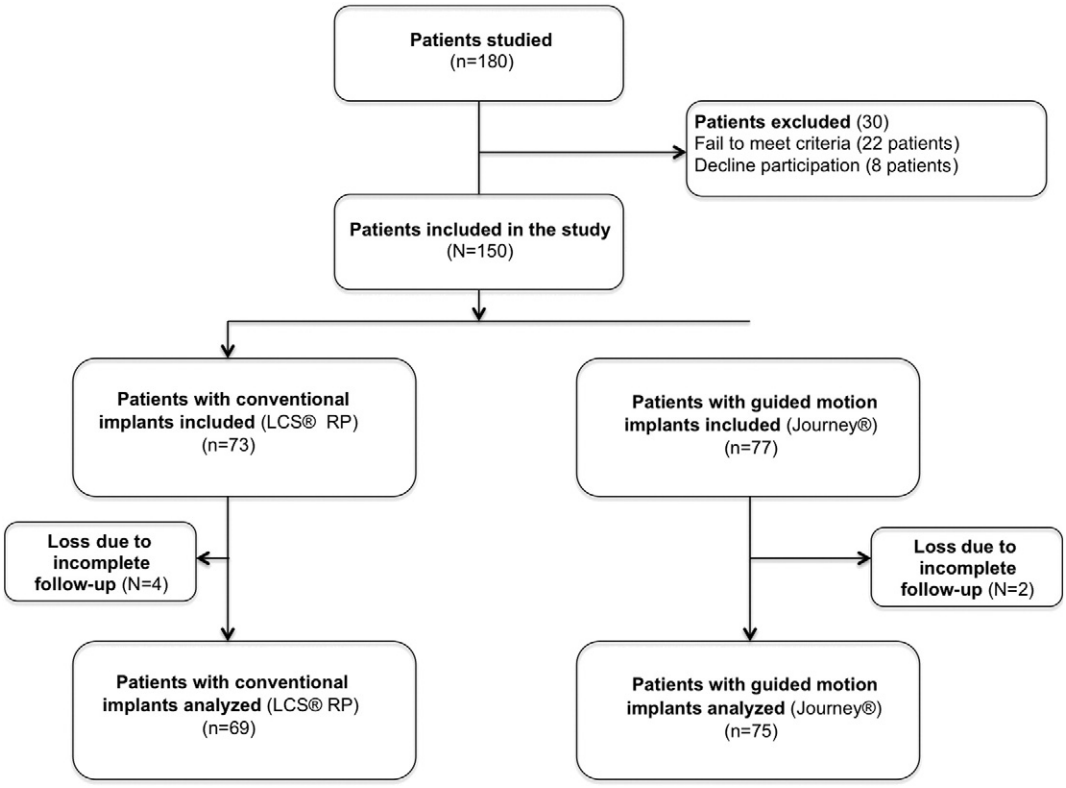

Figure 1. Flow chart of the patients included in the study. LCS = low contact stress, N = number, RP = rotating platform.