Joint Implant Surgery & Research Foundation
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A Transcutaneous Intramedullary Attachment For AKA Prostheses

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Introduction

Achieving good functional results for ambulatory amputees with above-knee amputation (AKA) can be challenging. Patients) often experience poor socket fit exacerbated by minor weight changes, sweating, and skin problems. There have been several attempts at transcutaneous intramedullary fixation with good results. Several investigators have had success since the late 1990's with a number of patients undergoing percutaneous, osteointegrated prosthesis implantation. Contemporary strategies include a transcutaneous, press-fit distal femoral intramedullary device whose distal external aspect serves as a hard point for AKA prosthesis attachment (Figure 1). Typically the implant is placed in retrograde fashion as a first stage, followed approximately 6 to 8 weeks later by stomatization in which the distal aspect of the implant is exposed and an extension added for fixation of the AKA prosthesis. Indications for surgery typically are persistent AKA prosthesis socket difficulties with a history of AKA following trauma or tumor.

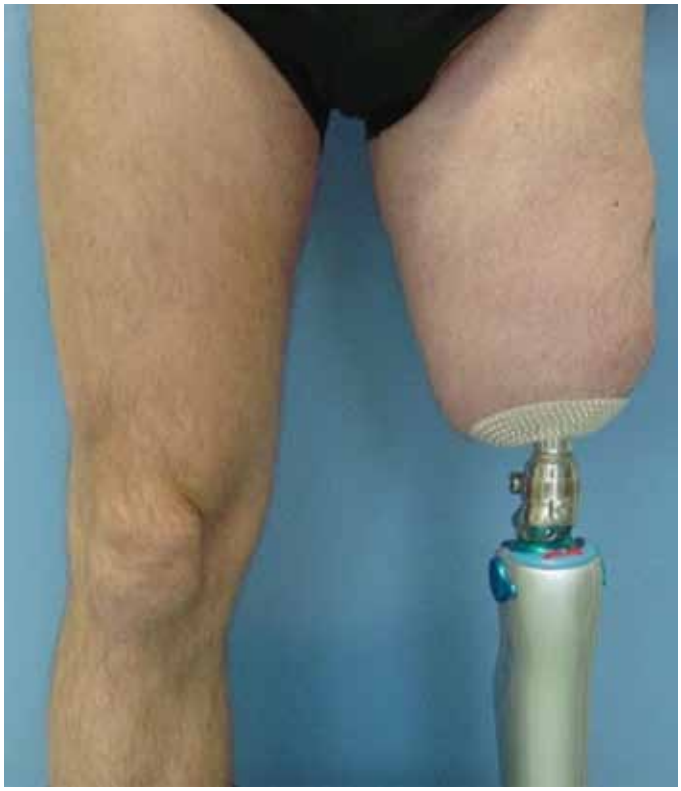

Figure 1. A transcutaneous, press-fit distal femoral intramedullary device whose distal external aspect serves as a hard point for AKA prosthesis attachment

Background

Most investigators credit Branemark in Sweden with the idea of a percutaneous, osteointegrated prosthesis which has been successful in dental implantation. In 1997, R. Branemark reported on the first femoral intramedullary percutaneous device using a 12 cm screw-type device for a patient with an above-knee amputation. In 1999, ESKA produced the Endo-Exo Femurprosthesis (EEFP) which was first implanted into the femoral canal of a young motorcyclist who lost his leg in an accident and subsequently used for a number of patients in Germany. There have been variations in the design, including some types to allow proximal fixation to other devices such as a hip replacement, but commonly the device is a modular, noncemented device that fits within the intramedullary canal of the femur and has a hardpoint attachment that exits through the skin (Figure 2).

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Figure 2. The device is a porous modular construct with the smoothly polished coupler distally exiting through the skin.

Challenges

Stable fixation and prevention of deep infection are the principal challenges with a transcutaneous femoral prosthesis of this type. First, a bone guided, soft tissue penetrating femur prosthesis has to have secure and durable fixation of the shaft of the prosthesis in the intramedullary canal of the femur; loading moments and stresses can be significant. Second, the dermal interface must heal adequately to allow functional activity and activities of daily living (including submersion) without significant persistent risk of infection.

Stable fixation can be achieved in several ways; the German device utilized a spongiosa surface of casted cobalt chrome that allows for a porous surface for bone ingrowth. This surface has been utilized on a number of different hip prostheses with good results as well. Other alternatives may include plasma sprayed titanium surfaces or HA coating.

Aschoff achieved good results and few issues with infection by breaking the procedure down into 2 stages, with the first stage comprised of a primary, closed procedure with the stump closed over the implanted prosthesis. Six to eight weeks later, the stoma is created with a second procedure, allowing the stump to heal with a solid seal around the prosthesis after tissue swelling has subsided.

Surgical Considerations

Preoperative planning requires consideration of the local stump, including scars or burns as well as radiographic determination of the length and diameter of the prosthesis. A CT scan is helpful for determining the necessary implant size and limb length. Typically at least 12 to 15 cm of femoral shaft is needed for stable fixation.

To minimize stump difficulties and soft tissue problems, the procedure is divided into 2 separate surgeries, which allows for the swelling and fluid accumulation in the stump to subside dramatically after the initial implantation. The first stage involves reaming the femoral canal in a retrograde fashion (similar to a retrograde femoral nail). A tight press-fit is achieved with the metal surface of the intramedullary component. The stump may also be debulked or scars can be revised at this point, and the stump is closed over the capped prosthesis.

The second stage is typically an outpatient procedure, essentially using a "cookie-cutter" to sharply cut an opening in the skin and soft tissue over the stump for the coupler. Approximately 6 to 8 weeks after the primary procedure with implantation of the endoprosthesis - assuming good healing of the wound and stump - the second procedure is performed to create the stoma and attach the transdermal coupler (Figure 3). The sharp cutter is passed percutaneously over the guide, producing an intentionally larger diameter circular skin incision than the coupler diameter. The coupler connects to a prosthetic leg, and essentially any type of external prosthesis may be used.

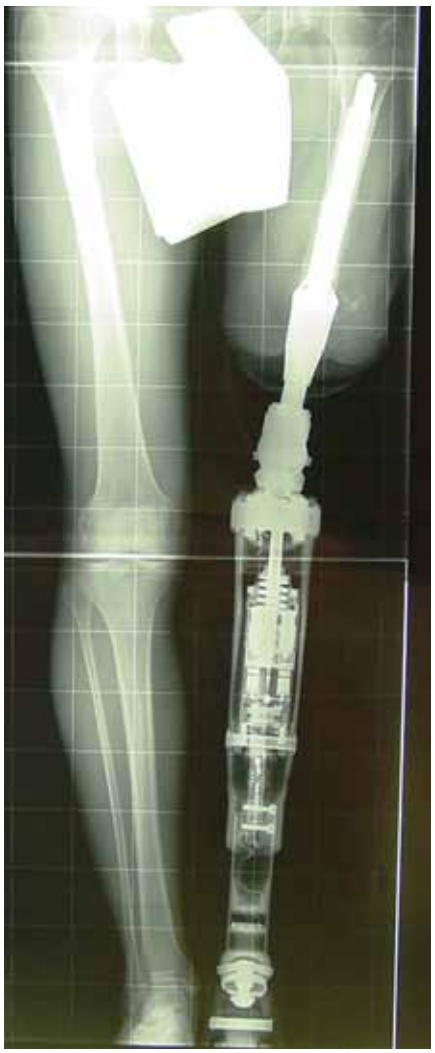

Figure 3. The device is coupled to a leg prosthesis, with a very functional transfer of the load across the prosthesis to the femur.

After the second procedure, the skin starts to scar down around the coupler. The skin will epithelialize around the stoma channel from the outer skin margin and connective tissue will fill in down to the femoral cortex, similar to a dental implant. Partial weight bearing can begin as early as 2 to 3 weeks after the stoma procedure. Full weight bearing and a secure gait can be achieved 4 to 6 weeks after the stoma procedure.

Future Directions

The devices in recent years have all included a smoothly polished coupler that replaced the initial rough surface couplers. Early designs used a porous surface for the transdermal coupler, but hypergranulation tissue sometimes appeared that was uncomfortable and occasionally necessitated soft tissue debridement procedures. In these cases, replacing the coupler with a smoothly polished surface resolved these issues and dramatically diminished soft tissue problems and minor superficial infections. Additionally, early stoma procedures were the same or slightly smaller diameter than the coupler. Aschoff reported that changing the stoma procedure now allows for sharply dissecting a slightly larger diameter than the implant, which promotes epithelialization. Some patients have returned to activities they previously could not do, such as diving and swimming.

Future directions include use of the endo-exo technique for tibial and humeral amputees. Additionally, the designs could possibly be improved from an engineering perspective by changing from a casted cobalt chrome intramedullary device to a titanium porous coated, plasma sprayed, or HA coated device.

Conclusion

The concept of using a transcutaneous intramedullary device for patients for whom a traditional socket type AKA prosthesis presents difficulties may be a benefit to many amputation patients. It is especially promising for active, healthy, post-traumatic amputees and may lead to fewer costly socket refittings and increased comfort. Additionally, it may also contribute to improved gait and comparatively less energy consumption by more efficiently transmitting the load directly to the skeletal frame.

Soft tissue problems at the stoma can be an issue, but recent investigators have reported improved results with modifications to the technique, particularly use of a smoothly polished coupler and larger circular incision and a two stage procedure. Future design changes, particularly in materials and by using more modern fixation techniques learned in hip arthroplasty evolution, may also improve the outcomes and durability of the procedure.