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ORIGINAL ARTICLE

Design Modifications May Improve Range of Motion Following Posteriorly Stabilized Total Knee Replacement: a Matched Pair Study

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Abstract *Background:* Our institution's latest knee implant design modifications aimed to decrease anterior knee pain, reduce the amount of bone that is resected in the femoral box, and improve range of motion. *Questions/Purposes:* Does this new knee design achieve desired clinical improvement in our patient population? This study was designed to compare our new design to that of its predecessor in a matched pair analysis. *Methods:* A consecutive group of 100 knees underwent total knee arthroplasty using the newer box reamer (BR) posterior-stabilized design was matched by age, gender, and body mass index (BMI) to patients with the classic posterior-stabilized (PS) component. Average follow-up was 29.6 months (range 21–47) in the new group. Preoperative range of motion (ROM) and clinical scores, such as Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Knee Society Scores, were obtained and compared to the patients' most recent follow-up. Manipulation under anesthesia (MUA) and revision of the implant for any reason were also analyzed. Ability to attain ROM of >120°, >130°, and >140° was also determined in each cohort. *Results:* At 2-year follow-up, 41% of BR knees achieved >130° flexion compared with 19% in the PS design group. WOMAC improved from pre-op 47 to 80 at 1 year in the newer BR design group and 48 to 80 in the classic PS design group. There were 9 MUAs in the newer BR design group compared with 14 in the classic PS design group. There were three revisions in the PS group and none in the BR group. *Conclusions:* Design improvements to this newer knee allowed more patients to achieve greater flexion and appear to have achieved clinical and design goals of the engineering modifications.

Keywords total knee replacement · posterior stabilized · outcomes · high flexion · box reamer

Level of Evidence: Therapeutic Study Level III

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Introduction

We have designed several knee prostheses at our institution to improve total knee arthroplasty. In 1994, the Optetrak® posterior-stabilized knee system (Exactech, Inc., Gainesville, FL) was added to the Insall-Burstein total knee arthroplasty (TKA) lineage. Changes to the implant addressed patellofemoral articulation to correct recurrent problems such as patellar clunk, fractures, and pain seen in previous models. Short- and midterm follow-up on Optetrak® patients has demonstrated improvement in range of motion (ROM) and implant survival [2, 9]. This project was undertaken to assess whether the specific modifications to this knee system have continued to improve total knee arthroplasty?

The latest design modifications aimed to decrease anterior knee pain, reduce the amount of bone resected in the femoral box, and improve range of motion. The newer design of the Optetrak® Logic® knee is intended to improve upon former posterior-stabilized knees by allowing for high flexion while preserving more natural bone. However, there have been no studies examining whether this correlates to an improvement in clinical outcomes for patients. Range of motion is an important outcome to assess how well the patients' overall functionality has improved.

This study was designed to compare our new design to that of its predecessor in a matched pair analysis evaluating a minimum of 2 years of follow-up of both types of implants implanted by one surgeon at our institution. It is important to observe if revision rates have improved as well as incidence of manipulations. With the opportunity for greater range of motion, do the patients with the new design implant achieve this high flexion? Additionally, do they have improved post-op clinical scores? We will examine whether the changes in design of the Optetrak® Logic® knee truly lead to better postsurgical outcomes.

Patients and Methods

This study is a retrospective review of two cohorts of patients receiving different designs of a posterior-stabilized TKA. A matched pair analysis was performed. The study group consisted of 100 knees (91 patients) that underwent total knee arthroplasty using the newer box reamer (BR) posterior-stabilized design. This consecutive series cohort was matched by gender and body mass index (BMI) to 100 knees (91 patients) that underwent total knee arthroplasty with the classic posterior-stabilized (PS) component by the same surgeon, senior author (GW). Exclusion criteria included revision TKAs, patients with instability who required greater knee constraint and underwent TKAs with a more constrained implant, and patients who failed to meet the minimum 2-year follow-up. Because extreme obesity can lead to further complication, it is important to note that no patients in the study in either cohort had a BMI over 40 at the time of their surgery (Table 1). Average follow-up was 29.6 months (range 21–47) in the BR group and 40.06 months (range 22–83) in the PS group. Preoperative Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [7], visual analog pain scale (VAS) [4], and Knee Society Scores [3] were obtained by the institution's research registry and compared by the authors to that of the patients' most recent follow-up. These validated instruments gave information regarding the patients' functioning and pain at rest and during activity. ROM was measured with a goniometer preoperatively and at the latest follow-up by the operating surgeon. Postoperative physical therapy was standardized to each patient with continuous passive motion machines and in-hospital exercise (ambulating on the same day with a walker) until approved for discharge. Revision of implants for any reason was compared in each group. Manipulation under anesthesia (MUA) was analyzed. Our indications for recommending MUA were a failure to obtain 90° of flexion by 2 months postoperatively. The ability to attain ROM of >130° and >140° was determined in each cohort.

Statistical analysis was performed by our institutions' biostatisticians to compare each variable to look for significant differences on any of the outcomes measures between the two groups of patients. p values for range of motion were obtained from a 2×2 chi-square test with multiple testing adjustments using the Bonferroni-Holm method. This was an institutional review board-approved retrospective study. p values for outcome scores of Knee Society Score and WOMAC were obtained with a two-sample t-test comparing the two groups.

Table 1 Patient demographics

	Optetrak		Logic	
	Mean	Range	Mean	Range
Age	68	45–85	68	41–86
BMI	29.76	18.71–39.91	29.56	18.39–41.53
	Number	Percent	Number	Percent
Gender				
Male	26	26%	26	26%
Female	74	74%	74	74%
Side				
Right	50	50%	51	51%
Left	50	50%	49	49%
Bilateral	12	12%	15	15%
Diagnosis				
OA	100	100%	100	100%

Results

At 2-year follow-up, patients that received the BR design had a greater success at achieving flexion above 130°. There were 41% of knees that achieved greater than 130° of flexion in the newer BR design group compared with 19% in the classic PS design group (p=0.0167), and 8% of the BR group achieved greater than 140° of flexion compared to 1% in the PS group (p=0.0750) (Table 3). The overall range of motion at the most recent follow-up visit in the BR group reached 125°, whereas the PS group reached 120.9° (p=0.7552) (Table 2).

There were three revisions in the PS group: two because of aseptic loosening (3.4 and 4.2 years after index surgery) and one because of instability (2.2 years after index surgery). However, there were no revisions in the BR group.

Patients implanted with the BR design required fewer MUAs. There were 9 (9%) MUAs in the newer BR design group compared with 14 (14%) in the classic PS design group. Of these MUAs, 3 of the 9 (33.3%) in the PS group and 5 of the 14 (35.7%) in the BR group had preoperative ROM less than 90°.

Knee Society Scores improved in both groups, but the BR group did show higher scores at most recent follow-up at 168.4±34.5 vs. the PS group at 161.6±38.0 (p=0.0018). There was no difference in the degree to which WOMAC scores changed in either group. WOMAC improved from pre-op 49.6±18.4 to 77.3±21.5 in the newer BR design group and 52.5±19.3 to 76.4±21.1 in the classic PS design group (p=0.1895) (Table 2). No patients were lost to follow-up or died.

Table 2 Outcome scores for Optetrak® vs. Logic implants at pre-op and latest follow-up visits

	Pre-op		*p* value from two-sample *t*-test comparing two groups	Latest		*p* value from two-sample *t*-test comparing two groups
	Optetrak®	Logic		Optetrak®	Logic	
Knee Society Score	78.9±27.6	85.4±34.3	0.1273	161.6±38.0	168.4±34.5	*0.0018*
ROM	104.8°±18.9	108.2°±18.3	0.3664	120.9°±8.8	125.0°±9.2	0.7552
WOMAC	52.5±19.3	49.6±18.4	0.1651	76.4±21.1	77.3±21.5	0.1895

Data in italic signifies Knee Society Score improvement

Discussion

Looking at 2-year follow-up of a new box reamer TKA implant in the Optetrak® Logic® series, results show further improvement in patient outcomes. With high flexion in patient's range of motion and self-reported Knee Society Scores demonstrating higher values with the new implant, we can confidently say that the changes in design have progressed positively.

This study has a few limitations. First, the newer implants had a shorter mean follow-up time than the older PS design, so follow-up time was widely varied across the two patient cohorts. Second, the cohorts were matched for BMI and gender, but not for age which could affect clinical outcome scores as younger patients tend to reach greater ROM. Third, the mean WOMAC pain subscale may have been different between the two groups; however, we did not collect this subset separately and, therefore, we cannot relate our WOMAC outcome results specifically to a difference in pain levels. Lastly, because this sample of patients is from a single surgeon, it might not be a true reflection of the incidence of aseptic loosening/revision in the new implant model.

Studies have shown excellent clinical outcomes in patients who have undergone TKA with the Optetrak® posterior-stabilized knee at mid- to long-term follow-up [2, 9]. Our previous study, which examined patients who had undergone Optetrak® TKA with an average of 7-year follow-up, showed that pain scores improved from 5.3 preoperatively to 44.6 postoperatively and range of motion increased from 105° to 120° [2]. Another study found that of 66 Optetrak® knees with a minimum of 5 years of follow-up, implant survival was 97% and 90% of patients rated good or excellent on the HSS and Knee Society Scores [9].

A few randomized, controlled studies have demonstrated that high-flexion PS designs lead to improved range of motion compared to the conventional PS designs [1, 6, 8, 10, 11]. Seng et al. established that older studies that showed no difference in outcomes of high-flexion PS knees were less than 125°, whereas their mean was 128, and therefore, an improvement was seen up to 5 years postsurgery [10]. Furthermore, Ritter et al. confirms that overall patient function will be better if a flexion between 128° and 132° is reached postoperatively [8].

The newer design of the Optetrak® Logic® knee is intended to improve upon previous posterior-stabilized knee designs by building in high flexion up to 145° and resecting less femoral bone from the intercondylar notch. Design improvements to this BR primary posterior-stabilized knee allowed for more patients to achieve greater flexion at 2 years. High flexion is defined as 125° or greater after TKA, which is most effectively achieved while simultaneously maintaining stability [5]. The early clinical success of this newer PS implant appears to have achieved the design goals of the engineering modifications. The new design demonstrated not only an improved average ROM at the latest follow-up visit, 125° vs. 120.9° (Table 2), but a greater number of patients in the Logic® cohort achieved more than 125° flexion (Table 3).

The overall rate of manipulations (MUA) in our patient population is consistent with that of previous studies. A 7-year survivorship study of the Optetrak® PS lineage demonstrated 21 MUAs in a cohort of 117 TKA patients with the same PS implant as half of our study patients [2]. In the older PS design group, 5 of the 14 MUAs (35.7%) and 3 of 9 (33.3%) in the new box reamer group had preoperative ROM less than 90°. In both groups, poor preoperative ROM seems to be a predictor for restrictive ROM after TKA needing MUA. However, additional analysis for other preoperative conditions putting patients at rise for lower postoperative ROM was not done.

In conclusion, our survival results (100%) and 2-year functional outcomes were favorably compared to those of previous studies of PS systems. However, further studies are recommended to examine long-term outcomes of this implant system.

Table 3 Number of total knee replacements that achieved greater than 125° flexion for the two different implants

	Optetrak®	Logic®	*p* value	
Pre-op mean flexion	111°	113°	0.3815	Independent *t*-test
N=125–129°	21	12	0.0806	Chi-square test
N=130–139°	18	33	0.0167	Chi-square test
N≥140°	1	8	0.0349	Fisher's exact test
Total *N*≥125°	40	53	0.0750	Chi-square test

Disclosures

Conflict of Interest: Allison Ruel, BA and Christine Pui, MD have declared that they have no conflict of interest. Geoffrey Westrich, MD is a board member of Eastern Orthopaedic Association and Knee Society; employee at Exactech, Stryker and DJO; receives payments for development of educational presentations from Exactech, Stryker and DJ; research support from Exactech and Stryker, outside the work.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was waived from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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