Syntactic End Seal Technique

Timothy B. Staats, M.A., C.P.

There are a variety of alignment couplings and prosthetic components that attach to wood or premade plastic end seals (Figure 1). The method of attachment is usually via wood screws or machine screws. The attachment of alignment couplings to wood end seals with wood screws is time consuming and prone to error. Premade end seals with threaded inserts offer the convenience of using machine screws for attachment, but require a separate step to attach the socket to the end seal with resin, foam or other adhesive material. The variety of hole patterns in the allignment couplings rarely allow interchangeability between different units and premade end seal hole patterns (Figure 2).

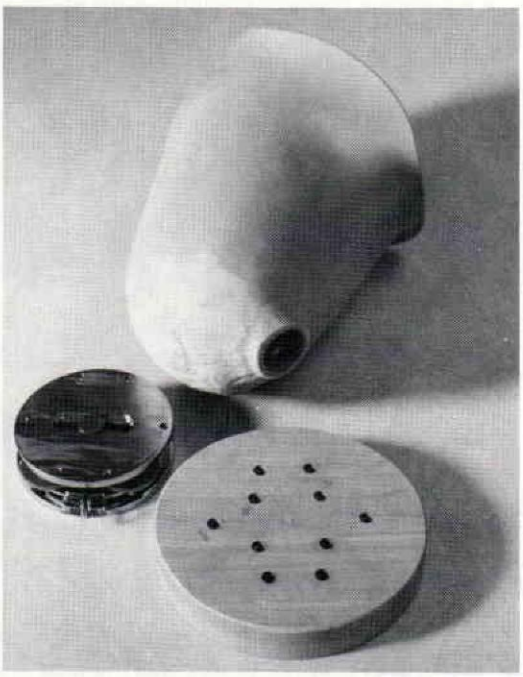

Figure 1. Recently developed universal end seal.

Figure 2. Hole patterns in alignment couplings vary greatly.

Figure 3. The top ring from the adjustable leg is aligned to the cup and its hole pattern is marked.

The Syntactic end seal technique creates an attachment end seal with imbedded threaded inserts while simultaneously attaching the socket to the end seal. The following procedures describe the technique in detail for use with the U.S.M.C.-V.A.P.C. below-knee adjustable pylon. But, many other prosthetic components require affixation for which the Syntactic end seal technique may also be useful. The plastic used in this technique was carefully

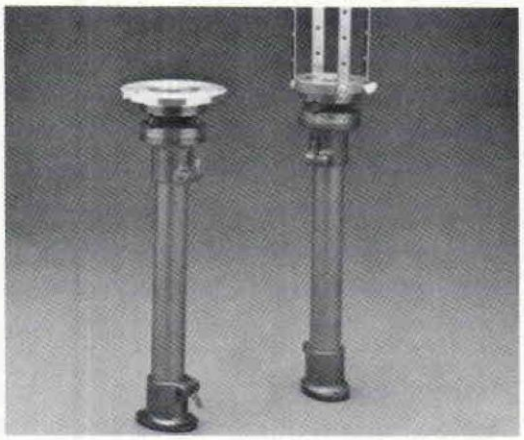

Figure 4. USMC below knee adjustable leg.

selected for its strength and durability. While other plastic materials may also be suitable for the Syntactic end seal technique, none were found to be as high in strength nor as fast curing as the new plastic called Syntactic resin.

The U.S.M.C. below-knee adjustable pylon (Figure 3) is the component we will use to demonstrate the Syntactic end seal technique. The attachment ring (Figure 4) at the top of the unit is available with six spaced holes. Remove the ring from the unit and place it on the bottom of a paper cup, noting the anterior position of the ring. The cup should have a large enough opening to permit the insertion of the dis-

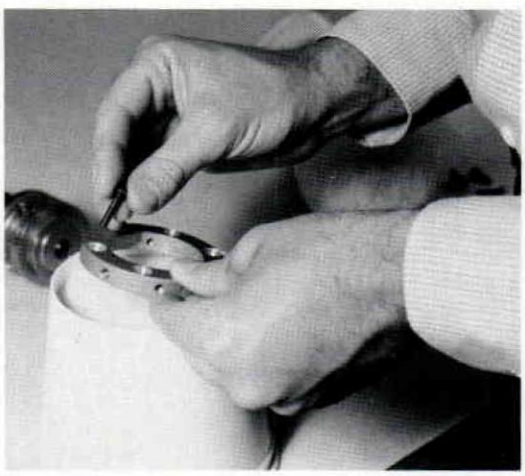

Figure 5. Machine screws are inserted through the ring and cup.

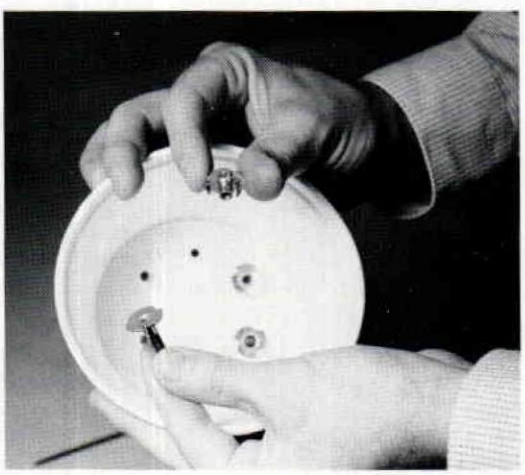

Figure 6. "T" nuts are fastened inside the cup to the machine screws.

tal end of a below-knee socket. Carefully mark the hole pattern using an awl or similar sharp instrument to pierce small holes through the bottom of the cup. Insert 10-32 flat head machine screws through the attachment ring and paper cup shown (Figure 5). Care must be taken to insure exact hole alignment. Inside the cup attach 10-32 "T" nuts to the 10-32 flat head machine screws and tighten snugly (Figure 6). Be sure the "T" nuts are inserted as shown with prongs facing upward toward the opening of the cup.

Noting the anterior position of the alignment ring, set the socket into the cup in standard bench alignment. The vertical duplication machine can be used to hold the socket in place, or alignment lines can be inscribed on the socket and the socket can be hand-held as shown in Figure 7. The socket should be generously roughened, particularly when thermoplastic sockets are used and a mechanical bond will be the primary adherent mechanism.

Syntactic resin is now used as a bonding agent to create the end seal with "T" nuts imbedded in it and at the same time to attach the socket to the end seal. A mixing ratio of 50/50 is suggested for maximum strength with Syntactin resin. The Syntactin resin will set in less than two minutes from the time the two components are mixed together. It is ready for grinding in less than ten minutes, or when the plastic has cooled. The strength of the resin increases for about eight to ten hours.

While patients have been walked within an hour after pouring the resin, precautions should be taken with any curing plastic before walking trials are started.

Syntactic resin may be used by itself or mixed with micro-spheres. The micro-spheres will, however, weaken the material. In a separate cup, mix 100 grams of the Syntactin resin "A" component. Carefully

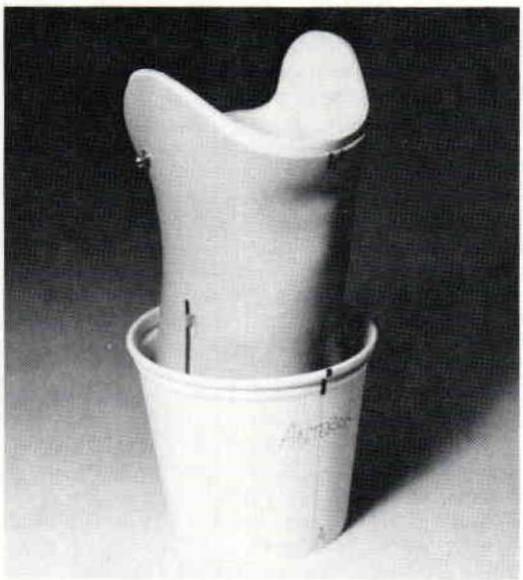

Figure 7. The below knee socket is balanced in proper bench alignment with "T" nuts in place.

Figure 8. Syntactic resin is mixed in a 50/50 ratio by weight.

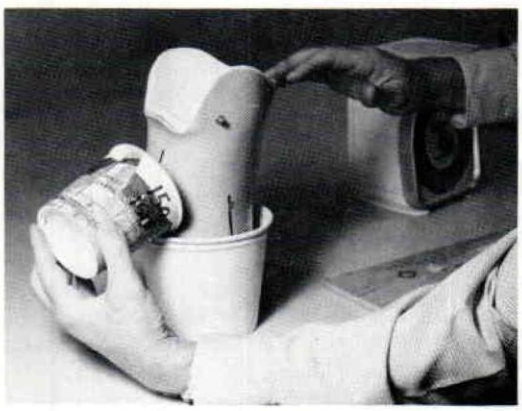

Figure 9. After a thorough and rapid mixing, the syntactic resin is poured into the cup.

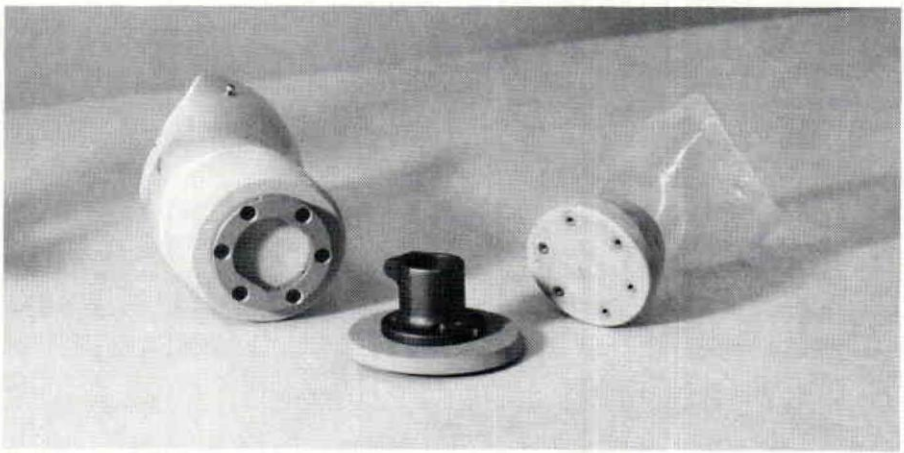

Figure 10. Syntactic end seal technique used with polyester below knee socket, Thermovac below knee socket, and with USMC below knee module clamping component.

measure the same amount of the "B" component into the cup and begin stirring immediately (Figure 8). Thorough mixing for 30 seconds is essential. Pour the contents of the mixing cup into the cup alignment and insert the socket in its proper alignment (Figure 9). Do not use silicone release agents on the interior of the cup as it seems to affect the surface cure of the Syntactic resin. Total organization of the work project is essential for good results.

When the Syntactic end seal has cooled, remove the cup by peeling or grinding (Figure 10). Care should be taken when grinding the attachment surface to remove material at exactly 90 degrees to the alignment of the "T" nut orientation (Figure 11). Syntactic resin may then be shaped as desired. Laminations with polyester or acrylic resin over Syntactic resin should be prefaced by roughing the surface of the Syntactic resin. Pure Syntactic resin without micro-spheres appears to adhere to or accept acrylic resin better than it does polyester resin. When Syntactic resin is mixed with micro-spheres, polyester or acrylic resin seem to adhere equally well.

In testing the strength of the Syntactic end seal technique in various prosthetic applications, the results in Figure 12 were compiled as pertinent to the prosthetic applications of the technique.

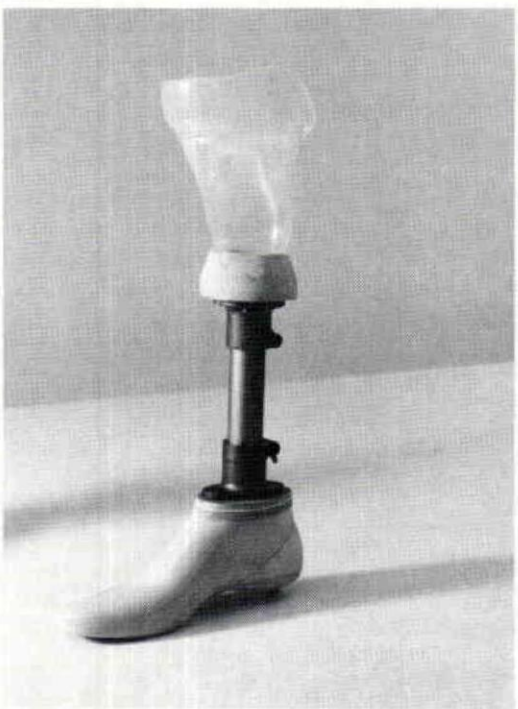

Figure 11. A Thermovac socket mounted on a USMC below knee pylon using syntactic end seal technique.

While further testing will be done on applications of Syntactic resin, experiences thus far have shown the material, when

TEST	DESCRIPTION OF TEST	BREAK POINT	COMMENTS
1	U.S.M.C. wood end seal with "T" nuts	950 lbs.	Pull to break, wood broke, "T" nuts intact
2	Syntactic Resin—Mix No. 1 micro-spheres	850 lbs.	Pull to break, Syntactic resin broke, "T" nuts intact
3	Syntactic Resin—Mix No. 2 micro-spheres	875 lbs.	Pull to break, Syntactic resin broke, "T" nuts intact
4	Syntactic Resin—unfilled	1000+ lbs.	Could not break
5	Polyester B/K socket U.S.M.C. wood end seal (polyester-solka floc)	580 lbs.	Wood Split in half at "T" nut locations, four "T" nuts used
6	Polyester B/K socket Syntactic end seal technique	650 lbs.	One "T" nut used, two three or four "T" nuts could not be broken on the test equipment
7	Thermo-Vac socket— Syntactic resin end seal	340 lbs.	Syntactic resin was filled with micro-spheres "T" nuts pulled out
8	Polyester socket-wood end seal U.S.M.C. below-knee adjustable pylon wood screws	130 lbs.	Wood screws pulled out, this socket had been walked on
9	Polyester socket-Syntactic resin V.A.P.C. below-knee adjustable pylon	450 lbs.	Coupling snapped in half and pylon bent. Syntactic end seal intact

Figure 12.

properly used, to be extremely high in strength. This may be possibly as high as 60,000 P.S.I. tensile strength.

CONCLUSION

The Syntactic end seal technique is an efficient method of creating an end seal and setting up a socket in bench alignment simultaneously. Research into the possibility of forming the socket at the same time as the end seal would further speed up the fabrication process, particularly in light of the high speed cure the Syntactic resin exhibits.

ACKNOWLEDGMENTS

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AUTHOR

The author, formerly technical director, United States Manufacturing Company, is currently Director of the Prosthetic Orthotic Education Program, 1000 Veteran Avenue, Los Angeles, California 90024.