

Acrylic TOE Prosthesis for a Partial TOE Amputation: A Case Report



Dental Science

KEYWORDS :

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ABSTRACT

Digital loss are most frequently encountered forms of amputation. The amputation of a central toe (2nd, 3rd or 4th) causes forefoot instability, not only because of the digitigrade contribution during the gait, but especially because it can cause deformities of the adjacent toes. This case report describes the fabrication of a custom made acrylic toe prosthesis for a patient after a road accident. The toe prosthesis was retained by a vacuum effect on the stump. The toe prosthesis being comfortable, esthetically acceptable offers a great psychological advantage in allowing the patient to pass unnoticed and also improved function by restoring the normal shape and length of the finger, protecting the stump, and transferring sensations such as pressure. The major role in rehabilitating the patient is being played by the maxillofacial prosthodontist and the anaplastologist.

Introduction

“Amputation” is derived from the Latin word “amputare” which means to excise or to cut out. It has been defined as the “removal of part or all of a body part enclosed by skin”.¹ There are various types of amputations some which are self amputation, congenital amputation, and traumatic amputation which may result from a factory ,farm, powdered tools or motor vehicle accidents ,including industrial or environmental accidents, terrorist attacks and lack of public health which often leads to diabetic, gangrene and /infection.² Amputation causes devastating physical, psychosocial and economic damage to an individual.³ Whatever the indication of an amputation, the result is a limb stump.² Digital loss are some of the most frequently encountered forms of amputation. The amputation of a toe leaves no significant disability in stance or gait although it must be remembered that amputation of the great toe, though not due to important instability in stance, greatly reduces the thrust force during the gait, the amputation of a central toe (2nd, 3rd or 4th) causes forefoot instability, not only because of the digitigrade contribution during the gait, but especially because it can cause deformities of the adjacent toes. For example, the space created after the amputation of the 2nd and/or 3rd toe, can create or worse a hallux valgus.^{4,5} The isolated amputation of the fourth toe, leaving in place the fifth, can cause traumas and sub-dislocations of the latter.^{6,7}

Rehabilitation of amputated digit is of utmost importance and the first choice is microvascular reconstruction.^{8,9} For some, reconstructive surgery cannot be performed due to the severity of the injury, technical difficulties, financial and psychological issues, or due to surgical complications and failure.¹⁰ At this juncture the concealment of the amputation via cosmetic replacement of the lost digit helps the patient to shield an amputee from social stigma and help improve emotional healing process.^{11,12} In addition, reconstructive surgery cannot restore esthetics as much as prosthesis can and thus has limited role in case of lost body parts.⁸ Thus, the purpose of this report is to describe a simple custom made rehabilitation technique for amputated toe using acrylic prosthesis to help to provide good esthetics, adequate retention and psychological benefit to the patient.

Case report

A 16 year old female patient reported to the Department of Prosthodontics, Government dental College, Alappuzah for prosthetic rehabilitation of partially lost second toe of right leg. She reported with history of trauma due to an accident while travelling in an auto 1 year ago which led to the partially lost second toe of right foot. On general examination it was noticed that amputation was carried out through the middle portion of the inter phalanx of the second toe. The residual toe stump measured 1.7 cm in height and 1.5 cm in diameter. The amputated toe showed tapered ends with normal surrounding area and no signs of any infection or inflammation (Fig.1).

Treatment plan

The objective of the prosthetic rehabilitation was to eliminate the psychological consequences of the amputation and restore passive function by fabrication of a toe prostheses which had good retention, was comfortable to use and aesthetically acceptable to the patients. After thorough examination, it was decided to fabricate an acrylic toe prosthesis extending up to the metatarsal-phalangeal joint to normalize appearance so that it is unnoticed in public, allowing the patients to lead a life without drawing attention. The treatment plan was discussed with the patient and an informed consent was signed to ensure her willingness for prosthetic reconstruction of partially missing toe before starting the procedure.

TECHNIQUE FOR FABRICATION OF SILICONE TOE PROSTHESIS

Impression making

The patient’s foot with missing toe was lubricated with a thin layer of petroleum jelly to prevent adherence of impression material to the skin and hair. The area around the toe was boxed and thin layer of irreversible hydrocolloid impression material (Imprint, Dental Products of India; batch no. 51114) 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 foot to be removed from the impression with the toes in flexion. The patient was instructed to keep the foot in the normal resting position without stretching while impression making (Fig. 2).

Model preparation

The impression was then poured in Dental stone (Gold stone, Asian Chemical, Rajkot, Gujrat, India; batch no. 1959/200) and a positive replica of the foot was retrieved (Fig. 3).

Wax pattern fabrication

Impression of the unaffected side toe was also taken and into which molten modeling wax (Maark, Shiva products, Mumbai, India: batch no.111) 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 toe of the other foot (Fig. 4).

Acrylic nail fabrication and nail bed preparation

Custom-made acrylic nail was fabricated using tooth coloured acrylic resin material (DPL, cold cure). Color and shade matching was done with the nail of adjacent toes. 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 leg and the length and fit was verified. The shade matching of artificial nail was also verified. The nail was removed and later re-attached to the acrylic prosthesis through slits on margin (Fig. 5).

Stump model preparation

To improve the retention of the prosthesis, it was essential to modify the stump model of the toe. 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. 6).

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 acrylic packing (Fig. 7).

Color matching and packing

Acrylic colour pigments (MP Sai Enterprises, Mumbai) 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.

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

The final prosthesis was inserted on the residual stump and the fit and color matching was evaluated. The snug fit of the prosthesis provided sufficient retention to the prosthesis. The patient was demonstrated about the use and instructions were given about maintenance of the prosthesis (Figs. 8).

Instructions and maintenance of the prosthesis

1. To put on prosthesis a thin layer of the water-based lubricant is applied to the residual stump and the prosthesis is gently pushed into place making sure all air has escaped.
2. To remove the prosthesis pinch the open end, allowing air to enter, thus breaking the suction, and slowly pull it off.
3. The prosthesis should be washed every day with water and soap, cleaning inside and out.
4. The prosthesis should not be worn overnight. Continuous use irritates skin.
5. Avoid exposure of prosthesis to high temperatures.
6. Care should be taken while walking over roads so as to not step over sharp objects.

Discussion

Whether the traumatic loss of limb or finger is due to war, congenital malformations, systemic diseases (diabetes), an industrial, domestic or vehicular accident, amputation leaves the individual with a long lasting emotional scar from the disfigurement.¹ The primary goal in the treatment of traumatic amputations is to evaluate the suitability of the amputated part of reimplantation.¹³ The amount of tissue lost, the current condition of the bone, and involvement of other fingers are some of the factors that have to be considered when choosing a suitable treatment option.¹⁴⁻¹⁶ Several microsurgical techniques such as toe-foot transfer, foot lengthening procedure and use of osteocutaneous flaps may offer opportunities to reconstruct the lost or missing phalanges due to surgery or trauma.^{17,18} In case of any contraindications or failure of these surgical methods, the problem of replacing external parts of the body missing often falls to the maxillofacial prosthodontist.¹⁹ Maxillofacial prostheses replace lost body parts using artificial substitutes like acrylic or silicones.⁸ Jean Pillet enumerated the essential characteristics of a prosthesis -the prosthesis should be of high quality both technically and aesthetically, resemble the digit of contralateral hand, skin must correspond to the natural skin in all details and match the colour as appropriately as possible, should not be effected by climatic variations, heat resistant and must not be stained by ordinary materials. Prosthesis must be cleaned easily and should not irritate the skin. It has been described in literature that the prosthetic replacement of digit can be satisfactory in patients who have at least 1.5 cm of residual stump.²⁰ In our case residual stamp had been 1.7 cm making it a feasible option for prosthetic rehabilitation.

There are two methods that are being described in literature for the prosthesis. The traditional method of prosthesis is replacing the lost finger by an artificial digit.¹ The artificial digit is made commonly of a silicone elastomer or acrylic.²¹ The silicones can be rendered to match the

skin color of the patient and give a more lifelike appearance. Almost all stains, including ballpoint ink, newsprint, clothing dyes, and food colourings can be removed easily with water and soap.^{22,23,24} The gentle, constant pressure of elastomer prosthesis can help desensitize and protect the injured tip.²⁵ Recent literature speculates that silicone gel improves the hydration of stratum corneum of immature hypertrophic scars.²³ Another prosthetic mechanism has been described by Branemark in which there is usage of bone anchored implant retained silicone finger prosthesis as an alternative.^{26,27} Osseointegrated dental implants have been used to retain prostheses and to avoid the problem of instability.¹⁸ It offers additional advantages because the technique enables short stumps, where a traditional prosthesis is not successful, to be restored and provides for tactile sensation by transferring stimuli to the bone through implant.^{18,27,28}

M. J. Pilley et al ²⁹ assessed the long term psychological response to digital prostheses after traumatic loss of a finger and also assessed their functional use. He reported that most of the patients specially women were concerned primarily with the cosmetic appearance of the hand and function was a secondary consideration, which happened to be a factor in choosing acrylic toe prosthesis as a mode of rehabilitation in our case where a female patient reported to the department with esthetic concerns. In this case microsurgical reimplantation was not possible as the finger was crushed and osseointegrated implants were ruled out due to economic reasons. As the amputated stumps were too thick, a second corrective surgical procedure was planned at a later stage to improve esthetics of the final prosthesis. In the interim stage, temporary cost effective acrylic resin prosthesis was planned in order to boost the morale of the patient and to enable her to continue normal social interactions. The acrylic resin and silicone although are the most common materials used for rehabilitation still there are certain advantages and disadvantages associated with the usage. Although resin can be easily characterized and presents great durability but it is a very hard material and uncomfortable for the patient.³⁰ On the other hand, silicone has texture and flexibility similar to the skin, provides a more comfortable prosthesis and presents better capacity for skin-prosthesis linkage. However, this material is more difficult to pigment and degrades due to colour instability when exposed to ultraviolet rays.³¹ Various materials have been developed used for fabricating digit prosthesis for eg. wood, leather, polyurethane and polyvinyl chloride which produce aesthetic prosthesis, but silicone rubber has proved to be the most promising in achieving the desired lifelike effects.³² But its poor adhesive ability limits the force that the prosthesis could withstand before detachment. Thus, pure silicone elastomer prosthetic finger has mainly cosmetic purposes and low functionality.²¹ On contrary, acrylic prosthesis has been proven out to be more acceptable as the shelf life of acrylic has been reported to be more and acrylic prosthesis being much more cost effective than that of silicone one. Furthermore, silicone prosthesis if used for toe will wear off much faster than that of acrylic prosthesis. Although various methods of retention are available for the retention of digit prosthesis such as implants, medical grade adhesives, rings and attachments, the degree of retention depends on the length and form of residual stump.³³ For the patient presented here, a vacuum retention was provided by the snug fit of the prosthesis. In addition, full-length toe prostheses ending at the metatarsal-phalangeal joint were fabricated as the morphology and residual length middle of the interphalnx of the second toe phalanx was inadequate for gaining retention only by suction method.

Thereby, the purpose of this report is to describe a simple convenient method for fabrication of acrylic toe prosthesis for a patient following a road accident. The main objective being to provide a cost effective, temporary, esthetic prosthesis to mask the disfigurement caused by missing second toe of the right foot, till a definitive prosthesis can be fabricated. A precisely fitting prosthesis offered improved function by restoring normal length, protecting the stump, maintaining sensitivity through the thin layer of the prosthesis and transmitting pressure and position sense for certain activities. Patient was highly satisfied with this prosthesis in terms of retention and esthetics. The morale of the patient was also boosted to a great extent.

Only limitation in terms of custom-made digit prostheses fabrication is that they are time-consuming and requires manual skill. Hence, computer-aided techniques have been proposed by several researchers to enable fabrication of finger prostheses using methods to overcome the limitations of custom made ones.³⁴

CONCLUSION

Despite the ongoing advancements in the microsurgical techniques, the reconstruction of the amputated digits may not be a feasible option for some patients due to one reason or other thereby, the role of maxillofacial prosthodontist comes into light. A high quality digital prosthesis not only fulfills all esthetic requirements, providing functional gains, restoring movement for the patient and protecting the stump but also assists the amputee's rehabilitation and return to society, socially as well as psychologically. Hence, the prosthetic rehabilitation of an amputated finger has become less challenging and offers several cosmetic and functional advantages over the complex surgeries.

1.



Figure 1 Patient's amputated right second toe .



Figure 2 Impression procedure



Figure 3. Working model of the Leg.



Figure 4. Wax pattern fabrication on model.



Figure 5. Wax pattern try-in.



Figure 6 Sectioned cast-wax pattern for investing procedure.



Figure 7. Investment technique.



Figure 8. Final prosthetic.

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