From Disney World to Parallel Bars

Bryce W. is an all-American kid whose idyllic childhood was interrupted by the cruel reality of cancer. On a long-awaited family trip to Walt Disney World in 2009, Bryce, then 9, suddenly could not walk due to pain in his left leg. A few days later, his stunned parents heard for the first time a word that would soon change their lives—osteosarcoma.

Less than four months later, the third-grader and his family learned another new word...disarticulation, as a surgeon amputated his left leg through the knee to prevent the malignancy from spreading.

There followed 12 more rounds of chemotherapy (he’d had six previously), additional surgery on his amputated limb and at length transition to a prosthetic leg. In the two years since his diagnosis, Bryce spent 99 nights in the hospital.

The nightmare began to subside upon completion of chemo. As a surgeon amputated Bryce’s leg, the oncologists told his parents that he was a candidate to be on their “driver” list. Bryce would receive a leg that would enable him to perform at the same level he would have in an intact limb.

Bryce was accepted to the N.U. prosthetics program this year. Tim was graduated from the University of Louisville physical therapy program in 2002 and attended the orthotics program at Northwestern University. He is attending the N.U. prosthetics program this year.

For more information on Orthotics and Prosthetics East, visit our web site at www.oandpeast.com or call us at 252-215-2215. We are located at 2485A Hemby Lane, Suite A in Greenville, N.C.
Creating a prosthetic socket involves two major decisions: (1) the design and fit of the socket itself and (2) the method of which by the prosthetist is held onto the residual limb, i.e., the suspension. More than any other aspect of prosthetics, socket design and suspension strategy usually spell the difference between prosthetic success and the closet.

Suction Suspension

For appropriate patients, using an atmospheric vacuum to hold the residual limb in the socket can provide a superior outcome. Suction options—whether via suction pump roll-on liner, possibly with some type of vacuum assist—limit limb movement within the socket and provide the best level of proprioception and greatest range of motion among current suspension methods.

With pure suction, precise socket fit enables residual limb skin to remain in full contact with the socket wall and thus preserve the vacuum created at donning. Donning typically involves actuating an expulsion valve at the distal end of the socket to evacuate air as the residual limb enters. A vacuum pump may be employed to enhance the suction once the residual limb is established in the socket.

Contraindications to suction include bony or residual limb irregular contours, often encountered with transarticular amputation level; significant residual limb volume fluctuations; residual limb skin challenges; and physical or mental impairment that interferes with donning or removing the socket.

Roll-on suspension liners can overcome most of these obstacles, protecting the residual limb from shear forces, providing an easier donning method, and compensating for irregular skin contours. “Cushion” liners can enhance a pure suction suspension and improve amputee comfort; more common are liners incorporating some type of locking device—locking pin and shuttle lock, lanyard or locking strap—to securely attach the liner to the socket.

Prefabricated liners, available in a variety of materials, designs, and sizes, will work for many patients, while custom liners can be created for patients with major residual limb issues or specific reasons, some older suspension methods may be employed. Strap suspension schemes, often used in combination with a waist belt, are relatively easy for the wearer to adjust and therefore are sometimes a good choice for individuals likely to encounter substantial changes in residual limb volume, as in the weeks after amputation surgery.

A suprapatellar cuff, which encircles the thigh over the femoral condyles and attaches to the socket with straps, may be a good choice for transtibial patients who have good knee stability. It is normally used with a waist belt. A thigh corset with metal side joints, may be prescribed and lateral upper-limb amputees with delicate residual limb unable to withstand full weight-bearing loads.

For transfemoral amputees who cannot use suction, a silesian belt, total elastic suspension (TES) belt, or hip suspension belt may be used for suspending the prosthesis.

Upper-Limb Suspension

Suspension methods for upper-extremity prostheses stress the importance of intimate fit around anatomic structures, a liner, one of several harness suspension methods, or a combination of these. Harness systems are generally easy to don and remove but can significantly restrict range of motion, and strap chafing is common. Pure suction, where applicable, can provide excellent suspension and is a desirable choice for an externally powered system that does not require a harness for body control.

Gel liners can be used for both above- and below-elbow systems and function mostly like lower-limb liners. A pin and shuttle lock may be used for short-to-medium transhumeral and transradial limbs, while a lanyard system is generally indicated for long transradial and wrist disarticulation levels.

Suspension How Prosthetic Limbs Stay Attached

Supercondylar-suction suspension is accomplished by extended medial and lateral walls that fully encompass the femoral condyles and a compressible, curved wedge that fits snugly above and against the medial condyle. Other anatomic suspension options include constructions that take advantage of con genital pro tuberances, often involving a cutaway section of the socket and a “door” panel to ease donning and doffing that is applied after the residual limb is in place.

Brats, Belts and Hinges

When suction or anatomical suspension is unavailable for various reasons, some older suspension methods may be employed. Strap suspension schemes, often used in combination with a waist belt, are relatively easy for the wearer to adjust and therefore are sometimes a good choice for individuals likely to encounter substantial changes in residual limb volume, as in the weeks after amputation surgery.

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Socket Optimization: A Challenge We Welcome Every Day

Today’s below-knee sockets are of two primary types: the “old reliable” patellar tendon-bearing (PTB) design focuses weight-bearing stress on certain pressure-tolerant structures, such as the patellar tendon and medial tibial flare, and relieves pressure-sensitive areas. The PTB socket is still preferred by many patients, notably those with shorter or bony residual limbs. It generally is not a good choice for patients with residual limb scar tissue and/or chronic skin breakdown.

The principal alternative trans- tibial design is a total surface-bearing socket (TSB) with a gel interface of some type (silicone or polyurethane liner, gel socks, etc.) that spreads the pressure across the entire residual limb surface at a level comfortable for the wearer.

A hydrostatic weight-bearing socket is a specific version of the TSB design intended to encompass the once-common quadrilateral (quad) shape. I.C. sockets feature a narrow medial-lateral dimension with the ischium encircled within the socket instead of sitting on the brim. 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 do not wish to change. A particular I.C. design, the Marlo Anatomical Socket® originally an effort to eliminate the socket brim outline clearly visible under the clothing of female above-knee amputees, also provides increased range of motion and may provide added comfort for appropriate patients.

Transfemoral Sockets

Contemporary above-knee designs typically employ some variety of shock absorbent (I.C.) strategy, which has largely replaced the once-common quadrilateral (quad) shape. I.C. sockets feature a narrow medial-lateral dimension with the ischium encircled within the socket instead of sitting on the brim. 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 do not wish to change.

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Upper-Extremity Sockets

Upper-extremity prostheses are controlled by one of two primary methods: body-powered incorporating a harness and control cables, and externally (electrically) powered, typically with myoelectric control.

Body-powered systems may be either harness-suspended, in which straps hold the prosthesis close to the body, or self-suspended, wherein the socket must be closely contoured to the residual limb to encompass bone anatomy or maintain suction. In either type, special care in designing and fabricating the socket is essential for maintaining control and suspension throughout the entire range of motion.

Regardless of limb or amputation level, all socket designs have benefits and drawbacks. Discerning and fabricating the socket required for a particular patient is accomplished only after thorough analysis of the individual’s physical condition and capabilities, clinical interaction, personal goals and careful anatomical measurements.

It’s a challenge we welcome every day.

Why Do Check Sockets?

I n these times of managed care, cost containment and Medicare caps, the idea of creating one or more preliminary sockets to evaluate design and fit before fabricating a final socket may seem unwarranted and perhaps even wasteful. So why do it? From the initial socket design, a check socket fabricated of transparent thermo-plastic enables you to visualize the all-important interaction between residual limb and socket. Variations in skin color indicate areas of excess pressure or absence of total contact, likely to produce skin breakdown in the future. Movement of the residual limb within the socket forebodes less-than-optimal gait, suboptimal weight-bearing distribution, reduced comfort, increased fatigue and likely skin problems.

In addition to static evaluation, check sockets can also be attached to alignment components and evaluated dynamically as the patient ambulates. In the absence of check socket evaluation, patients are much more likely to have problems with their prosthesis and require subsequent modification and medical care due to improper fit. This additional step in the prosthetic process may add some additional time and cost up front, but it can head off significantly greater expense and lost time down the road.

Note to Our Readers

Mention of specific products in our newsletter neither constitutes endorsement nor implies that we will recommend selection of those particular products for use with any particular patient or application. We offer this information to enhance professional and individual understanding of the orthotic and prosthetic disciplines and the experiences of professionals in our practice. We gratefully acknowledge the assistance of the following resources used in compiling this issue:

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SOCKET OPTIMIZATION—A CHALLENGE WE WELCOME EVERY DAY
From Disney World to Parallel Bars

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There followed 12 more rounds of chemotherapy (he’d had six previously), additional surgery on his amputated limb and a length transition to a prosthesis. In the two years since his diagnosis, Bryce spent 99 nights in the hospital.

The nightmare began to subside upon completion of chemotherapy. With return visits to his prosthetic team and learning to walk again with the aid of parallel bars, Bryce began to gain control of and confidence in his new limb. An active boy in the 99th percentile in height and weight for his age, he requires a sturdy componentry set and still keeps his prosthetist busy.

Eighteen months after receiving his first prosthesis, Bryce, now 11, is making up for lost time. He wears his leg 12 hours a day, runs, rides his bike and plays soccer and drums. Not surprisingly, he is already on his third leg and has gone through three prosthetic feet and two knees...because he wears them out.

Bryce’s rehabilitation has been assisted by various national and community organizations that support those with physical challenges. In mid-2011, he attended a camp sponsored by the Challenged Athletes Foundation (CAF). Initially adamant about not attending, he was equally upset at having to leave after an “awesome” experience.

While not every pediatric amputee is able to do as well as Bryce, it is most rewarding to prosthetic practitioners when we can help achieve outcomes that are this positive. He still has the occasional not-so-good day on his prosthesis, but the trend is steadily upward.

More importantly, he once again has a promising future ahead of him, and he and his family have their lives back.

The Prosthetic ‘Tune-up’

A prosthetic limb is like a new car in some respects: It’s fine-tuned and shiny when it leaves our “showroom,” but use and time take a toll to the point that periodic servicing becomes necessary if the “driver” wants to continue to enjoy top performance.

As a general rule, we recommend a prosthetic tune-up every six months, more often if the client has undergone weight gain/loss of five or more pounds, changed activity level, or is experiencing significant discomfort or functional problems with the limb.

During this maintenance visit, we will:

• evaluate socket fit and integrity;
• ensure all components are in good shape and provide replacements or adjustments as needed;
• evaluate limb performance and check alignment for gait optimization; address any questions or problems the client may raise; and
• assist with any needed prosthetic supplies (suspension sleeves, liners, limb socks, etc.)

The socket should be replaced if it has become significantly worn, discolored or cracked; if it no longer fits intimately due to changes in residual limb size or shape; or if the wearer has undergone additional residual limb surgery. Most patients can expect to receive several sockets during their lifetime.

To schedule a tune-up, call our office.

Keeping Prostheses out of the Closet

The prosthetic socket, essential point of integration between human tissue and replacement limb, is most often also the place where degree of prosthetic success is defined.

• It is the socket that accepts and transfers to the residual limb the stresses of weight-bearing, suspension and ambulation.
• It is the socket that encompasses and accommodates the often irregular and tender tissues of the residual limb and thereby helps determine how well, and for how long at a time, an amputee can function in the prosthesis.
• It is the socket that can, through intuitive and comfortable fit, smoothly deliver the advanced gait performance promised by today’s sophisticated upper- and lower-limb prosthetic componentry.

In other words, a prosthetic limb may incorporate the most sophisticated, technologically advanced and expensive components available, but if the socket does not fit well and allow the residual limb anatomy to function to its capabilities, the result will be less than optimal, the user will not be happy, and the prosthesis may well stay in the closet.

For this reason, our prosthetic staff devotes paramount attention to designing and fabricating the best possible socket for each amputee we serve.

Sockets are as unique as the people who wear them; no two are alike, but certain principles proven to enhance comfort and functionality are built into many current-day designs:

• Total contact — Through careful creation and modification of a positive model of the residual limb, our prosthetic team forms the unique optimal socket—courts the N.U. prosthetics program this year.

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