

# Total Knee Arthroplasty in a Transtibial Amputee

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## Learning Point of the Article:

This article presents the challenges faced when performing a total knee arthroplasty in a transtibial amputee and offers possible solutions using this case study and previous literature

## Abstract

**Introduction:** With the diversity of prosthetic components patients with a transtibial amputation can now expect to return to high function. Subsequently, the ipsilateral knee is at risk of developing osteoarthritis with a need for a provision of total knee arthroplasty (TKA).

**Case Report:** We describe a novel technique for TKA in a transtibial amputee utilizing navigation with a tibial jig. Post-operative radiographs revealed varus tibial alignment with neutral limb alignment. Resolution of stump swelling allowing accurate prosthesis fitting was seen at 8 weeks. A new prosthesis optimized functional alignment and a return to moderate labor was achieved at 10 weeks. At 1-year postoperatively, patient satisfaction was excellent.

**Conclusion:** Navigation alongside stump alignment is a useful technique. We found that after socket fitting, radiographic tibial varus alignment can correspond with a stump position that allows balanced loading of the knee and excellent function.

**Keywords:** Amputee, transtibial, total knee replacement, total knee arthroplasty.

## Introduction

With the development of technology increasing the diversity of prosthetic components and rehabilitation techniques used in assisting people with lower limb loss to achieve maximum functional performance, patients can now expect to return to intensive and heavily manual jobs, and high level competitive sport[1]. Subsequently, the ipsilateral knee is at risk of developing osteoarthritis.

Performing a total knee arthroplasty (TKA) without the stability and alignment guide of the lower leg presents surgical challenges, and delayed prosthesis fitting demands a tailored approach to rehabilitation. An understanding of how the stump transmits load through the prosthetic limb to the knee is important. Our objective was to propose a new surgical technique with a navigation system combined with an extramedullary jig, and provide a tailored rehabilitation

program to maintain range of motion and reduce stump swelling.

## Case Report

### Patient details

A 56-year-old man sustained a traumatic amputation at the mid-calf combined with dislocation of the proximal tibiofibular joint and rupture of the posterior cruciate ligament. His tibiofibular joint was stabilized which provided enough knee stability for rehabilitation and eventual full activity as a motorcycle mechanic using a vacuum assisted suspension system (VASS) socket with a hydraulic foot and ankle. Over the next 2 years, heavy labor saw a progression of underlying knee osteoarthritis which significantly affected his ability to work and mobilize. Plain films revealed predominantly patellofemoral joint (PFJ) osteoarthritis with some degenerative changes also seen in both

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## Author's Photo Gallery



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**Figure 1:** Pre-operative radiographs demonstrating osteoarthritis and a hemarthrosis.

medial and lateral compartments (Fig. 1). Prosthetic adjustment was not effective in offloading the PFJ and given his increasing pain, recurrent hemarthroses and inability to perform heavy work it was decided to proceed to a TKA. Patient consent and local ethics committee approval were obtained (N S L H D H R E C

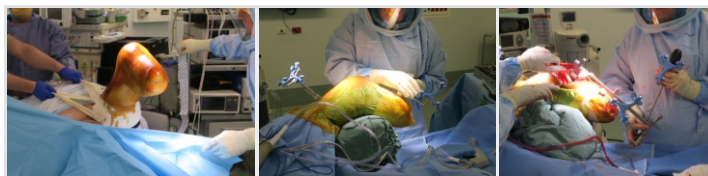
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### Surgical technique

Skin preparation and draping in the absence of the distal leg presents difficulties otherwise not encountered. This was achieved using a sling under the posterior thigh and tourniquet cuff flexing the hip and allowing sterile skin preparation (Fig. 2a). Two soft wedges of rolled towels were placed under the knee to provide support and allow varying ranges of flexion of the hip and knee.

Navigation pins were placed in the distal femur and proximal tibial stump to mount trackers (Fig. 2b). While registration and navigation of the femoral side were unchanged, an extramedullary tibial jig was pinned to the proximal tibia and carefully aligned with the entire stump to create a virtual ankle position where the two malleoli reference points can be estimated (Fig. 2c).

Exposure of the femur was performed with both knee wedge supports. The tibial exposure was made more challenging by



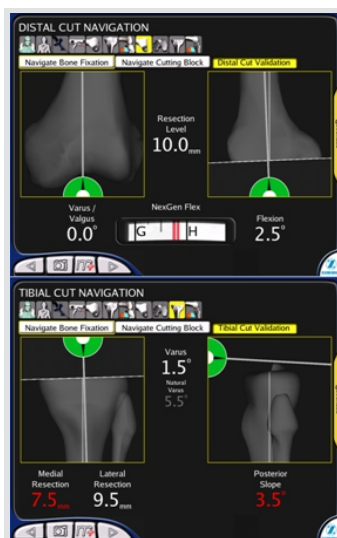
**Figure 2:** (a) Prepping and draping the leg using a sling held from the top of the table. (b) Final patient set-up with navigation trackers. (c) Use of an extra-medullary jig to simulate the distal leg for navigation referencing.

the lack of a fixed foot position which resulted in internal and external rotation of the hip when retractors were placed in the medial and lateral aspects of the knee, and by the absence of counter-leverage for an adequate anterior draw with the popliteal fossa retractor. For this stage, transferring to a single knee wedge allowed the hip to push up into full flexion and a second assistant was useful to support the stump.

With no ankle reference points to guide alignment of the tibial prosthesis, pre-operative templating was also performed on long leg films of the contralateral leg which suggested that neutral tibial alignment would be achieved if 4mm more bone was removed from the lateral plateau than the medial. Navigation allowed estimation of the bony resection depth on each side of the knee and this combined with registration using the extension of the extramedullary jig was utilized to plan the tibial cut (Fig. 3). The resected bone measurements were 7.5mm from the medial plateau and 9.5mm from the lateral side, suggesting slight varus. A cemented posterior stabilized TKA with patella resurfacing was performed.

### Rehabilitation

Stump swelling was expected and it was predicted that the patient's prosthesis could not be used in the early recovery period. Regular high elevation with application of circumferential ice packs was used along with daily stump compression dressings. Frequent sessions with physiotherapy helped to maintain knee range of motion both actively and passively. This was achieved by binding bungee ropes to the stump which can be pulled either anteriorly to gain extension or posteriorly for



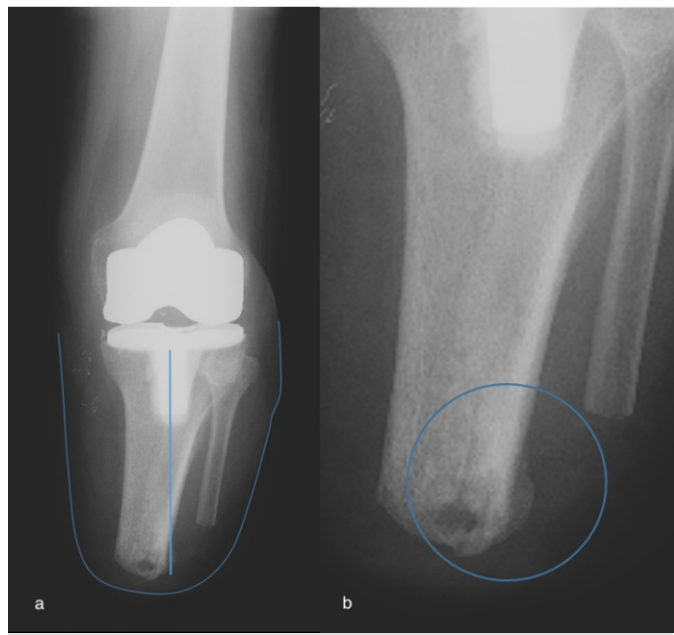
**Figure 3:** Navigated cut validation for the femur and tibia.



**Figure 4:** Post-operative radiographs demonstrating varus tibial alignment.



**Figure 5:** One year follow-up demonstrating functional alignment and range of motion.



**Figure 6:** (a and b) One-year post-operative radiograph demonstrating alignment with the stump and lateral tibial cortex. Magnification showing increased bone density at the lateral tibial cortex as a response to load.

exion. A good fitting prosthetic socket is crucial for efficient and comfortable use of a prosthesis [2]. A new prosthesis fitting occurred when the stump swelling had fully resolved. The new prosthesis was designed to accommodate any changes in limb alignment and length.

### Findings and Outcomes

Post-operative radiographs reveal an unexpected proximal tibial cut in varus alignment (Fig. 4). Stump swelling had settled by 6 weeks and was sufficiently stable enough to allow fitting with a new prosthesis at 8 weeks. The new VASS socket fitting resulted in neutral functional coronal alignment and a range of motion from 0° to 110° of flexion (Fig. 5). The patient returned to full manual duties in his job as a motorcycle mechanic 2 weeks after prosthesis fitting and 10 weeks after surgery.

At 1-year follow-up, the Oxford Knee Score improved from 32 to 42, the Veterans Rand 12 Item Health Survey (VR-12) physical score from 38.6 to 42.9 and the mental score from 42.2 to 48.8. In a patient satisfaction questionnaire, he described very good relief of pain, and very good ability to perform heavy manual labor including squatting and lifting.

### Discussion

There have been a number of reports of a successful TKA in the presence of various different levels of ipsilateral below knee amputation [3, 4, 5, 6, 7, 8, 9]. Authors describe different methods of overcoming the challenges they faced.

It has been demonstrated that the weight bearing load which is distributed by the VASS from the prosthesis to the stump

concentrates the highest stump pressures during the gait cycle onto the lateral cortex of the tibia [10]. Therefore, when viewing the stump to guide alignment, the center of the most distal aspect should be at the far lateral aspect of the shaft of the tibia. Radiographic varus tibial alignment is a potential consequence of this and this is where the tibial component was aligned in this case (Fig. 6a). If an intra-operative radiograph had been performed and alignment matched to the tibial shaft, overall functional alignment may not have been correct. In addition, increased bone density can be seen laterally as a potential response to the load with this alignment (Fig. 6b).

Radiographic evidence of a tibial cut in varus alignment appears to be commonly seen. Crawford and Colman described using a sterile box to hold the stump with the knee fully flexed and supported throughout by an assistant. They used an intramedullary rod to gain tibial alignment with post-operative radiographs similar to our result with varus tibial alignment. Clinical review at 8 months revealed good function [4]. Amanatullah et al. presented 13 TKA cases; however, only one was in the ipsilateral knee. Surgical technique is not described but they state component positioning as a serious issue because of the loss of anatomic landmarks and their post-operative radiograph also shows varus alignment [5]. Konstantakos et al. described the use of a plaster mold of the stump to create a modified prosthesis which was sterilized and enabled intraoperative alignment when paired with an extramedullary tibial jig. While complex, post-operative radiographs show that with this setup they achieved neutral alignment [6]. This was also achieved by Dudhniwala et al. who reported sequential TKAs on a patient with bilateral fibular deficiency. Due to a long residual tibial stump, an intramedullary alignment rod and long stemmed primary components were used [7].

A novel approach was adopted by Fleming and Dixon [8] who performed a TKA for a patient with progressive arthritis who 17 years earlier had received a below-knee amputation. They were faced with a very short, truncated valgus tibia, and opted to use custom computer generated cutting guides. Pre-operative computerized tomography images were taken while the prosthetic leg was worn to determine the mechanical axis. Post-operative radiographic alignment was not evaluated but functional outcome was reported as excellent.

In our case, the prosthesis could not be fitted reliably onto the stump until 8 weeks postoperatively due to swelling. Pasquina and Dahl [9] reported the use of a modified prosthesis which was fitted preoperatively and casted over 12-ply stockings to accommodate the anticipated post-operative edema and allow immediate postoperative training and full weight bearing by day 4 and final prosthesis fitting was achieved at 6 weeks. Dudhniwala et al. [7] managed prosthetic leg fitting at 6 weeks



after an initial period of non-weight bearing and wheelchair use.

and needs to be considered during the rehabilitation program.

### Conclusion

TKA can give excellent clinical results for a transtibial amputee with advanced knee osteoarthritis. The use of navigation alongside stump alignment has shown to be a useful technique. Radiographic tibial varus alignment can correspond with a well aligned stump allowing functional socket fitting and balanced loading of the knee. Post-operative stump swelling is inevitable

### Clinical Message

Performing a TKA on a transtibial amputee is challenging and takes planning. Surgeons should look at published cases for guidance.

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**Consent:** The authors confirm that Informed consent of the patient is taken for publication of this case report

### How to Cite this Article

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