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The Knee

Post traumatic knee arthritis: Navigated total knee replacement without hardware removal

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ABSTRACT

Background: The Authors present the results of a series of navigated total knee replacements (TKR) without hardware removal in patients with post-traumatic arthritis following femoral fractures. The purpose of the paper was to determine the effectiveness of computer-assisted TKR in these patients compared to routine primary implants.
Methods: Sixteen patients with post-traumatic knee arthritis following a distal femoral fracture and retained hardware were included in the study (group I). Patients in the study group were matched with patients who had undergone a computer navigated TKR using the same implant and software (group II). The indication for TKR in all group II patients was atraumatic arthritis and surgery was performed in the same period as the study group. Patients were matched for age, gender, pre-operative range of motion, severity of arthritis pre-operatively, type and grade of deformity and implant features.
Results: There were no statistically significant differences in surgical time, hospital staying or intra-operative and post-operative complications between the two study groups. At the latest follow-up no statistically significant difference was seen for the Knee Society Score and WOMAC indices. Implant alignment and radiological parameters were similar in both groups.
Conclusions: This study demonstrated that post-traumatic knee arthritis following prior distal femoral fracture can be safely managed using a computer navigated TKR without hardware removal. Comparison between this patient group and a matched group with atraumatic arthritis showed similar post-operative results and complication rates.
Level of evidence: III.

1. Introduction

The incidence of knee arthritis after femoral fracture is considerably less than following tibial plateau fracture. Distal femoral fracture more frequently leads to knee arthritis and this may be related to residual malalignment or direct intra-articular injury. Therefore, it is not infrequent for orthopedic surgeons to deal with patients following femoral fractures who have developed end stage arthritis requiring total knee replacement (TKR) [1–3]. In this situation the presence of retained hardware often combined with femoral sclerosis can make the use of intramedullary guides difficult during the replacement procedure [4]. Staged surgical procedures to remove the hardware combined with femoral osteotomy to correct post-traumatic deformity may be required in these cases before TKR. However, multiple surgical procedures prior to knee replacement have been linked to an increased risk of arthrofibrosis and infection [3]. Simultaneous arthroplasty and removal of hardware may require either two incisions or the use of a skin flap for adequate exposure both increasing the risks of soft tissue necrosis and septic contamination. In addition, the screw holes left after hardware removal are potential stress risers which may limit post-operative weight bearing or require additional support such as stems, intramedullary rods, and strut allografts [5,6]. In 1998 Ries suggested prophylactic femoral nailing during TKR with simultaneous femoral plate removal to reduce the risk of fracture through the screw holes particularly in osteoporotic bone [7]. The removal of older and sometimes bulky hardware can be particularly challenging for the surgeon requiring a longer and more complex surgical procedure. Extramedullary jigs have been proposed as an alternative on the tibial side. However, femoral extramedullary instrumentation requires radiographic identification of the center of the femoral head with free hand pinning of the cutting block affecting the accuracy of implant placement [4]. The literature suggests that the outcome of TKR following femoral fractures using traditional techniques may be somewhat inferior to those seen after routine arthroplasty [1–3].

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Computer-assisted TKR has been shown to improve implant alignment and to correct limb deformity [8–10]. Computer navigation does not require intramedullary instrumentation and can therefore be performed without femoral hardware removal. As a result, staged surgery or simultaneous hardware removal is not required avoiding the risks associated with these procedures and providing economic savings [11–13]. In Italy, the costs of hardware removal using a diagnostic related group (DRG) model are in excess of 2000 Euros.

The aim of this study was to assess the effectiveness of computer-assisted TKR in managing post-traumatic arthritic joints following prior distal femoral fractures without removal of retained hardware. The study group was compared with a matched group of patients with atraumatic arthritis who underwent 'routine' TKR.

2. Materials and methods

In our department 789 computer-assisted primary TKR were performed between March 2001 and March 2009. In this series 23 patients were treated because of post-traumatic knee arthritis following a prior distal femoral fracture. Of these 16 patients underwent computer-assisted surgery (group I). In the remaining seven patients were excluded from the study as hardware was removed in separate procedure prior to TKR. The interval between the fracture and subsequent TKR averaged 5.8 years (range 1.9–12 years). Eight patients were male and eight female. In all cases the hardware used for original fracture fixation was retained. Retained hardware included a distal lateral plate and screws in seven patients, an intramedullary nail in six patients, and screws alone in three patients. In 10 patients an E.motion knee prosthesis (BBraun, Tuttlingen, Germany) was implanted using dedicated computer navigation software (Orthopilot, BBraun, Tuttlingen, Germany). In the remaining six patients a computer-assisted Genesis II TKR (Smith & Nephew, Memphis, TN, USA) was performed using implant specific software (Vector Vision, BrainLAB, Munich, Germany).

Pre-operatively extra-articular femoral deformities were seen in four patients as a result of malunion (mean: 7.2°). The deformity was situated in the distal third of the femur in two patients and the middle third of the bone in the other two patients. In all the cases the correction of the limb deformity was planned using the prostheses and no extraarticular or intraarticular corrective osteotomy was required. In three patients implantation of the prosthesis required removal of the most distal screws in the femoral plate. This was achieved through small incisions without extension of the standardized TKR approach using a maximum 14-centimeter skin incision.

At a minimum follow-up of approximately 2 years, each patient in group I was matched with a patient who had undergone a computer-assisted TKR using the same implant and software (group II). All patients in group II had atraumatic knee arthritis and had undergone knee replacement surgery in the same time period as the group I patients.

The ethics committee approved the study and prior consent to study involvement was obtained for all the patients.

Patients were matched in terms of age, gender, pre-operative range of motion, pre-operative arthritis severity according to the Albaack classification, type and grade of deformity and implant features (cruciate retaining or sacrificing). Patients were matched with a maximum difference with respect to age of 3 years, pre-operative flexion of 10° and varus–valgus deformity of 5° (valgus to valgus and varus to varus).

In both groups an antero-medial longitudinal knee incision and medial parapatellar arthrotomy was used. All knee implants were cemented and the same pre-operative and post-operative rehabilitation protocols were used for both groups. Passive knee flexion was delayed in the two patients who required a tibial osteotomy. Early weight bearing as tolerated was encouraged in all patients. The

duration of surgery was documented in all cases. Surgery was carried out using a standard navigation technique with anatomical trackers rigidly fixed in the distal end of the femur and the proximal end of the tibia carefully avoiding the retained hardware in the distal femur in group I. Preoperatively all the knees were evaluated using the Knee Society Score [14].

At latest follow-up one author (C.C.), not involved in the original surgery, evaluated all patients using both the Knee Society Score and the WOMAC Arthritis Index (self-administered questionnaire) [15]. The surgical time, duration of hospital stay and intra-operative and post-operative complications were recorded and compared. A radiological assessment was carried out using a standardized protocol and magnification. Standing radiographs were obtained with the knee in maximum extension, the patella pointing forward and both hips and ankles visible on the film. The lateral radiographs were taken with the knee in 30° of flexion on a radiographic film (20×40 cm). The radiographs were repeated if malrotation was detected. These standard radiographs were used to determine the Hip–Knee–Ankle angle (HKA), frontal femoral component angle (FFC), frontal tibial component angle (FTC) and sagittal orientation (slope) of both femoral and tibial components. Two independent surgeons measured all angles on two separate occasions and the final value for each angle was derived from the mean of these measurements. The FFC was determined as the angle between the mechanical axis of the femur and the transverse axis of the femoral component. The FTC was determined as the angle between the mechanical axis of the tibia and the transverse axis of the tibial component. The slopes of the femoral and tibial component were evaluated by measuring the angle formed between a line drawn tangential to the base plate (surface in contact with bone) of the respective components and the anterior femoral cortex or mechanical tibial axis.

The ideal alignment for each parameter was determined prior to the study as a FFC angle of 90°, FTC angle of 90°, HKA angle of 180°, femoral slope of 90° and a tibial slope of 87°. The total number of outliers for each parameter was determined. Outliers were defined as prostheses with any alignment parameter beyond 3° of the ideal value. Statistical analysis of the results was performed through a non-parametric test (Mann–Whitney U Test) using Statistica 7.0 (StatSoft Inc., Tulsa, OK, US). A statistically significant result was given a $P \leq 0.05$.

3. Results

The mean pre-operative ages were 69.9 years (range: 54–82) for group I and 71.3 years (range: 56–84) for group II. In each group there were eight females and eight males. The mean numbers of previous surgeries were 1.6 (range: 1–4) in group 1 and 0.3 (range: 0–2) in group II. The mean pre-operative flexions were 105.6° (range: 85–125) and 108.7° (range: 90–120) for groups I and II respectively. The mean pre-operative HKA angles were 175.8° (range: 170–186) and 174.9° (range: 171–183) for groups I and II respectively. There were three patients with a valgus and 13 with a varus malalignment in each group. In both groups the arthritis grade, according to Albaack, exceeded grade III in all patients. Pre-operatively the mean Knee Society Scores were 43.7 (range: 39–51) in group I and 45.1 (range: 40–49) in group II. The pre-operative Functional scores were 46.9 (range: 42–52) for group I and 48 (range: 42–52) for group II. There were no statistically significant differences in the pre-operative data between the two groups (Table 1).

No complication specifically related to the computer navigation was seen in either group. Two patients in group I required a tibial tubercle osteotomy to obtain adequate exposure and to avoid excessive traction on the patellar tendon. In both these cases the tubercle was reattached with screws at the end of the surgery without any adverse effect on the final outcome. There were no statistically significant differences in the duration of surgical time or hospital stay (Table 2). Eleven patients in each group required postoperative blood transfusions.

At the latest follow-up (55.1 and 53.5 months respectively for groups I and II) no implant had been revised and no major signs of radiological loosening were seen in either group. The mean Knee Society Scores were 84.7 (range: 76–94) in group I and 86 (range: 76–94) in the group II. The Functional scores were 86.6 (range: 75–95) and 88.4 (range: 80–95) for groups I and II respectively. No statistically significant differences were seen in the Knee Society and Function scores between the two groups (Fig. 1). The WOMAC Arthritis Index showed no statistically significant difference between the two groups for pain, function and stiffness indices (Fig. 1).

The HKA angles were 179.1° (range: 177–182) and 178.6° (range: 176–182) in group I and group II, respectively. The FFC and the FTC angles were respectively 89.6° (range: 86–92) and 89.6° (range: 87–92) in the post-traumatic group and 88.5°