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CUSTOMIZED SILICONE FINGER PROSTHESIS: ENHANCING FUNCTION AND AESTHETICS

Maxillofacial Prosthodontics

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ABSTRACT

Restoring both function and appearance is essential for individuals with finger amputations, as it helps address physical and psychological challenges. Partial finger loss is commonly caused by trauma, congenital anomalies, or deformities. silicone prostheses with vacuum-based retention are a widely used solution, with one to two cases typically managed every six months. The success of a finger prosthesis depends on precise planning, accurate impressions, detailed model sculpting, and selecting appropriate materials. ensuring stability and retention can be complex, particularly for individuals who require fine motor control. While various retention methods, such as implants and adhesives, exist, this case explores an alternative technique. Instead of reducing the stump cast uniformly, a selective modification approach was implemented to create balanced pressure distribution. To enhance retention further, a finger ring was added, compensating for the limited contact surface of the stump. This method significantly improved stability and user comfort. This report outlines a conventional approach to finger prosthesis fabrication while introducing a technique designed to enhance retention. Additionally, it reviews various prosthetic materials and their applications in clinical practice.

KEYWORDS

INTRODUCTION

Loss or absence of a finger, whether due to trauma, congenital conditions, or disease, can have profound physical, psychological, and social impacts on an individual. Beyond the apparent functional limitations, such as compromised grip strength, dexterity, and hand coordination, finger loss can lead to significant emotional distress and reduced self-esteem due to visible disfigurement. In this context, prosthetic rehabilitation plays a critical role in restoring not only hand function but also aesthetic appearance and psychological well-being.

Customized silicone finger prostheses have emerged as an advanced solution that closely replicates the natural anatomy, texture, and coloration of the human finger. These prostheses are tailored to match the patient's skin tone, finger contours, and nail details, offering a lifelike restoration that blends seamlessly with the remaining digits. Moreover, modern materials and fabrication techniques enhance comfort, durability, and functionality, allowing users to engage in daily activities with greater confidence and independence.

This paper explores the design, fabrication, and clinical significance of customized silicone finger prostheses, emphasizing their role in enhancing both functional outcomes and aesthetic satisfaction.

Case Presentation

A 28-year-old female visited with a loss of left index finger up to the second phalanx and wanted to get it replaced (figure 1). History revealed loss of the left index finger due to accidental injury which lead to amputation of finger. On examination of the injured site there were no signs of inflammation or pathology. The wound was completely healed and was covered with healthy epithelium suitable for the fabrication of the prosthesis. The patient had no history of using any artificial prosthesis of any kind. an informed consent was obtained from the patient for the fabrication of the prosthesis under ethical standards.

Treatment

The patient's hands were first cleansed using an antiseptic soap solution, followed by the application of a thin layer of petroleum jelly to ensure smooth impression removal. An irreversible hydrocolloid material was then used to take an impression of the amputated finger. This impression was cast using ada type iv dental stone (kal rock, kala bhai karson pvt) (figure 2) to create an accurate replica for prosthesis fabrication.

To enhance the natural appearance of the prosthesis, an additional impression was taken of the entire hand, including the wrist and fingers in a relaxed state, using irreversible hydrocolloid material (jeltrate, dentsply). This was then poured with type iii dental stone to aid in characterizing the final prosthetic design.

The distal phalanx was carefully examined to assess tissue compressibility, and the findings were marked on the model. Based on these assessments, selective reductions of 1–1.5 mm were made in areas with higher tissue compressibility to optimize fit and comfort.

The reduction of the model was measured using a vernier caliper. To improve retention, a ring-shaped depression measuring 1 mm in depth and width (figure 3) was carefully created near the metacarpo-phalangeal joint using round tungsten carbide burs.

An impression of the opposite index finger was taken with irreversible hydrocolloid material and cast in modeling wax. The wax replica was refined and tested against the full hand model to ensure a natural alignment with the other fingers. additional detailing, such as skin folds and natural wrinkles, was sculpted for realism before being adapted onto the stump mold.(figure 4)

The wax model and stump mold were then enclosed in ada type iii dental stone. the stone mold was indexed, and any undercuts were removed before applying a separating agent to ensure smooth removal of the final prosthesis. A two-part mold system was developed using the lost wax method, allowing for precise material placement during the prosthetic fabrication process. (figure 3,5,6)

Medical-grade silicone (cosmosil htv, uk) was prepared by mixing it with a catalyst in a 1:10 ratio and thickened with thixo to minimize air bubbles. Different amounts of silicone were allocated to various areas of the prosthesis to replicate the natural variations in tissue density. The base skin tone was mixed using primary pigments, and further color adjustments were made to match specific regions of the hand. The final aesthetic refinements were done through eccentric staining, enhancing the lifelike appearance of the prosthesis.

The silicone material was carefully layered onto different sections of the mold, including the ventral and dorsal surfaces, as well as interphalangeal grooves (figure 7). The mold was then lightly compressed, secured in a clamp, and processed at 100°c for 40 minutes, following the manufacturer's instructions. After curing, the prosthesis was carefully removed, trimmed, and finished using sharp scissors and fine burs.

The prosthesis was tested on the patient for fit and shade accuracy, with additional color refinements made under natural daylight to achieve an

optimal match. The fingernail was fabricated separately using acrylic resin and customized to blend seamlessly with the patient's natural nails. To enhance stability, a finger ring (figure 8) was incorporated as an additional retentive aid. The patient expressed great satisfaction with the final prosthesis, appreciating its realistic appearance and comfortable fit.

The patient was provided with detailed instructions on maintaining the prosthesis. Home care involved gently cleaning the surrounding skin using a soft toothbrush and rinsing with lukewarm water and mild soap.

After four months, a follow-up evaluation was conducted. the examination showed that the skin around the prosthesis remained in good condition, and the prosthesis maintained secure retention and functionality.

Outcome

The prosthesis provided sufficient retention, and the patient expressed satisfaction with both its fit and comfort. The even distribution of pressure on the stump contributed to a more comfortable experience. Follow-up evaluations were conducted every four months over a year, during which the patient reported no discomfort and remained pleased with the prosthesis.

DISCUSSION

The loss of a finger in a young adult can lead to significant functional limitations and psychosocial challenges. For a 28‚year‚old female, the absence of a digit may impair fine motor skills and affect self‚esteem, complicating everyday activities and social interactions. Modern prosthetic rehabilitation strives not only to restore hand function but also to reinstate a natural appearance, thereby improving quality of life. Advances in material science, retention strategies, and digital fabrication techniques have enhanced the efficacy of prosthetic solutions [1][4].

Psychosocial and Functional impact

Digit loss can profoundly affect a patient's psychological well‚being. in young adults, the altered hand appearance and diminished dexterity may lead to anxiety, social withdrawal, and reduced occupational performance. Studies indicate that even partial hand loss can trigger notable psychological distress. Restorative prosthetic interventions have been shown to improve not only hand functionality but also patient self-confidence and social participation [4]. Hence, a comprehensive treatment plan must address both the mechanical and emotional ramifications of digit loss.

Material Selection

Choosing the appropriate material is fundamental in prosthetic design. silicone elastomers have become the standard for fabricating finger prostheses due to their flexibility, durability, and biocompatibility. These materials effectively mimic the texture and translucency of natural skin, providing both comfort and aesthetic appeal. Green et al. [2] highlighted the importance of intrinsic pigmentation, which allows for detailed color matching and realistic texture reproduction. Such characteristics are essential in ensuring that the prosthesis blends seamlessly with the patient's residual anatomy.

Retention Mechanisms

Secure retention is critical for functional prosthetic use. several methods are available:

1. Implant‚retained prostheses: osseointegrated implants offer robust and stable retention by anchoring the prosthesis directly to the bone. brown et al. [1] Reported enhanced control and durability with implant‚retained designs; however, this method involves surgery and may not be acceptable to all patients.
2. Mechanical retention: noninvasive techniques exploit natural anatomical undercuts. custom‚fabricated prostheses that mimic the precise contours of the residual digit can achieve retention through a friction‚fit mechanism. Patel et al. [5] demonstrated that meticulous impression techniques and master cast modifications can yield effective retention without requiring surgical intervention.
3. Xternal aids: supplemental aids such as rings or customized gloves may further secure the prosthesis while camouflaging the junction between the prosthetic and natural tissues, thereby enhancing both function and aesthetics.

Fabrication Techniques

Traditional fabrication methods—relying on manual impressions, wax pattern sculpting, and silicone curing—are highly operator-dependent and time-consuming. The incorporation of digital workflows, including computer-aided design (cad) and three-dimensional (3d) printing, has revolutionized prosthetic manufacturing. Kim et al. [3] demonstrated that digital techniques improve precision and reduce production time. for the patient in this case, digital methods allow for accurate replication of the contralateral finger, ensuring a harmonious bilateral appearance and improved functional outcomes.

Functional and Aesthetic Considerations

The primary goal of prosthetic rehabilitation is to restore hand function. incorporating joint mobility—via flexible hinges or articulating components—can enhance dexterity and grip strength, thereby facilitating the performance of daily tasks [1]. Aesthetic detailing is equally important. advanced molding techniques enable the recreation of fine anatomical features such as skin creases, fingerprints, and nail beds. lee et al. [6] Emphasized that both intrinsic and extrinsic pigmentation are vital for maintaining a natural and enduring appearance, thereby bolstering the patient's confidence.

Patient Education and Maintenance

Sustained prosthetic success hinges on proper patient education. patients should be instructed on regular cleaning—using mild soap and water—to prevent material degradation and skin irritation. Routine follow-up visits enable clinicians to assess wear and address any necessary adjustments, ensuring that the prosthesis continues to function optimally and maintains its aesthetic integrity over time.

CONCLUSION

The rehabilitation of a 28‚year‚old female with a finger amputation requires a multidisciplinary approach that integrates advanced silicone materials, secure retention strategies, and digital fabrication techniques. By addressing both functional deficits and psychosocial impacts, clinicians can offer prosthetic solutions that significantly improve patient outcomes [2][3]. The inclusion of comprehensive patient education and maintenance protocols further ensures the long-term success of the intervention, ultimately restoring not just hand function but also the patient's self-esteem and quality of life. such comprehensive care not only addresses the physical deficits but also significantly improves the patient's psychological well‚being and overall quality of life.

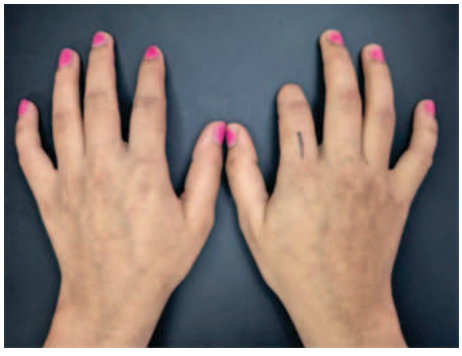

Figure 1 Pretreatment.

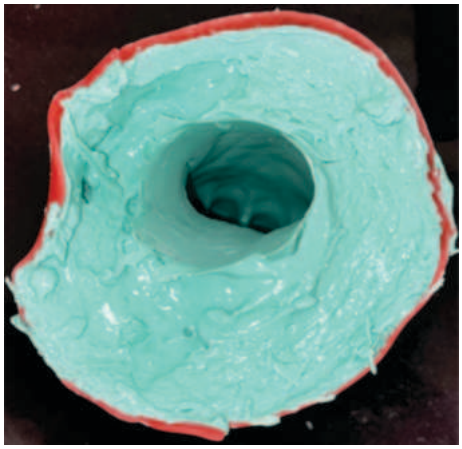

Figure 2- Alginate Impression of the Amputated Finger.

Figure 3- Stone Model of the Stump Followed by Scoring.

Figure 4- Wax Pattern of the Amputated Finger.

Figure 5- Ventral Surface of the Stone Mould.

Figure 6- Dorsal Surface of the Stone Mould.

Figure 7- Finished Prosthesis.

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