Case report

Total knee replacement for tricompartmental arthritis in a patient with a below-knee amputation after a previous closing wedge high tibial osteotomy

Mark A. Fleming, MBBCH, FC orth(SA), MMEDa, *, Michael C. Dixon, FC orth(SA), FRACSa, b

a Sutherland Public Hospital, Caringbah, New South Wales, Australia
b Kareena Private Hospital, Caringbah, New South Wales, Australia

Article info

Article history:
Received 1 June 2015
Received in revised form 13 August 2015
Accepted 17 August 2015
Available online 11 February 2016

Keywords:
Below-knee amputation
Total knee arthroplasty
Total knee replacement
Patient-specific instrumentation
Transtibial amputation

Abstract

This is a report of a 64-year-old man who had undergone a high tibial osteotomy (HTO) 17 years ago of his right knee for medial compartment osteoarthritis; 5 days later, he received a below-knee amputation owing to a missed popliteal artery injury at the time of the HTO. We elected to perform a total knee replacement (TKR) for progressive arthritis of the ipsilateral knee 17 years after the transtibial amputation. Although there is a plethora of literature regarding TKR in the contralateral knee of amputees, there is a paucity of data of TKR in the ipsilateral knee. Using medical search engines including Google Scholar and PubMed, we were only able to identify 4 case reports of TKR in the ipsilateral knee of below-knee amputees. This is the first description in the English literature that has the following rare pathology list: tricompartmental arthritis with a previous closing wedge HTO with a resultant truncated valgus tibia and short transtibial amputation.

Introduction

Although there is a plethora of literature regarding total knee replacement (TKR) in the contralateral knee of amputees, there is a paucity of data of TKR in the ipsilateral knee. Using medical search engines including Google Scholar and PubMed, we were only able to identify 4 case reports of TKR in the ipsilateral knee of below-knee amputees [1–4]. None of these knees had had a previous closing wedge high tibial osteotomy (HTO) with a resultant short truncated valgus tibia.

Performing arthroplasty in an amputee is an uncommon procedure in the amputated knee. Arthritis involving the contralateral knee is more common than the population average. Prosthetic manipulability allows the mechanical axis of the amputated limb to be adjusted thereby simply off-loading the arthritic compartment.

When tricompartmental osteoarthritis is present, prosthetic limb alterations are of no help.

Many surgical challenges need to be met by the surgeon faced with tricompartmental pathology in the below-knee amputee; additional challenges in this case included an altered proximal tibial anatomy after prior closing wedge HTO, extensive soft tissue scarring of the stump, and limited range of movement (Fig. 1).

Consideration needed to be taken when preoperatively planning our tibial and femoral resections with regard to what type of alignment guide to use. The incisions needed planning because of multiple scars being present. While performing the surgery, we had to plan how to hold and position the leg to create a stable platform on which to operate. The fact that the fibula had been removed at the time of amputation identifies a likelihood that the fibular collateral ligament would be absent, attenuated, or nonanatomic which may lead to imbalances requiring greater constraint.

Case history

This 64-year-old man had undergone a right HTO 17 years ago, intended to treat medial compartment osteoarthritis. However, 5 days after surgery, he required an emergency below-knee
amputation owing to iatrogenic popliteal artery injury. Multiple skin grafts were performed with staged closure because of compromised perfusion specifically anterolaterally over the proximal tibia. A firm adherent anterolateral scar on his stump remains (Fig. 1). Progression of his knee arthritis occurred in the lateral and patellofemoral joints leading the patient to present 17 years after the HTO with pain sufficient to warrant TKR. His lifestyle had become significantly affected, reducing his walking distances. He struggled to finish a game of golf despite using a golf cart and was taking regular paracetamol and nonsteroidal anti-inflammatories for this knee pain.

Clinical examination demonstrated an antalgic gait on his amputated side with limited range (10°–90°). The carbon-fiber suction cup of the prosthesis is designed to overlap the joint line significantly both medially and laterally because the stump is shorter than usual.

Radiographs showed tricompartmental osteoarthritis with a truncated valgus proximal tibia, evidence of the fully united closing wedge HTO. The proximal fibula was absent (Fig. 2). During the surgery, we would not be able to use traditional means to reference the tibial cut because there is no lower leg. For this reason, we chose to use custom computer-generated cutting guides (Fig. 3). Computerized tomography (CT) was performed (Fig. 4) to aid surgical planning and generate patient-specific cutting blocks (TRUMATCH; Depuy Synthes, Warsaw, Indiana). The scan was performed while wearing his prosthetic lower leg to determine his current mechanical axis. Surgery was performed with 2 assistants. Skin incisions were chosen after gaining advice from a plastic surgeon. To minimize the risk of skin necrosis, we used the medial approach from the last surgery extending it proximally taking care not to cross the midline (Figs. 5 and 6).

During balancing, the lateral collateral ligament was found to be partially deficient, and we chose to eliminate the risk of spinout by using a fixed-bearing, cemented posterior-stabilized TKR with patella resurfacing (PFC Sigma; Depuy Synthes, Warsaw, Indiana) rather than rotating platform that we were initially planning to use (Fig. 7).

At the time of this article submission, clinical follow-up is only 4 months after surgery. The patient is pleased with the result of his knee replacement (Fig. 8). He has not required any analgesics for the past 8 weeks. His range is 0 to 92°. He has returned to playing 18 holes of golf 3 weeks ago. His comfortable walking distance is 1.5 km limited by pain where his suction cup is abrading the anterolateral skin over his tibia. He has been measured and is receiving his newly shaped prosthesis this week that should help this problem. He is attending gym where he runs for 20 minutes on the treadmill and cycles 10 minutes on an exercise bike before performing leg curls and extensions with 10-kg resistance.

**Discussion**

Total knee arthroplasty in the ipsilateral limb of below-knee amputees is extremely uncommon. This case is unique to literature in that the tibia had had a prior HTO and fibular excision resulting in unique planning considerations including implant positioning, choice and constraint.
The key differences between this case and the 4 other previously reported cases are the following: The surgical approach had to be performed through a medial skin incision to avoid devascularizing the existing skin flaps. The large amount of soft tissue needing to be retracted laterally made visualization of the lateral compartment more difficult and provided resistance initially to seating the tibial cutting block initially. The tibia was unusually shaped: being truncated and valgus from the prior closing wedge HTO. The lateral collateral ligament was partially deficient as a result of prior fibular head excision.

Positioning the hip flexed to 45° with the leg being held in that position by a transverse cylinder bolster placed under the thigh. This allowed the knee to be flexed without abutting the bolster. Using 2 assistants is helpful because the stump needs to be controlled by one set of hands constantly, while the other assistant holds the retractors (Fig. 9).

The short stump does not provide a reliable reference to guide the angle of the tibial cuts. With the advent of patient-specific instrumentation and digital preoperative planning, the cutting blocks facilitate accurate sagittal alignment regardless to the absence of the lower leg.

The shortness of the tibia makes soft tissue balance assessment difficult; the lever arm length of the tibia is very short making it difficult to apply varus and valgus force. The lateral collateral ligament was noted to be partially incompetent at surgery. To achieve balance in extension, multiple releases were performed including the deep medial collateral ligament, the posteromedial capsule, part of the pes anserinus, and the use of a tibial downsizing osteotomy [5]. Owing to this balancing difficulty, we changed our choice of prosthesis from a rotating platform to a fixed-bearing highly conforming design (PFC Sigma; Depuy Synthes, Warsaw, Indiana) to remove any risk of spinout. The valgus truncated proximal tibia lends itself to lateral wall penetration by the tibial tray keel. To avoid this, an offset tibial keel may be used; however, in this case, we managed to avoid this.

Existing case reports describing TKR in an amputated lower limb helped us plan our surgery, expecting difficulty with positioning...
and the requirement of 2 assistants. In contrast to the 4 reported cases, we used custom cutting blocks, designed to match the patients’ specific anatomy from the CT scan. When performing presurgical planning based on CT, the bony cuts planned do not take soft tissue balancing into consideration. Thus, despite following our presurgical plan accurately, we found the need to perform extensive medial release and a medial tibial resection with downsizing of the tray to gain balance [5]. This case report is primarily intended to describe the intraoperative considerations with this complex arthroplasty case. The short-term follow-up is encouraging; however, it is too short to predict longer term outcome. Follow-up highlights the importance of maintaining excellent soft tissue envelope around the stump—the only complaint he currently expresses is the ill-fitting suction cup.

Summary

This is a unique case with a number of challenges. The advent of patient-specific cutting guides allows us to preoperatively plan accurately. During the surgery, they provide alignment of the femoral and tibial resections in lieu of having a lower leg to reference the mechanical axis. This case demonstrates that soft tissue balance is critical, despite the preoperative planning of bony resection; extensive soft tissue releases may be required in cases following HTO.

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