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Original Article

Computer-assisted navigation for cruciate-retaining total knee arthroplasty in patients with advanced valgus arthritic knees

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ABSTRACT

Background: The valgus arthritic knee is a complex deformity involving both soft tissue and bony problems that significantly affect the positioning of the components for, and decrease the accuracy of, reconstructed alignment in total knee arthroplasty (TKA). The unique bony deformity and soft tissue problem makes the use of conventional mechanical instrumentation difficult and leads to unsatisfactory results.

Purpose: The purpose of this study was to investigate the effect of computer-assisted navigation for TKA on the postoperative mechanical axis, component alignment, and functional outcomes in the arthritic knee with genu valgus deformity.

Methods: From January 2003 to August 2009, 24 patients (24 knees) with advanced valgus knee arthritis who underwent computer-assisted navigation for cruciate-retaining TKA were retrospectively reviewed. The accuracy of the postoperative mechanical axis and component alignment, and functional outcomes were assessed.

Results: The mean postoperative mechanical axis was 180.2° (range, 178.1–182.5°). All patients achieved the targeted goal of a leg axis within 3° of the neutral axis. The joint line was not substantially elevated. No patient required conversion to a constrained component to achieve stability. At a mean follow-up of 45.5 months, the Hospital for Special Surgery (HSS) knee score improved from a mean preoperative score of 55.6 to 92.8 postoperatively. The International Knee Society (IKS) clinical score improved from 42.2 to 95.9. The IKS for pain improved from 15.4 to 47.1, and the IKS knee function score improved from 35.8 to 95.4.

Conclusion: Computer-assisted navigation for TKA is a useful alternative technique for advanced valgus knee arthritis where accurate restoration of the joint line, proper alignment of the limb and prosthetic components, and meticulous soft tissue balancing may be challenging because of bony deformities and soft tissue contractures.

1. Introduction

Total knee arthroplasty (TKA) is a reliable, successful, and reproducible procedure for treating the advanced arthritic knee. The effectiveness of computer-assisted navigation for TKA for the arthritic knee has been well-documented in the literature, and provides excellent results for accuracy of component alignment, correction of the limb axis, and soft tissue balancing.[1–9] Approximately 10% of patients requiring TKA present with a valgus deformity (Fig. 1). When using the mechanical alignment guiding systems, correction of the valgus deformity has posed technical challenges and has produced variable clinical results. The bony abnormalities encountered with the valgus knee include distal femoral hypoplasia, posterior femoral condylar erosion, unusual proximal femoral neck-shaft angles, external rotation deformity of the distal part of the femur, patellar maltracking, and metaphyseal remodeling of both the femur and the tibia (which can lead to malalignment or malrotation of the femoral component).[10,11] Even experienced surgeons often rely on a constrained implant and mechanical alignment guiding systems to correct a valgus deformity.[12] Application of computer-assisted navigation for TKA in the valgus knee would allow precise cutting of the femur and tibia in conjunction with meticulous soft tissue releases and likely offer improved outcomes.

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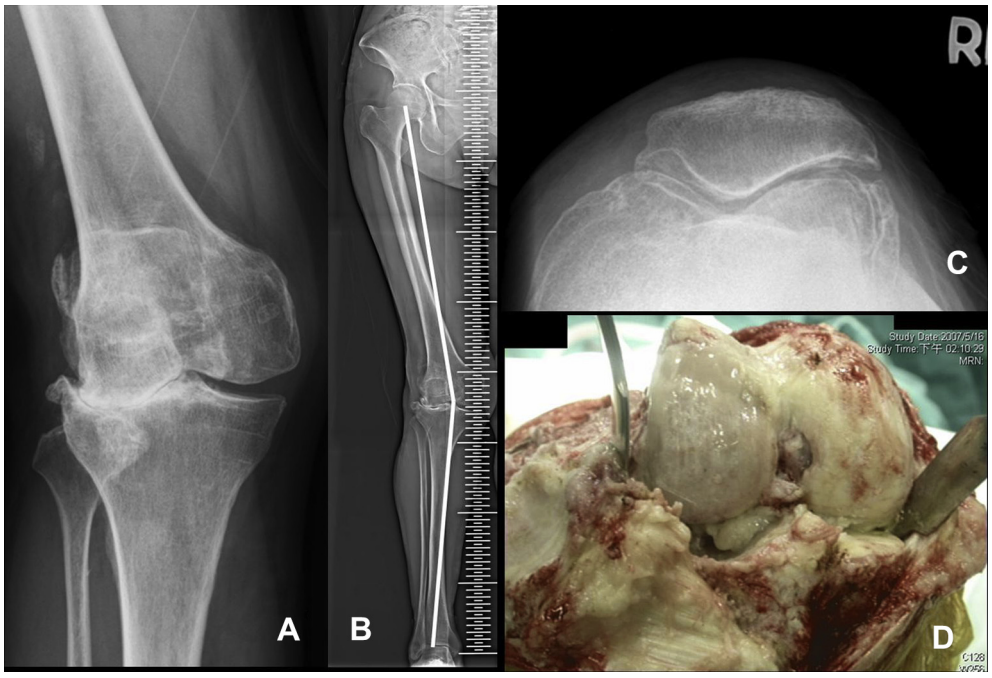

Fig. 1. A 78-year-old male with an advanced valgus deformity of the right knee. (A) Radiograph of the right knee before surgery. (B) Preoperative standing full-length weight-bearing radiograph shows significant genu valgus deformity with a 13.3° preoperative mechanical axis. (C) Preoperative skyline view shows advanced osteoarthritis of the right patellofemoral joint. (D) Intraoperative picture shows destruction of the tibiofemoral and patellofemoral joints and hypoplasia of the lateral femoral condyle.

2. Purpose

There have been few attempts to clarify the role of computer-assisted navigation for TKA patients with genu valgus deformities. The purpose of this study was to investigate the effect of computer-assisted navigation for TKA on the postoperative mechanical axis, component alignment, and functional outcome in the arthritic knee with genu valgus deformity (Fig. 2).

3. Materials and methods

This study was approved by the Institutional Review Board of Chang Gung Memorial Hospital (99-2386B).

A retrospective review was performed on the medical records, radiographic data, and functional outcomes of all patients who had arthritis of the knee joint with genu valgus deformity and underwent computer-assisted navigation TKA at the Chiayi Chang Gung Memorial Hospital between January 2002 and August 2009. Clinical data collected included age, sex, diagnosis, type of valgus deformity (explained below), perioperative findings, tourniquet time, total amount of blood loss, and radiographic assessments before and after surgery. Preoperative and postoperative functional scores were obtained for all patients with the use of the Hospital for Special Surgery (HSS)[13] and International Knee Society (IKS) scoring systems.[14] Patients who had an extra-articular deformity of the femur or tibia related to trauma or previous surgery, or incomplete medical records with respect to radiographic analyses and functional evaluations were excluded from the study.

All patients enrolled in this current study were evaluated using radiographic analyses with long-leg weight-bearing split scanograms and anteroposterior (AP) and lateral radiographs of the knees taken preoperatively and postoperatively, as previously described.[15] The skyline view of the patellofemoral joint was also obtained, and the lateral patellar tilt and displacement were estimated according to the criteria of Laurin et al.[16,17] Radiographic parameters including mechanical axes, valgus correction angle of the distal femur (explained below), and the components of alignment (i.e., femoral valgus angle [FV], tibial valgus angle [TV], femoral flexion angle [FF], and tibial flexion angle [TF]) were measured.[18] The position of the prosthetic joint line was measured on radiographs taken at the last follow-up. Adequate restoration of the joint line was defined as 10 ± 3 mm proximal to the fibular styloid and 25 ± 3 mm distal to the medial epicondyle of the femur.[19] All measurements were made with a precision of 0.1°, on digital radiographs using a computer.

Ranawat et al described three types of valgus knees.[11] Type I deformity has minimal valgus and medial soft tissue stretching. Type II fixed valgus deformity has a more substantial deformity (>10°) with medial soft tissue stretching, and type III deformity is a severe bony deformity after a prior osteotomy with an incompetent medial soft tissue sleeve. The valgus correction angle of the distal femur was measured according to the method described by Yau et al,[20] and represents the angle between the line joining the center of the femoral head and the intercondylar notch of the distal femur and the line joining the femoral intercondylar notch and the femoral isthmus.

The planned position of the tibial component was at a TV of 90° in the coronal plane; the planned position for the femoral component was at a FF of 0°; and the planned position for the tibial component was at a TF of 87° in the sagittal plane. The desired FV angle was based on the valgus correction angle of the distal femur, which was measured by long-leg weight-bearing split scanograms. The goals of TKA were to reconstruct the mechanical axis and component alignments (FV, TV, FF, and TF) to within 3° varus/valgus after surgery.

3.1. Surgical technique

All patients received the same cruciate-retaining type of total knee prosthesis (DePuy PFC knee systems, DePuy Orthopaedics,