

Innovative technique for fabrication of hand prosthesis

Clinical Report

Satheesh Kumar, Ravindra C. Savadi, Srinivasan M., Preeti Satheesh

ABSTRACT

A precisely fitting hand prosthesis can improve function by restoring normal length, maintaining sensitivity through a thin lamina, protecting a sensitive stump and transmitting pressure and position sense. Although implant hand prosthesis has a superior outcome, due to economic factors, it may not be advisable in all patients. This article focuses on an innovative method of fabricating 'hollow' glove type of hand prosthesis which aims to reduce the weight and thereby the cost of prosthesis. It also enables us to color match the dorsal and ventral surfaces separately so that the prosthetic form, coloration and texture be as indiscernible as possible from the surrounding tissues.

KEY WORDS: Amputee, hand, prosthesis, silicone

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INTRODUCTION

Both function and form are important attributes of the hand. Hands may be affected by many conditions varying from congenital abnormalities to disease, but the greatest cause of functional impairment is trauma.^[1,2] Traumatic amputation represents not only a serious insult to the hand, but also to the psychology of the individual. Many severely injured and traumatically amputated hands can be saved by microsurgical reimplantation. In some patients, however, reconstruction is contraindicated or unsuccessful. It is in this group of patients that prosthesis may be provided and may offer great psychological help.^[3]

Esthetic prosthesis for hand can offer psychological, functional and rehabilitative advantages. By restoring the natural appearance of the hand, the prosthesis eliminates the trauma caused by constant reminder of the handicap and thus, offers true psychological therapy.^[2] A precisely fitting prosthesis can improve function by restoring normal length, maintaining sensitivity through a thin lamina, protecting a sensitive stump and transmitting pressure and position sense for

activities.^[2,3] The definition of function^[4] is an interesting one, because surely if a patient is using a prosthesis for cosmetic reasons then it is serving a function. Therefore both the psychological and functional effects of the prosthesis enhance rehabilitation by helping patients adjust to their loss and permitting a more normal professional and social life.^[2,5]

This article presents a method of prosthetic rehabilitation of a hand using an innovative technique.

Objectives of using this technique are:

- To make the hand prosthesis as light as possible so as to aid in retention, the primary determinant in the success of any prosthetic restoration.
- To make a hollow glove type of prosthesis which will not only reduce the weight of the prosthesis, but also reduce the cost (making a solid prosthesis will cost a fortune in silicone material)
- To enable us to color match the dorsal and ventral surfaces separately so that the prosthetic form, coloration and texture be as indiscernible as possible from the surrounding tissues.

Department of Prosthodontics, The Oxford Dental College, Hospital & Research Hospital, Bommanhalli, Hosur Road, India

Address for correspondence: Dr Preeti Satheesh, Dept of Prosthodontics, The Oxford Dental College, Hospital & Research Institute, Bommanhalli, Hosur Road, India. E-mail: to_preeti@yahoo.co.uk

CASE REPORT

A 31-year-old female patient who lost her left hand in an accident presented for treatment. An informed consent was taken from the patient before starting the treatment to ensure her willingness and co-operation.

Technique:

- **Hand Impression:** Various methods over the years have been used to achieve this type of impression. Clarke CD^[6] described a method similar to the one used except that he used agar as the impression material. The patient's hand was lubricated with a thin layer of petroleum jelly. A cardboard box of the dimensions, large enough to allow adequate impression material to encase the stump or hand, was used to contain the impression. The patient was instructed to stand in a relaxed position with the arm held loosely by her side. The box was positioned to check for access. A thin mix of alginate (Neocolloid, Zhermack, Kab Dental supplies) was painted over the impression surface and then the impression material was poured into the box. When set, the hand/stump is removed by gentle flexing [Figure 1]. The impression was then poured in Dental stone, (Kalastone, Kalabhai Dental Pvt Ltd) using vibrator to avoid voids and the working cast of the missing hand was retrieved [Figure 2].
- **Wax glove technique utilizing a donor pattern:** selecting a donor involved finding someone the same age, sex, and build as the patient. After a suitable donor had been found, an impression of the hand to be used was made. This impression was poured in wax, (Modeling wax, Dental products of India Ltd) allowing the wax to cool for five minutes before pouring, to ensure good consolidation and reproduction of detail.
- **Nail bed preparation:** an undercut was created beneath the cuticle margin that would function to retain the acrylic resin nail within the final prosthesis. To complete the prosthesis an appropriate sized artificial nail was adapted into place. To achieve an enhanced realistic appearance, the nail was shaped according to the nail of the natural fingers [Figure 3].
- **Stump model preparation:** As the prosthesis was to be a "glove" construction, it was essential to ensure a tight fit of the silicone to the tissue. Another precaution to be taken was that the prosthesis was not to be too tight so as to be uncomfortable or painful. In order to control this tightness, the original stump impression was reduced accurately by around 2-3 mm, so the silicone stretches and flexes over the stump as it is fitted. The wax donor hand was then adapted to the stump model. By

placing the wax pattern into warm water the hand and the fingers were shaped to mimic the natural opposing hand when it is held at rest. 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 [Figure 4].

- **Investment Technique:** As the pattern could not be flaked with conventional flasks, a dental stone box (Type III Kalastone, Kalabhai Dental Pvt Ltd) was fabricated exclusively for flasking and packing of the prosthesis. The wax pattern was placed on the stump with an iron rod embedded in the stump. This will not only ensure ease in dewaxing but also aid in fabricating a hollow prosthesis. The first pour was done till the junction of the dorsal and ventral surface [Figure 5a]. The second pour was done to stabilize the stump and iron rod to the first pour (towards the mesial end) [Figure 5b]. The third pour was done to cover the entire wax pattern. Die stone (Type IV Kalrock: Kalabhai Karson Pvt Ltd) was used in the critical areas. When set, the wax was boiled out and the mold carefully opened. Separating medium was applied between the two pours in preparation for loading the mold with silicone [Figure 6].

Advantages of three pour technique with the removable stump are:

- Minimizes the wax distortion which occurs in two pour technique.
- Usually silicone which has more viscosity does not flow easily into inaccessible areas, resulting in unsightly voids in the prosthesis. This technique ensures a easy void free packing of the silicone material.
- It facilitates ease in color matching so that the undersurface of the hand can be matched first with a lighter shade and packed. Next the stump is inserted in place and color matching of the dorsal surface with the appropriate darker shade followed by packing is done.

All this eventually, will ensure a more accurate fit and esthetic prosthesis.

Color matching: The Silicone (Cosmesil RTV) was matched intrinsically to match different shades of the patient's skin. The advantages of intrinsic coloration are increased service life of the prosthesis and planned translucency. Color matching of the undersurface was done first as this tends to be lighter than the top surface. Colored silicone was layered into the mold. As silicone binds well, both the materials were packed simultaneously [Figure 7].

The molds were closed, light pressure was applied to remove excess material and the molds were

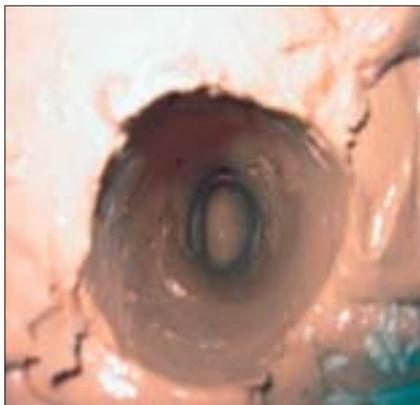


Figure 1: Impression of the defective hand



Figure 2: Working cast



Figure 3: Wax pattern



Figure 4: Try in



Figure 5: (A, B) Flasking procedure



Figure 6: After dewaxing



Figure 7: Silicone material color matched and packed



Figure 8: Completed prosthesis



Figure 9: (A) Pre prosthetic

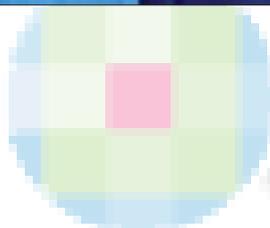


Figure 9: (B) Post prosthetic



Figure 10: (A) Pre prosthetic



Figure 10: (B) Post prosthetic

transferred to a clamp. The silicone was processed at room temperature. When the molds were sufficiently cool, the prosthesis was carefully removed. Excess material was trimmed with scissors. The fit and shade was evaluated on the patient. Extrinsic coloration was applied on some areas for further color matching.

The prosthesis was inserted and the patient was instructed in home care and prosthesis maintenance [Figures 8, 9A, 9B and 10A, 10B].

Maintenance of Prosthesis:

- Prosthesis is resistant, but in order to increase their useful life, certain recommendations must be followed:
- Stay away or be extremely careful when using sharp or cutting tools or material, such as knives or paper sheets. Siloxane is very similar to skin; whatever can cut skin, undoubtedly can cut the prosthesis.
- Do not expose the prosthesis to high temperatures, and avoidance of too much exposure to sunlight.
- Silanes have excellent elastic properties, but do not over elongate. It must be borne in mind that even steel can break if enough tension is applied.
- Prosthesis should be cleaned with mild antibacterial soap and soft brush. Patient should be instructed not to wear the prosthesis during sleep and in case of signs of inflammation. Avoid smoking as it stains

the prosthesis yellow.

However, complications associated with silicone prosthesis:

- Rapid degradation of elastomers and color dexterity
- Deterioration due to environmental exposure to UV light, air pollution, changes in humidity and temperature
- Tearing of margins
- Surface topography of skin and environmental factors will reduce the adhesive joint strength
- Microbial growth due porous nature of silicones
- Short durability (1-2 years)

Initial placement and adjustment of the prosthesis is certainly not the end of treatment of a prosthetically rehabilitated patient. Periodic reevaluation of the patient is critical for early Recognition of changes to allow appropriate steps to be taken.

CONCLUSION

The use of hand prosthesis with modern prosthetic designs provides excellent esthetics. This aids the person in integrating himself within his social, family and working environment. Prosthesis covers up the missing part and shows esthetic balance. Prosthetic rehabilitation is advantageous in that it is relatively quick, reversible and medically uncomplicated.

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