American Journal of
Biomedical Science & Research

www.biomedgrid.com
ISSN: 2642-1747

Research Article

Computer-Navigated versus Individual Total Knee Replacement: A Retrospective Study

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To Cite This article: *Grigorov Veselin, Dobrilov Svetoslav* and Ivanov Stoyan, Computer-Navigated versus Individual Total Knee Replacement: A Retrospective Study. Am J Biomed Sci & Res. 2026 30(2) AJBSR.MS.ID.003910,* **DOI:** 10.34297/AJBSR.2026.30.003910

Received: February 16, 2026; **Published:** February 26, 2026

Abstract

Objective: Computer-assisted surgery application in total knee arthroplasty (TKA) has shown more accurate implant alignment compared with conventional instrumentation and is associated with more homogeneous alignment results. However, so far there is almost no data in the literature that compares computer-assisted TKA with individual TKA. The aim of this study was to compare navigated TKA with individual TKA regarding clinical and radiological outcomes after a 1-year follow-up under the hypothesis that navigated TKA would provide similar outcomes to individual TKA using standard implants and at much lower cost.

Material and methods: In a retrospective study, 23 patients underwent navigated TKA with off-the-shelf (OTS) implants and 26 patients received individual instrumentation and implants. Patients were evaluated at the baseline and at postoperative months 1, 3 and 12. Analysis included the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Short Form-12 (SF12) Health Survey, and radiographic assessment.

Results: All clinical scores improved significantly for all patients during the follow-up and results in the navigation group were comparable to the individual implants group.

The percentage of patients showing a mechanical axis between 6° of varus and 6° of valgus in the individual group was 100% (26/26) and in the navigated TKA group 95.65% (22/23).

Conclusions: The use of computer-assisted surgery in TKA provides accurate mechanical alignment and similar short-term functional outcomes compared to the individualized TKA.

Introduction

Achieving good long-term clinical and functional outcomes after total knee arthroplasty (TKA) depends on various factors; in particular the correct alignment of the implant and appropriate balance of the soft tissue. Imageless computer-assisted surgery (CAS) was introduced in the nineteen nineties as a navigation method to help surgeons plan and perform surgical procedures with more precision without using computerized tomography imaging. A CAS system uses infrared communication to spatially locate the patient's limb and, by calculations performed by the computer, enables the surgeon to plan bone cuts before making them, check them when made and assess the postoperative alignment of the implant components. The purpose of using CAS in TKA is to achieve a standardized technique for more precise positioning and alignment of implants compared to the use of conventional instruments [1]. Navigation has shown more homogeneous outcomes in alignment on the sagittal plane with a greater number of implants placed between 3° of varus and 3° of valgus compared to conventional TKA

[2-4]. However, their efficacy in achieving better sagittal alignment remains controversial [3,4]. CAS also enables appropriate balancing of the ligaments and of the flexion and extension gaps using the space balancing technique and sequential soft tissue release [5]. Although the individualized instrumentation and implants have shown great results so far [6], the procedure demands long preoperative planning and manufacturing period and costs far greater to conventional or computer navigated TKA.

The aim of this study was to compare, after 1-year follow-up, the clinical and radiological outcomes of navigated knee arthroplasties with those of prostheses implanted using the customized individual technique, with the hypothesis that navigation provides similar outcomes at lesser cost and using off-the-shelf implants (OTS).

Material and Methods

Sample Description

In this retrospective study were included 49 (20 male and 29 female) patients who underwent TKA in "St. Marina" University hospital Varna, Bulgaria. Most of the patients were of advanced age, the range was from 46 to 85 years (mean: 66.51 years; standard deviation [SD]: 10.59 years). The number of left and right operated knees was 21 (42.85%) and 28 (57.15%), respectively.

Intervention

All patients were implanted with posterior stabilized (PS) type of implant using a standard medial parapatellar approach with patellar eversion. All components (femoral and tibial) were cemented.

The patients were divided into two groups: the first consisted of 26 total knee replacements in 24 patients using individual instrumentation and implants (Symbios ORGIN), and the second consisted of 23 knee replacements in 23 patients in which a computer-assisted navigation system (OrthoPilot) was used and an off-the-shelf implant (BBraun Columbus) was implanted. This is a closed navigation system, with no previous images, that uses kinematic analysis of the hip, knee and ankle and anatomical mapping of the knee joint surfaces to build a working model. After placing the infrared sensors by bicortical fixation in the distal femoral metaphysis and in the proximal tibial metaphysis and resecting the osteophytes, tibial and femoral cuts were made depending on individual patient kinematics and symmetrical extension and flexion gaps with equal soft tissue tension. Using this technique the Hirschmann functional knee phenotypes were taken into consideration [7-9]. All components (femoral and tibial) were cemented in both groups.

Follow-up and Evaluation

The patients were evaluated at the baseline and at 1, 3 and 12 months after the surgery. The Western Ontario and McMaster's Universities Osteoarthritis Index (WOMAC), KSS and the Short Form-12 Health Survey (SF-12) were completed in all cases. Simple anteroposterior and lateral views were taken for the radiological assessment, and standing telemetry to measure the hip-knee-ankle angle. The measurements were taken digitally on X-rays taken with the lower limbs fully extended, with the anterior tibial tuberosities facing forward and the medial malleoli separated 30cm. The hip-knee angle was determined by connecting the center of the femoral head, the center of the knee and the center of the ankle.

Results

Clinical Outcomes

The clinical outcomes are shown in Table 1.

Table 1

Scale	KSS knee		KSS function	WOMAC pain	WOMAC stiffness	WOMAC functional
	Type	Mean	Mean	Mean	Mean	Mean
Preoperative	Navi	38.7	54.2	12.4	5.9	56.1
	Individual	42.5	57.8	14.3	5.1	42.7
1 month	Navi	77.4	70.1	6.3	2.1	21.8
	Individual	79.1	71.7	6	1.7	20.7
3 months	Navi	81.1	78.6	2.2	0.8	9.7
	Individual	80.9	79.1	1.9	1.1	10.4
12 months	Navi	82.6	93.3	0.9	0.1	3.1
	Individual	81.5	92.8	0.8	0.2	2.6

Note*: KSS: Knee Society Score; WOMAC: Western Ontario and McMaster's Universities Osteoarthritis Index.

There were no significant differences in all the clinical parameters measured at the first month, third month or one year post surgery.

Radiological Results

At 12 months, the radiological examination confirmed good fixation of the implants in all the patients. The characteristics of

radiological osteointegration of the implants were also optimal in all cases, both on the coronal and the sagittal planes, no implant migration or progressive radiolucencies were observed in any of the patients. The percentage of patients who showed optimal postoperative kinematic alignment, i.e., a femorotibial mechanical angle between 6° of varus and 6° of valgus was 100% for the custom-made instrumentation and implants group (26/26) and 95.65% (22/23) for the computer-navigated group.

Discussion

CAS has shown advantages as a surgical instrument to improve the accuracy of postoperative alignment and reduce the number of atypical values [10-13]. Although some authors have obtained disparate results [13-15], there is general consensus that postoperative coronal alignment is the most important factor towards guaranteeing the survival and preventing aseptic loosening of the knee arthroplasty [16,17]. Although the follow-up period of our study was not sufficient to assess the survival of the implants, better clinical outcomes were found on all the scales evaluated when the mechanical axis was within the interval of 3-6° from the neutral mechanical axis.

The effect of navigation on the functional outcomes of TKA remains controversial but with more practice and experience it shows better results than conventional TKA [1]. The customized, individually made TKA proves to be convenient for the surgeon and shows theoretically better alignment results [6], but the procedure requires meticulous preoperative planning with a specialized CT protocol, a long manufacturing period for the implants, and in many countries comes at a great financial cost for the patient. The planning results given by the producing companies are very precise and descriptive, but the computer-navigated system gives the surgeon live data about alignment and, more importantly, soft tissue balance in flexion and extension. So far there are many studies and meta-analyses comparing navigated to conventional TKA, but no studies comparing navigated to individualized TKA, and surely more studies with larger patient samples and longer follow-up periods are needed.

The limitations of our study included absence of controlled process of randomization, a small sample size and a short follow-up period. Nevertheless, in the short-term period navigated TKA shows similar results to customized individual TKA.

Conclusions

The use of computer-assisted surgery in TKA provides accurate mechanical alignment and similar short-term functional outcomes compared to the individualized TKA.

Confidentiality of Data

The authors declare that they have followed the protocols of their centre of work regarding patient data confidentiality.

Right to Privacy and Informed Consent

The authors declare that no patient data appear in this article.

Conflict of Interests

The authors have no conflict of interests to declare.

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