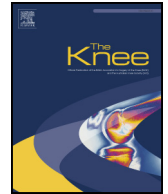




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The Knee



Novel techniques

Experience of total knee arthroplasty using a novel navigation system within the surgical field

Richard Niehaus^{a,d}, David Schilter^a, Paolo Fornaciari^b, Christian Weinand^c, Marcus Boyd^a, Marcel Ziswiler^a, Stefan Ehrendorfer^{a,*}

^a Department of Orthopaedic Surgery, Kantonsspital Uri (KSU), CH-6460 Altdorf, Switzerland

^b Department of Orthopaedic Surgery, I'HFR Fribourg, Hôpital Cantonal, CH-1700 Fribourg, Switzerland

^c Department of Plastic and Aesthetic Surgery, Dietrich-Bonhoeffer-Klinikum, Universität Greifswald, 17033 Neubrandenburg, Germany

^d Balgrist University Hospital, CH 8008 Zurich, Switzerland

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ABSTRACT

Background: With the aim of improving component alignment and outcome in total knee arthroplasty (TKA), several computer-assisted devices (CAD) have been developed.

Methods: In February 2014, the present unit started to use a new imageless navigation system with accelerometric pods within the surgical field for all primary TKAs; there was no need for optical trackers or cameras. This paper presents the results of the first 72 TKAs using this iAssist system in 71 prospectively collected and retrospectively analyzed patients. It analyzed component positioning in standard and full-length leg x-rays.

Results: The mean age of the patients was 70 years (range 52–88). The center of hip, knee and ankle (mechanical axes) deviated on average 0.5° (standard deviation (SD) of 1.8) valgus from the targeted straight alignment. Three TKAs had >3° deviation (i.e. four degree varus, five degree and seven degree valgus). The frontal tibial tray alignment was an average of 89.9° (range 86.4–100.1°, SD ±2.0) with the target being 90°, and the sagittal slope was as targeted at 85.0° (range 78.4–88.8°, SD ±1.7).

Conclusions: This CAD facilitated good mechanical alignment and reproducible accuracy in component positioning. Pods clipped onto cutting jigs within the surgical field provided simple and accurate navigation, with little extra time needed for calibration and no need for optical trackers or pre-operative imaging.

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1. Introduction

Total knee arthroplasty (TKA) is a well-described orthopedic procedure that is beneficial to patients with osteoarthritis (OA) of the knee joint [1–2]. The goals of TKA are pain relief, improved function and stability, implant longevity [3–6], and patient satisfaction [7]. However, many patients remain dissatisfied with their outcome [8].

Implant component alignment is considered to be an important factor for successful outcome and is, together with ligament balancing and patella tracking, a key focus during surgery. To improve component alignment and positioning, several computer-assisted TKA devices (CAD) have been developed over the past decade and are gaining surgical acceptance for improving surgical accuracy and clinical outcome [1–2,4]. CAD is reported to reduce surgical trauma through less-invasive surgery (no medullary

* Corresponding author at: Department of Orthopaedic Surgery, Kantonsspital Uri (KSU), Spitalstrasse 1, CH-6460 Altdorf, Switzerland.

E-mail addresses: stefanehre@hotmail.com, stefan.ehrendorfer@ksu.ch (S. Ehrendorfer).

rodding) and help surgeons to achieve better implant positioning, [9] leading to improved implant performance and survival, [9–10] and reduced failure rates [11–14].

The Australian Orthopaedic Association National Joint Registry observed a reduced revision rate for navigated TKAs for loosening/lysis in patients aged <65 years [15]. Several recent studies have reported that good alignment improves function, [2,7,11,16–17] pain, [1–2] and quality of life, [6–7] as well as patient satisfaction [18].

While there is ongoing debate about the ideal mechanical alignment in TKA, the target zone of coronal leg alignment is considered to be within three degrees of the centre of hip, knee and ankle (mechanical axes) deviating from a straight line [2]. This paper presents the first clinical results, to the authors' knowledge, based on standard and full-length leg radiographs of the first 72 prospectively collected and retrospectively analyzed consecutive patients undergoing primary TKA using the novel imageless iAssist* system.

The null-hypothesis was that there would be no difference in measured alignment in comparison with other computer-assisted TKA surgery (CAS) or conventional surgery (CONV).

2. Materials and methods

In February 2014, the present orthopedic unit started to use iAssist CAD for all primary TKA. Between February 2014 and June 2015, the first 71 consecutive patients undergoing primary TKA using the iAssist CAD system were prospectively recruited into this study. The cemented Zimmer Persona TKA was implanted using the highly cross-linked polyethylene inlay posterior-stabilized or ultracongruent.

All consecutive patients, irrespective of age, diagnosis, deformity and body mass index (BMI) undergoing primary TKA at the unit were operated with the iAssist system. They were all informed about this study and all consented to be included. The only exclusion criterion was revision surgery. A total of 71 patients (72 primary TKAs, one bilateral) with a mean age of 70 years (range 52–88) were included into this study. There were 40 (56%) female and 31 (44%) male patients, with 39 TKAs being right and 33 left. Three board-certified general orthopedic surgeons (two with >12 years and one with <2 years of independent experience) performed surgery. The two experienced surgeons performed 34 and 22 TKAs each and supervised the remaining 16 operations.

This iAssist system operates with small 'pods', which are clicked onto surgical cutting blocks and thereafter onto jigs to evaluate the bony cuts. All relevant alignment information is accessible on the 'pods'. LEDs on the pods directly show the varus/valgus alignment from +3 to −3° of the neutral axis. With adjustment screws, the surgeon can fine-tune the cutting jigs to the desired orientation. With the same pod, the femoral flexion and tibial slope can be navigated. There, the cutting block can be adjusted from 0 to 10°. There is no need for additional trackers being fixed onto Schanz screws, cameras or surgery outside the approach. There were no failure of fixation of any trackers in the present study, but care has to be taken that the cutting jig holding the 'pod' onto the proximal tibia is well fixed with screws. In case of soft bone, it is preferable to fix the jig close to the tibial tuberosity, where bone is stronger, and in very large patients, the incision needs to be long enough to avoid excessive soft tissue tension, which can jeopardize fixation. On the femoral side there is no risk to fixation.

The sterile, single-use pods have to be calibrated in combination with a non-sterile laptop placed in theater pre-operatively by the scrub nurse, which takes about three to four minutes. Intra-operatively, the surgeon needs to take the leg through a range of movements for the computer to identify the axis of the tibia, femur and center of the hip. This CAD system supports the surgeon intra-operatively to achieve the pre-operatively planned frontal orientation (mechanical axis) as well as the sagittal orientation (i.e. femoral flexion, tibial slope) of the femoral and tibial bony cuts. It does not help with rotational alignment or soft tissue balancing, and does not prevent component malpositioning due to cement wedges, etc.

The aim is to achieve neutral alignment in the frontal plane, a tibial slope of five degrees and femoral flexion of four degrees, which is essentially concordant with the principles of Whiteside [19]. Both components are cemented with Zimmer cement. No tourniquet is used. A single i.v. shot of 1.5 or three grams of cefuroxime antibiotic is prophylactically given. None or one drain is used, depending on surgeon's preference. The wound is closed with staples in all patients.

2.1. Radiological measurement

The axial alignment of the limb and orientation of the components were evaluated on standardized postoperative full-leg-length weight-bearing radiographs, and antero/posterior (A/P) and lateral radiographs. Two independent observers performed the measurements. On the full-length radiographs the mechanical axis (MECH), the anatomical axis (ANA), the valgus correction angle (VCA) and the mechanical-condyle-angle (MCA) (Figure 1) were measured. On the A/P radiographs the α and β angles (valgus angle of the femoral and tibial component, Figure 2) were measured, and on the sagittal radiographs the γ and σ angles (femoral flexion angle and tibial slope, Figure 2) were measured. The measurements were based on the Knee Society total knee arthroplasty roentgenographic evaluation system [20].

* Zimmer iASSIST Knee Surgical Technique, Zimmer CAS, 75, Queen Street, Suite 3300, Montreal (Quebec) H3C 2N6, Canada.

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