Principles and Alignment Problems in Custom Built Orthopedic Shoes

By Erich Hanicke, C.P.O.
Kansas City, Missouri

Our industry is aware that there is a real problem for persons with deformed feet to obtain properly fitted, functional and comfortable shoes. We should be concerned with these problems and help to solve some of the difficulties encountered with modern footwear in relation to orthotic and prosthetic devices.

Custom built shoemaking is becoming almost a lost art and since so many foot problems are related to brace and leg problems, we feel that our profession with its background and experience would be the most logical and qualified to undertake some leadership in this direction. Most of us have the materials and machinery for the necessary procedure. We have a great deal of anatomical knowledge; we have practical experience and skill; we are well adapted to interpret doctors' prescriptions and make most anything required in the Orthotic-Prosthetic field. We need not feel and do not intend to encroach in someone else's profession.

In many instances it may be a good practice to consult with an orthopedic physician to obtain his advice and suggestions. A doctor's prescription would insure a more intelligent and efficient approach to the patient's existing problems. A custom built shoe must perform a multitude of duties. It must hold and support the foot in its best anatomical position; it must support the foot in its best functional position; it must support the foot in its most comfortable position. This position should be in accord with the requirements of a functional knee joint in its anterior-posterior as well as the lateral plane in relation to foot and hip. This position should not be a pseudo-alignment which means that the leg and foot may be fairly well balanced but at the expense of the articulating mechanism of the knee and hip. This is the reason the complete leg must be taken into consideration. The custom built shoe must also be acceptable from the standpoint of appearance.

We as a profession should concern ourselves with the problems of alignment, taking the casts, construction of lasts, etc., and leave the actual manufacture of the shoes to one of the few shoemakers available or to a shoe factory having a custom shoe department who is interested in cooperating with us. It will will be impossible to cover every phase of this worthwhile project but we will discuss our technique briefly.

Examination of the Patient

Assuming that the patient has been referred by his physician who has recommended certain paramount necessities, it will be your job to examine this patient from a mechanical point of view to ascertain the various limitations of static and dynamic alignment and flexibility of motion. This should include not only the foot proper but also the knee and hip. Establish the

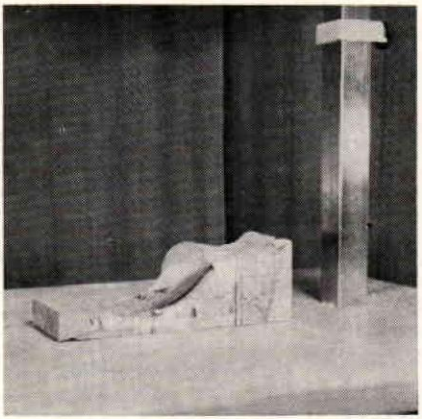


FIGURE 1—Rehearsal block shaped to take care of malformation of foot.

FIGURE 2—Taking cast under weight bearing. Note guide lines.

degree of correction desired, necessary and tolerable. Be sure to ascertain the length of both legs. After discussion with the patient it may be necessary to discuss the complete problem with his physician.

Before attempting to take the cast of the foot, we make what we call a rehearsal block to determine alignment. (Figure 1) We use a block made of cork and shape it to take care of any shortness of the affected leg, pad it to take care of any malformations that are apparent. We have the patient stand on this block so that we may note the desired amount of correction. The patient should have his shoe on his good foot while testing and taking cast. At this point, you can establish the center line of gravity in the anterior-posterior as well as mediolateral aspect. This rehearsal block is used while taking the cast.

Taking the Negative Cast:

1. Preparation prior to taking cast.
   a. Powder the foot well, preferably with Zinc Stearate.
   b. Apply light cast sock to foot. Place a black leather strap under sock on dorsal side of foot to toes. Pull sock tight, but do not squeeze toes.
   c. Place plastic sheeting on rehearsal block. Place thick blanket material on plastic to absorb moisture.
   d. Mark any sensitive or pressure areas.
2. Taking of actual cast.
   a. Using 3" or 4" bandages, wrap foot in oblique fashion, taking care not to compress toes. Allow the metatarsal region of the foot to expand under weight bearing.
   b. After wrapping, place foot on rehearsal block with about 75% weight bearing. Watch flexion or hyper-extension of leg as well as varus and valgus of knee. Hold leg and foot steady until cast is dry.
   c. Mark cast medial, lateral, anterior and posteriorly while patient is standing on rehearsal block with vertical lines square to floor. Extend lines downward on to rehearsal block. (Figure 2)

d. When cast is set, have patient sit down, mark cross lines where cast is to be cut. Cut cast open on dorsal side and remove from patient's foot carefully.

So that we may have a duplicate of the correct alignment we fill the negative model using our modified Bock type alignment jig. (See Figure 3) Insert pipe that is to go into cast on bracket in receptacle on upright column of jig. A set screw on the bracket fits into the hole at the upper end of the pipe. This arrangement will guarantee as accurately as possible the exact position of the patient's foot in its various angles to the floor. It will indicate eversion, inversion, abduction, adduction, plantar as well as dorsal flexion, valgus and varus but not the distance from plantar surface of the foot to table top. Therefore, it is important to record the height from table top to a set collar on upright column below bracket.

Construction of Positive Model:

1. Place cast back on rehearsal block, aligning to marks on cast. Tape cast to block and close front seam with plaster. Let cast dry.
2. Powder inside of negative cast with Zinc Stearate.
3. Place the cast on rehearsal block on table of jig. Lower pipe into cast to within ½" from the bottom of heel of negative cast. (Figure 3)
4. Mix plaster of Paris fairly thin and pour slowly into negative to prevent air pockets.
5. Let stand for about an hour.
6. Separate cast from rehearsal block.
7. Raise bracket on upright column (including cast) about 5". Do not disturb set collar on column.
8. Remove cast from bracket on alignment jig.
9. Mark cast around its anterior-posterior axis along the center of the foot-dorsi-plantar surface.
10. Cut negative from positive cast with a razor sharp knife. Cut should be straight and smooth so that cast comes off in halves. Should cast become too hard, use a vibrating cutter.
11. Keep rehearsal block and both halves.

This positive plaster of Paris model represents not only the shape of the patient's foot and its relation to the lower leg but also it represents the line of gravity, balance and amount of correction tolerable and possible. Pressure areas are clearly indicated by indelible pencil. This method is comparable to the adjustable leg set up jigs as used in prosthetics.

Modification of Plaster Model in Preparation for the Last:

When the shoe is completed there is very little chance to make any major alteration as to tension, fit and alignment. If there is any doubt, it might be well to try the negative on the patient's foot with his regular sock.

The positive cast must now be modified so that it will assume the shape of the desired shoe. The sensitive areas should be spotted with leather, well skived around the edges. Shave off areas where more pressure is desired.

To extend the toes, put cast in jig, draw around foot on a piece of paper. At least ¾" should be added to the end of toes. Decide on the shape of toe of shoe, whether pointed, blunt, broad, etc. and sketch with

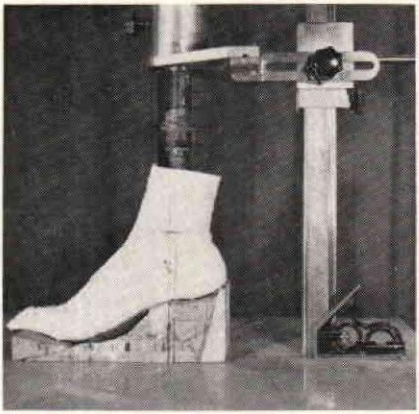


FIGURE 3—Cast is filled on modified Bock jig to maintain same alignment.

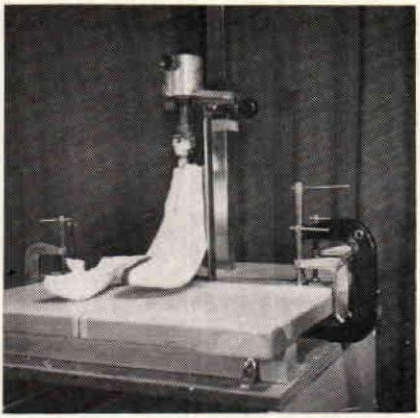


FIGURE 4—This shows making the negative over the corrected positive cast in preparation for last.

indelible pencil on paper. Wet positive cast where plaster is to be added to extend the toe. The entire toe section on the dorsal surface should also be enlarged.

After the addition of plaster has dried, sand the cast until smooth. Holes and other imperfections may be filled out with Synkaloid Spackling paste. This material spreads like cream, hardens quickly and can be sanded. It is not affected by PVA emulsion or Johnson's wax.

When this model is completed, it represents the pattern for the shoe last. After cast is completely smooth, coat with two coats of Hosmer parting lacquer. Let dry between coats. Then add two coats of Johnson's wax rubbing to a polished finish. Apply a third coat of Johnson's wax but do not rub down. Now the model is ready for construction of negative from which the Last proper is made.

Construction of the Last:

This procedure is of utmost importance so it will be described in minute detail. Place the model in any convenient vice or use the alignment jig. Take a new negative paster of Paris model, applying plaster wrap directly to the coated cast (do not use cast socks or stockinette). Wrap bandages tight and rub bandages between layers of plaster in order to obtain a smooth inside finish.

Remove cast while still moist, using a sharp razor knife. Cut so that cast comes apart in two halves. The cut must be a clean sharp edge.

So that we may duplicate the last in the same alignment as our positive cast, the following steps are necessary.

1. Leave one half shell on positive and tie to positive with a string. (Positive is in jig.) (Figure 4)
2. Make a strong right angle bracket which will not bend under weight of filler material for last.
3. Place the vertical arm of this bracket close to negative half shell which is tied on positive.
4. Clamp the horizontal section of bracket to the table of jig. Reinforce with guide blocks on other side. Tape with masking tape and mark across guide blocks.

5. Attach the vertical section of bracket to half shell *only* with plaster of Paris gunk and a bandage looped back and forth.
6. Remove half shell and bracket from the model. Let both shells and gunk dry well. Do not disturb guide blocks on table.
7. Remove positive model from jig.

After the negatives have dried well, coat the half shells with two coats of Johnson's wax. Let first coat dry well and polish. Do not polish the second coat but remove any excess wax. Paint the inner surface of the half shells with two coats of PVA emulsion. Paint well along cut seam of cast. Let dry well between coats. Then spray with one coat of Releasagen S-1. This will not dry, let stand for about 30 minutes.

Unite the two halves and tie. The entire seam should be closed tight enough so that the resin will not find a way out. Play dough and pressure sensitive tape can be used. Attach this negative to the table of the jig between the guide and clamp down. Insert a new pipe attachment in jig and attach Last ferrule with allen screw pointed toward front. Cover area around screw with Johnson's wax. Lower this unit into negative cast. Height on upright column may be changed now. Do not let the bottom border with allen screw at top of ferrule extend below the top edge of the cast. (Figure 5)

Record number on the height indicator on upright column of jig, below the set collar on patient's chart. Wrap screw and set collar with tape to prevent loosening. Raise this unit with ferrule out of the cast sufficiently to clear top of cast but do not disturb position of set collar. Remove cast and bracket from table and place in a refrigerator for about 30 minutes. Also, place a large fruit juice can (for mixing resin) in refrigerator. This is done to prevent resin from over heating. After the cast has cooled, replace in jig in previous position.

Mix about 1500 grams of resin, using 50% Versamid #140 and 50% Genepoxy #177. Use an extra strong shear mixer in drill press to thoroughly mix resins. Add pulverized cork slowly, mixing it to a consistency of fairly thick cream of wheat. Mixture should be thin enough so that it can be poured into cast. Use some white pigment so Last can be marked with pencil.

Pour mixture into negative model rather slowly to avoid air bubbles. It is best to do this in a fairly cool room to prevent overheating. If this reaction should occur, pour mold in two or three sections, letting each cool sufficiently before adding additional resin. They will adhere well. Let resin set a few minutes to permit settling. Add more if necessary. Fill to within ¼" from top of cast to allow room for metal ferrule.

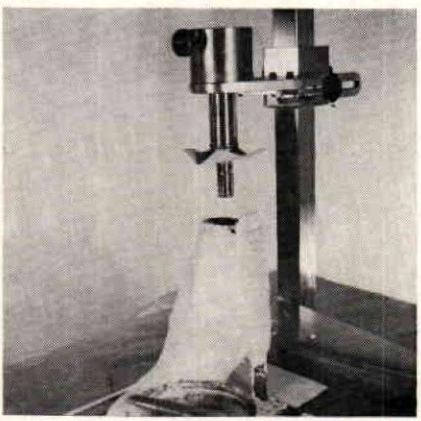


FIGURE 5—Shows negative corrected cast ready to fill with resin.

Lower the ferrule on the cross bracket until it meets the set collar on the upright of the jig. Important: this ferrule is the only guide to indicate the proper position of the Last with regard to all angles to the table top as well as the correct height of the foot of the patient to the table top. Let this mixture dry about 24 hours.

After the resin is set, compare height of lower border of set collar with the record on patient's chart. Then loosen and remove clamps which hold right angle bracket attached to cast on table top. Raise entire unit upward on upright post of jig about 4". Do not disturb set collar but leave it taped securely. Loosen allen set screw in ferrule and pull last off receptacle. Remove bracket from shell. Place last with plaster negative in refrigerator for about 30 minutes.

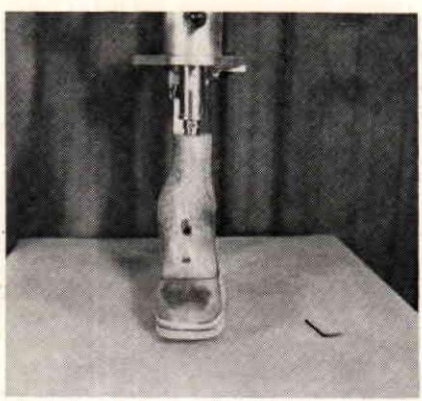
Pry open seams of half shells and remove from plastic last model. Use a sharp narrow chisel and wooden mallet. The plastic last model can be suspended in the jig in the exact position the patient's foot will be held in the shoe. Check Last model for air pockets. Fill with resin and cork and sand smooth.

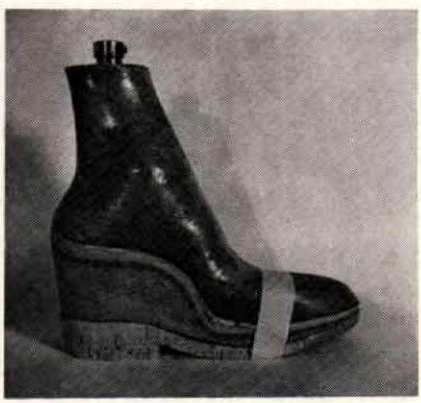
It will be necessary to provide the Last with a joint across the instep so that the Last can be removed from the shoe when completed. This joint is a curved cut from the distal anterior or dorsal aspect of the Last toward the posterior proximal area of the plantar surface of the foot. Bear in mind that the distal segment must be extricated from the shoe without ripping the distal end of the blucher or french cut.

Adequate room must be allowed for 3/8" hexagon nuts and shoulders of allen socket screws to be embedded into the plantar and dorsal surface of last. Before cutting the Last, draw a curved line for the proposed cut. Then draw a line along the center of the dorsal surface of the Last. Select the best possible spot for inserting two screws and nuts. Use a 3/8" drill and drill through entire last. Drill proximal section—dorsal surface of Last with a 9/16" counter borer having a 3/8" pilot. Do not counter bore too far down, otherwise the remaining section of resin will not be strong enough to withstand the strain exerted during manufacture of shoe.

Next, use a 13/16" counter borer with a 3/8" pilot to fit the drill diameter and bore out the space the nuts will occupy on the distal section of the Last (plantar surface). Again, be careful not to bore down too far. Leave adequate thickness of plastic for the units to hold together during construction of the shoe. Be sure that nuts and screws do not protrude beyond plantar surface but keep them about 1/8" below surface. (Figures 6 and 7)

Now cut Last along curved line marked on side of Last. Replace sawcut with a piece of 1/16" sheet cork, attaching to proximal section only. Insert screws and attach nuts and screw together. Do not screw down too





FIGURES 6 & 7—Completed last with cut so that it can be removed after shoe is made over it.

tightly. Let screws extend 1/8" above top of nuts. This will prevent breaking the plantar surface when screws are tightened later.

Now turn last with plantar surface up and fill out area around nuts. Start with fairly thin resin so it will flow around edges of nuts. Next mix resin fairly thick and smear into space like putty. After this has dried, last must be sanded carefully. Apply two coats of Hosmer Lac.

This last represents the exact features of patient's foot. It is made of a tough and yet easily fabricated material. It can be sawed, filed, nailed. The Last is now ready for any special insole or elevation which will be described in the next issue of the Journal. (Figures 6 and 7)

World Veterans Federation Prize to Dr. Rusk

The Rehabilitation Prize of the World Veterans Federation was awarded to Dr. Howard A. Rusk, Director, Institute of Physical Medicine and Rehabilitation, New York University Medical Center, in ceremonies held in Lausanne, Switzerland, May 5, on the closing day of the Eleventh General Assembly of the World Veterans Federation.

The prize is presented each second year to an individual who has made distinguished contributions to international cooperation for the rehabilitation of the disabled. It consists of a bronze trophy of the WVF emblem and entitles the recipient to allocate a WVF rehabilitation fellowship for training or research during each of the two subsequent years.

In presenting the prize to Dr. Rusk, WVF Secretary General Norman Acton said, "During and since World War II, Dr. Howard A. Rusk has combined an inspired dedication to rehabilitation with an exceptional world statesmanship to produce achievements which will never be forgotten. His leadership has earned the gratitude and respect of war veterans, of all disabled persons, and of men and women of good will throughout the world."

During World War II, Dr. Rusk was director of the rehabilitation program of the United States Air Force, for which he was awarded the Distinguished Service Medal, and retired as a Brigadier General. He is consultant on rehabilitation to the United States Veterans Administration, and has served in a similar capacity with the United Nations and other organizations. Dr. Rusk is currently president of the World Rehabilitation Fund, Inc., a non-profit organization supported by American industry, foundations and individuals to assist in the international development of rehabilitation services for the handicapped, and from 1954 to 1957 served as president of the International Society for Rehabilitation of the Disabled.

The Institute of Physical Medicine and Rehabilitation, of which Dr. Rusk is director, is the largest university center in the world for rehabilitation of the physically handicapped. Through its educational training program, more than 1,200 medical and paramedical personnel from 68 countries around the world, have studied at the Institute, and returned to their own communities to establish new centers for rehabilitation.

The World Veterans Federation is an organization combining more than 160 associations of veterans and war victims in 50 countries. Dedicated to support of the principles of the United Nations Charter, the WVF carries out a program emphasizing economic development, including especially rehabilitation of the disabled, disarmament and the protection of human rights.