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Original Article

Gait Parameters and Functional Outcomes After Total Knee Arthroplasty Using Persona Knee System With Cruciate Retaining and Ultracongruent Knee Inserts

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ABSTRACT

Background: Total knee arthroplasty is a well-established treatment for managing end-stage symptomatic knee osteoarthritis. Currently, different designs of prostheses are available with majority ensuring similar clinical outcomes. Altered surface geometry is introduced to strive toward gaining superior outcomes. We aimed to investigate any differences in functional outcomes between 2 different polyethylene designs namely the Persona CR (cruciate retaining) and Persona UC (ultracongruent) tibial inserts (Zimmer-Biomet, Warsaw, IN).

Methods: This prospective single blind, single-surgeon randomized controlled trial reports on 105 patients, (66 female and 39 male), who underwent simultaneous bilateral total knee arthroplasty using the Persona knee system (Zimmer-Biomet) UC inserts in one side and CR inserts in the contralateral side. By a blind assessor, at regular time intervals patients were assessed in terms of function and gait. The functional knee scoring scales used were the Western Ontario and McMaster Universities Osteoarthritis Index and Modified Knee Society Score. The gait parameters evaluated were foot pressure and step length.

Results: During the study period, no patient was lost to follow-up or underwent revision surgery for any cause. Western Ontario and McMaster Universities Osteoarthritis Index scores, Modified Knee Society Score, and knee range of motion of all 105 patients assessed preoperatively and postoperatively at 6 months, 1 year, and 2 years showed statistically better results ($P < .05$) for UC inserts. Gait analysis measuring foot pressures and step length, however, did not show any statistically significant differences at 2-year follow-up.

Conclusion: Ultracongruent tibial inserts show significantly better functional outcomes as compared to CR inserts during a 2-year follow-up period. However, in this study these findings were not shown to be attributed to differences in gait parameters.

Total knee arthroplasty (TKA) is a gold standard surgical procedure for treating symptomatic end-stage osteoarthritis [1]. It not only relieves the patients from excruciating pain but also improves function including range of motion and walking ability. TKA also helps to restore the anatomical alignment of the tibiofemoral joint [2], thereby, improving biomechanics of the knee. Despite various improvements in surgical technique, implant design, and perioperative management, a significant proportion of patients after TKA continue to exhibit long-term functional deficits [3] and report difficulties with lower limb function during activities of daily living [4,5] when compared with age-matched controls [6-8]. One year after TKA, patients walk 15% slower than age-matched individuals without known knee pathology [4]. During the timed stair-climbing task, individuals after TKA had even greater functional limitations as evidenced by a 50% slower performance compared to age-matched healthy individuals [4]. These functional deficits are mainly attributed to altered kinematics of the replaced knee joint.

Currently there are a number of different designs of prosthesis available for TKA. These include the cruciate retaining (CR) knee

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design where the posterior cruciate ligament (PCL) is retained, the cruciate sacrificing knee design where the PCL is sacrificed and the posterior stabilizing (PS) knee design where the PCL is substituted [9] The philosophy of CR knee assumes that the PCL retains some function in the absence of the anterior cruciate ligament. It is suggested that the PCL has a beneficial effect on femoral rollback, range of movement, quadriceps efficiency, joint stability, and on reducing tibial shear forces [10]. The philosophy of PS knee questions the function of the PCL in isolation but acknowledges the need for posterior stabilization and uses the cam/post mechanism to replicate the physiological functions of the PCL [11]. The primary function of PCL is to limit the posterior glide and femoral rollback during knee flexion. However, in the absence of anterior cruciate ligament, PCL alone does not function optimally, and therefore, many surgeons resect the PCL as well and substitute its function by using a PS knee which has a cam-post mechanism [10].

A cam on the femur articulates with a post on the tibial insert ensuring obligatory femoral rollback. Although in theory this should improve knee flexion and reduce instability, in practice this is not always the case. Femoral rollback after a PS knee has been shown to be not too dissimilar to CR knee possibly because of lack of cam-post engagement in early-to-mid flexion arc. In addition, use of a PS design is associated with resection of a significant amount of bone and soft tissues from the femur, and there is an additional risk of increased wear at cam-post interface with risk of loosening [10] and of "cam over post" jump [12,13].

Deep-dished bearings have been introduced to minimize bone loss and improve knee stability without the risks of cam-post issues. One such design is the Persona ultracongruent (UC) knee system (Zimmer-Biomet, Warsaw, IN). The deep-dish design provides larger tibiofemoral contact area and reliable femoral rollback because of raised anterior and posterior lips [14]. The raised anterior lip theoretically prevents anterior subluxation of the femoral condyles during flexion [15,16], whereas the raised posterior lip provides posterior stabilization as in the PS knee but without bone sacrifice (as against the PS knee). This increased congruence and conformity of surfaces should theoretically avoid contact stress peaks providing better distribution of stress forces [17] which may further help to achieve better functional outcomes by improving gait patterns and postoperative range of motion [14]. Using these inserts the stability of the knee is guaranteed by a more conforming articulation in conjunction with correct soft tissue tension. However, no in vivo study comparing the gait and functional outcome after TKA using UC bearings with TKA using conventional bearings has been conducted so far.

Present study is aimed at assessing differences in pain, function, and gait parameters in terms of step length and weight bearing on foot, in the UC, and CR knee inserts.

Materials and Methods

A consecutive series of 105 subjects, 66 women and 39 men, who underwent simultaneous bilateral TKA using Persona knee system (Zimmer-Biomet) with a UC insert and CR insert on contralateral sides (randomly allocated), participated in this study. As per the Altman nomogram [18] (Fig. 1), using a standardized difference of 0.5 with a power of 80% and a *P*-value of .05 the sample size required for this study was 64. We took a standardized difference of 0.5 with a power of 95% and a *P*-value of .05 resulting in a required sample size of 104.

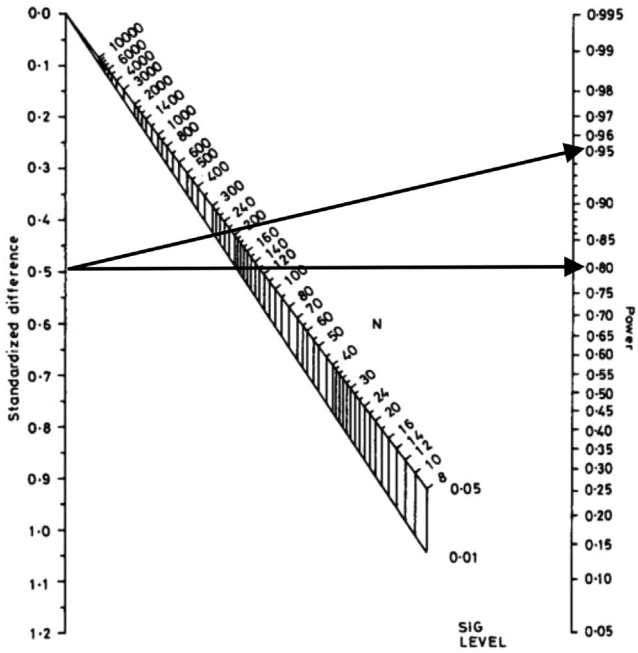

Fig. 1. Altman nomogram showing priori sample size calculation.

All the patients were operated by the same orthopedic surgeon. Subjects with bilateral TKA were excluded if they had any previous lower extremity surgery, spine surgery, or neurological impairments with altered sensation in the feet. Subjects were also excluded if they had arthritis in other joints of the lower extremities, were blind, or had completely ankylosed knee joints before the surgery. Subjects with cardiac involvement, flexion deformity accounting to >20° and valgus >5° were also excluded from the study. The study was approved by local ethics committee and institutional review board. All patients gave informed consent for participation in the study.

All the subjects underwent a clinical assessment at 4 stages—preoperatively, at 6 months, at 1 year, and at 2 years postoperatively. The clinician/assessor was blinded with regard to which prosthesis was implanted in each knee of the patient. Clinical assessment included Modified Knee Society Score (MKSS) [19] and WOMAC scores [20] along with a careful record of any complications encountered. Following this, gait of all subjects was analyzed using H/P Cosmos Gait Analyzer (2011, h/p/cosmos sports & medical GmBH, ISO 9001:2008). Two key outcome measures were taken into account for the gait analysis—weight distribution on forefoot, midfoot and hindfoot, and step length. Foot rotation

Table 1
WOMAC Score and Score Comparison Between CR and UC at 6 Months, 1 Year, and 2 Years.

WOMAC Score					
Comparison Between CR and UC	CR Mean ± SD	UC Mean ± SD	Comparison Mean Difference (CR-UC) ± SD	*t* Value	*P* Value
At 6 mo	55.70 ± 8.01	47.72 ± 8.17	7.97 ± 3.83	8.713	.000[a]
At 1 y	20.15 ± 3.48	16.39 ± 3.35	3.76 ± 2.42	4.230	.000[a]
At 2 y	19.45 ± 2.88	15.60 ± 2.54	3.85 ± 2.84	4.397	.000[a]

CR, Persona cruciate retaining; UC, Persona ultracongruent; SD, standard deviation; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.
[a] *P* value < .05, statistically significant.