‘Pre-preg’ AFOs—Stronger, Lighter, Dynamic

Composites have been applied in prosthetics for some time in socket fabrication and advanced ankle-foot construction. Now, a recent variation, pre-impregnating the composite with a thermosetting resin, gives the fabrication team some exciting new applications for orthotic componentry.

“Pre-pregs” as these new materials are coming to be known, provide high durability at low weight and can be designed to flex, providing dynamic response. Compared to similar orthoses made from plastics, pre-preg AFOs and KAFOs offer a high strength-to-weight ratio, thin profile and enhanced patient comfort. While early applications appeared primarily in prefabricated devices, fully custom pre-preg braces are beginning to enter the mainstream.

Dynamic Response

Energy storage and release has become a mainstream characteristic of many prosthetic feet models but heretofore has not found major application in orthotics. Now, the dynamic properties of pre-preg composites make possible the same sort of gait assistance from an AFO.

A dynamic-response AFO can be designed to allow motion and a gradient resistance throughout the stance phase, capitalizing on the patient’s strengths while supporting weaknesses. Customized dynamic forces through-out the gait cycle enable the patient to ambulate longer and further before exhaustion.

An exciting pre-preg option still in development is interrupted cure processing, in which a partially cured pre-impregnated composite pre-shaped into the general form of a particular AFO design can be custom-molded, trimmed and adjusted for the needs of a particular patient, sometimes in a single office visit. This technique could conceivably eliminate the casting, vacuum forming and extensive sanding commonly required in the fabrication of plastic orthoses. Pre-preg thermoformable composites may accept several fine adjustments before the material completely cures.

Applications and Contraindications

Pre-preg lower-extremity orthoses can be prescribed to provide improved function and enhanced comfort for patients with drop foot secondary to stroke, multi-sclerosis, polio, spinal cord injury, and other neurological conditions, as well as various ankle instabilities. On the other hand, patients with spasticity or mild-to-severe clonus can be stimulated by a dynamic-response device and are thus not considered good candidates for a pre-preg brace.

Still in their infancy, pre-preg composite orthoses are just beginning to stir excitement and gain acceptance in the rehabilitation community. We can look forward to further news and advances about this technology in the near future.

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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 experience and capabilities of our practice.

We gratefully acknowledge the assistance of the following resources used in compiling this issue:

- Becker Orthopedics
- Bio-Mechanical Composites Inc.
- Custom Composite Mfg. Inc.
- Fillauer LLC
- Hope Orthopedic
- Oscar
- Otto Bock Health Care

A whole new delivery system has emerged, encompassing pharmacies, shoe stores and other retail entities, affiliated rehabilitation providers such as physical and occupational therapists, and even physicians. The question is, when are these alternative delivery options appropriate for the patient’s needs.

New Day Dawning in Orthosis Fabrication

Just as the introduction of plastics to orthotic fabrication several decades ago was a quantum improvement over the then-prevalent leather, wood and metal, so now is the emerging application of advanced composite materials—layers of carbon or other fabric bound with a resin—promising to at least partially supplant plastic construction.

(Continued on page 2)

Prefab Braces—When, Where, Why?

A new day is dawning in the fabrication of lower-extremity braces—ankle-foot orthoses (AFOs) and knee-ankle-foot orthoses (KAFOs). When the full potential of this new technology is realized, the outcome will be stronger, thinner, and lighter devices, some of which will deliver dynamic response to facilitate ambulation. For good measure, the fabrication process will be shorter and easier on the patient and potentially more cost-effective.

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(Continued on page 4)
Orthotic Management of Charcot Foot Deformities

The most prevalent medical disorder seen in American orthotic and prosthetic practice is typically involving peripheral neuropathy affecting the feet. Insensitivity to pain and proprioceptive loss leave diabetic individuals at increased risk of developing Charcot foot (also known as Charcot joints or Charcot arthropathy) deformities of the foot and ankle, resulting from repetitive, undetected insult and abnormal stresses. Charcot foot is also associated with peripheral neuropathy affecting the feet. Insensitivity to pain and proprioceptive loss leave diabetic individuals at increased risk of developing Charcot-related deformities, a patellar tendon-bearing AFO may be necessary to contend successfully with recurring plantar ulcerations. This Orthotic Management of Charcot Foot Deformities

Orthotics Today

When Are Off-the-Shelf Orthoses Appropriate?

To be sure, some types of “soft goods”—e.g., spinal corsets, soft cervical collars, elastic knee support and wrist gauntlets—don’t require the training and experience of a certified orthotist. These are generally short-term applications in which precise fit and control are not required. In the right circumstances, the use of OTS devices provide satisfactory support and control and produce cost savings for patients and/or their insurance companies. But...in various other situations or in the hands of unqualified providers, prefabricated orthoses not only fail to achieve their intended results but can also be detrimental to the patient. This is in recognizing when optimal fit and custom design are required to achieve the desired results.


custom fit vs. custom fab

Custom-fitted and custom-fabricated products are two different things. An off-the-shelf device can be modified and adjusted to achieve the best possible result, given that it was not constructed to a custom mold of the patient’s anatomies and accommodations require a degree of training...minimal for basic fabric corsets, soft collars and other soft goods, considerably greater for AFOs, advanced spinal and cervical orthoses, therapeutic knee braces, and others. The certified orthotist is uniquely trained for this function, as well as all aspects of custom fabrication. The experienced orthotist can both recognize patients and conditions for which prefabricated bracing is appropriate and work closely with the referring physician, therapists and others involved in the patient’s care to obtain the desired therapeutic outcome.

The Compliance Issue

Obviously, all efforts at orthotic management, whether custom-fabricated or off-the-shelf are essentially worthless if the patient refuses to wear the brace. Compliance involves three primary factors: comfort, self-image, and ease of application and removal. The experienced orthotist pays an important role in all three.

Comfort—It stands to reason that a brace formed from an anatomical model will fit more comfortably than a several-sizes-fit-all approximation. Fine adjustments to correct for minor discomfort, add padding, and/or compensate for patient growth are usually easier to complete on a custom-made device.

Self-image—Some patients refuse to wear their orthosis simply because it is embarrassing to them. Prefab braces are usually more bulky and therefore are frequently more obvious to others than custom orthoses. Spinal braces provide a good case in point: Most off-the-shelf models are too large to wear under clothing; whereas many custom spinal jackets can be designed to worn under reasonably fashionable clothes and thus remain largely hidden.

Dunning and doffing—With a custom orthosis, we can design a custom brace to match the needs and abilities of the patient, but prefabricated braces often incorporate an amazing number of straps and buckles to achieve as close a fit as possible with a general-sized product. The more closures and adjustments, the more difficult for the patient and caregiver to apply the device correctly and with maximum effectiveness. Add the potential for improper initial fitting of the device by an undertrained provider, and you have a recipe for noncompliance.

In Conclusion

Properly employed, prefabricated braces definitely have their place in today’s rehabilitation milieu. While we respect and value our relationship with all providers of clinical rehabilitation services, we also believe that a certified orthotist is the only provider qualified to select, design, fit and maintain orthotic devices, whether prefab or custom.

The Orthotist Advantage

Whether prefabricated or custom-made, most orthopedic braces require finishing, patient instruction, and follow-up modifications and maintenance. In our prevailing reimbursement climate, the “system” tends to seek out the “least-expensive” option. Seldom does this practice work to the benefit of the patient.

When another practitioner is asked to assume the role of the certified orthotist, the patient is deprived of the expertise offered by a dedicated specialist in biomechanics, orthotic evaluation, component design, materials, and fabrication technology, not to mention in most cases the availability of a full-on-site fabrication laboratory. Typically such short cuts produce suboptimal prefabricated or “semi-custom” orthoses or components made in a remote facility based on a prescription and measurements provided by an individual underqualified to perform that role optimally.

There are exceptions to every rule, of course; but generally speaking, the best outcome results when a certified orthotist is allowed to exercise the expertise he/she brings to the table. 

The primary difference between this orthosis and a pure cast is that the CROW may be removed for dressing changes, bathing and sleeping. Many patients learn to drive while wearing the boot. The CROW is easy to don and remove and exhibits a high level of patient acceptance. Upon wound healing, some patients benefit from a transition to an AFO, notably a floor-react reaction AFO. This less-cumbersome option gives the wearer some additional freedom, while the anterior force applied in stance phase provides an added measure of proprioception to compensate for that lost with the advancing Charcot process. For some patients with only severe Charcot-related deformities, a patellar tendon-bearing AFO may be necessary to contend successfully with recurring plantar ulcerations. This design incorporates prosthesis that redistribute weight-bearing forces away from the plantar surface. These orthotic strategies for accommodating Charcot foot help us realize our primary goal in managing diabetic patients: preventing the need for limb amputation.
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**Prefabricated KAFO incorporating pre-preg technology**

_Courtesy Becker Orthopedics_

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**Pre-preg composites extend dynamic response properties to orthoses.**

_Courtesy Bio-Mechanical Composites Inc._

Thermoplastics are durable and allow orthotists to build in required flexibility by varying thickness and geometry. However, they also present certain drawbacks, including a thick profile that can limit footwear choices, heat discomfort (thermoplasic is an insulator), and a sometimes lengthy fabrication process. With KAPDS the weight of the orthosis can be a detriment to patient tolerance and effective ambulation, as well.

**Pre-preg carbon fiber composite**

_Courtesy Becker Orthopedics_

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**Now Fitting the MAS Socket!**

Welcome to the Autumn 2006 edition of First Step, a professional publication of Gulf Coast Orthotics & Prosthetics. Through this quarterly newsletter, we endeavor to keep the Florida rehabilitation community abreast of the latest trends, developments and technology in the orthotic and prosthetic management of physically challenged patients.

We are excited to announce that we are now certified to fit the revolutionary MAS socket for transfemoral amputees, the latest innovation in the evolution of transfemoral socket design. This completely new approach features containment of the ischial ramal complex, providing improved ML stability, unlimited range of motion and excellent cosmesis. Transfemoral amputees report increased walking and sitting comfort and improved muscular control of their prosthesis.

We hope you find this newsletter to be a useful resource and welcome your input, referrals and requests for further information. Call us at (850) 477-4880 or contact us through our website at www.gulfcoastoandp.com.