Eight-Year Follow-Up of Total Knee Arthroplasty in a Patient With an Ipsilateral Below-Knee Amputation

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With the recent increase in the number of patients with a lower extremity amputated because of combat-related injury, there may be an increase in the number of cases of osteoarthrosis in these patients.[1-3] It has been shown that patients who have had a lower extremity amputated are more likely to develop osteoarthrosis in the knee of the uninjured leg than in the knee of the injured leg.[4-6] Only 2 cases of total knee arthroplasty (TKA) performed in patients with a below-knee amputation (BKA) in the ipsilateral leg have been reported over the past 20 years.[7,8] BKA presents a unique problem during TKA: It makes proper overall limb alignment difficult to obtain.

In this article, we present the case of a man who had a left BKA, developed degenerative arthritis, and underwent ipsilateral TKA that involved a novel intraoperative approach for limb alignment.

Case Report

A man in his early 40s presented to our orthopedic department with worsening left knee pain 13 years after sustaining an open tibial fracture of the left leg (treated with open reduction and internal fixation at another institution), developing an infected nonunion, and undergoing a limb-salvage attempt with Ilizarov external fixation, aggressive débridement, and bone transport and 4 years after developing another infection in the nonunited distal tibia and undergoing BKA. Since the BKA, he had been an active member in his community and had been ambulating in his prosthesis without assistive devices.

Three years before his latest presentation, the patient developed left knee pain that proved refractory to conservative measures, including use of nonsteroidal anti-inflammatory drugs, intra-articular steroid injections, and physical therapy. Radiographs of the knee showed significant tricompartmental arthritis, and the patient's symptoms were disabling enough to warrant TKA (Figures 1, 2). Preoperative range of motion was 0° to 123°.

After discussing treatment options, the patient underwent left posterior-stabilized cemented TKA without complication under the direction of Dr. Krishnamurthy. Before surgery, a plaster mold of the amputation stump was made in order to create a modified prosthesis, which was then sterilized and used intraoperatively to support the BKA stump. For accurate alignment of the tibial cut, the rod attached to the socket was aligned at exactly a right angle to the socket (Figure 3). The

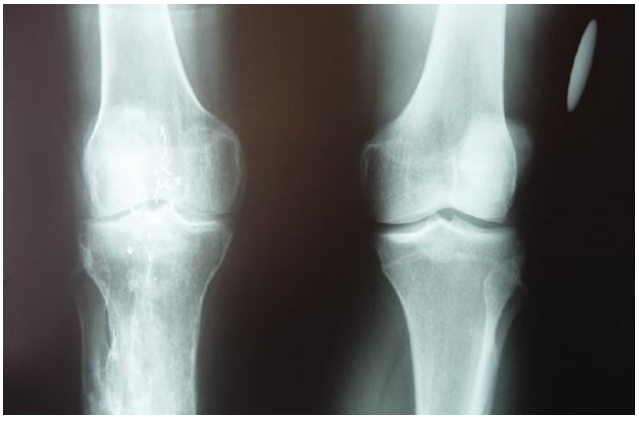

Figure 1. Preoperative posteroanterior radiograph.

Figure 2. Preoperative lateral radiograph.

Figure 3. Modified custom prosthesis used for intraoperative limb support and tibial extramedullary alignment.

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Am J Orthop. 2008;37(10):528-530.

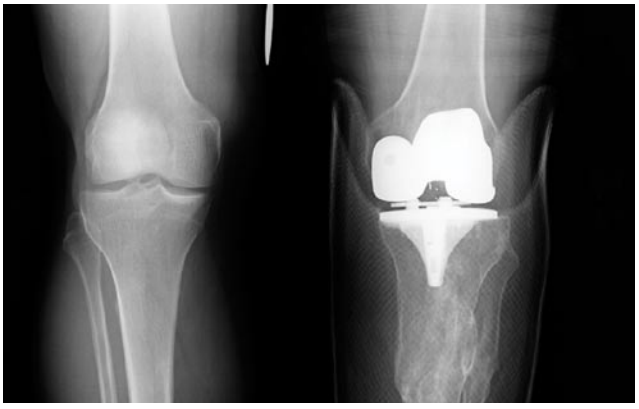

Figure 4. Weight-bearing anteroposterior radiograph 8 years after left total knee arthroplasty.

operation was performed under spinal anesthesia with a tourniquet applied to the proximal thigh. A midline incision and standard medial parapatellar approach to the knee were used. After the arthrotomy and patellar eversion, the femur was prepared in the usual manner. The sterilized prosthesis was then placed on the distal stump, and the knee was fully flexed with the prosthesis supporting the stump. Then, an extramedullary jig was placed over the prosthesis, the jig was aligned parallel to the rod of the prosthesis, the cutting guide was pinned to the proximal tibia and set to cut 10 mm off the high side, and the tibial cut was made. The tibia was then prepared in the usual manner. At the end of the cuts, the overall alignment of the lower extremity was checked with trial components and an extramedullary rod and was found to be satisfactory. All the components were then cemented in position, and the knee was held in full extension until the cement hardened. A suction drain was placed, and the wound was closed in layers.

Physical therapy was started on postoperative day 1 with knee flexion-extension and quadriceps-strengthening exercises in accordance with our standard postoperative rehabilitation protocol. The suction drain was removed on day 2. By day 6, the patient had reached 10° to 62° of flexion, was ambulating with axillary crutches, and was discharged home non-weight-bearing on the operative limb. Weight-bearing in the adjusted prosthesis was allowed at 3 weeks, when the skin staples were removed and wound was healed.

After the initial follow-up visits, the patient was reviewed annually. He continued reporting good function of the operative lower extremity. At the most recent review, 8 years after TKA, range of motion was 0° to 120°. Knee score (Knee Society clinical rating system) had improved from 44 to 80, and Function score had improved from 10 to 40.[9] Radiographs obtained at this review showed well-fixed implants with no wear or loosening (Figure 4). Weight-bearing radiographs of the left lower extremity showed alignment of 6° of valgus (the intended alignment).

The patient mentioned and discussed in this case report has fully acknowledged and has agreed to be involved in the publication and/or reproduction of this case report via written informed consent. All identifying details of the patient have been omitted.

Discussion

To our knowledge, TKA in the ipsilateral limb of a patient with BKA has been reported twice previously and had good outcomes in both cases. In a 1-year follow-up, Pasquina and Dahl[8] reported positive experience with bilateral TKAs in a 76-year-old man with a right BKA (they performed the amputated-limb TKA first and the contralateral-limb TKA 1 year later). Crawford and Coleman[7] presented the case of an 8-month follow-up of bilateral TKAs in a 75-year-old woman with a right BKA (they performed the contralateral-knee TKA first and the amputated-limb TKA 4 years later).

Our patient's amputated-limb knee pain was severe enough to limit his activities of daily living and mobility. Conservative treatments had failed, and surgical options were explored and discussed. Alternatives to TKA include arthroscopic débridement, arthrodesis, and conversion to above-knee amputation. Arthroscopic débridement has not been clearly defined as an effective means of treating knee osteoarthritis; long-term data are not entirely favorable, and tricompartmental disease has been reported as a contraindication.[10,11] Although knee fusion and above-knee amputation were also discussed, we thought it important to preserve the knee joint for independent ambulation; lesser energy expenditure made these options less desirable and would have ultimately adversely affected our patient's outcome.[12,13] In addition, his relatively young age was strongly considered. Traditionally, knee arthrodesis and realignment procedures are viable alternative treatments for incapacitating arthrosis in a young patient. However, for the reasons already mentioned, knee fusion was disregarded. Because of our patient's tricompartmental disease, realignment was not a viable alternative. We discussed the need for future revision at length, and he ultimately decided to pursue TKA.

The association between lower extremity amputation and contralateral knee pain and osteoarthritis has been reported. Norvell and colleagues[6] examined a large group of veteran traumatic transtibial and transfemoral amputees to determine the risk for symptomatic knee osteoarthritis in the amputated and intact limbs. They reported a prevalence ratio of symptomatic knee osteoarthritis in the intact limb of 1.4 compared with 0.1 for the knee of the amputated limb. They postulated that gait abnormalities and increased physiologic loads on the intact limb produce a cumulative stress effect that leads to joint degeneration, while these compensatory mechanisms shift weight away from the amputated limb, producing a relative protective effect from osteoarthritis in that knee. Interestingly, our patient's findings were in direct contrast to these findings. The knee of his amputated limb was symptomatic, while the intact-limb knee was pain-free, and radiographs did not show any significant degenerative disease. Perhaps his relatively short time (4 years) ambulating in his prosthesis was not sufficient to produce the proposed biomechanical effects. Also, it is possible that the amputated-limb knee had been injured in his original accident (leading to posttraumatic osteoarthrosis).

Extramedullary alignment was used in tibia preparation. Crawford and Coleman[7] reported the length of residual tibia in their patient as 12.5 cm and commented on the limited insertion of the intramedullary tibial alignment rod. The tibial length in our

patient was 17 cm from the medial joint line to the distal tibia. We agree with their comment that even limited insertion of the intramedullary alignment rod would provide a useful reference for tibial cuts and placement of tibial components. However, it has been shown that incomplete penetration of intramedullary tibial alignment rods to the distal epiphyseal scar (<80% penetration) resulted in inaccurate radiographic positioning of the intramedullary alignment system, and the resultant malalignment corresponded inversely with the depth of the insertion.[14] Clearly, intramedullary alignment becomes less accurate when a shorter tibial length is encountered. We decided to use extramedullary alignment to provide us with intraoperative precision. However, as extramedullary alignment guides require an appropriate length of tibia for proper rod alignment over the medial third of the tibial tubercle and over the second toe, we were still able to obtain correct tibial alignment, as the extramedullary alignment rod was exactly parallel to the supporting rod of the prosthesis and perpendicular to the supporting socket. The relatively low wear at 8 years demonstrates the absence of dramatically abnormal or elevated forces at the TKA.

We have described a novel approach to supporting the limb stump during ipsilateral surgery and obtaining accurate alignment for the tibial cut. Crawford and Coleman[7] described using a polystyrene packaging box wrapped in sterile drapes for support of the amputation stump, and they recommended having 2 assistants for further support. The sterilized custom prosthesis that we used provided a more efficient lever arm for more stable limb positioning and support during surgery (Figure 3). This not only made the case easier but also avoided potential reinfection from placing an intramedullary rod down the tibia into the previously infected area of nonunion. The knee can be flexed and the distal end of the prosthesis placed against a bump secured to the table, eliminating the need for manual distal control of the stump during the procedure.

The mold was made of the patient's BKA stump, and the socket was fixed at a right angle to the base plate supporting the rod, also perpendicular to the base plate—ensuring a perpendicular cut of the tibia. There was no play between the socket and the stump of the tibia, as evidenced during surgery, primarily because the socket was custom-made. For surgeons trying this technique, there are no potential sources of error in making or using the sterilized custom prosthesis because the technique of creating the socket is very similar to that of making a BKA prosthetic socket, which is routinely prepared by prosthetists.

We also report a similar postoperative rehabilitation experience. Our patient's rehabilitation differed only in his immediate weight-bearing status and still produced a good result. In standard TKA, we encourage full weight-bearing on the operative limb on day 1. We feel that, with TKA in the ipsilateral limb of a patient with BKA, wound healing on the weight-bearing stump outweighs allowing immediate full weight-bearing in a modified prosthesis.

This case demonstrates that TKA should be considered for patients with BKA and symptomatic knee arthritis. Our patient's Knee score improved almost 40 points, and his Function score increased 30 points—consistent with what has been reported previously.[7] Good results can be obtained with little modification of a standard protocol. Length of the residual tibia should be considered. Use of a modified prosthesis during surgery significantly eases the problem of supporting the shortened limb and also aids in accurate alignment of the tibial cut. Postoperative rehabilitation should be modified to limit weight-bearing until wound healing is complete, particularly with regard to prosthetic fitting over the incision.

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Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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This paper will be judged for the Resident Writer's Award.