The Knee 24 (2017) 863–868

Contents lists available at ScienceDirect

The Knee

Coronal alignment predicts the use of semi-constrained implants in contemporary total knee arthroplasty

J. Ryan Martin [a], Keith A. Fehring [a], Chad D. Watts [a], Daniel L. Levy [b], Bryan D. Springer [a], Raymond H. Kim [b,c,d,*]

[a] OrthoCarolina Hip and Knee Center, Charlotte, NC, United States
[b] Colorado Joint Replacement, Denver, CO, United States
[c] Dept. of Mechanical and Materials Engineering, University of Denver, Denver, CO, United States
[d] Department of Orthopedic Surgery, Joan C. Edwards School of Medicine at Marshall University, United States

ARTICLE INFO

Article history:
Received 2 September 2016
Received in revised form 20 March 2017
Accepted 25 March 2017

Keywords:
Total knee arthroplasty
Semi-constrained TKA
Complex primary TKA

ABSTRACT

Background: Semi-constrained, or varus–valgus constrained, implants are occasionally necessary to achieve stability in primary total knee arthroplasty (TKA). However, outcomes with these implants are largely unknown. Therefore, the primary goals of this study were to determine 1) can we identify preoperatively which patients might require a semi-constrained implant and 2) are there any clinical and or radiographic differences for those that require a semi-constrained implant?

Methods: A multicenter retrospective study was performed to retrospectively review patients that had a Stryker Triathlon (Kalamazoo, MI) TKA with a Total Stabilized (TS) tibial insert ($n = 75$). This TS cohort was subsequently matched 1:1 based on age, gender, and BMI to a cohort of patients with the same primary TKA design with a PS insert ($n = 75$). Preoperative and postoperative radiographic and clinical data were compared between the two groups.

Results: Preoperatively, the TS cohort had significantly greater varus (9.72 vs. 3.48; $p = 0.0001$) and valgus (14.1 vs. 7.57; $p = 0.0001$) deformity. Post-operatively, there were no statistically significant differences in revisions ($p = 1$), reoperations ($p = 1$), or complications ($p = 1$). Mean clinical and radiographic follow-ups were equivalent between groups (25.5 vs. 25.8 months, $p = 0.8851$).

Conclusion: As suspected, use of a semi-constrained insert to achieve intraoperative coronal stability was most predicted by preoperative coronal deformity (either varus or valgus). Longer follow-up and larger patient cohorts are necessary to determine.

1. Introduction

Achieving coronal stability is a basic goal of primary total knee arthroplasty [1,2]. Normally, this can be achieved with bony resection, soft tissue balancing and only minimal component restraint such as posterior stabilized or cruciate retaining designs. However, a subset of patients require increased implant constraint to achieve a knee that is stable in the coronal plane [3,4]. Increasing levels of constraint, in ascending order, include posterior stabilized or cruciate retaining inserts, varus–valgus or semi-constrained tibial inserts and hinged implants. Since most surgeons prefer to employ the least amount of constraint to achieve coronal stability, these implants may not be immediately available at all centers, leading to painful intraoperative delays.

* Corresponding author at: Colorado Joint Replacement, 2535 S. Downing Street, Suite 100, Denver, CO 80210, United States.
E-mail address: roseannjohnson@centura.org (R.H. Kim).

http://dx.doi.org/10.1016/j.knee.2017.03.013
0968-0160/

Data regarding the outcomes of higher constraint implants at the time of primary total knee arthroplasty (TKA) are limited [5,6]. While there is some suggestion that constrained implants have worse outcomes, most existing studies include mixed cohorts of primary and revision TKAs, making the interpretation and application of their outcomes difficult [6–8]. To our knowledge, we are unaware of any study that has compared the outcomes of standard primary TKA constraint implants with semi-constrained implants.

The two primary goals of the following study were to determine: 1) What preoperative radiographic and or clinical characteristics could reliably predict patients that would require a semi-constrained implant to achieve coronal stability at the time of primary TKA and 2) How do the radiographic and clinical outcomes of semi-constrained implants compare to standard constraint implants?

2. Materials and methods

Institutional Review Board (IRB) approval was obtained at two academic institutions prior to performing this study. Each institution's joint registry, which contains prospectively collected data, was retrospectively reviewed to identify patients that underwent primary TKA with the use of a Stryker Triathlon (Kalamazoo, MI) posterior stabilized TKA with a Total Stabilized (TS) tibial polyethylene insert (TS cohort). The TS insert has the following parameters that increase constraint: 1. 18 mm of jump height, 2. two degrees of varus/valgus constraint, and 3. allows seven to eight degrees of internal/external rotation. All patients were required to have a minimum of one year radiographic and clinical follow-up to be included in the study ($n = 75$ TKA). During the study duration 1293 Stryker primary total knees were performed at the two centers (5.8% TS inserts).

All surgeries were performed by one of three fellowship-trained arthroplasty surgeons. A similar gap-balancing technique was performed to achieve symmetric flexion and extension gaps. The sequence for gap balancing began with the 1) the distal femur cut, 2) the proximal tibia cut, 3) the extension gap was then measured and medial/lateral releases were performed to achieve a symmetric extension gap, 4) and finally the flexion gap was then cut to the same value as the extension gap to achieve symmetric and equal flexion and extension gaps. However, patients that required a TS insert were all noted to have a mismatch in the medial and lateral gaps in flexion, extension, or both of >2 mm after releases were performed, which were uncorrectable with the use of a standard Posterior stabilized (PS) insert. The most commonly encountered scenario that led to the use of a TS insert occurred while balancing the gap in extension. If >2 mm of extension mismatch was identified, the tighter gap measurement in extension was then utilized to set the flexion gap resection level. Anatomic landmarks were then utilized to secondarily confirm component rotation.

TKAs in the TS group were matched 1:1 with primary TKAs which utilized posterior stabilized components from the same manufacturer (PS group). Matching was based on patient age, gender, and body mass index (BMI). Patients were 72% female with an average age of 70 years and BMI of 29 kg/m^2. The most common diagnosis in each cohort was osteoarthritis ($p = 0.68$, Table 1).

Preoperative clinical and radiographic evaluations were performed for both cohorts. Acceptable knee radiographs were included if the tibial/fibular head overlap was approximately 45–55%. Clinical data was collected utilizing data obtained from the two center's joint registries as well a chart review when additional data points were necessary. Preoperative clinical data included: range of motion, number of previous surgeries, and type of previous surgery. The preoperative radiographic evaluation was performed by two fellowship-trained arthroplasty surgeons and included a review of full-length hip-to-ankle radiographs, as well as Anteroposterior (AP), lateral and merchant knee radiographs. The following data points were recorded on all patients: hip–knee–ankle angles, the presence of hardware around the knee, and the amount of medial and lateral tibiofemoral joint space.

Intraoperative data was collected from the operative reports in the patients' chart including: length of surgery, amount of blood loss, implant constraint (PS vs. TS), and implant sizes.

Postoperative clinical data points were also obtained from joint registry and chart review data collection and included: range of motion, duration of follow-up, and the number and types of revisions, reoperations, and complications. Six-week post-operative and final follow-up full-length hip-to-ankle radiographs, as well as AP, lateral and merchant knee radiographs were reviewed. The following information was collected on all post-operative patients: hip–knee–ankle (HKA) angles, the presence and location of radiolucent lines, and the presence of implant loosening. The HKA was measured on full-length standing films at the angle formed at the intersection of the mechanical axis of the femur and the tibia.

A statistical analysis was performed utilizing Student's t-tests for continuous data and Fisher exact tests for categorical data to compare preoperative patient demographics, intraoperative data, and postoperative clinical and radiographic outcomes. Differences were considered to be significant for $p < 0.05$.

Table 1
Patient demographic data.

	TS cohort	PS cohort	p-Value
Age (years)	70.5 ± 9.3	69.6 ± 8.6	0.56
Female (%)	72	72	1
BMI (kg/m^2)	29.1 ± 6.1	29.1 ± 5.8	0.99
Osteoarthritis (%)	94.7	97.3	0.68