Computed navigated total knee arthroplasty compared to computed tomography scans

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ABSTRACT

Background: Successful total knee arthroplasty (TKA) includes accurate alignment. Controversy remains as to whether computer-navigated TKA improves the overall result and clinical outcome. Our aim is to compare the limb alignment and prosthesis positioning according to the pre- and postoperative computed tomography (CT) scans with the data collected from the navigation system.

Methods: We compared the pre- and postoperative limb alignments and prosthesis alignment provided by the Orthopilot navigation system, Aesculap®, with CT scans measured by the Traumacad® software of 70 TKAs.

Results: A positive correlation with statistical significance ($P = 0.00001$, $r = 0.874$) between the navigation system data and the CT images was found. Mean femoral cut was five degrees (valgus), and mean tibial cut was one degree (varus). Our study revealed that the navigation system assisted the surgeon to implant the prosthesis at a good acceptable alignment.

Conclusion: We found that the navigation system is accurate and correlates to the pre- and postoperative CT scans. Furthermore, the navigation system can assist the surgeon to achieve good limb alignment and cutting planes of the prosthesis.

1. Introduction

As of 2010, over 600,000 total knee arthroplasties (TKAs) had been performed and the figures are predicted to reach 3.48 million procedures by 2030 [1]. The common practice of TKA surgery consists of three major methods: (1) conventional TKA; (2) customized patient instrumentation (CPI): this model is utilized to create a customized surgical plan, which defines the surgical cuts of the tibia and femur; this surgical plan is used to create customized cutting jigs that uniquely fit the individual patient's anatomy [2]; and (3) image-free computer-assisted TKA (method of choice in our study): an active computerized guidance system operated with infrared-camera sensors which detect fixed probes on the operated leg and surgical tools that assist the surgeon with decision making for accurate alignment and orientation of the implants.

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The success of TKA is measured upon pain alleviation, restoration of knee function and correct alignment. The literature shows that malalignment of the implants can lead to early loosening of the prosthesis and increased polyethylene wear with poor functional outcome [3–5]. Moreover, it can lead to maltraction of the patella [6,7]. Many studies have been published about navigated vs. conventional TKA, but there is insufficient evidence about the patient's pain, function, quality of life and longevity of the implant using navigated TKA. Hence, there is a need for further research in this field [8–12]. The purposes of this study were to: (1) assess the correlation between the navigation system and computed tomography (CT) images of the operated patient and (2) determine whether limb mechanical alignment based on pre- and postoperative CT scan was achieved.

2. Materials and methods

This study utilized data collected by our institute from April 2012 to July 2013. After receiving the approval of the local ethics committee, 70 patients signed written consent to be included in our study. A total of 70 TKAs were performed with Columbus, Posterior Cruciate Ligament Retained, fixed bearing, and cemented implants. In our study we used the Orthopilot, Aesculap (Tuttlingen, Germany) navigation system, which is an active intraoperative computerized guidance system operated with an infrared camera sensor which detects fixed probes on the operated leg.

3. Study sample

Inclusion criteria were: patients with severe osteoarthritis of the knee, avascular necrosis or rheumatoid arthritis, age over 18 years, with failure of conservative treatment. Patients with severe vascular disease, secondary knee deformation due to muscular atrophy or disease, active infection, morbid obesity, neuropathic knee and osteomyelitis were excluded.

4. Outcome assessment

All patients underwent pre- and postoperative CT scans of the lower limb in the supine position, straight leg and forward positioned patella. Postoperative CT scans were conducted 24–48 h after surgery. The mechanical axis of the leg (angle between a line connecting the hip center of rotation with the center of the ankle joint, and normally cross the center of the knee joint) with 0° is set as a reference, the negative angle was considered as valgus while the positive angle was considered as varus. Tibial and femoral cuts were measured by the Traumacad software. We compared the leg axis and the knee axis pre- and postoperatively based on the CT images.

5. Statistics

Statistical analysis, which included the Pearson test and Student's t-test for equality of means and correlation between the CT images and the navigation system, was determined using SPSS 19.

6. Results

Of the 70 TKA included in the study, 48 were female patients and 22 were male patients. Average age was 68 years (range, 51–81 years). The indication for operation was knee pain and diminished function associated with degenerative joint disease not osteoarthritis alone. The study patients group was diagnosed with: (1) osteoarthrosis in 63 patients; (2) one avascular necrosis; and (3) six rheumatoid arthritis. Forty-one left knees and 29 right knees were operated on)Table 1).

Our Traumacad software measurements of preoperative knee alignments CT surview demonstrated 83% (58/70 knees) with a mean of 5.3° varus (range, two to 12°) and 17% (12/70 knees) with a mean of 7.5° valgus (range, three to 14°). Similarly, the navigation system measurements exhibited a mean of 5.5° in varus knees with a maximum of 11° and a minimum of one degree. Furthermore, navigation measurements in valgus knee showed a mean of 7.5° with a maximum of 12.5° and minimum of 1.5°. Thus, the preoperative comparison between the CT scan and the navigation system showed high similarity (Figure 1(a)). Likewise,

Table 1
Demographic data.

Patient no.	70
Female	48
Male	22
Age	68 (range 51–81)
Pre-OP diagnosis	
OA	63
AVN	1
Rheumatoid arthritis	6
OP side	
Left	41
Right	29

OA, osteoarthritis; AVN, avascular necrosis; OP, operation.