

Polyvinylchloride Gel in Orthotics and Prosthetics

Part II

Silicone Gel Below-Knee Amputation Prostheses

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In cases of leg amputation, surgeons are increasingly aware of the need to spare the knee joint whenever possible, because of the great functional advantage for the patient. Ordinarily, a good surgical below-knee stump can be fitted successfully with one of the 22 kinds of modern prostheses. Following severe trauma, however, it is often difficult to salvage the knee and at the same time provide a stump that can be fitted to a prosthetic limb. Split-thickness grafts may be necessary to provide coverage for soft

tissue deficits. Some stumps may have extensive scars or areas without sensation; others may be very short, offering little surface area in relation to the body weight that must be supported. In such cases the prosthesis may fit well initially, but within a short time the forces exerted at the stump-socket interface will induce further shrinkage of the stump area and may lead to problems such as pain in the stump, "choke syndrome," loss of skin, or ulceration.

In an attempt to insure optimal

distribution of pressures and lessen shear forces on the stump, a silicone gel envelope contoured to the stump was developed in the University of Michigan Prosthetic Shop (by Joseph P. Giacinto and Richard A. McUmber) as a modification of a total contact below-knee prosthesis. To reduce the customary sliding of the prosthesis on the stump, a rubber sleeve suspension can be provided as a substitute for a thigh corset, suprapatellar cuff, fork strap, waist belt, or other type of suspensory device.

As shown in Figure 1, the standard patellar-tendon-bearing prosthesis with SACH foot (solid ankle cushion heel) has been modified by substituting silicone gel in an envelope of lightweight horsehide for the conventional socket liner of rubber (Kem-Blo*) and Naugahyde.* Conventional cotton, wool, or nylon stump socks are applied to the stump before donning the prosthesis.

The new gel liner has been tested by 50 patients, 18 of whom had experienced serious stump disorders as the result of wearing one of several conventional sockets. In 6 of these 18 patients the stumps were shorter than 6 inches; 3 were partially insensitive; 3 had large adherent scars. In 1 patient the knee flexion was limited to 35°, and in 5 there was little muscle near the end of the stump and the distal portion of either the tibia or fibula was subcutaneous. In addition to these 18 patients who had previously worn artificial limbs, 32 new patients were fitted, 2 of whom had

undergone below-knee amputation of both legs. The patients have been followed from four months to two years, and all have expressed their satisfaction with the new type of prosthetic socket. None have reported excessive perspiration.

Pressure transducer studies of the stump-socket interface, under the direction of Dr. James L. Cockrell, have shown that a silicone gel socket appears to distribute pressures more evenly than a hard socket made from an identical cast of the stump. The qualities of silicone gel may approach some of those found in liquids, and it is appropriate to speculate that shear forces or tangential pressures are less in a silicone gel than with other socket materials.



FIGURE 1—Silicone gel insert for below-knee amputation stump prosthesis with molded rubber sleeve suspension.

* Uniroyal, Inc., New York, New York.

Unfortunately, this prosthesis is somewhat more expensive than others and only a few prosthetists are experienced in its fabrication. However, silicone gel sheets[†] of the proper durometer, and molded rubber sleeves[‡] of various sizes are now available to facilitate the construction of this device.

Summary

The addition of contoured sili-

[†] Atco Surgical Supports, Inc., Cuyahoga Falls, Ohio.

[‡] Perry Rubber Co., Massillon, Ohio.

cone gel to the socket of a well fitted total contact below-knee prosthesis suspended with a molded rubber sleeve has proved to be superior to other kinds of prostheses. Pressure transducer studies have demonstrated more uniform distribution of pressures and suggest that shear forces are probably reduced at the stump-socket interface. For these reasons, below-knee amputation stumps considered as inadequate might be fitted successfully with this modified prosthesis.