

Clinical Report

Fabrication of a glove type finger prosthesis using silicone elastomers

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Finger and partial finger amputations are some of the most frequently encountered forms of partial hand loss. The most common causes of these amputations are trauma, congenital absence or malformations. All of these may present similar clinical challenges. Maxillofacial Prosthodontics is an art and science which provides a lifelike appearance to the lost structures of the patient. Prosthetic restoration is usually considered difficult for the whole or a part of the finger and it worsens if multiple fingers are involved. Conventional semi-custom finger prosthesis centrally fabricated of polyvinyl-chloride is often rejected due to poor aesthetics and the tendency to stain. Rejection is frustrating to the patient as well as the prosthodontist. A case report has been presented, where a custom made glove type prosthesis, comfortable in use and aesthetically acceptable to the patient was fabricated using Silicon Elastomers.

Key words: Maxillofacial, prosthesis, silicone elastomers

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INTRODUCTION

The success of the prosthesis depends on the precision of planning the prosthesis, making the impression, carving the model and choosing the material that best suits the concerned circumstances.

Prosthetic form, coloration and texture must be as indiscernible as possible from the surrounding tissues. Rehabilitation efforts can only be successful when patients can appear in public without fear of attracting unwanted attention. To create such prosthesis, which has a realistic skin surface and seamless visual integration with the surrounding tissues, requires both artistic and technical expertise.

This paper presents the prosthetic rehabilitation of an amputated finger with a custom-made glove type prosthesis fabricated using silicon elastomers, which is comfortable in use and aesthetically acceptable to the patient.

CASE REPORT

A 42-year-old female patient reported to the Department of Prosthodontics, Institute of Dental Studies and Technologies, Modinagar, for the fabrication of a Removable Partial Denture involving her right mandibular first molar.

On general examination, it was noticed that the patient

had lost a part of her index finger of the right hand, about 20 years back, due to a traumatic injury.

A solitary healed wound/scar was seen on the base of the amputated index finger. The surrounding area appeared to be normal with no signs of any infection or inflammation [Figure 1].

After taking an informed consent from the patient, to ensure her willingness and co-operation, the case was taken up for reconstruction of the partially missing index finger of the right hand, with all ethical standards intact.

Technique

1. The patient's hand was lubricated with a thin layer of petroleum jelly. This prevents the hydrocolloid impression material from adhering to the surgical site and the tissue surface. Following this, the area around the hand was boxed and the impression material (Irreversible Hydrocolloid) was placed over the palmer side first and then the dorsal side. The patient was instructed to keep the hand in normal resting position, without stretching.
2. The impression was then poured in Dental Stone, using a vibrator to avoid any voids [Figure 2].
3. The positive replica of the hand was retrieved and prosthesis of the missing finger was sculpted in modeling wax. The wax pattern of the finger was placed in the correct position on the hand

[Figure 3], so that the markings could be made on the cast for the fabrication of rings. These rings serve the purpose of retention and are evaluated on the patient's hand [Figure 5]. During the try-in stage, the fit, stability and seating of the wax pattern were evaluated, along with the shape and size of the pattern.

4. The pattern was then flaked, and care was taken to avoid undercuts for the counter flasking. The pattern

was flaked to enhance the accuracy at the stage of shade matching, such that the dorsal and the ventral aspects of the finger were separable. Separating medium was applied between the two pours. After dewaxing, the mould was allowed to cool.

5. Shade matching was done using natural daylight. The best time for this procedure is between 11:00 AM and 1:00 PM IST. Intrinsic colours were mixed to achieve the appropriate characterization for the



Figure 1: Pretreatment



Figure 2: Impression poured in dental stone



Figure 3: Hand model with wax pattern carved



Figure 4: Artificial nail placed on retrieved unfinished prosthesis



Figure 5: Rings placed for retention of prosthesis



Figure 6: Prosthesis in function

palmer and dorsal surfaces. It is critical to carry out this procedure in the presence of the patient, in order to gain her approval.

6. The mould created by the elimination of the wax was packed with silicone rubber. It was kept in mind that the higher surface tension of the silicone causes easy entrapment of air within the material and every precaution must be taken to avoid this.
7. The material was allowed to bench cure overnight and for the final polymerization, it was placed in hot water, for one hour, at 45 degrees Celsius.
8. Once the final prosthesis was retrieved, the flash was trimmed using a sharp blade and the final finishing was accomplished using fine sand paper.
9. To complete the prosthesis, an appropriate sized artificial nail was adapted into place [Figure 4].
10. The final step was to place the prosthesis on the patient's hand in lieu of the missing finger [Figure 6]. The patient was instructed and demonstrated about the use and maintenance of the prosthesis. The gratitude and satisfaction in the patient's eyes made the tedious and time-consuming procedures well worth the while.

DISCUSSION

The loss of even one finger produces significant deficiencies. The more dexterous individuals suffer the greatest degree of impairment: A professional musician missing even a portion of one phalanx is significantly disabled. Prosthesis can often restore near-normal function in distal phalangeal amputations. If at least one centimetre of mobile phalanx remains, some restoration of active grasp is feasible.^[1] The longer the residual finger, the more secure the resulting grip.

In addition to immediate loss of grasp strength and security, finger absence also may cause marked psychological trauma. Individuals who keep their hands hidden inside pockets due to embarrassment over appearance are as functionally disabled as a forequarter (scapulothoracic) amputee.^[2]

Individuals who desire finger replacement usually have high expectations for the appearance of the prosthesis.^[3] The polyvinyl chloride material generally used is easily and permanently stained by such common materials as ballpoint pen and newspaper ink and has not proven durable enough for active use.

The acceptance rate has been much higher when an individually sculpted custom restoration using silicone elastomer is provided.^[4] Layers of clear silicone over each layer of colour add a lifelike translucency and protect the coloration from environmental damage.

The overall durability and stain resistance of silicone is far superior to any other material currently available

for finger restorations. Almost all stains can be removed easily with water and soap.^[5]

Silicone finger restorations may have additional functional benefits. Many traumatic amputees experience painful hypersensitivity at the termination of finger remnants. The gentle, constant pressure of an elastomer prosthesis can help desensitize and protect the injured tip. Over time, scar tissue contained within a silicone prosthesis seems to become more pliant and comfortable. Recent literature speculates that silicone gel improves the hydration of the stratum corneum of immature hypertrophic scars.

Placing a decorative ring over the margin of a finger prosthesis ending at the metacarpal-phalangeal joint will make the changing color of the hand less noticeable although the distal joint functions will be slightly restricted.^[6] To maintain a natural appearance, the prosthesis is sculpted with each joint slightly flexed. For very short remnants, pliable wires may be inserted into the silicone to allow a change in curvature for typing, writing and similar functions.

Careful coloration is crucial for maximal patient acceptance. Ideally, coloring will be done while the patient is wearing the prosthesis, under a variety of light sources preferably natural light.

Factor II Brand Medical Grade Silicone was used for the fabrication of the prosthesis. It is an easy to pour, clear-to-translucent material with High Strength (esp. Tear Strength) and High Elongation, along with good physical and electrical stability. The MDX-4210 Medical Grade Elastomer, that was used by us is Platinum Cured, better known as Dow Corning Brand Silicone. It cures at room temperature (RTV or Room Temperature Vulcanisation) and does not shrink on curing. Unlimited thick section cures are also possible with these specifications.

In our case, we have used artificial detachable nails available in the market so as to enhance the ease of replacement according to the nail polish used by the patient. The nail, made of Acrylic (Monomer and Polymer), was purchased from a L'Oreal Brand Showroom at a local shopping complex.

It is available in Single Colour (White), Pink and White, Glittered and Coloured forms. For our finger prosthesis, we used the Single Coloured White Acrylic Nail.

The superb elasticity of silicone elastomer, combined with the intimate fit made possible by using a rectified positive model of the amputation site for the male mould, makes suction retention the preferred mode of suspension.^[7] Vaseline should be used to lubricate the skin to facilitate donning and doffing of the prosthesis.^[8]

The most challenging cases are those where suction suspension is not feasible. When suction is marginal because of a short or fleshy residual finger, medical

adhesive may be used to hold the prosthesis *in situ*.^[9]

It is rarely necessary to cover the entire hand with a prosthesis in cases of isolated finger loss. However, when multiple fingers are missing, extensive skin coverage must be considered. Most women with the same amputation will prefer single finger prostheses even when grasp is reduced and it is necessary to use adhesive to supplement the suspension. These considerations must be discussed with the patient, prior to designing the restoration.

Another major problem while using silicone elastomers is the phenomenon of Air Entrapment. In our case too, this problem was encountered. It was avoided by allowing the mixture to set for 30 minutes before pouring. If air bubbles are still present and visible, Vacuum Deairing may be required. Deairing is done in a container with about four times the liquid volume to allow for expansion of the material. The vacuum (about 28-30 inches of Hg) is maintained till the liquid expands and settles to its original volume, after which the bubbling subsides. The average time taken is fifteen minutes to two hours, depending on the volume of air entrapped.

However, since prevention is better than cure, the use of glass or metal stirring instruments and a smooth stirring motion may produce satisfactory curing results.

CONCLUSION

The custom-made finger prosthesis is esthetically acceptable and comfortable for use in patients with amputated fingers, resulting in psychological improvement and personality. Good suspension alone is not sufficient for patient acceptance of finger prostheses. For many patients, a high level of cosmesis is paramount. Characteristics such as a pleasing shape, thin margins, lifelike fingernails, and realistic colour, contours and detail are also essential for patient satisfaction. This level of restoration is most

successful when finger prostheses are individually sculpted and coloured *in situ*, under a variety of lighting conditions.

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