Case Report

# Computer-Assisted Navigation of Total Knee Arthroplasty for Osteoarthritis in a Patient with Severe Posttraumatic Femoral Deformity

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**Abstract:** In the setting of extraarticular deformities of the knee, total knee arthroplasty (TKA) is difficult, as anatomical abnormalities obstruct identification of alignment landmarks and may preclude the use of traditional instrumentation. The long-term clinical value of computer assistance for TKA is a point of ongoing controversy. Few reports describe the use of computer-assisted orthopedic surgery as a method to decrease alignment outliers in TKA with associated posttraumatic deformities. In this report, a 70-year-old woman who had a severe distal femoral deformity from a previous open fracture underwent computer-assisted TKA for osteoarthritis. The use of a computer-assisted navigation system achieved a high degree of accuracy relative to the desired target alignment and led to improved function in a patient in which standard instrumentation was not feasible. **Keywords:** computer-assisted orthopedic surgery, extraarticular deformity, total knee arthroplasty, surgical navigation, lower extremity alignment.


Computer-assisted orthopedic surgery has been applied to total knee arthroplasty (TKA) as a method to decrease alignment outliers in this procedure [1-3]. A number of authors have suggested that malalignment in TKA is a risk factor for early revision and failure [4-8]. Despite the purported advantages of using navigation for TKA, some have raised concerns about the increased costs, surgical time, and potential complications associated with this extra surgical factor in the face of a lack of clinical evidence supporting its benefit [9,10]. Some have felt that these risks are warranted in the face of improved accuracy relative to conventional TKA [1-3,11-13], whereas others have shown no such advantage [14,15]. However, one area where the advantages of computer-assisted TKA is clear is in the presence of posttraumatic extraarticular deformities, retained hardware, ipsilateral long stem total hip arthroplasty, or any situation where traditional instrumentation is not feasible.

The following describes a case where the advantages of using computer-assisted TKA are realized in the treatment of osteoarthritis in the setting of a complex extraarticular distal femoral deformity. The use of the navigation system achieved a high degree of accuracy relative to the desired target alignment on postoperative long-standing radiographs.

## Case Report

A 70-year-old woman presented with a history of a severe motor vehicle accident leading to an open femur fracture in December 1963. She was treated in a hip spica cast for 6 months. The fracture healed uneventfully with minimal visible deformity on examination. Over the subsequent 45 years, she developed progressive knee arthritis. She presented with right knee and leg pain that was sharp and persistent during her waking hours at a pain intensity of 8 on a scale anchored at 0 with a maximum level of 10. She did not use any walking aids. On physical examination, her gait was antalgic. Her knee had a small effusion, medial joint line tenderness, and a flexion contracture of 10° with further

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flexion to 110°. Her right leg was approximately 2 cm shorter than the left leg clinically measured from the anterior superior iliac spine to the medial malleolus and 1 cm shorter on the long-standing radiograph. Pulses, motor strength, and sensation were all normal.

Long-standing radiographs revealed severe osteoarthritis of the right knee with patella infera. The right distal femur demonstrated a complex deformity with a portion of the distal femoral shaft translated posteriorly and laterally. On the anteroposterior projection, the distal femoral mechanical-articular angle (angle between the femoral mechanical axis and the distal femoral condyles) was 5.3° varus. The proximal tibial mechanical-articular angle (angle between the tibial anatomical axis and the tibial plateaus) was 5.5° varus (Fig. 1A, B). The right patellofemoral joint demonstrated advanced patellofemoral arthritis on the lateral view (Fig. 1C).

The patient underwent right total knee arthroplasty with an imageless navigation system (VectorVision; Brainlab, Feldkirchen, Germany). Navigation arrays were placed through separate percutaneous incisions on both the femur and tibia. The femoral pins were markedly more posterior than normal because of the femoral deformity. The total tourniquet time was 110 minutes. Postoperative films demonstrate distal femoral mechanical-articular angle of 0.0° varus/valgus and proximal tibial mechanical-articular angle of 0.2° valgus (Fig. 2A, B). In the sagittal plane, on a long-standing lateral radiograph, the angle between the femoral mechanical axis and the femoral prosthesis was 0.2° flexion (navigation set point was 0°) (Fig. 2C, D).

During the most recent postoperative appointment at 12 months after surgery, the patient reported no pain of the operative right knee. The right knee demonstrated equal leg lengths both clinically and radiographically, no instability, normal alignment compared with opposite side, and range of motion from 0° extension to 120° flexion. The Western Ontario and McMaster Universities score improved from 44 preoperatively to 12 at latest follow-up. The Knee Society Pain Score improved from 44 to 94 points and the Functional Score


**Fig. 1.** Standing preoperative anteroposterior radiographs of the leg on long (A) and short (B) cassette demonstrating the distal femoral mechanical-articular angle of 5.3° varus and the proximal tibial mechanical-articular angle of 5.5° varus. A lateral short cassette radiograph demonstrates a severe posttraumatic femoral deformity in the sagittal plane with patellofemoral arthritis (C).

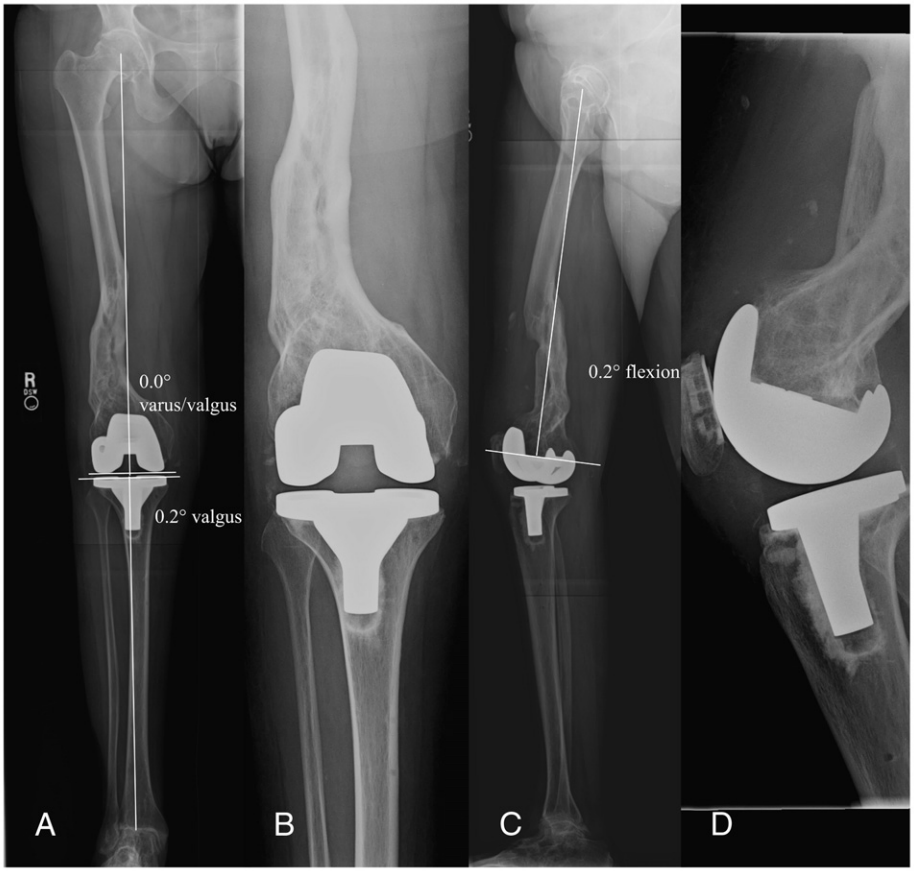


**Fig. 2.** Standing postoperative anteroposterior radiographs of the leg on long (A) and short (B) cassette demonstrating the distal femoral mechanical-articular angle of 0.0° varus/valgus and the proximal tibial mechanical-articular angle of 0.2° valgus. Standing postoperative lateral radiographs of the leg on long (C) and short (D) cassette demonstrating the angle between the femoral mechanical axis and the femoral prosthesis of 0.2° flexion.

improved from 90 to 100 points between the preoperative and latest follow-up examinations. The prosthesis remained well fixed radiographically and maintained its mechanical alignment.

## Discussion

Total knee arthroplasty for the treatment of posttraumatic arthritis has demonstrated an increased rate of complications when compared with TKA for primary osteoarthritis. One factor leading to these results is the presence of both intraarticular and extraarticular deformities. Previous reports have shown higher complication rates, arthrofibrosis, and a greater need for TKA revisions in the posttraumatic setting [16-18]. Occasionally, such deformities preclude the use of standard alignment instrumentation such as intramedullary guides. As a result, obtaining adequate information for alignment can be challenging in these cases.

The use of surgical navigation in TKA has been a matter of debate. Several investigators have shown an improvement of component position and alignment in conventional TKA [1-3,11,13]. Other studies have demonstrated no significant difference in component positioning between the use of computer-assisted navigation and standard instrumentation in TKA [14,15]. However, in cases such as the one presented, the advantages of surgical navigation are clear in achieving near-perfect alignment in a particularly severe femoral deformity. Previous case reports have demonstrated the utility of surgical navigation in TKA of distal femoral and proximal tibia deformity in implant placement [19-21]. In our case, the entire distal femoral deformity was posteriorly translated in the sagittal plane of the knee joint. Using an imageless navigation system, the targets for alignment of the distal femoral mechanical-articular angle, the proximal tibial mechanical-articular angle, and the mechanical flexion angle of the femoral component in the sagittal plane were all achieved to within 1°.

Before the development of computer-assisted navigation, surgeons dealt with extraarticular femoral deformities in TKA with a variety of strategies. These included the use of fluoroscopy and extramedullary guides [22,23]. In addition to the risks of radiation exposure and contamination, the accuracy of fluoroscopy can be variable. The use of an extramedullary femoral guide in routine TKA has also been studied; it has been shown to be less accurate than the use of an intramedullary system [23]. Thus, cases such as this with severe extraarticular deformity are particularly well suited to the use of surgical navigation.

In summary, despite the controversies regarding the safety and utility of computer-assisted surgery in TKA, this technology provided a tremendous advantage in achieving a high degree of alignment accuracy with no complications and a manageable surgical time, especially in the setting of a posttraumatic extraarticular deformity.

## References


1. Chin PL, Yang KY, Yeo SJ, et al. Randomized control trial comparing radiographic total knee arthroplasty implant placement using computer navigation versus conventional technique. J Arthroplasty 2005;20:618.
2. Haaker RG, Stockheim M, Kamp M, et al. Computer-assisted navigation increases precision of component placement in total knee arthroplasty. Clin Orthop Relat Res 2005;433:152.
3. Mullaji A, Kanna R, Marawar S, et al. Comparison of limb and component alignment using computer-assisted navigation versus image intensifier–guided conventional total knee arthroplasty. A prospective, randomized, single-surgeon study of 467 knees. J Arthroplasty 2007;22:953.
4. Alden KJ, Pagnano MW. The consequences of malalignment: are there any? Orthopedics 2008;31:947.
5. Incavo SJ, Wild JJ, Coughlin KM, et al. Early revision for component malrotation in total knee arthroplasty. Clin Orthop Relat Res 2007;458:131.
6. Sharkey PF, Hozack WJ, Rothman RH, et al. Why are total knee arthroplasties failing today? Clin Orthop Relat Res 2002;404:7.
7. Fehring TK, Odum S, Griffin WL, et al. Early failures in total knee arthroplasty. Clin Orthop Relat Res 2001;392:315.
8. Gioe TJ, Killeen KK, Grimm K, et al. Why are total knee replacements revised? Analysis of early revision in a community knee implant registry. Clin Orthop Relat Res 2004;428:100.
9. Spencer JM, Chauhan SK, Sloan K, et al. Computer navigation versus conventional total knee replacement. No difference in functional results at two years. J Bone Joint Surg Br 2007;89-B:477.
10. Novak EJ, Silverstein MD, Bozic KJ. The cost-effectiveness of computer-assisted navigation in total knee arthroplasty. J Bone Joint Surg Am 2007;89:2389.
11. Mason JB, Fehring TK, Estok R, et al. Meta-analysis of alignment outcomes in computer-assisted total knee arthroplasty surgery. J Arthroplasty 2007;22:1097.
12. Fehring TK, Mason JB, Moskal J, et al. When computer-assisted knee replacement is the best alternative. Clin Orthop Relat Res 2006;452:132.
13. Matziolis G, Krocker D, Weiss U, et al. A prospective, randomized study of computer-assisted and conventional total knee arthroplasty. Three-dimensional evaluation of implant alignment and rotation. J Bone Joint Surg Am 2007;89:236.
14. Bauwens K, Matthes G, Wich M, et al. Navigated total knee replacement. A meta-analysis. J Bone Joint Surg Am 2007;89:261.
15. Kim YH, Kim JS, Choi Y, et al. Computer-assisted surgical navigation does not improve the alignment and orientation of the components in total knee arthroplasty. J Bone Joint Surg Am 2009;91:14.
16. Weiss NG, Parvizi J, Trousdale RT, et al. Total knee arthroplasty in patients with a prior fracture of the tibial plateau. J Bone Joint Surg Am 2003;85:218.
17. Papadopoulos EC, Parvizi J, Lai CH, et al. Total knee arthroplasty following prior distal femoral fracture. Knee 2002;9:267.
18. Lonner JH, Pedlow FX, Siliski JM. Total knee arthroplasty for post-traumatic arthrosis. J Arthroplasty 1999;14:969.
19. Chou WY, Ko JY, Wang CJ, et al. Navigation-assisted total knee arthroplasty for a knee with malunion of the distal femur. J Arthroplasty 2008;23:1239.e13.
20. Klein GR, Austin MS, Smith EB, et al. Total knee arthroplasty using computer-assisted navigation in patients with deformities of the femur and tibia. J Arthroplasty 2006;21:284.
21. Mullaji A, Shetty GM. Computer-assisted total knee arthroplasty for arthritis with extra-articular deformity. J Arthroplasty 2009;24:1164.
22. Wang JW, Wang CJ. Total knee arthroplasty for arthritis of the knee with extra-articular deformity. J Bone Joint Surg Am 2002;84:1769.
23. Engh GA, Petersen TL. Comparative experience with intramedullary and extramedullary alignment in total knee arthroplasty. J Arthroplasty 1990;5:1.