SILICONE FINGER PROSTHESIS FOR PARTIALLY AMPUTED INDEX FINGER- TWO CASE REPORTS

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Abstract:

Finger and partial finger amputations are commonly due to traumatic instability and economic crises. This renders an amputee incapable of leading a relatively normal life. Prosthetic rehabilitation of amputed finger or lost body part proves to be promising when surgical restoration is contraindicated, unavailable or unaffordable. Silicone finger prosthesis provides life-like natural appearance of the prosthesis, alleviating psychological problems and thus improving function and quality of life. This paper presents two case reports of prosthetic rehabilitation of partially amputed index finger with custom made silicone prosthesis.

Key words: Finger prosthesis, Partial finger amputation, Silicone finger prosthesis, Silicone elastomer, Residual stump, Circumferential reduction.

Introduction:

A finger is a type of digit, an organ of manipulation and sensation found in the hands of humans and other primates.[1] Fingers enable us to interact with our environment and help in many day to day functions. The index finger, generally known as the forefinger is a great precision performer.[2] Amputation causes immediate loss of grasp, strength and security and absence of a finger may cause marked psychological trauma.[3,4] Self amputation, congenital amputation, and traumatic amputation are various types of amputations which are documented in literature. 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 and malformations.[5] Currently, many injuries and traumatic amputations of fingers can be rehabilitated by microsurgery through reimplantations. However, in few patients surgical reconstruction is contraindicated, unavailable or unaffordable. In such situations prosthetic rehabilitation with esthetic silicone finger prosthesis is considered as an alternative. This paper presents two case reports of prosthetic rehabilitation of partially amputated index finger with custom made silicone prostheses.

CASE REPORTS

Case-1

A 42 year old male patient reported to the Department of Prosthodontics, P.M.N.M. Dental College and Hospital, Bagalkot, Karnataka, with a chief complaint of

partially missing right index finger. He had a history of occupational trauma to his right index finger 12 years ago. On general examination it was noticed that amputation was carried out through the distal portion of the proximal inter-phalanx. The residual finger stump was found to be stable and measured 3 cm in height and 2.4 cm in diameter. The amputed finger showed thickened ends with normal surrounding area and no signs of any infection or inflammation .The patient had no history of a previous prosthesis. (Fig. 1A)

Fig. 1A: Patient 1 with amputed right index finger

Case-2

A 37 year old female patient reported to the Department of Prosthodontics, P.M.N.M. Dental College and Hospital, Bagalkot, Karnataka, with a chief complaint of partially missing left index finger. She had a history of occupational trauma to her left index finger 3 years ago. On general examination it was noticed that amputation was carried out through the proximal portion of the middle inter-phalanx. The residual finger stump was found to be stable and measured 2.8 cm in height and 1.9 cm in diameter. The amputed finger showed no thickened ends with normal surrounding area and no signs of any infection or inflammation. The patient had no history of a previous prosthesis. (Fig.1B)

Fig. 1B: Patient 2 with amputed left index finger

Treatment plan:

After thorough examination, it was decided to fabricate 'glove'-like silicone finger prosthesis for both patients it was decided to use metal ring to enhance retention and comfort. Identical technique was used for fabrication of silicone finger prosthesis for both the patients. The treatment plan was discussed with both the patients and an informed consent was obtained.

Technique For Fabrication Of Silicone Finger Prosthesis

Impression making

The patient's hand with missing finger was lubricated with a thin layer of petroleum jelly to prevent adherence of impression material to the skin and hair. The area around the hand was boxed and thin layer of irreversible hydrocolloid impression material (Imprint, Dental Products of India; batch no. 12164) was placed over the palmar side first and then the dorsal side to prevent tearing and distortion of the material. This technique also allows the hand to be removed from the impression with the fingers in flexion. The patient was instructed to keep the hand in the normal resting position without stretching while impression making.

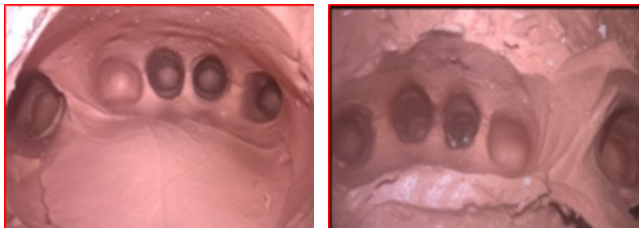

Fig. 2: Alginate impression of the hand of patient 1(left) and patient 2(Right)

Model preparation

The impression was then poured in Dental stone (Gold stone, Asian Chemical, Rajkot, Gujarat, India; batch no. 3BF137) and a positive replica of the hand was retrieved. (Fig 3A,3B)

Fig. 3A: Working model of the hand of Patient-1

Fig. 3B: Working model of the hand of Patient 2

Wax pattern fabrication

Impression of the unaffected side index finger was also made and into which molten modeling wax (Maark, Shiva products, Mumbai, India: batch no.0616) was poured to get the wax pattern of the prosthesis. The wax pattern was then hollowed from the inside by sculpting. The wax pattern was placed in warm water and then placed on the cast and modifications in sculpting were carried out to resemble the finger of the other hand.

Acrylic nail fabrication and nail bed preparation

Custom-made acrylic nail was fabricated using tooth coloured acrylic resin material (DPI, cold cure). Color and shade matching was done with the nail of adjacent fingers. To be more natural integral half moons, white margins and other details were incorporated. The acrylic nail was larger than the nail bed by 2 mm proximally (edge-to edge), reducing on the lateral borders to matching size distally. The size and position of the acrylic nail was established and the nail bed was prepared, where the custom-made acrylic nail was adapted into place. An undercut was created beneath the cuticle margin to retain the acrylic resin nail within the final prosthesis.

Try in

The wax pattern was tried in the patient's hand and the length and fit was verified. The shade matching of artificial nail was also verified. The nail was removed and later reattached to the silicone prosthesis through slits on margin. (Fig-4A,4B)

Fig. 4A: Wax try-in of Patient-1

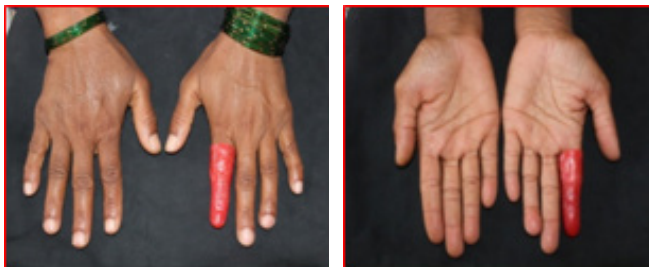

Fig. 4B: Wax try-in of Patient-2

Stump model preparation

To improve the retention of the silicone prosthesis, it was essential to modify the stump model of the finger. The circumference of the stump was reduced accurately by 1 mm in order to provide a snug fit of the prosthesis and aid in vacuum retention.(Fig:5)

Fig. 5: Stump model preparation of patient 1(Left) and Patient 2(Right)

Investment technique

The wax pattern was invested in a dental stone till the junction of dorsal and ventral surfaces in a varsity flask. Second pour was done to stabilize stump to first pour and third pour to cover the entire wax pattern. This mold facilitates an easy packing of silicone and separate color matching for dorsal and ventral surfaces. This mold was dewaxed by immersing in a boiling water bath. After the mold was carefully opened separating medium was applied between the two pours before silicone packing. (Fig-6)

Fig. 6: Investment technique

Color matching and packing

The Silicone (RTV Silicone, MP Sai Enterprises, Mumbai.) and pigments were mixed intrinsically to match patient's skin. Color matching of the dorsal and ventral surface was done separately in natural light. After getting the desired shade the silicone material was packed into the mold and light pressure was applied to remove excess material. Curing was done as per manufacturer's instructions. After polymerization, the prosthesis was carefully retrieved from the mold and finishing was done.(Fig-7)

Fig. 7 Color matching and packing of silicone material

Acrylic nail fixation

A slit was made along the crease on the nail bead area, where nail is to be inserted. The excess 2 mm nail portion was inserted into the slit and a cyanoacrylate adhesive was applied on the undersurface of the nail for bonding with the silicone surface and placed back on the mold to achieve a stronger bond to the nail bed.

Final prosthesis

A wide ring over the margin of a finger prosthesis ending at the metacarpal-phalangeal joint was placed using a cyanoacrylate adhesive to disguise the junction line. This also helped in retention of the finger prosthesis. The final prosthesis was inserted on the residual stump and the fit and color matching was evaluated. The patient was demonstrated about the use and instructions were given about maintenance of the prosthesis.(Fig-8A,8B,8C)

Fig. 8A: Final prosthesis of Patient 1

Fig. 8B: Final prosthesis of Patient 2

Fig. 8C: Patient 1 and Patient 2 with final prosthesis

Discussion

Currently, many severely injured and traumatically amputated digits can be saved by microsurgical replantation. When surgical reconstruction is contraindicated, unsuccessful or unavailable, prosthesis can provide and offer great psychological help.[6] A precisely fitting prosthesis

can improve function by restoring normal length, providing opposition for the remaining digits, maintaining sensitivity through a thin lamina, protecting a sensitive stump, and transmitting pressure and position sense for activities such as writing or typing.[7]

Jean Pillet described the essential characteristics of the prosthesis as the prosthesis must be of high quality, both technically and aesthetically. It must be very similar to the digit of the opposite hand. The skin must correspond to the normal skin in all details and match the color as precisely as possible. The material of the prosthesis must be strong and repairable if torn. It must not stiffen at low temperatures within the normal climatic range and must also be heat resistant. It must not be stained by ordinary materials such as newsprint and, if soiled, must be easily cleaned by washing in water with a mild soap. It must not irritate the skin.[8]

Traditionally various methods have been used for fabrication of wax pattern for finger prosthesis which includes donor technique i.e. a donor whose finger dimensions & contours closely mimicked the finger of the patient is chosen and impression of finger is made or making impression of normal finger of the contralateral hand and modifying it. These methods require physical presence of the patient for adjustment of wax pattern.

John-John Cabibihan[9] suggested computer-based design and fabrication methods, which reduced the number of visits, while having the characteristics of patient's fingers to be replicated accurately and immediately. Botolin et al[10] suggested the use of CAD-CAM high resolution technology.

Over time various materials have been developed and used for fabricating finger prosthesis. Wood, leather, polyurethane and polyvinyl chloride have been used to produce aesthetic prosthesis, but silicone rubber has proved to be the most promising in achieving the desired lifelike effects.[11]The overall durability and stain resistance of silicone is far superior to any other material currently available for finger restorations. Almost all stains, including ballpoint ink, newsprint, clothing dyes, and food colourings can be removed easily with water and soap.[12]

Pillet et al, suggested that, the length of the finger prosthesis is determined by the level of the amputation. Partial or total amputation of the distal phalanx requires a thimble like prosthesis extending to the middle phalanx, with the proximal interphalangeal joint left free. When amputation occurs at the middle phalanx or just distal to the proximal interphalangeal joint, the prosthesis is extended to the proximal phalanx to achieve the most desirable esthetic result even though some restriction in finger movement results. Amputation at the proximal phalanx level requires a minimum stump length of 1.5 cm measured from the metacarpophalangeal crease for adequate fixation of a digital prosthesis. The patient with a stump shorter than 1.5 cm requires surgical interdigital web recession.[8]

Retention of the prosthesis is important for esthetics, function, and comfort, thereby improving patient quality of life. Finger prostheses are generally retained by a vacuum effect on the stump[8]use medical grade adhesives[13] and placement of finger ring[14]. Recently osseointegrated implants are used to retain the finger prostheses.[15]For the patients who are contraindicated for surgery or feels that the implants are expensive, the choice remains between suction retention and standard ring retention. In the suction-fitted prosthesis, the elastic and nonporous silicone rubber allows an airtight "cupping" of the residuum such that an incipient slippage of the prosthesis is immediately followed by an internal vacuum effect that checks further displacement. The short residual length distal to the proximal interphalangeal joint that is available for a suction type fit is associated higher probability of suction loss. Various techniques have been advocated to improve the retention of the prosthesis. Michael et al, advocated the use of separate vacuum chambers formed from the biostar clear acrylic of 1.5 mm thickness to get the suction and enhance retention.[14] Leow suggested in his study that, 7% circumference reduction in the finger model showed good fit of a thimble-type prosthesis for distal finger amputation.[16] The disadvantage of suction-fitted prosthesis is that, it acts very much like a pressure garment and when worn for a protracted period, can shrink the residuum via soft tissue compression.

For both the patients presented here, a full-length finger prostheses ending at the metacarpal-phalangeal joint were fabricated as the morphology and residual length was inadequate for gaining retention only by suction method. A wide ring was placed over the margin of a finger prosthesis ending at the metacarpal-phalangeal joint to aid in retention and to make the changing color of the hand less noticeable.

Conclusion

Finger and partial finger amputations are some of the most frequently encountered forms of partial hand loss. The loss of a single finger has a profound effect upon the amputee's body image, self-esteem, and psychological status. In these cases the restoration of form and esthetics becomes of utmost importance. When surgical reconstruction is contraindicated, unsuccessful, unavailable or unaffordable a high quality esthetic prosthesis with passive function can assists the amputee's rehabilitation and return to society, socially as well as psychologically.

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