

The Total Contact Partial Foot Prosthesis

by Richard LaTorre, C.O.

The purpose of this paper is to present a prosthetic fitting procedure for a "Partial Foot" level amputation. The "Transmetatarsal," "Lisfranc," "Chopart," and "Pirogoff" type amputations are all treated with this procedure with some modification, mainly in length of forefoot. The partial foot as a category presents more anxiety among physicians and prosthetists and clinics, than is generally realized. For the avascular patient, a "toe filler" is not adequate, no matter how cosmetic it appears. Classically, patients who are diabetics and have been given toe filler type prostheses tend to develop eversion, a tightening of the Achilles tendon, and are usually doomed to perforating ulcers on the distal plantar anterior or distal anterior portion of the residual foot.

The solution presented here is an ultra-light-weight prosthesis, one that removes stress (caused by torque on the leg), protects the extremity from shock at heel strike and toe off, controls plantar and dorsi-flexion, controls eversion, controls edema, and still is cosmetically acceptable. This style prosthesis has been in use since March, 1974. By 1977, 62 prostheses of this type had been successfully delivered. The largest group of patients was between 45 and 65 years of age and almost equally divided between males and females. The next largest group was geriatrics (over 65) and only four patients were in the 20 to 45 age group. Only one patient went on to further amputation.

As a result of wearing this type of prosthesis, the residual limb is usually warm, free of ulcers, callosities, and edema. When compared

to the contra-indicated extremity, it appears to be generally healthier and most patients state "it feels better than my other leg."

By 1984, this type of prosthesis was being fabricated at the rate of one every three weeks. At present, the average is one every two weeks.

"Lower Profile" partial foot prostheses are also fitted, but only after the patient has successfully worn this two piece design for at least six months. This insures, if trouble starts with a Low Profile prosthesis, there is no "down time" for the patient; they simply go back to "old faithful."

Incidentally, we have also developed three different styles of the Low Profile partial foot prosthesis (that we have not described in the literature), but have never been able to develop a series of four or more successes for each design.

Evaluation and Casting

Prior to casting, a prosthetic evaluation is made to determine joint limitations, noting mainly inversion/eversion and degree of plantar flexion/dorsi-flexion. Old scars are noted, as is the condition of skin over bony prominences and any possible weeping of draining areas. The patient's weight, height, and occupation are included in the evaluation before casting. Determination of material, usually polypropylene, thickness of material selected, and length of the prosthesis to be fitted is made at this time. The negative cast is usually taken with the patient in the sitting position. Any scab or draining area is covered with Saran

Wrap® or its equal. Stockinette is then applied to the extremity from the toe to the supra-condylar area. With indelible pencil the malleoli, anterior crest of the tibia, head of the fibula, old scars, and any extremely sensitive-to-touch areas, as well as those that may cause future problems, are marked.

Casting is a two step procedure. The residual foot should be barely touching the floor and the foot to tibia relationship should be 90°. Splints of plaster of Paris are laid on the anterior tibia from a point approximately 2 cm. distal of the level of the tibial tuberosity distally to the point of floor contact. If it has been decided to weight-relieve the ankle complex, the well known P.T.B. casting procedure is used at this point.

The extremity is now wrapped with Coban bandage. Coban is a plastic seersucker type material that acts as a waterproof Ace bandage and will not adhere to plaster. This technique enables the practitioner to make a thin-walled cast that is easier to remove from the tender extremity. The "Coban Technique" gives an eggshell hard cast, because it compresses the plaster, thus enabling the user to use less plaster and still obtain a firm satisfactory cast.

As soon as the extremity is wrapped, it is replaced in the original position, (i.e. foot to tibia relationship of 90°). After the cast has sufficiently hardened, the bandage is removed and rerolled for future use.

The already cured plaster and stockinette are now coated with K-Y Jelly. Plaster strips 4" × 12" are applied vertically to the posterior and lateral aspects of the extremity, overlapping the anterior cured cast from 3/4" to 2". The extremity is wrapped once again with the Coban bandage and returned to the sitting position. The Coban bandage is removed and reference lines are horizontally laddered across the cast overlapping areas when the posterior section has hardened. The exterior cast is carefully removed, the stockinette is cut away posteriorly, and the anterior "shell" carefully removed. Both sections are quickly re-oriented to each other and sealed together.

In the laboratory, the negative cast is rinsed with a solution of soap or detergent, the surplus is poured out, the cast is placed in a sandbox, and the positive model is poured with bulk plaster. A pipe is placed in the cast and held in place until the plaster has set.

Fabrication

When the model is hard, the negative cast is stripped away. The model is held in a bench vise, sanded smooth, and plaster is added to problem areas noted at the time of casting. The amount added is 6-7 mm. at both malleoli, fibular head, and along the tibial crest. A 3mm. buildup over any scar or weeping area is sufficient. At this point, the model is covered with a layer of stockinette.

An appropriately cut section of sheet polypropylene is placed in an oven at 400°F for ten minutes. The material is draped over the anterior portion of the model. The material will have the consistency of taffy when removed from the oven. If any wrinkles appear, the plastic must be discarded and a new piece cut and molded. Sometimes several trials are necessary until satisfactory results are achieved.

When cooled, the anterior portion is removed from the model, trimmed, and all edges smoothed to the touch. The plantar trimline is just anterior of the os-calcis. The medial and lateral trim lines are on the midlines viewed in the sagittal plane. The original technique has been modified so as to provide a more posterior plantar trim line that now encompasses the os-calcis. This reassembles an inverted "T" shape.

The model, minus the anterior molded shell, is further prepared by tacking a leather innersole that fits the patient's shoe (or opposite foot pattern inverted) to the plantar surface of the model. One inch nails are driven into the anterior portion of the positive model to provide an anchor for the plaster to be added next.

The cast with the innersole attached is placed on a casting board. This is usually done with the aid of a vertical alignment jig, but can be accomplished manually without a jig if great care is exercised. This aligns the model to simulate the normal contour of the shoe relative to ball and heel. Bulk plaster is now applied to the innersole and built up onto the anterior foot portion. When firm, the plaster is trimmed to the edges of the innersole.

The model is placed back in the vise horizontally and rotated so the posterior surface faces the fabricator. Appropriate size plastic is laid out and cut, and the molding process is repeated.

Once cooled, the posterior shell is removed

from the model. The forefoot is trimmed away laterally so all that remains, from midfoot running distally, is an innersole-like projection (i.e., it resembles a molded polypropylene solid ankle-ankle-foot orthosis).

The anterior buildup of plaster is now removed from the original model. The polypropylene anterior shell snaps back on the model and the posterior shell goes over it. A Velcro® closure is attached to the proximal portion and a filler is cemented onto the innersole portion to simulate the forefoot and fill the shoe. The material used is plastazote bonded with barge cement.

This version was used until 1983 when a woodsman who complained that "the toes lose their spring" was encountered. This was found not to be a problem with other patients. To satisfy this patient, roughly ten modifications of the forefoot section were tried. Unsuccessful were thicker polypropylene, metal reinforcement (spring steel), "double soling" the forefoot, and many other less involved changes. All met with patient displeasure. Success came with the fabrication of a forefoot "box section."

To fabricate one, bulk plaster is poured into a shoe box top to provide a mold. Polypropylene is molded over this. The molded plastic is cut into quarters and the four corner pieces are arranged in such a manner that the corners fit together forming a three dimensional cross shape. Place them onto the anterior "sole" of the prosthesis. Trim to fit the edges of the sole. Rivet the two anterior (left and right) sections to each other and then to the toe section of the prosthesis. Next, rivet the remaining two pieces together and place this section against the anterior shell. Trim and fit it until a $\frac{5}{8}$ " gap is formed between it and the "anterior box" section. Rivet the remaining loose box section to the sole (Figure 1). The $\frac{5}{8}$ " gap between the two "box" sections is filled with foam rubber (Figure 2). The durometer selected depends on how firm a toe break is desired. This design has provided the more aggressive patient with a toe action that simulates the push-off activity of the contralateral foot.

Fitting

The prosthesis is now ready for fitting. Shoes used have usually been of the double

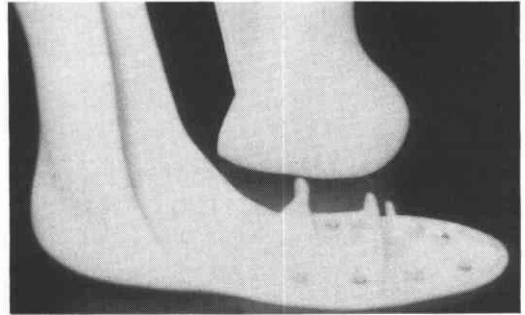


Figure 1. Box sections rivetted in place. Anterior shell shown in the back ground.

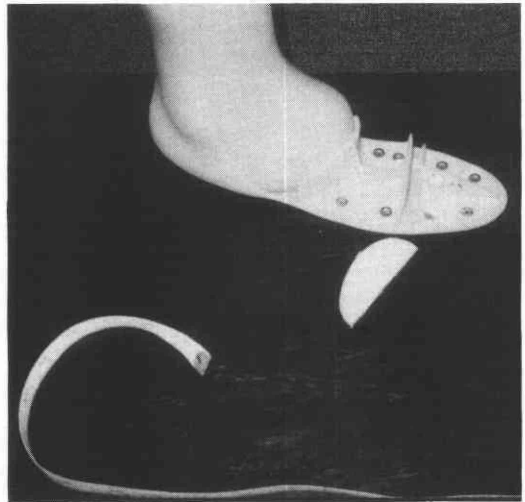


Figure 2. Foam rubber bumper laying beside forefoot section. Anterior shell in place.

depth type with removable innersole. This type is preferred because it gives extra depth inside the shoe for the affected extremity and allows room for, and needed balancing of, the remaining foot. Most often the patient has been fit with the extra depth shoes and they later purchase ordinary footwear and manage without incident.

It is felt that the total contact principle that has been so beneficial to other amputees has been adopted successfully in the design of this prosthesis. By encapsulating the extremity, edematous problems have been prevented and circulation boosted, or so the patients have reported. The skin texture is soft and warm by comparison to the contraindicated limb. In fact, many patients have remarked that the extremity

had always felt cold but now the other leg feels cold by comparison. This prosthesis prevents the problem of distal end friction that can result in further amputation.

It is not possible for a shoe to cause friction to any part of the residual limb. One patient, who is a farm machinery repairman, has also found that it prevents the problem of bruising of the shin he encountered in his occupation.

This style prosthesis, for all its length and function, weighs little more than the toe-filler type prostheses and is certainly lighter than other versions. It is relatively more expensive than most toe-fillers, but considerably less expensive than other types of prostheses, such as a conventional Chopart.

On heel strike, the material "puckers" slightly, cushioning the impact. On foot flat, as well as at toe-off, the action of the foresection simulates the norm. In many patients, better gait on the affected extremity than on the contra-indicated limb has been observed.

The gaits of all patients fitted have improved dramatically and some are undetectable to the eyes of even trained personnel.

Conclusion

Experience to date is that the above described prosthesis provides superior gait, less cost, less weight, and better patient acceptance than other types of Chopart prostheses. The material will torque with the extremity and does cause friction to tissue of poor quality.

This material was originally presented in 1974 and not submitted for publication because it was thought that it would be outdated within a year or two. Evidently, this was a wrong assumption. With an ever increasing number of surgeons doing more distal amputations, there have been more and more requests for this information.

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