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Dynamicnews

a publication for patients and clients of
DYNAMIC ORTHOTICS *and* PROSTHETICS

Back to Back Publications for Dynamic O&P Clinicians

Clinicians at Dynamic O&P were recently published in consecutive issues of the *Journal of Prosthetics and Orthotics*. Phil Stevens CPO, was a co-author in the final issue of 2005, and Miguel Gomez MD, LO, was a co-author in the first issue of 2006.

Working with plastic surgeons from Texas Children' Hospital, Phil's article was entitled, "A Preliminary Investigation of Postoperative Molding to Improve the Result of Cranial Vault Remodeling.1" The article focused on children diagnosed and treated with a medical condition known as craniosynostosis. The bony plates which comprise the infant skull are originally unconnected. This is necessary to allow the skull to pass through the birth canal. In most children, the plates begin to fuse together between 10 and 18 months of age. In patients with craniosynostosis, a fusion between two plates occurs prematurely at one or more junctions or sutures. As the infant continues to grow, bony growth of the skull compromised, resulting in often dramatic asymmetries of the skull and face.

Such cases have historically been treated with complicated plastic surgeries when the child is about 8 months old. During the operative procedures, plastic surgeons attempt to reconstruct a more symmetric head shape. While the improvement obtained surgically are often quite dramatic, for several years the surgeons at TCH have referred patients for remolding helmets immediately after the surgery. The intent of the helmets is to protect the infants head after the surgery and to further improve its shape by encouraging and discouraging growth in targeted regions.

The study reported on a group of infants treated by the plastic surgery team at TCH and subsequently treated at Dynamic O&P with protective/remolding helmets. The study found that all of those treated were observed to improve with respect to their cranial symmetries in the months following surgery. While previous studies have evaluated the use of such helmets in conjunction with endoscopic procedures, or in the presence of sagittal synostosis, this was the first publication to document the

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Phil Stevens, CPO and Miguel Gomez, MD, LO stand with copies of their recent publications in the Journal of Prosthetics and Orthotics.

If your organization would be interested in an in-service on prosthetics and/or orthotic care, please contact company President, Tom DiBello at (713) 747-4171.

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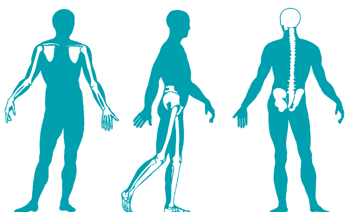

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Art Meets Science in Creation Of Transfemoral Limb Systems

To a prosthetist, the approach to creating an above-knee or transfemoral (TF) replacement limb can be considerably different than for a lower amputation level. Where a below-knee or transtibial (TT) prosthesis must replace the foot, ankle and part of the lower leg, a transfemoral system adds the critical knee joint and part of the femur. Unsurprisingly, the degree of difficulty jumps exponentially.

Pediatric above-knee prosthesis. *Courtesy:* Ossur

During the early years of amputation surgeries, above knee amputations were very common secondary to concerns about achieving adequate wound healing in the more bony portions of the leg beneath the knee. Fortunately, advancements in surgical and wound healing techniques have greatly reduced the number of unnecessarily high amputations. Still, nearly 20 percent of all individuals with limb loss in the U.S. have a transfemoral deficiency, and an estimated 29,000+ above-knee amputations are performed in this country annually.

For patients, TF prostheses present a much greater challenge than TT systems, 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. Our three main questions:

- What can the patient physically – and mentally – do?
- How much residual limb do we have to work with?
- What are the patient's mobility and lifestyle desires?

Surgical Considerations

The adage Prosthetic success begins in the O.R. is quite apropos for a transfemoral amputation. Particular issues at this level are (1) the inability of the residual femur to tolerate virtually any end-bearing load and (2) muscle imbalance resulting from severed adductors and extensors leading to an abnormal outward leg swing during the swing phase of prosthetic gait, and awkward trunk shifting during the stance phase of gait.

When it is practicable for surgeons to restore balance through myodesis reconstruction of these muscles (attaching the distal end of the transected muscle to the distal end of the transected bone), the residual limb can be restored to a more balanced natural position in which weight-bearing can be better directed to the side of the residual limb. Moreover, myodesis keep the femur centered in the muscle mass, facilitating socket comfort.

Courtesy: Ohio Willow Wood

In lieu of or in combination with myodesis, a myoplasty reconstruction, (the attachment of transected muscle groups to opposing muscle groups) may also enhance the prosthetic outcome.

While aggressive post-operative management with an IPOP (immediate post-operative prosthesis) is common for transtibial amputees, it is much less frequently used for transfemoral patients. The benefits of early ambulation must be weighed against the patient's ability to tolerate a non-removable rigid cast incorporating the pelvic area. In the absence of an IPOP, the post-operative focus is on wound healing and protection and prevention of hip contractures. The latter is critical as patients with this level of amputation are at risk for tightening of the muscle groups which flex the hips. Prone positioning, or lying on one's stomach is one common way to prevent this common complication.

When the patient is deemed ready for a replacement limb, a preparatory prosthesis consisting of a check socket, a mechanical 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, endurance and coordination to do so. Others lack the mental ability and/or will to do so. The percentage of non-ambulators increases directly with amputation level. Absent a natural knee joint, the challenge becomes significantly greater for a TF patient.

To rise from a sitting position or vice-versa, a transfemoral amputee must possess a good measure of strength and coordination in the remaining lower limb, arms, shoulders and torso. Unlike a prosthesis at the transtibial level, which often makes standing easier, a prosthesis at the transfemoral level is a liability during standing. The less strength and coordination the transfemoral amputee has, the greater chance of a fall.

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Limb Systems (continued)

involves careful weighing of the amputee's overall health and capabilities, predicted level of prosthetic use, and cost. We choose from among six basic types, with hybrid combinations of the various features becoming increasingly common:

Computerized limb systems help solve life's ups and downs
Courtesy: Otto Bock Health

- 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. While rarely used, this is the most stable choice and is appropriate for limited, debilitated ambulators for who safety is an overwhelming concern.
- 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.
- Stance-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.
- Polycentric 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. Many designs incorporate a geometry that brings the functional knee center closer to the hip. This provides an "inherent stability" as it becomes easier for the amputee to control the flexion of the knee.
- Hydraulic and pneumatic knee systems are appropriate for patients capable of variable cadence. These designs immediately match leg swing to a limited range of walking speeds so the amputee can confidently change velocity.
- Microprocessor-controlled knee units, such as the C-Leg® or Rheo Knee, constantly monitor cadence parameters and make instantaneous adjustments to knee function to provide an extremely natural and efficient gait across a wider range of speeds than those associated with hydraulic systems. As the most technologically advanced option, these knees are unsurprisingly the most costly. Increasing numbers of patients, however, are judging the results they provide to be well worth the expense. One notable outcome is that many amputees wearing a microprocessor controlled knee gain such confidence in their gait that they no longer have to think about each step, thereby gaining more stamina through reduced mental energy expenditure.

Ankle-Foot Components – It comes as a surprise to many that the type of prosthetic foot that works for a transtibial amputee may not be best for a transfemoral patient. New transfemoral amputees feel more secure when their prosthetic foot is flat on the ground. Therefore, this patient group benefits from single axis or multi-axis feet, which accommodate to the terrain quicker than rigid ankle systems. For high activity patients, the ground accommodation of a multi-axis foot can be combined with a dynamic response construction for optimal results.

Single-axis foot helps A/K amputees achieve foot-flat quickly.
Courtesy: Ohio Willow Wood

Alignment

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.

Meet Our Staff

Technician **Moises Sauceda**

Q: What do you like about working at Dynamic O&P?
A: What I enjoy the most about working with this community is that it never gets boring. There is always so much to learn, and I get a little better every day.

Q: If you could retire tomorrow, what would be the first thing you would do?
A: Take a vacation to Hawaii with my family.

Q: Tell us about your family?
A: I have a great family with 2 precious girls and a caring wife. My oldest daughter is 3, and youngest is one. It may sound like a small family, but it's a handful.

Q: What is the best advice you've ever received?
A: I think most advice is good advice if you stop and consider what people are saying.

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Limb Systems (continued)

However, for the transfemoral patient who can stand independently and take steps in the parallel bars or with crutches, the addition of an appropriate prosthesis can facilitate easier ambulation, and reduce the demands on the non-amputated limb. Thus, we evaluate each new patient's condition, abilities and functional desires before developing a management plan.

David Baty working on an MAS transfemoral socket with Marlo Ortiz at Dynamic.

Componentry

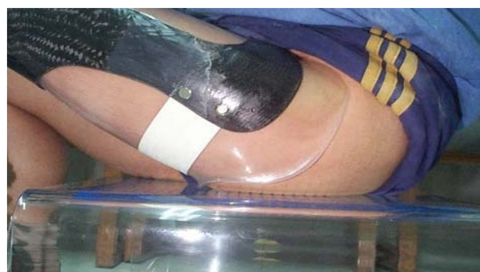
A prosthetic limb incorporates essential components, each with its own specialized function. For each able above-knee amputee entrusted to our care, our prosthetic staff creates an individualized prosthesis incorporating the best combination of socket design, suspension scheme, knee and ankle-foot components 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 which results from the replacement limb migrating outward during gait.

Quad sockets are still applicable for various patients, both for a preparatory prosthesis and as the socket of choice for patients 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 which is often clearly visible under the clothing of a transfemoral amputee. Beyond that cosmetic goal, the MAS also provides increased range of hip motion, improved side to side control and comfort when sitting down. The MAS features a low posterior brim and pronounced medial alignment that facilitates a more normal and energy-efficient gait. While this socket is still relatively new, and the design continues to evolve, many of our transfemoral patients have been successfully fit with this new technology.

Today's transfemoral socket construction consists of flexible yet durable plastics, which provide rigid support where needed while still allowing for muscle motion. A flexible wall socket consists of a very flexible inner socket positioned within a rigid outer frame. This allows the material of the socket to contour to the patient's bony anatomy during walking and sitting while still maintaining a very strong socket.



MAS design's low posterior brim allow enables wearers to sit on gluteal muscles instead of hard plastic.

Suspension – Almost as important as socket fit is the method of suspension, 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 movements within the socket.

Several suspension options are available:

- True suction using a one way expulsion valve. In this system, as the residual limb is inserted in the socket, air is forced out of the valve, but cannot re-enter. This creates a vacuum within the socket, but requires a mature limb that is not going to fluctuate in volume.
- Roll-on gel liner fitted with a locking pin, lanyard 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. Roll-on liners 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. This option is often used with newer amputees as it allows for the accommodation of volume changes as their limb matures. Once the residual limb has matured, true suction is the most efficient mechanism of suspending a transfemoral socket. For patients who require a higher sense of security, or have very short residual limbs, soft suspension belts are sometimes prescribed. These may also be utilized with preparatory transfemoral prosthetic systems, when aggressive changes in the size of the residual limb are anticipated. Though rarely utilized, in cases where additional stability is needed side to side, rigid belts with hip hinges may be prescribed.

Prosthetic Knees – Selecting the most appropriate knee component See **Limb Systems** Page 4

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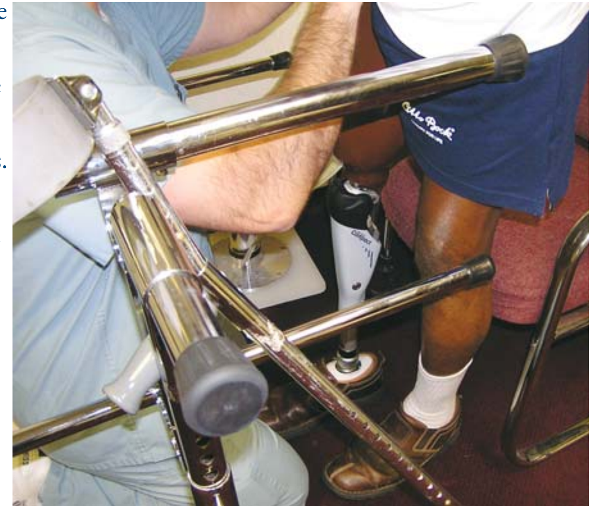
RoadShow (continued)

a less demanding lifestyle, was fitted with the "Compact." Both knee units offer something Otto Bock describes as automatic stance phase response. Using data collected by joint angle sensors and strain gauges, a microprocessor ensures that the hydraulic mechanism provides just enough resistance to knee flexion during any given instant. This allows the knee to sense and respond to stumbles, ramps, and stairs. In addition, the "C-leg" also has automatic swing phase response. Using the data described earlier, the microprocessor makes real-time assessments and changes to knee resistance, allowing the patient to walk at whatever speed he needs to, without worrying about the prosthesis keeping up with him.

Both patients were videotaped as they walked with their existing prostheses. They were then shown videos describing the new technology while their existing prostheses were being modified, their current prosthetic knees and feet being replaced with Otto Bock products. Once the prostheses were realigned, the patients were ready to experience the microprocessor technology. Before the morning was over, both gentlemen were walking comfortably, on level surfaces, down ramps, and even descending stairs. Additional video footage was collected before the RoadShow left for Sugarland.



Once unloaded, the Otto Bock team presented information to a collection of local therapists and physicians in Sugarland. The presenters showed video clips and lead discussions outlining the response of the knee technology in various terrains and situations. The patients who had been fitted with the knees earlier that morning were on-hand to answer questions and demonstrate the differences they experienced.

The next day, two new patients were on hand and given similar experiences, including a bilateral transfemoral amputee. In spite of missing not one, but two of his legs, this young, motivated patient had soon mastered all the obstacles presented, including descending ramps and stepping down stairs, step over step. With video tape collected before and after the use of the new knee units, the RoadShow departed again, this time traveling north to present to a group of therapists gathered in the Woodlands.

Dynamic O&P would like thank everyone who participated in this unique event, including our patient volunteers, the experts from Otto Bock, and the doctors and therapists who came out to see and learn.

Publish (continued)

use of post-operative helmets following aggressive cranial vault remodeling involving frontal orbital advancement.

Writing with another experienced orthotist and an engineer from the Illinois Institute of Technology, Miguel's article was entitled "Orthotic Treatment of Degenerative Disk Disease with Degenerative Spondylolisthesis: A Case Study.2" As people age, the repetitive stresses and strains of life gradually compress the fluid disks that are spaced between each vertebrae of the spine. As these disks degenerate, they lose their ability to resist the motions of the vertebrae against each other. When this occurs in the lumbar spine, the tilt of the bottom vertebra causes the spinal column to slide forward, often compressing the nerves in the spinal canal. This slipping of one vertebral body over the one beneath it is called spondylolisthesis.

It is a common problem, affecting a tenth of all males and a quarter of all females. The chief complaint of these patients is pain. The treatments range from steroid injections and pain medications, to therapy and back braces, to surgical treatment. Miguel's article reports on a single case in which a 66 year old woman with spondylothisthesis is successfully treated with a custom back brace.

The authors report the key components they believe resulted in this individuals decreased pain, increased activity level and enhanced quality of life. Specific procedures were followed to reduce the tilt of the sacrum while maintaining the patients lumbar lordosis, thus reducing the amount of shear force occurring at the site of the anterior slippage.

While some have claimed that bracing has no scientific evidence for efficacy, and perhaps no place in the treatment of lumbar spinal disorders, Miguel and his collaborating authors demonstrated radiographic evidence to dispute that claim in this case.

Articles

1. Higuera S, Hollier LH, Stevens PM, Stahl SS. A preliminary investigation of postoperative molding to improve the result of cranial vault remodeling. *J Prosthet Orthot* 2005;17(4):125-128.
2. Meade K, Flanagan P, Gomez JM. Orthotic treatment of degenerative disk disease with degenerative spondylolisthesis: A case study. *J Prosthet Orthot* 2006;18(1):1-7.

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RoadShow Comes to Houston

Dynamic O&P was pleased to host the Otto Bock RoadShow earlier this Spring as local patients were given the opportunity to try out some of the latest technology in the field of Prosthetics. On the morning of January 19th, a 20 ft cargo van emblazoned with the Otto Bock Logo pulled into our parking lot. Inside the van was an assortment of prosthetic feet, pylons and knee units. Accompanying the van were national experts in the fitting and alignment of the "C-leg" and "Compact" knee units.

> …local patients were given the opportunity to try out some of the latest technology in the field of Prosthetics.

The two knee units represent the current standard in micro-processor controlled knees. These knee units are unique in that they collect an array of data from various sensors located throughout the prosthesis to make real-time decisions about how quickly the knee will bend. The purpose of the road show was essentially two-fold: To allow patients interested in the technology to experience it, and to allow local physicians and therapists to become more familiar with the advantages such prosthetic components offer.

On Thursday morning, the Otto Bock team sat down with two current patients at Dynamic Orthotics and Prosthetics. The first, a young active male, was given the opportunity to experience the C-leg. The second, an older male with See Road Show Page 5

Bilateral amputee, Patrick, descends stairs step over step with microprocessor controlled knee units.

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