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To Champion Triathlete
From Average Amputee

Art Meets Science in Creation Of Transfemoral Limb Systems

To a prosthetist, the approach to creating a transfemoral, or above-knee (A/K), replacement limb can be considerably different than for a lower amputation level. Where a transfibial (B/K) prosthesis must replace the foot, ankle and part of the lower leg, an above-knee system adds the critical knee joint and part of the femur...and the degree of difficulty jumps exponentially. Fortunately, surgeons have become quite good at predicting the level at which amputation wound healing will be successful, reducing the number of unecessarily high amputations. Still, nearly 20 percent of all individuals will lose limb in the U.S. have a transfemoral deficiency, and an estimated 29,000+ above-knee amputations are performed in this country annually.

For patients, an A/K prosthesis presents a much greater challenge than a B/K system, in terms of weight, energy expenditure, balance, safety, comfort, and functional mastery. Thus, we select and recommend particular components and materials that will help transfemoral amputees achieve their maximum possible rehabilitation outcome. The process of accomplishing this outcome is as much art as science.

Ideally, prosthetic management involves the active participation of the patient’s physician, amputating surgeon, family and physical therapist. Interviewing patient and family before surgery can give us a head start on planning a new amputee’s course of treatment and prosthesis design.
Componentry Choices Make Most of Amputee Abilities

(Continued from page 1)

In lieu of or in combination with myodesis, a myoplasty reconstruction may also enhance the prosthetic outcome. While aggressive post-operative management with an IPOR (immediate post-operative prosthesiology) is common for transtibial amputees, it is less frequently used for above-knee patients. The benefits of early ambulation must be weighed against the patient’s ability to tolerate a non-prosthetic rigid cast incorporating the pelvic area. In the absence of an IPOR, the post-operative focus is on wound healing and protection and prevention of hip contractures.

When the patient is deemed ready for a replacement limb, a preparatory prosthesis consisting of a check socket and knee and foot components may be prescribed to assess socket and component function before proceeding with the finished system.

Ability Considerations

While we would like for every amputee to be able to walk again with a prosthetic limb, the reality is that a fair number lack the physical strength, coordination, mental ability and/or will to do so. The percentage of non-ambulators increases directly with amputation level.

For each able above-knee amputee entrusted to our care, our management plan and goals in conjunction with residual desires before developing a management plan and goals in conjunction with the patient, family, and others on the rehab team.

Components

A prosthetic limb is in fact a system incorporating various essential designs and components, each with its own specialized function. For each above-knee amputee entrusted to our care, our prosthetic staff creates an individualized leg incorporating the best combination of socket design, suspension scheme, knee and ankle-foot components for that patient’s capabilities and functional desires.

Socket Designs—While all aspects of a transfemoral prosthesis are important, patient surveys reveal that the fit and comfort of the socket are by far the most critical considerations for a successful outcome. Today’s sockets typically employ some variety of an ischial containment (I.C.) design, which has largely replaced the long-popular quadrilateral (quad) shape. I.C. sockets feature a narrow medial-lateral dimension with the ischium encapsulated within the socket instead of sitting on the brim. Some I.C. socket proponents contend the design helps maintain the residual limb in an anatomically normal adducted position, solving the common side lurch gait resulting from the replacement limb migrating outward during swing phase. Quad sockets are still applicable for various patients, both for a preparatory prosthesis and as the socket of choice for individuals who have worn a quad for many years and have no wish to change. A unique I.C. design, the Marlo Anatomical Socket (MAS), resulted from an effort to eliminate the posterior socket brim outline clearly visible under the clothing of female amputees. Beyond that, any prosthetic socket, the MAS also provides increased range of hip motion and is comfortable to wear when standing, walking and sitting down. The MAS features a low posterior brim and pronounced medial alignment that facilitates a more normal and energy-efficient gait. This socket is still relatively new, and the design continues to evolve.

Today’s transfemoral socket design is trending to be more soft and durable plastics, which provide rigid support where needed while still allowing for muscle motion. A flexible wall socket consists of an elastic inner socket within a rigid outer frame with open spaces, providing a comfortable interface with the residual limb at all weight.

Suspension—Almost as important as socket fit is the suspension method, i.e. how the prosthesis is attached to the body. A good suspension maintains the socket in snug contact with the residual limb and prevents undesirable sliding, rotation and/or pistoning movement within the socket.

Several suspension options are available:

- Total contact pure suction using an expansion valve, which allows air to escape from the socket as the residual limb is inserted, creating a vacuum within the socket.
- Roll-on gel liner fitted with a locking pin, lan- yard or strap-and-buckle-type attachment device.
- Soft straps or waist belts (TES belt, Silesian band).
- Rigid belt with hip hinge. Each of these methods works better for some patients than others. Locking pins with a locking pin have become widely used in recent years; however, this method concentrates significant force at the distal end of the residual limb, which some patients cannot tolerate. Alternative locking methods, e.g. a lanyard or buckles, can be an effective alternative.

Pure suction, while difficult to achieve for some amputees, often works when a locking liner will not. Soft suspension belts and rigid belts with hip hinges are sometimes prescribed for patients who need a high sense of security that their suspension will hold. Soft belts are often used with a preparatory transfemoral system when residual limb changes preclude suction suspension.

Prosthetic Knees—Selecting the most appropriate knee component involves careful weighing of the amputee’s overall health and capabilities, predicted type and intensity of prosthetic use, and cost. We choose from among several basic types:

- A manual locking knee is locked for ambulation, unlocked for sitting. The amputee walks stiff-legged and must swing the leg outward for floor clearance, which is both awkward and energy-consuming. However, this is the most stable choice and is appropriate for limited ambulators.
- Constant friction knees are simple, lightweight and dependable, but they limit the wearer to a single cadence. The friction setting determines the speed of leg swing and is adjusted for the patient’s normal walking speed.
- Stand-control or safety knees incorporate a weight-activated brake that prevents knee buckling while in stance phase. This knee is often prescribed for a new amputee’s first prosthesis.
- Polycast knees provide a moving center of rotation keyed to the degree of knee flexion and thus help ensure swing phase floor clearance for patients with a long residual femur or knee disarticulation.
- Hydraulic and pneumatic knee systems are appropriate for patients capable of variable cadence. These designs immediately match leg swing to walking speed so the amputee can confidently change gait, walk on slopes and ambulate in a step-over-step fashion.

When the building blocks of the transfemoral limb are selected and ready for assembly, the art of prosthetics again comes to the fore. Optimal alignment of the various components when creating the finished prosthesis can make all the difference between a great outcome and a poor one. The alignment process balances safety and stability with an efficient, comfortable gait. Technology has provided us with wonderful prosthetic designs and products. Our mission is to select and assemble them such that the finished limb is far greater than the sum of the parts and our patient realizes his or her full potential.
From Average Amputee To Champion Triathlete

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