CUSTOM ORTHOTICS

Custom Orthotics are Orthotics that are fabricated by a trained professional to help provide optimal care for persons with upper extremity injuries and functional deficits.

Some of the advantages of Custom Orthotics are:

- They provide a more specific action.
- They may be more comfortable to wear.
- There is often less restriction of uninvolved joints.
- Custom Orthotics may be necessary with complex injuries.

Some disadvantages of Custom Orthotics are:

- They can be more costly
- They are more time consuming to fabricate and adjust.
- Adjustments can be more complex.
- May be bulkier and heavy to carry.

Materials and Equipment needed for fabricating Custom Orthotics

- Orthotic pan with thermometer
- Heat gun
- Orthotic Materials – Low Temperature Thermoplastics
- Tool to remove materials form Orthotic pan / spatula
- Marker to trace patterns onto the Orthotic material – grease pencil or scratch awl
- Scissors – sharp to protect your joints
- Utility knife
- Patterns
- Strapping – velcro
- Padding
- Stockingette
- Paper towels
- Hand towels
- Hole punch
- Dynamic components – rubberbands, springs, etc.
- Static Progressive Components – guitar key etc.

Thermoplastic Orthotic Materials

Low temperature thermoplastic (LTT) materials are most commonly used to fabricate custom splint. Materials are low temperature because they soften in water heated between 135 and 180 degrees fahrenheit. When the plastic is heated, it becomes pliable and then hardens to its original rigidity after cooling.

The first commonly available low temperature thermoplastic material was Orthoplast. Now, many types are available from several companies. The type of material that is used vary on the basis of the persons diagnosis, therapist's preference and availability. Decisions must be made regarding the best type of thermoplastic material to use for Orthotic fabrication. Decisions are based on such factors as cost, properties of the material familiarity with the materials and therapeutic goals. Thermoplastic materials are elastic, plastic and a combination of plastic and rubberlike and rubberlike. Each has unique properties defined by handling and performance characteristics.

Handling Characteristics

Handling characteristics refer to the thermoplastic material properties when softened (heated).

Memory: Memory is a property that describes the materials ability to return to its preheated (original) shape, size, and thickness when reheated. memory allows the therapist to reheat and reshape Orthotics several times without the material stretching excessively. New orthotic fabricators who wish to correct errors in a poorly molded Orthotic frequently use materials with memory. Materials with memory are easily used with serial static orthotics due to the intermittent remolding. Spot heating as with a heat gun may inadvertently change the entire Orthotic because of shrinkage. It may be best to reheat the entire Orthotic and remold. Refer to the Memory section of the Thermoplastic Property Guideline Table for Examples of thermoplastic material with Memory.

Drapability: Drapability is the degree of ease with which a material conforms to the underlying shape without manual assistance. The degree of drapability varies among different types of material. Material with drapability must be handled with care. The therapist should avoid holding the plastic against gravity, clean countertop cutting is the best. Materials with drapability is difficult to handle for beginning splinters. Successful molding requires the therapist to refrain from pushing the material during shaping. Material should be lightly stroked into place. Light touch and constant movement will result in cosmetically appealing splints. Refer to the Conformability, Drapability and Moderate Drapability sections of the Thermoplastic Property Guideline table for examples of thermoplastic materials with Drapability.

Elasticity: Elasticity refers to a materials resistance to stretch and its tendency to rebound to their original shapes during molding. Resistance to stretch describes the extent to which a material resists pulling or stretching. Materials with memory have a slight tendency to rebound to their original shape during molding. Materials with high resistance to stretch can be worked more aggressively than materials that stretch easily. They tend to hold their shape and thickness when warm. Resistance to stretch is helpful when working with uncooperative people or persons with high tone. Materials with little elasticity with stretch easily and become thin therefore a light touch must be used. Refer to the Resistance to Drape and Resistance to Stretch sections of the Thermoplastic Property Guideline table for examples of thermoplastic material with Elasticity.

Bonding: Bonding is the degree to which material will stick to itself when properly heated. Some materials are coated and will require surface preparation with a bonding agent or solvent. A bonding agent or solvent is a chemical that can be brushed onto both pieces of the plastic to be bonded. Scoring or roughing up the surfaces may be required to allow better adherence. Coated materials tack (stick together) at the edges because the coating only covers the surface and not the edges. When a coated material is stretched it becomes tackier and more likely to bond. Self bonding or uncoated materials may not require surface preparation. When heating self bonding material, the therapist must be cautious that the material does not overlap on itself or it will stick to itself. It can adhere to everything. It may be necessary to apply an oil based lotion to the clients extremity. Self adherence is an important characteristic for dynamic splinting when attaching outriggers to Orthoticbases or when plastic needs to attach to itself for support. Whether coated or uncoated, the material forms stronger bonds if the surface is prepared with a solvent or bonding agent. Refer to the Self Adherence section of the Thermoplastic Property Guideline table for examples of thermoplastic material with self bonding.

Self Finishing Edges – Self Sealing Edges

Self finishing – self sealing edges is a characteristic that allows any cut edge to have smooth texture if the material is cut warm. The edges round and seal themselves when heated material is cut.

Other Considerations

Heating Time: You do not want to leave splinting material in hat water to long or it can become excessively soft and stretchy. You do not want the the material to hot before applying to the patients skin as not to burn them.

Working Time: Monitor working time closely. The thicker the material the longer the working time. 1/8 inch thick material (most commonly used) when heated sufficiently usually has a 3-5 minute working time – some up to 4-6 minutes. Materials that are thin and perforated cool more quickly therefore having a shorter working time.

Shrinkage: Some plastics shrink slightly as they cool. This is an important characteristic to be aware of especially if fitting to a circumferential area as a thumb. The Orthoticmay be difficult to remove if shrinking takes place when cooling.

Performance Characteristics

Performance characteristics refer to the properties of the material after the material has hardened.

Conformability: Conformability refers to the ability of the material to fit immediately into contour areas. Materials that drap easily have a high degree of conformability. Conforming materials pick up marks easily ie. Fingerprints, crease marks, ring marks etc. Conforming orthotics are usually more comfortable. The orthotics fit well, reduce pressure and decrease the chance of orthotic migration. Refer to the Conformability, Drapability section of the Thermoplastic Property Guideline table.

Flexibility: Materials with a high degree of flexibility can take repeated Stresses. This is an important characteristic for circumferential splints.

Durability: Durability refers to the length of time the material will last. Rubber based materials are more likely to become brittle with age.

Rigidity: Materials that have a high degree of rigidity are strong and resistant to repeated stress. Rigidity is important when making medium to large Orthoticsfor areas like the elbow or forearm to support theweight at larger joints. Rigidity can be enhanced by contouring a Orthotic to an underlying body shape. Most low temperature materials are not appropriate for foot orthosis as they cannot tolerate repeated forces or weight bearing. Refer to the Rigidity section of the Thermoplastic Property Guideline table for examples of thermoplastic material with Rigidity.

Perforations: Perforations allow for air exchange to the underlying skin. Various perforation patterns are available.
Precautions with perforated materials are:

- Do not stretch. Stretching will enlarge the holes in the plastic and will decrease strength and pressure distribution of the splint.
- Try to cut between the perforations to prevent uneven or sharp edges.

Finish: Finish refers to the texture of the end product. Smooth or grainy texture. Coated materials are easier to keep clean.

Colors: Thermoplastic materials have many colors available. From skin tones to bright colors. Appearance or color can affect a persons compliance with wearing a splint. Children love the colored splints. Disney workers compensation clients had to were flesh tone colored splints. orthotics with color may help with treatment as well. A person with unilateral neglect may notice a extremity if wearing a colored splint. It is also easier to find a lost orthotic if it is a bright color. It is less apt to blend into the environment.

Thickness: Orthotic materials come in various thicknesses – 1/16, 3/32, 3/16, 1/8 inch. The most common thickness is 1/8 inch. Thinner thermoplastics are commonly used for small splints, arthritic and pediatric splints. 3/16 inch thickness materials are commonly used for lower extremity Orthotics and for fracture braces. Thinner plastics will soften and harden more quickly therefore it is best for the beginning splinter to learn with 1/8 inch thick materials.

Soft Orthotic Materials

Soft orthotic materials such as cotton duck, neoprene, knit elastics and plastic impregnated materials may be used alone or in combination with metal or plastic straps to fabricate semi-flexible splints. These materials allow fabrication of orthotics that permit partial motion around a joint, yet still limit or protect the part.

Indications for soft Orthotic material:

- sporting activities
- assisting patients with chronic pain in returning to a functional activity.
- geriatric patients
- arthritic patients who cannot tolerate rigid splits.

Choosing the Best Category of Material for the Orthotic

Forearm/ Hand based Orthotics

Forearm and Hand based Orthotics need conformability around a part when they:

- serve as a base for a dynamic Orthotic to decrease migration.
- stabilize a part of the body.
- reduce contractures
- remodel scar tissue
- immobilize to facilitate healing of an acute condition.

When conformability is not crucial, the Orthotic can be made from a material
with a high resistance to stretch and low to moderate drape. As with:

- burn patients or other acute trauma
- a spastic body part. Resistance is needed to stretch and use with more aggressive handling.

Large Upper Extremity Orthotics

Long orthotics fabricated for the elbow or shoulder should be made of a material that has high resistance to stretch to provide the control necessary for dealing with large pieces of material. These Orthoticsdo not need as much conformability as they are molded over broad expanses of soft tissue.

Circumferential Orthotics

Circumferential orthotics are orthotics that wrap around a part and should be fabricated from materials that have a high degree of memory and tolerate stretching without forming thin spots. These materials should be perforated, thin and able to stretch evenly. Circumferential orthotics should have some flexibility to allow easy donning and doffing of the splint.
Indications for circumferential splints:

- fracture bracing
- contracture reduction
- stabilizing or immobilizing a joint

Serial Orthotics

Serial orthotics require frequent remolding to accommodate for the change in joint ROM. A material that has considerable memory or is highly resistant to stretch to avoid thinning with repeated moldings is indicated. Materials with moderate to high rigidity to oppose resistive forces works well with serial orthotic.

Patterns

Patterns are beneficial when making orthotics for a number of reasons however the one that is in the forefront in my mind is the ability to use the splinting material more efficiently therefore saving money and time. Especially new splinters should use patterns to help with the learning process of how to fit orthotics appropriately. Patterns can be custom made to fit the patient or there are generic patterns available through catalogs.
Generic patterns rarely fit persons without adjustment. Having several sizes of generic patterns for trial fittings help (small, medium and large). materials used for generic patterns should be sturdy for durability. You may want to transfer the pattern to a paper towel for fitting to the patient. Standard patterns can be reduced or enlarged on a copy machine if needed.

To make a custom pattern you would want to trace the patient's hand onto a paper towel. Although I have never tried it they also say that aluminum foil is good for trial fittings. Make certain the hand is in the flat and neutral position. If you are unable to trace the affected hand you can use the contralateral hand. Mark any landmarks needed for the pattern before the hand is removed. Next, draw the orthotic pattern over the hand

Tracing a pattern with a flat hand does not take into account the position in which the hand or part will ultimately be held in the splint. For example: Take a pattern of a hand that is traced (paper towel) with the hand flat Then put it on the volar surface of the hand with the hand in the functional position (wrist 30 degrees of extension, MP's 70 degrees of flexion and IP's in 10 – 20 degrees of flexion). Note that the pattern extends beyond the fingertips and is to long. Now take the same pattern and place on the dorsum of the hand with the wrist in flexion. The pattern will be to short. You should always check the pattern on the hand in the position in which the hand will be splinted before tracing the pattern to the splinting material.

When making patterns that include the forearm, you should make sure the orthotic extends 2/3 the length of the forearm as measured from the wrist proximally. With the pattern in place, bend the elbow fully and mark where the forearm and bicep muscle meet. The orthotic should be trimmed ¼ inch below this point to avoid limiting elbow flexion and preventing the orthotic from being pushed distally. The ideal trim lines of a single surface orthotic will fall midline of a hand, arm to provide optimal support and will allow for proper strapping to secure the orthotic in place. You need to remember that the forearm is cone shape, not a straight cylinder and graduates with depth proximally. MAKE SURE YOUR PATTERN FITS BEFORE TRACING IN ONTO ORTHOTICMATERIAL!

Tracing, Heating and Cutting

After the appropriate pattern is made it must be traced onto the orthotic material. The pattern should be positioned in a way to conserve material. Trace with a grease pencil or scratch awl. The grease pencil will leave marks that will not come off in the water. I usually outline the pattern a little large so that I can completely cut off the pencil marks for cosmetic purposes. The scratch awl puts marks in the material where you would want to cut the material. Do not use pen ink. It will smear on the plastic.

If you trace the pattern onto a large sheet of thermoplastic, you will want to cut away a portion of the material with a utility knife. You will have to fold the edges and cut again with scissors or a utility knife. Place the potion cut away in the orthotic pan to soften the material before cutting out the pattern. A orthotic pan works the best but you can also use a fry pan. The text suggests a hydroculator however I feel this is difficult to use especially with materials that have a lot of drap and conformability. It is important to have a temperature regulated heating equipment. To ensure temperature consistency you should have a thermometer. The pan should be approximately ¾ full and the water temp between 135 – 180 degrees.

Self- adhering materials are difficult to cut when heated. You may want to cut the material cold with tin snips or prepare the scissors with a non-stick substance before cutting. When the thermoplastic material is larger than the pan, you will want to heat a portion then place a paper towel in the pan over the heated area and fold over when soft enough.

Remove the material form the hot water with a spatula. Place the material on a flat towel surface (self adherent material will stick to the towel). Cut out the pattern with sharp scissors (have you scissors sharpened frequently to save your hands). Sharp round or flat edge scissors work well with thermoplastics. You may want to keep many different sizes of scissors for cutting contours or small areas. After the pattern/ material is cut out, it will need to be reheated before molding.

Molding and Application of the Orthotic Material

While the orthotic material is heating, you will want to position your patient and explain the molding process. Make sure you include the following information:

- the temperature of the thermoplastic
- please try to relax and let me do the work. DO NOT try to to help me
- I will be placing you hand/arm in the position I want it in for molding your splint. Please try to maintain that position as best as you can. This instruction will be dependent upon the patient's cognition level.

Place a cotton stockingette on the patient before applying the material to avoid burning the patient. Do not use stockingette with self adherent orthotic materials as the material will stick to the stockingette.

According to the part that is being splinted, you want to position the patient as comfortable as possible with gravity assist.
<u>Hand and Wrist</u>: If possible use a foam wedge with a towel to rest the extremity. Stabilize the elbow so the patient will not move the extremity. Take care not to apply pressure at the elbow (ulnar nerve)
<u>Elbow</u>: If possible try to lie the patient down for a gravity assist position. Use pillows, wedges or blanket to help with positioning. Often a second is needed to help hold the extremity in the correct position. If the patient has shoulder problems they may not be able to raise the arm for appropriate positioning of the elbow.
Shoulder / Upper Arm: Positioning for a humeral fracture brace. I often have the patient sitting, propped on pillows with the shoulder in minimal abduction if possible so that I can get the orthotic material circumferentially around the upper arm. A second therapist to help with molding is almost always required.

After you have positioned your patient and the orthotic material is heated, remove the material from the orthotic pan with a spatula. Dry the material on a towel. Check the temperature of the material before placing on the patient. Place the material on the patient. Take into consideration the hand creases, bony prominences etc. Focus on getting the appropriate position of the body part and the shape of the orthotic while molding. You can fine tune the splint, trim away edges after you have the general shape of the orthotic correct.

Some situations may require the therapist to speed up the cooling process of the orthotic material. Examples of these situations might be a hard to hold position for a period of time to allow cooling, tendon tightness, spasticity, a heavy extremity requiring two therapist or an uncomfortable position for the patient. Options to speed up the cooling process are:
Cold Spray: An agent that serves as a surface coolant. Needs to be environmentally friendly. Cautions against persons with allergies or respiratory problems. The spray is flammable and must be stored properly.
Cold Water: Submerging the orthotic in cold tub of water or running under cold tap water. No recommended for persons with increased tone if leaving the orthotic on the extremity while cooling.
Frozen Theraband: Use heavy resistance theraband. Keep in a freezer and wrap around the orthotic while on the patient to hold in place and cool at the same time.

Adjustments After Molding

You want to try to trim the thermoplastic marked lines before complete cooling of the splint. This makes the task easier on the therapist cutting and scissors. After trimming, you need to round and smooth the edges. Place the edge of the orthotic in the heat pan then smooth with the heal of a hand or countertop surface. You may also want to round the edges to decrease pressure in that area or contour for strength.

Heat guns may also be used for spot adjustments. Heat guns are helpful for warming small focused areas for finishing touches. It is best to continually move the heat guns air projector on the area of the orthotic to be softened. Make sure you heat both sides of the plastic. This tool is good for “punching out” areas of bony prominences or to use when bonding materials with the application of an outrigger to a orthotic base. You can also heat metal components before applying to the material to help hold them in place. Heating the back of self adhesive Velcro helps to achieve a good sticky base before applying to the orthotic.

Strapping

The orthotic will be secured in place with strapping materials. Velcro strapping is the strapping of choice. Prior to the invention of Velcro straps were riveted onto orthotics– think goodness for the invention of Velcro. Velcro has many different properties. There is hook and loop Velcro. There are many different sizes and colors. There is also self adhesive Velcro. There are also different types of foam straps that are great as far as comfort however the most durable strapping id Velcro webbing. D ring straps are also available. This is a strap that combines the orthotic attachments and fits circumferentially around a orthotic to allow a good, secure closure. This is a very good strap for tight security application with one hand. With self-adhesive strapping material the adhesive will get on the scissors. Do not use the same scissors for cutting orthotic material as the material will stick to the scissors. What a mess! Cut strapping materials with rounded edges. Not only does this help with the cosmesis of the orthotic but will help decrease the chance self-adhesive hook peeling away from the orthotic base.

Where to apply the strapping?

Straps are placed at selected sites of the orthotic or spiral strapping can be used.
Anchor points for strapping: with a wrist cock up you would want to definitely secure at the wrist, the palmar bar and the proximal splint. You want to ensure that all areas of the orthotic are secure. Circumferential or spiral strapping is most useful with the digits and thumb but can also be used for the forearm. You also want to take in consideration the patients swelling with strapping. You do not want the patient securing the straps so tightly that edema pools between straps. You would want to make sure the straps are secured snug, but not to tight or consider loose circumferential strapping. If necessary, to prevent lost straps you can secure them to one side of the orthotic with a rivet or strong adhesive glue. You can make a cut out (hole punch, heat gun, butter knife) in the orthotic, push the strapping material through and secure to itself with the glue.

Strategic placement of strapping is very important – ESPECIALLY STRAPPING AT THE WRIST AREA. It is always good practice to provide the patient with a second set of straps.

Padding

There are many different types of padding available. Padding is most helpful with bony prominences ie. the ulnar styloid, joints of the thumb and digits. The dorsum of the hand has very little padding. At the elbow you have the medial and laterail epicondyles and you want to make sure to avoid compression of the ulnar nerve at the cubital tunnel.

When using padding you must allow sufficient space for the thickness of the padding otherwise pressure may actually increase. Padding should not be done as an after thought.

Padding example: Forming over the ulnar styloid area. To allow room for the padding you can place on the patient before molding of the orthotic therapyputty, gel disc, or elastomer. After forming the orthotic, padding may be placed in that area. You may also use a heat gun to "punch out" or assist with molding the area for padding. If padding the entire surface of the orthotic you can trace the area before forming you would want to allow an additional ¼ to ½ for edge overlap. Most padding is self-adhesive. Padding adsorbs moisture, perspiration which can lead to smell. Padding may need to be changed often.

Reinforcement

When thermoplastic material has been stretched too thin or is to flexible to provide adequate support ie. the wrist – it must be reinforced. This is done through adding an additional piece of material bonded to the outside of the orthotic to the increase strength. You may also mold a ridge into the reinforcement piece to add additional strength.