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Upper Extremity Cosmetic Gloves

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INTRODUCTION

Upper extremity rehabilitation includes the restoration of function and cosmesis to simulate the human hand.[6] Producing a replica of the hand which is functionally and psychologically beneficial to the amputee and quite importantly, acceptable to those with whom the amputee socially interacts,[4] is both challenging and of high priority.

The technology for producing either custom made or mass produced cosmetic gloves has changed little in more than 20 years.[2] However, within the last several years, with the advent of new materials, there have been new developments. More specifically, there have been developments in a family of silicone elastomers the application of which offers solutions to problems associated with existing cosmetic glove technology.

Briefly, cosmetic gloves have been made with latex, urethanes, and RTV silicones, but these materials were not successful because they had serious drawbacks. Latex skins were impermanent, coloration was unacceptable, tear strength was very low, absorption of clothing dyes was common,[5] and they did not last very long before deteriorating. Urethanes held promise, but the components to produce a plastic film are very difficult to control in small laboratories. They are too sensitive to moisture and extraneous contaminants, and require precise measuring. After limited use, they are weakened by ultraviolet light and thus their useful life as terminal device coverings is limited.[8] RTV or room temperature curing silicones, when first utilized in prosthetic restorations and glove-making, proved ineffective because the material required complicated molding procedures, was often manufactured pre-colored, had extremely low tear strength, and had very low elasticity and flexibility. In addition, one small tear would easily propagate, rendering the glove useless.

PVC GLOVES

PVC, or polyvinyl chloride, has dominated glove making and still does to the present. Historically PVC is inexpensive and readily available. Gloves can be fabricated en masse in metal molds or custom made in flexible slush molds. In either technique, the plastisol cures against the wall of the mold, producing a thin skin of vinyl which can either be intrinsically and/or extrinsically colored.[6] Stabilizers and plasticizers are introduced to make the cosmetic glove flexible and resistant to degradation by ultraviolet light. Replication of the human hand has been adequate using PVC and thus these gloves have been widely available for most amputees. However, there are disadvantages associated with PVC as a material for use in prosthetic gloves.

First and foremost is the inability of PVC to resist attack by most chemicals, soiling and staining agents, and newsprint. These substances are absorbed by the plasticizing agents and are impossible to remove. At temperatures close to freezing, the PVC stiffens and its flexibility is greatly reduced. This can inhibit the proper functioning of an electric or mechanical

hand as the inability to open a finger or thumb can render a terminal device useless.[9] In warm temperatures, the plasticizers and stabilizers tend to bleed to the surface of the glove, causing peeling of the extrinsic coloring, as well as darkening and stiffening. PVC "feels" like plastic and not like human tissue, and for the most part, unless a PVC glove is custom made and tinted, the surface is rather opaque and cadaverous looking. Custom made PVC gloves present all of the above problems, but do match skin tone, hand shape, and surface characterization of the intact hand better. The time required to fabricate a custom glove is much longer because the technique is more elaborate, and as a result more expensive. Of course, the success of the glove is directly proportional to the ability of the prosthetist to make the cosmetic glove appear natural and reasonably well matched to the other hand.

No matter what technique is utilized, the consensus is that PVC gloves are rather short lived: two weeks to eight months on average. Efforts to strengthen the glove with nylon fabric reinforcement or to retard discoloration by spraying clear solutions on the surface of the glove produce disappointing results.[2] Finally, there is a problem donning and doffing a PVC glove due to the inflexibility of the material proximal to the wrist. This gave rise to the practice of sewing zippers into gloves. Besides being bulky and unsightly, zipper installation is time consuming and the zipper may be easily jammed or broken. Thus, a better material which might resolve some of the above problems is needed.

SILICONE GLOVES

Silicone rubber offers excellent solutions to some of the aforementioned problems, and they now have properties which make them more readily processed in glove making.[3] In general, the new generation of silicones are tougher, more resilient, more durable, and more permanent than previously utilized materials. While not ideal, the silicone gloves presently being developed resist chemicals, dyes, soiling, and staining almost completely. The skins may be washed with mild detergents and water for cleaning. Unlike PVC, lower or higher temperatures have little effect on the strength, flexibility, or elasticity of the glove.[7] The result is better functioning of electro/mechanical hands, and in some cases, the elastic resistance of gloves can actually enhance functioning of the terminal device.

Unlike PVC, silicone rubber may be modified to increase its elasticity where necessary without loss of tear strength. Cosmetic gloves of silicone elastomers may be intrinsically or extrinsically colored as with PVC. However, there is much greater adhesion of external pigments to silicone gloves and the resultant glove rarely sheds its external tinting. It is more color stable and is less affected by ultraviolet light than its PVC counterpart; Silicone neither darkens nor stiffens with the passage of time. Once fabricated, the glove is non-toxic as compared with PVC. This is an obvious advantage when fabricating gloves for babies and toddlers, as harmful agents do not leach out to the surface of the glove to enter the baby's mouth. Silicone can be formulated to reflect and absorb light in much the same way human skin does, producing a more natural and life like appearance. Likewise, silicone also simulates the "feel" of skin more closely as it relates to softness and texture.[1] Its higher coefficient of friction helps prevent glasses and other objects from falling out of the hand's grasp.

DISCUSSION

There are some disadvantages in the production of silicone gloves which need to be addressed. The cost of manufacturing, the increase in fabrication time, and the slightly higher cost of silicone rubber[3] is retarding the availability of such gloves.

However, if the technology to produce silicone gloves improves, and if they become more widely available, their cost and fabrication time should decrease. They have greater durability and esthetic appeal than PVC, and there can be no doubt that silicone offers possibilities heretofore unavailable with PVC.

Silicone cosmetic coverings for the lower extremity are a future possibility. Swim and sport legs could be greatly inhanced by these tough, resilient and cosmetic coverings. Silicone compounds are presently used in maxillofacial prosthetics, breast prostheses, partial hands, partial

feet, leg and arm buildups, and other body restorations.[1]

There is no doubt that a more natural, functional, esthetically and psychologically appealing cosmetic glove is needed by upper extremity amputees and that silicone gloves, despite some imperfections, will prove to be more promising and acceptable than PVC gloves.

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