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Research Article

SILICONE ELASTOMERS - THEIR ROLE IN MAXILLOFACIAL PROSTHETIC REHABILITATION

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ABSTRACT
Maxillofacial prosthetics are used to rehabilitate parts of the body that are congenitally missing or lost due to trauma or cancer. A case report of the rehabilitation of a missing ear and finger has been described in this article.

Key Words: *Maxillofacial Prosthetics, Silicone Elastomers*

INTRODUCTION

Silicone elastomers are used in the fabrication of artificial external body parts such as ears, nose and eyes. The loss of such organs can be congenital, traumatic or as a result of resection following cancer surgeries.
Maxillofacial prosthetics may be defined as the art and science of anatomic, functional, or cosmetic reconstruction, by means of nonliving substitutes, of those regions in the maxilla, mandible, and face that are missing or defective because of surgical intervention, injury, or congenital malformation (Bulbulian 1965).
Gold, silver, leather, vulcanised rubber, gelatine, latex, polyvinyl chloride, polyurethane, chlorinated polyethylene, and silphenylenes have all been used at various stages of evolution of materials for such prostheses (Bulbulian 1965). All these materials have reported drawbacks. (Lewis 1980) For example acrylics cause abrasion of skin, difficulty to match edges of skin to prosthesis and increased bulk and weight of prostheses.
Today, silicone elastomers are the most commonly used materials for fabrication of prostheses (Gunay 2008, Lewis 1980) .They have been commercially available since the 1950s and have been researched upon extensively. Chemically, silicone elastomers are low surface energy cross linked polymers consisting of long chain molecules with repeating units (Anusavice 2004).
Silicone is biocompatible and biodurable. It is easy to manipulate with adequate working time and good color stability. Its physical properties of relevance include hardness, high tear resistance and reliable bonding to acrylic substructures which are frequently used along with them. However, they undergo wear, degrade and start discolouring within 2 years (6-14 months) (Gunay 2008, Haug 1999, Beurmer 1996, Mohite 1994, Hulterstrom 1999). They can tear easily if not handled properly and can be difficult to maintain and keep clean (Gary 2001, Gunay 2008, Haug 1999, Hooper 2005, Hulterstrom 1999, Mohite 1994).

Composition

The exact composition of silicones is not known. However, the base contains polymethyl hydrogen siloxane and siloxane prepolymers. The catalyst contains divinyl polydimethyl siloxane and siloxane prepolymers (Anusavice 2004).Both heat and self cure vulcanizing silicones are used. Dyed rayon fibres, dry earth pigments, oils and other characteristics can be added to enhance the properties (Anusavice 2004).

Manipulation

Different manufactures use different ratios of base and catalyst. For example, Z004 (Technovent, UK) has a 1:1 ratio and M511 (Principality Medical, UK) has a 10:1 ratio. The material is weighed out as per the manufacturer's instructions using a digital scale. The silicone is manipulated on a clean plastic slab with a white background. The inorganic color pigments may be in a liquid or powder form. They are dispensed on the slab and small amounts are added to change the shade of the silicone. Different shades are prepared to match different parts of the concerned area.

Figure 1: Manipulation of Silicone *Properties:* The properties of silicone elastomers can be summarised as follows:

Clinical Application 1:

Rehabilitation of a missing ear with auricular prosthesis, the following case presentation is of a patient who has a congenitally missing right ear with some soft tissue remnants present. An adhesive retained silicone prosthetic ear was planned for him.

Table 1: Mechanical and physical properties of silicone elastomers (Lewis 1980)

Tear Strength	**30 to 100 psi**
Tensile Strength	1000 to 2000 psi
Modulus at 100% Elongation	50 to 250 psi
Elongation at Break	400% to 800%
Glass Transition Temperature	< o" c
Heat Distortion Temperature	> 120° c
Critical Surface Tension	30 to 45 dynes/cm
Coefficient of Friction	0.4 to 0.6
Hardness	25 to 35 Shore A scale
Water Absorption	None

Figure 2: Soft tissue remnants

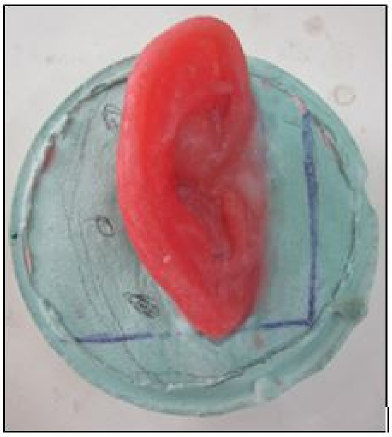

Figure 3: Wax sculpt of Ear

Figure 2 shows an impression with an elastomeric material was made of the tissue surface of the prosthetic site with the patient in a relaxed position. Dental plaster (plaster of Paris) is poured into the impression to get a positive replica. The prosthetic ear is artistically fabricated on this model with a wax. It is modified to give similar features as the adjacent ear. The protrusion, inclination, length and width of the adjacent ear are measured and a mirror image in wax was produced.

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Figure 3 shows this wax up was tried onto the patient and is checked for size, fit, protrusion and minor detailing which will add to the natural look. The surface was stippled to give it a matt finish.

Figure 4: Trial of wax pattern on patient

Figure 5: Fabrication of a plaster mould

Figure 4 show a three part mould was made in plaster. Figure 5 show subsequently the wax was boiled out to leave a mould for packing pf the silicone. Silicone (Z004) in a 1:1 ratio was measured using a weighing scale. It was manipulated by mixing the base and the catalyst .The shades of different regions on the patient's skin were achieved by adding color pigments. After desirable shades were obtained, the mould is packed. Different shades for different areas enhance the prosthesis and make it more lifelike. The mould was then cured in an oven for 1 hour at 80 degrees Celsius.
Extrinsic pigments were added to give the prosthesis fine detailing and a finishing touch. These pigments are inorganic compounds dissolved in ethyl alcohol as a volatile solvent. After they are artistically painted onto the surface of the silicone, they are sealed using a silicone sealant.

Figure 6: Final prosthesis

Figure 7: Thumb stump of the patient

Clinical Application 2: Rehabilitation of a partially amputated finger with finger prosthesis. A 21 year old male patient reported with a partially amputated left thumb due to trauma. The retained bone stump was functional and had normal movements. A thumb prosthesis which fits snugly on this stump and also does not restrict movement of the thumb and soft tissue was planned.

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A similar procedure of making an impression, pouring the plaster model and carving out a wax replica for the prosthesis was done. It was tried on and modifications were made.
Subsequently it was converted to a silicone finger by the previously described mould forming technique. The only difference was that an acrylic nail was incorporated. The nail material is Polymethyl methacrylate resin (PMMA). It is bonded to the silicone by using an intermediary platinum primer material.

Figure 8: Finger Prosthesis

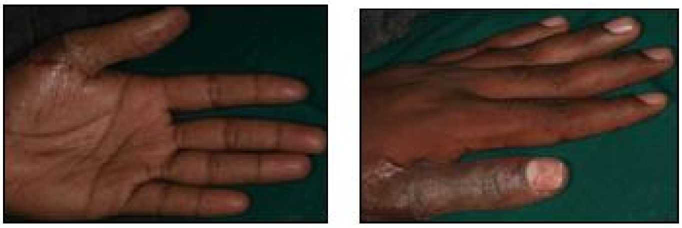

Figure 9: Finger prosthesis worn by patient

CONCLUSION
Silicone elastomers are thus materials that have properties suitable for making prostheses for replacing lost bodily organs. Their bio compatibility, flexibility, ability to be coloured artistically render them ideal materials for this purpose. Some of their inherent drawbacks such as their hardening and loss of colour are topics of exciting current cutting edge research in this field.

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