

Amputation Surgery

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KEYWORDS

• Amputation • Osseointegrated implant • Targeted muscle reinnervation • Allograft

KEY POINTS

- There are instances when stump revision should be considered to provide a better prosthetic fitting and function.
- The best level of amputation must take into consideration the newest socket designs, methods of prosthetic suspension, and technologically advanced components.
- Targeted reinnervation is a new neural-machine interface that has been developed to help improve the function of electrically powered upper prosthetic limbs.
- Osseointegrated implants for prosthetic suspension offer amputees an alternative to the traditional socket suspension, and are especially useful for transfemoral and transhumeral levels of amputation.
- Cadaver bone can be used to lengthen an extremely short residual bony lever arm.

INTRODUCTION AND PHILOSOPHY OF AMPUTATION SURGERY

Amputation surgery should always be viewed as reconstructive surgery, with the thought that the amputated extremity will provide less pain and better function than the limb would have if it had not been amputated.

Included in the goals of amputation surgery should be:

1. Remove nonviable, diseased, or infected tissues
2. Provide a residual limb that will be useful for prosthetic function
3. Cover the residual limb with full-thickness soft tissue including muscle and fascia covering the bone
4. Taper the ends of the bone without sharp or rough edges
5. Provide a cylindrically shaped residual limb that provides a better prosthetic fit than a conically shaped limb
6. Primary wound healing within 3 to 5 weeks
7. Control of postsurgical edema
8. No hematoma formation

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9. Gentle handling and retraction of the nerves up into the stump
10. Preservation of length that will accommodate contemporary prosthetic components
11. Excellent postoperative pain control

Surgical techniques to achieve these goals are covered in other surgical texts noted in the Selected Readings at the conclusion of this article. However, a few of the newer surgical options are mentioned here. Increasing in popularity for the below-knee amputee is the Ertl procedure, which is categorized as an osteoplasty. For the below-knee amputee, a piece of autologous bone is placed between the ends of the tibia and fibula, secured in place and permitted to solidly fuse in place. This procedure usually results in a more cylindrically shaped residual leg that is considered to permit better fitting of the prosthetic socket, and often can take direct end pressure on the stump.

Another newer technique now available to salvage a limb or to provide longer length is the use of allograft (cadaver) bone. If there is inadequate tissue to cover the increased bone length, full-thickness flap surgery can be used to cover the new bone length. Often this can add an additional 3 to 4 inches (7.5–10 cm) of bone length that can make a significant difference in the lever arm available to move the prosthesis, especially if the starting residual limb is very short.

A surgery used in Sweden and being investigated in the United States is called osseous integration, or direct skeletal attachment. A female coupling device is inserted into the residual bone and held in place with cement. The exoskeletal prosthesis is then attached using a male coupler that is the proximal end of the prosthesis. With this secure coupling, no socket is needed for the residual limb. With this design, all movement of the bones of the residual limb is directly transferred to motoring the prosthetic components. One disadvantage of this process is that as yet, no material has been found into which the skin will heal and provide a bacterial barrier. In some cases, infection has become a chronic problem and the long-term use of antibiotics has been necessary. In a few cases, the residual limb has fractured above the inserted female component, which then needs to be removed.

Free bone grafts have become useful in preserving all available length of the residual limb. These grafts are autografts, and can be taken from a fibula or a scapular margin.

Targeted muscle reinnervation (TMR) is being used in a few centers to create new muscle signals for myoelectric control. This procedure is often used in proximal levels of arm amputation where few muscles remain from which to obtain muscle signal sites.

Postoperative techniques to protect the residual limb incision include a variety of methods:

1. Rigid postoperative casting
2. Rigid removable cast
3. Immediate-fit prosthesis
4. Soft, bulky dressing

Each of these techniques has its advantages and disadvantages. The best technique is probably the one agreed upon by the amputation team, the pros and cons of which are understood by the team. No one technique has been shown to improve the eventual outcome of wound healing or prosthetic use, or to lessen the costs of health care.

Covering the residual bones with muscle, fascia, and full-thickness skin provides the most durable covering for the constant pounding of the residual limb from prosthetic

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