Technical Note:

Prosthetic Applications of Methylmethacrylate Acrylic Plastic

Scott Hornbeak, C.P.O., B.S.
Richard J. Boryk, C.P., B.A.
Timothy B. Staats, M.A.C.P.

Methylmethacrylate, or acrylic, is a plastic material used extensively in dentistry for dental plates and repairs of dental work. Sterile methylmethacrylate is used as bone cement for total hip and knee replacements in orthopedics, and has also been used as a structural replacement for bone in certain cervical spine surgeries.

The prosthetic and orthotic applications of methylmethacrylate have been clinically tested for two and a half years in the UCLA Prosthetic-Orthotic Laboratory. The unique qualities and versatile applications of this plastic have shown it to be superior to polyester resin mixed with Solka Floc or Micro Balloons. Methylmethacrylate is now used routinely to attach laminated sockets to wooden end seals, to repair and fill socket cracks, pits, or rough areas, to replace suction socket valve housings, and to bead or build up sharp edges or insufficiently rolled socket brims (Fig. 1). The material is particularly useful in shaping or recontouring below knee and above knee plastic sockets (Fig. 2). The time necessary to complete socket fills or adjustments has been reduced on the average from one hour down to twenty minutes when compared to typical polyester resin techniques.

Methylmethacrylate is a two component, cold cure, acrylic plastic, the type used consisting of a fine powder and a liquid monomer. This material is available in a fast or

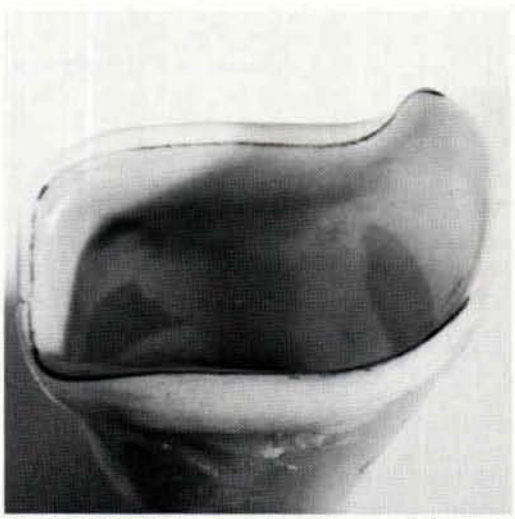

Fig. 1 – Rolled brim of an above knee socket adds to patient comfort (methylmethacrylate unpigmented and outlined).

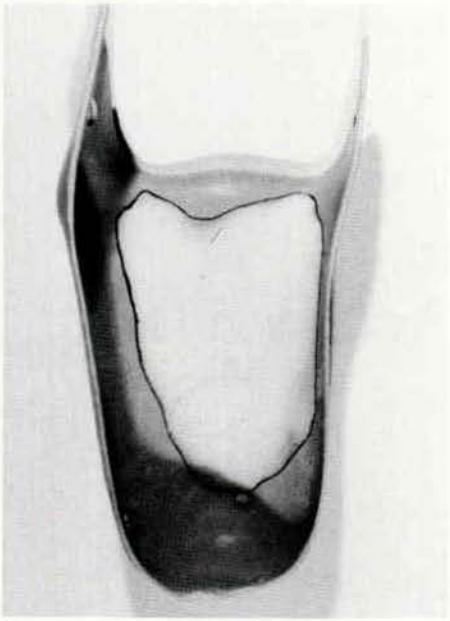

Fig. 2—Split below knee socket illustrates a fill in the gastrocnemius area (outlined area).

regular set time. The fast set cures in approximately five to ten minutes and the regular cures in fifteen to twenty minutes.

Acrylic laminating resin, which is also in the methylmethacrylate family, is a different material and cannot be used in the same manner as the methylmethacrylate described.

Methylmethacrylate is mixed to different consistencies for different applications. By varying the ratio of powder to liquid monomer the user may mix a thin liquid or a stiff paste. Methylmethacrylate increases in viscosity as it cures until it reaches a moldable, dough-like consistency which can be shaped and smoothed using fingers or a brush with a small amount of liquid monomer.

PRECAUTIONS

Some cases of contact dermatitis in dentists and surgeons from use of methylmethacrylate monomer have been reported (1). It is advisable to wear gloves whenever working with methylmethacrylate. The long term effects of using this material directly against skin before it has cured are unknown. If sensitivity to the liquid monomer is noticed, further use should be discontinued. After methylmethacrylate has cured, contact with the skin is safe.

METHOD

The procedures used when working with methylmethacrylate are divided into five steps:

- Surface preparations
- Mixing
- Molding
- Smoothing
- Polishing

Surface Preparations

Methylmethacrylate bonds well with polyester resin, acrylic resin, epoxy, and wood surfaces. Roughen the surface to which methylmethacrylate will be applied with 80 to 120 grit sand paper to achieve good bonding. Prime the roughened surface with an application of a small amount of liquid monomer.

Methylmethacrylate Mixing Procedures

Combine two to three parts methylmethacrylate powder with one part liquid monomer by volume to obtain a workable consistency of methylmethacrylate. Add powder to liquid when possible. If the mixture is too thin, methylmethacrylate monomer can be added to thicken it, and conversely if the mixture is too thick, liquid monomer will thin the mix. One or two drops of standard lamination pigment adequately colors methylmethacrylate. The proper consistency for most applications is a thick putty-like mixture. A thick mixture is advantageous for three reasons: first, with a putty-like consistency, it is easy to apply and shape complex curves and contours; second, the mixture will cure quickly when mixed to a thick paste allowing rapid shape modification; and third, thin mixtures have a tendency to bubble and pit during the curing process.

Fig. 3 – Methylmethacrylate (unpigmented for illustrative purposes) is added to the outside of a below knee check socket to provide room to grind over the fibular head.

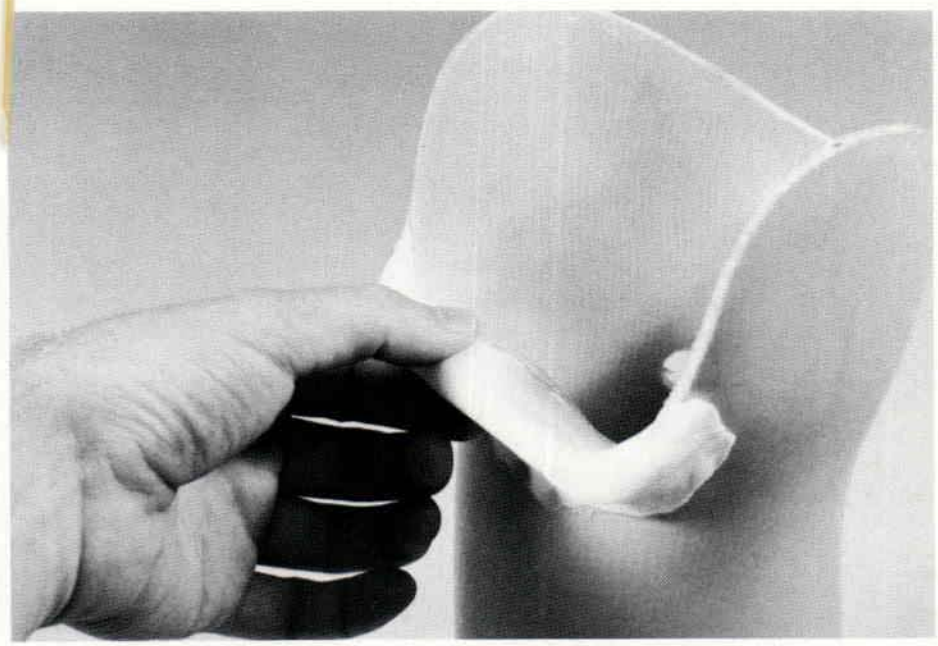

Fig. 4 – Methylmethacrylate being shaped to lengthen the posterior shelf of a PTB socket.

For normal laboratory procedures fill two eight ounce cups with approximately three quarters of an ounce of liquid monomer in each. One cup will be used for mixing the methylmethacrylate powder. The second cup of monomer will be used as a smoothing agent as the plastic begins to cure.

Molding

Apply the methylmethacrylate mixture on the prepared surface with a tongue depressor (Fig. 3). The surface should be wet from the application of monomer as a primer. When applied, the mixture will be somewhat tacky to the touch and not easily molded. The methylmethacrylate is spread over the roughened surface to insure good bonding. After thirty seconds to one minute the material can be molded and shaped by hand without plastic sticking to the fingers (Fig. 4). Any plastic that does adhere to the skin or gloves is easily removed during the curing process.

Smoothing

Smoothing of the methylmethacrylate can be initiated after the buildup is no longer tacky and the general shape has been obtained. Monomer liquid is used to feather the margins and to even any bumps on the methylmethacrylate buildup. By moistening the fingers or a small brush in the liquid monomer, the buildup can be rubbed or brushed to provide a smooth transition on to the socket (Fig. 5). The liquid monomer acts as a lubricant at this stage of the curing process. Note: Curing methylmethacrylate generates an exothermic reaction which may be slowed down by placing a cool towel or water on the hardening plastic, thus further avoiding pits and bubbles. With practice, a smooth, finished buildup can be completed at this stage without the further grinding, shaping, or coating common to polyester resin techniques.

Fig. 5 – Smoothing the methylmethacrylate with liquid monomer.

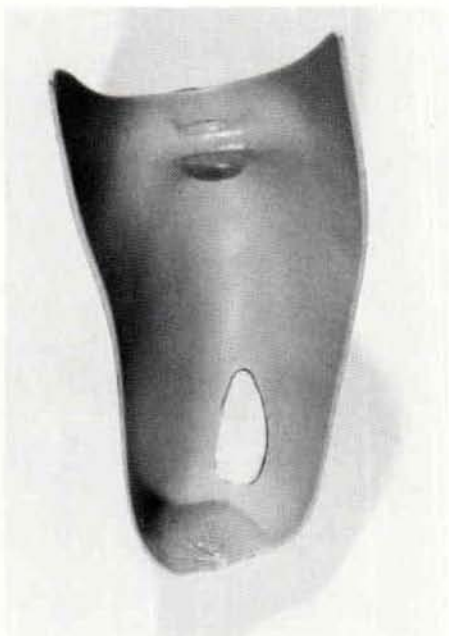

Fig. 6 – Methylmethacrylate added to the outside of a below knee socket allows grinding for an anterior-distal tibial relief.

Polishing

Should sanding or polishing be necessary, ridges and bumps are quickly removed by grinding with a 120–220 grit cone on the router. Initial grinding is followed by wet or dry sanding with 220 grit Durite and final polishing is done with 400 to 600 grit wet or dry sand paper. A felt cone is used to buff any rough edges along the trimlines, socket edges or filled rivet holes.

Approximately five quarts of monomer are required to set off twenty five pounds of powder. Methylmethacrylate powder is generally sold by the pound. Liquid monomer is sold by the quart or gallon.

SUMMARY

The advantages of using methylmethacrylate over polyester resin techniques are that it is moldable as it cures, it does not require fillers to create a thick paste, it sands quickly to a smooth gloss, and provides almost immediate compatibility for the socket-skin interface. Methylmethacrylate bonds well to polyester and acrylic laminates and is hypoallergenic when cured. Methylmethacrylate allows the prosthetist to make changes in socket size and shape in about twenty minutes as compared to other plastics that normally take over sixty minutes before the patient can wear the prosthesis. The ability to change shapes rapidly also provides an extremely useful diagnostic tool when using laminated check sockets (Fig. 6). Although it is more expensive per volume used when compared to polyester resin, clinical experience with methylmethacrylate has shown it to be technically advantageous in terms of application and time saved.

References

1. Fires, I.B., Fisher, A.A., and Salvati, E.A.: Contact Dermatitis in Surgeons from Methylmethacrylate Bone Cement. The J. Bone and Joint Surg. Vol. 57-A: 547-549, June 1975.