

# The Prosthesis and Its Components

## *Choices, Choices and More Choices!*

ACA has not included photos of the prosthetic components described in this story because of our endorsement policy. We recommend that parents discuss the options with their child's prosthetist to determine the best combination for their child.

For more information about prosthetic options, tips on choosing a prosthetist, or a listing of prosthetists in your area, please contact the ACA toll-free at 888/267-5669 or visit the ACA Web site at [www.amputee-coalition.org](http://www.amputee-coalition.org)

by Jon B. Holmes, PT, CP

Knowing what options are available when deciding on a prosthesis and its various components for your child or teen is very important so that you, as a parent, can make informed decisions. Being educated and having the relevant information will help you make good choices and can help you feel that you have some control over the situation. You should, therefore, gather as much information as possible. In addition, you should seek out a clinic team that can assist you with all aspects of caring for a person with a limb difference. Doctors, prosthetists, peers, support groups, books, magazines, and the Internet all offer excellent opportunities to learn more. Once you have enough information, making the best choice will be much easier.

It is essential to keep in mind that all good prosthetic devices are custom-made for each individual. No one thing is best for everyone. The choice should be based on what is best for a certain person at a certain time. As situations change, so will the choices. The prosthetic process will evolve as needs and technology change. On average, a growing child will need a new prosthesis every two years. Thus, choices need to be made often, and the learning process must occur at a very rapid pace. On the positive side, this gives you the chance to consider new technology and to learn from the success or shortcomings of your previous prosthetic choices.

These decisions can be thought of as stages. What is best at one time might not be the right choice next time. Or something that might be too big or complex now might be a good option next time or the time after that.

### **When and How to Fit the Prosthesis**

The age and development of the child or teen are the first things to consider when deciding when and how to fit the prosthesis. It is best to first begin fitting a child with a lower-limb prosthesis when he or she is pulling up to stand, which is usually at 9 to 12 months of age. Pulling to stand should be encouraged by fitting the prosthesis, which will also help the child begin to learn to walk. If the amputation is acquired by the child or teen at a later time, the process should begin as soon as he or she is physically able. Even if the youngster is missing his or her knee joint, the first prosthesis will often not include one to keep things simpler during the learning process. A knee should, however, be incorporated as soon as it is safely possible.



The rule for fitting children with upper-limb amputations is to fit them when they

are able to sit. This will facilitate normal development by allowing bimanual tasks, such as crawling, holding a bottle, or playing with a ball. This first prosthesis is generally passive and works well for what a child typically needs to do. At the age of 18 months to 2 years, the child is usually ready to have a functional terminal device that will operate through body power or myoelectrically. The conservative approach would be to fit a body-powered device first and then a myoelectric device at the age of 3 or 4 when the child should be better able to tolerate its increased weight and complexity. An elbow joint should be added after the terminal device has been used and understood. This often occurs at about 3 years of age. Regardless of the level of amputation, when some skeletal maturity has taken place and growth is not occurring at such a rapid pace (13 to 15 years of age), the child or teen should be treated prosthetically as a young adult.

### **“The Motor”**

Generally speaking, the prosthetic parts closest to the body are considered the most important, and they decrease in importance as they go away from the body. In fact, the most important aspect of the prosthesis is “the motor,” or the amputee. Unfortunately, this “component” is sometimes not considered enough. The condition of the residual limb and the amputee’s strength and range of motion should be optimized whenever necessary and possible.

Revision surgeries and therapy programs may help make the individual better able to maximize the use of his or her prosthesis. For young people with amputations through the long bones, overgrowth can be anticipated. Though prosthetists can often use strategies to help postpone and minimize the need for surgeries, revision may be necessary when pain dictates.

## The Socket

After the motor is prepared, it is time to construct the socket. This is the part of the prosthesis that the amputee's residual limb fits into. Because of the necessity of an intimate fit for this part of the prosthesis, many things must be considered and many choices must be made.

Comfort is first and foremost. When the prosthetist is designing the socket for optimal fit, he or she should consider its shape and the materials that will be used. If a socket fits with minimal discomfort, anything is possible.

The prosthetist should also consider the wearer's potential for growth, hygiene issues, and the need for durability of the prosthesis. Allowing for growth in a prosthetic socket can be very challenging. Growth generally occurs more longitudinally from 1 to 7 years of age and more circumferentially from 8 to 14 years of age.

Adjustable distal pads can be worn inside the socket and adjusted as bones grow longer. Similarly, thick or multiple prosthetic socks or liners can be used, giving wearers the freedom to reduce their thickness or their number as their limb grows.

Liners can either be made of different foams that are easily replaced or of gel. Today, these gel liners are available in various thicknesses, and manufacturers are making them in much smaller sizes to accommodate youngsters. Some people choose not to use liners, however, because they are difficult to keep clean, are not very durable, and are relatively expensive to replace.

Though the use of locking liners provides improved attachment of the residual limb to the socket (suspension), they are more difficult to adjust for longitudinal growth. If distal pads are used from the beginning, however, the pads can later be removed, possibly enabling the socket to fit for a longer period of time.

Flexible thermoplastic sockets contained in some sort of hard frame can also increase the prosthesis' comfort and adjustability.

These inner sockets can be stretched or replaced by thinner ones or the frames can be cut open more to allow for changes in girth (circumference).

These socket designs and materials can be used for almost any level of amputation, depending on the individual amputee's needs. Though some amputees need to leave a lot of room in their sockets for growth, others may not. Those with disarticulations, for example, may have fewer problems with longitudinal growth because they are bearing their body weight on the end of the bone. As a result, their sockets can typically be simpler in design.

## Suspension

Suspension is another important aspect of the socket to consider. The better the socket holds onto the body, the better it



will work. Straps and belts made of a variety of materials, including cotton, Dacron, and leather, and worn around the waist traditionally work best for transfemoral (above-knee) amputees.

Locking liners are often used with youngsters, but linear growth should be considered. If they are used, lanyard systems or tab locks work well because they allow for more padding at the bottom and help accommodate some growth. Suction sockets, on the other hand, are difficult to adjust for growth and are harder for youngsters to put on without help. Because of these problems, suction sockets are generally not used until there is more skeletal maturity.

Transfemoral (below-knee) prostheses can also be suspended using straps and belts, which usually fit above the kneecap, are made of leather or Dacron, and are durable and easy to replace.

Knee sleeves made of neoprene, rubber, or gel also work very well. Often, simple versions bought at a local sporting goods store will serve the purpose.

Anatomical suspension – a type of suspension in which the socket fits tightly above some bony part of the body to keep the prosthesis from slipping off – can also be used at times. Unfortunately, although this type of suspension works well and can add stability, it offers little ability to adjust for growth. As a result, the socket may need to be replaced more often.

## Knees

Many types of knees are made specifically for children now. They are best thought of in the following categories:

- **Manual Locking Knees.** These knees lock in the fully extended position and can, therefore, be useful for very young or first-time prosthesis users who

require maximum stability. Often, bilateral amputees will prefer this knee choice as well.

- **Single-Axis Knees.** These knees consist of a very simple design in which the knee swings on a fixed pivot point, or hinge.

There is very little that can go wrong with this type of knee so it is very durable. Its chief limitation is that it only swings at a constant speed, which can be a problem for active children or teens who are always changing speeds.

- **Stance-Control Knees.** These knees include some sort of braking mechanism that inhibits the knee from “buckling” when weight is placed on it. Though few stance-control pediatric knees are available, they can be very useful for younger

children or anyone who needs increased stability.

- **Polycentric Knees.** These knees offer multiple axes of rotation, and because of the way the mechanical linkages work, there is an effective moving center of rotation. Instead of having a fixed center of rotation like in a single-axis knee, the center of rotation is constantly changing. These knees are a good choice for amputees with knee disarticulations or long transfemoral amputations because it is possible to match the knee center more closely due to the way the linkage moves. Though these knees allow good control in stance, providing a very stable knee, they can also be easily bent when desired. Their major disadvantages are the additional maintenance required because of their multiple moving parts and the additional weight. Many pediatric choices are available in this class of knees.

- **Fluid Control Knees.** These knees, which use either hydraulic (fluid) or pneumatic (air) systems to provide variable resistance in the knee, allow the knee joint to move at various speeds during the swing phase of gait. This allows the user to walk at various speeds or to run with the knee responding accordingly. Although these knees are excellent for youngsters, there are only a few choices available in the small sizes.

## Feet

Feet should also be thought of in categories.

- **SACH (Solid Ankle Cushioned Heel) Feet.** These are the simplest feet. They have a rigid keel and a soft rubber heel, and compression of the soft heel provides the ankle action. Because they are so

simple, they require little maintenance and are very cost-effective feet for growing youngsters.

- **Multiaxis Feet.** Because they move side to side and up and down, allowing them to conform to the ground, these feet are recommended for walking on uneven surfaces. They require more maintenance due to moving parts, however.

- **Dynamic-Response Feet.** When users walk, these feet absorb energy and “spring” back to provide push off. They come in

many versions and vary in cost, stiffness, and ease of use. They are recommended for active people and are, therefore, a good choice for youngsters. However, cost and ease of adjustability should be considered in selecting the most appropriate one.

## Covers

The choice of cosmetic finishing will vary according to the

individual and/or the type of prosthesis he or she has. In general, however, tough, durable covers that will last should be chosen for this active population. Fragile, highly cosmetic covers will be likely to fail. Often, a realistic-looking cosmetic cover will be avoided completely, and children and teens will choose to use a mechanical-looking prosthesis with no cover or a prosthesis with a design on it.

## Upper-Limb Amputees

The choices involved in fitting an upper-limb amputee are much more individualized and must be made based on what will help the child or teen function better. The prosthesis should be thought of as a tool and geared to help him or her perform functional tasks. Often, the loss of sensation that occurs when a child or teen uses a prosthetic arm is not worth it, and he

or she will prefer to use his or her residual limb as an assistive device.

Early fitting is the most essential factor in achieving a successful outcome. Passive arms and functional body-powered and myoelectric hooks and hands all have their place and can be successful in the right setting. Again, there is no one thing that is best for everyone. You must give the youngster the opportunity to try different things and assess what works best for him or her.

## Reassessing Prosthetic Solutions

Follow-up care is extremely important, and no prosthetic design feature can replace it. It is generally recommended that a child or teen be reassessed by his or her clinic team every six months. At this time, prosthetic devices will generally need adjustments for growth to ensure a proper socket fit and to ensure that the remaining limb and the prosthetic limb are the same length. The young person's goals may also have changed. He or she may have decided to take up a sport or activity, which might affect his or her prosthetic needs. In addition, routine maintenance will need to be done to help avoid catastrophic failures of the prosthesis.

## Adapting to the World

In conclusion, take comfort in knowing that the success of the child or teen depends on his or her ability to adapt. Fortunately, youngsters are extremely good at adapting, in general, and, therefore, with or without a prosthetic device, they will often accomplish things never expected or even considered possible. Make choices in an orderly and logical fashion based on the young person's developmental skills. Help the child or teen reach his or her potential just as you would any other. ❖

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