

# When a Prosthesis or Mobility Device Isn't Enough

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Below-knee amputees frequently ask me to cut down the top back section of their prosthesis to enable them to bend their knee more easily. At other times, they ask me to cut down the sides because of discomfort or because the trim lines of the socket stick up too far and are cosmetically unpleasing. When above-knee amputees ask me for similar help, the area of the socket that needs to be cut for increased comfort is on the inside top and for better cosmetics on the outside top. Though I sometimes accommodate my patients' requests because they are not detrimental to the fit or function of their prosthesis, many times, I have to tell them, "I can't do that because it is not in your best interest."

Amputees have a host of biomechanical and anatomical problems, including muscle weakness, abnormal bone structure, and abnormal bone alignment. In most cases, the trim line height and design are established by the prosthetist to help compensate for these problems.





Figure 1

If a person has a short below-knee amputation, for instance, he or she will generally have some knee instability during gait. A high trim line on the inside and the outside top (Figure 1) will help stabilize the knee. With above-knee amputations, the main muscles that stabilize the person's femur, and subsequently the pelvis and body, have been cut. To help stabilize these areas, the top of the prosthesis is kept high and tight on the inside and outside (Figure 2).

Your prosthetist knows that this is not as comfortable as it would be without these trim lines, but he or she also knows that cutting these down may compromise your gait and overall function.

Sources of gait problems in amputees are numerous and include bad habits, tendon strains, ligament sprains, fractured bone, neurological impairment, skin breakdown, balance and visual disorders, fear of falling, an ill-fitting or poorly aligned prosthesis, and, as we have noted, improper trim lines.

These problems may affect a person's gait symmetry and velocity, the body's center of mass, stride length, arm swing and other parameters. Unfortunately, when a person's gait falls outside the normal range, the effects may range from negligible to catastrophic. These gait problems can lead to back pain, knee problems, injury to the foot, muscle injury, fall injuries, etc.

If a below-knee patient insists on cutting the trim lines down even against professional advice, it could result in a loss of support and excessive forces being applied to one side of the knee. Because of the resulting instability and pain, this could then result in the need for a knee orthosis section to be added to the prosthesis.

Similarly, cutting down the trim lines for an above-knee amputee may compromise pelvic stability, possibly resulting in excessive wear at the hip joint, spinal problems, or poor gait habits. As a result, a Silesian belt or a hip joint and pelvic band orthosis may have to be added. The patient may also have to use some type of spinal support. Even worse, the patient might ultimately require hip or spinal surgery or even lose the ability to walk.

The preceding examples make it clear that healthcare practitioners and patients need to compromise to meet all of the goals of the patient, especially in situations where solving one problem causes others. Unfortunately, when there is no perfect solution, the practitioner and the patient must find the best available solution. This solution, as shown in the previous examples, might often include the use of a supplemental orthotic device.

### Crutches and Wheelchairs

The use of mobility devices like crutches and wheelchairs can also cause harm to a patient's nervous, muscular and skeletal systems.

Consider a standard pair of axillary crutches. Most people have probably, at some point, walked with a set of crutches for support, and no one enjoys being shown how to properly use them. Proper fitting and education is a must, however, and not a luxury. If not appropriately fit and used, excess pressure from the crutches can cause damage to the large nerves passing through the armpit (axilla). The most common cause is the person's elbows being bent (flexed) excessively and not enabling sufficient weight-bearing through the hands, thus causing too much body weight to be borne in the axilla area. In addition to this problem, if axillary crutches are used with excess elbow flexion, the person's gait will be less efficient. When the elbows are flexed just slightly, on the other hand, more power is readily available from the arm muscles to vary gait speed and change the stride length.



Figure 2

Wheelchairs are also a necessary part of many peoples' lives. When fit and used properly, they are a highly beneficial means of mobility for their users. Unfortunately, wheelchairs that are typically used for transporting are not intended for long-term sitting, and these wheelchairs are notorious for providing a hammock-type seat surface, an insufficient back support, and an improper hip flexion angle. In such cases, the user is likely to slump forward with poor spinal posture from the pelvis to the skull and to have over-rotated and flexed hip joints.

In some cases, footrests may be necessary components of a wheelchair. If they are needed, but not in place, the distance from the seat to the floor will exceed the user's leg length and his or her foot will not contact the floor. To compensate, the user may slide forward in the seat, resting on the sacrum (tailbone) until the foot contacts the floor and prevents further sliding.

In other instances when footrests are needed, a user may have the proper wheelchair components and the correct measurements but still slide forward, slump in the seat, or experience other problems because of disease or a pathologic condition. If the wheelchair user is unable to sit with proper alignment due to muscle weakness or spinal deformity, some type of spinal orthosis may rectify the problem and enable healthy spinal positioning and weight-bearing. If the feet continue to slide off of the footrests due to malpositioned ankles, ankle-foot orthoses (AFOs) may also be needed to place the feet flat on the rests and maintain the body's position in the seat.

These corrective actions may seem trivial to some, but to people who spend much of their time in a wheelchair, they may be vital in preventing further deformity or breakdown associated with overloading skin that is not intended for bearing weight.

## Prostheses: Combining Prostheses and Orthoses

There are also situations where a

prosthesis (a combination of a prosthesis and an orthosis) is beneficial. These combination devices serve the dual role of replacing a lost limb and bracing the residual limb for protection, support or other orthotic function.

Probably the most common prosthesis is the joint and corset below-knee prosthesis, which is generally used when the integrity



of a person's knee joint is questionable (Figure 3). First, this is a below-knee prosthesis with a prosthetic socket interface, pylon (shin), and foot. This is the prosthetic portion. Because ligament instability is present, however, orthotic joints are also added to limit the patient's accessory knee movement and prevent it from undesirably stressing the anatomic knee.

Often, the user's residual limb is short and/or highly sensitive, and this prosthesis transfers much of the body's weight from the person's thigh through the orthotic joints to the prosthetic foot, thereby bypassing the residual limb. If the joint and corset

prosthesis is needed but not used, the result may be a knee that has excess laxity and instability or a needlessly uncomfortable prosthesis.

### Figure 3

*This joint and corset prosthesis has the top half of a knee orthosis (KO) attached to it. This is for two reasons. First, the patient has an extremely short residual limb with insufficient surface area to fully bear weight through it. The KO allows some of the weight-bearing to be transferred to the thigh. Second, it is typical for a patient with a short residual limb to have knee instability because the "lever arm" (the remaining part of the limb below the knee) is too short to support the forces that are placed on the residual limb during weight-bearing. The KO artificially extends the "lever arm" well above the knee to assist it against these forces.*

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As shown in the preceding examples, there are times when a prosthesis alone cannot solve the problems of a person with limb loss. In these cases, an orthotic device may be a beneficial supplement to the patient's care.

In fact, sometimes when patients complain that their prosthesis is painful, that it doesn't fit well, or that it just isn't working for them,

the problem might not be in their prosthesis at all. It might, instead, be that they need additional orthotic support to help with weight-bearing, to keep their body in proper alignment, etc.

Orthotic treatment is, therefore, something that should be considered in many patients who use prostheses or mobility devices and who are having or are likely to develop additional problems as a result of poor gait, crutch or wheelchair misuse, or simply wearing a prosthesis. It's something that practitioners and patients both must keep in mind. ■



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