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Case Report

Post-surgical rehabilitation of squamous cell carcinoma with finger prosthesis: A case report

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ABSTRACT

Squamous cell carcinoma (SCC) of the finger can lead to both functional and aesthetic impairments, particularly when surgical excision and radiotherapy result in finger amputation. This case report presents the rehabilitation of a 55-year-old male, Mr. Ramamurthy, who lost his fourth finger due to SCC. Following wide local excision (WLE) and radiotherapy, a custom silicone prosthesis was designed to restore both the appearance and functionality of his right hand. The fabrication process included shade matching, texture replication, and a focus on providing passive functionality for daily tasks. The patient reported significant improvement in self-confidence and functional ability, although challenges such as limited dexterity and the potential need for prosthetic replacement over time were noted. Despite the limitations of silicone prostheses, the case highlights the positive impact of personalized prosthetic solutions on both physical function and psychological well-being, significantly improving the quality of life for patients recovering from SCC-related finger amputation.

1. Introduction

The most common types of non-melanoma skin cancer is squamous cell carcinoma, primarily affecting the epidermis. While SCC can affect any part of the body, it is most frequently found in areas exposed to the sun, such as the hands, ear, neck and face.[1] The common susceptible site for SCC is fingers, due to prolonged exposure to mechanical trauma, ultraviolet (UV) radiation, and other environmental factors. Though SCC generally affects the skin of the face, ears, and neck, when it does occur in the hand, it is often seen in the distal parts of the finger—particularly the thumb and index fingers—as these areas are frequently exposed to environmental stresses such as sunlight, injury, and contamination.[2–4] The development of SCC in the fingers can be particularly debilitating because of the vital functional role the hand plays in daily activities, and the visual prominence of the fingers in social interactions.

The etiology of SCC on the finger can be attributed to several factors, with UV radiation being the most significant cause. Chronic sun exposure, especially in individuals who spend significant time outdoors without adequate sun protection, is the leading contributor to the development of SCC. Other risk factors include mechanical trauma, chronic irritation, scar tissue, human papillomavirus (HPV) infection, and pre-existing skin conditions, such as actinic keratosis.[5,6] Additionally, medically compromised individuals, particularly those on with a history of organ transplants or immunosuppressive therapies or, are at higher risk of developing SCC. The development of SCC in only one finger is typically due to the localized nature of these environmental factors, such as concentrated UV exposure on one hand, repeated mechanical stress, or specific

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predisposing skin lesions only affecting that digit.[5–7]

The management of SCC on the finger is multifaceted and involves a combination of surgical and adjunctive treatments. The primary treatment for SCC is surgical excision, where the tumor and surrounding tissue are removed to achieve clear margins and reduce the risk of recurrence. In the case of SCC in the finger, wide local excision (WLE) is commonly performed, in which tumor was removed along with a healthy marginal tissue to ensure all malignant cells are excised.[8] The extent of the surgical intervention depends on the location, depth and size of the tumour involvement with finger. In some cases, digital amputation may be required to ensure complete excision of cancerous cells, which may result in the loss of part or all of the affected finger.[9]

Once the tumor has been surgically excised, radiotherapy is often recommended, particularly if the margins are not clear or if there is a risk of local recurrence. Radiotherapy helps to destroy any remaining cancerous cells that might have been missed during surgery. The typical radiation dose for SCC treatment is 60-70 Gy, delivered in fractions over several weeks, depending on the clinical situation.[10] Radiation therapy is particularly important when the tumor is located in areas that are difficult to fully excise or when there is evidence of lymphatic involvement.[11] However, radiotherapy can also have side effects, including fibrosis, skin changes, and reduced mobility in the treated area, which must be managed carefully in post-operative care.

Following surgical intervention and radiotherapy, the loss of a finger or part of a finger can have both functional and emotional consequences. The loss of a finger affects the self esteem of the affected patient which often leads to psychological distress and functional limitations in performing everyday tasks.[12,13] In this context, finger prosthetics become a vital part of the rehabilitation process. The role of the prosthodontist is crucial in restoring both the function and appearance of the hand, allowing the patient to regain a sense of normalcy and confidence.[14]

A custom finger prosthesis is designed to restore both the function and aesthetics of the affected finger. The prosthesis is typically made from silicone elastomers, which offer the advantage of being both lifelike in appearance and durability. Prosthodontists work closely with the patient to ensure that the prosthesis matches the texture, skin tone, and overall appearance of the natural hand.[14–16] The prosthetic design may also incorporate features that allow for some passive functionality, such as helping with gripping or holding objects, although full dexterity and motor function cannot be restored. The prosthesis is custom-made to ensure a fit and to allow the patient to use it with comfort therefore preventing the disruption to their daily life.[14,15]

Squamous cell carcinoma of the finger is a debilitating condition that can lead to significant functional and psychological consequences, particularly when it necessitates the amputation of part of the finger. The most effective management of carcinoma is combination of surgical intervention and radiotherapy, but it often results in the loss of a finger, which requires prosthetic rehabilitation. Prosthodontic solutions, particularly custom finger prostheses, play a vital role in restoring both the form and function of the hand. These prostheses not only improve the patient's appearance but also significantly enhance their quality of life by improving psychological well-being, social confidence, and functional ability.

2. Case Report

Mr. Ramamurthy, a 55-year-old male, presented to the Department of Prosthodontics and Crown & Bridge with a loss of the fourth finger on his right hand. (Figure 1) The finger loss was a result of squamous cell carcinoma (SCC), which had developed due to prolonged sun exposure. The carcinoma was diagnosed in the fourth finger, and a wide local excision (WLE) was performed to remove the tumor along with a margin of healthy tissue. The amputation extended to the proximal phalanx, resulting in a stump with a length of 21mm and a width/thickness of 30mm. The surrounding soft tissue appeared irregularly bulbous with small nodules, a post-surgical characteristic indicative of tissue changes following excision. After the surgery, the patient underwent radiotherapy to target any remaining cancerous cells and prevent recurrence. He completed a six-week course of external beam radiation, with a cumulative dose of 60 Gy. The patient expressed significant concerns regarding the functional limitations of his right hand, particularly related to his ability to grip objects and perform routine activities. Additionally, he was troubled by the aesthetic implications of the missing digit, as it affected both his appearance and confidence in social situations.

After a thorough examination and considering the patient's needs, it was decided that a custom finger prosthesis would be the most appropriate treatment. The goal was to restore both aesthetic appearance and functional capability of the hand. The treatment plan involved a meticulous approach to colour matching, texture replication, and designing the prosthesis to allow some degree of motion for improved functionality. The use of silicone elastomers was chosen for the prosthesis due to their durability, flexibility, and realistic appearance, providing both aesthetic value and functional advantages.

The fabrication of the finger prosthesis began with making of primary impression. (Figure 2) A thin layer of vaseline was first applied to prevent the impression material from adhering to the finger tissue. Irreversible hydrocolloid impression material was then applied to the palm and dorsal side of the hand after boxing the surrounding area to ensure that all details were captured. The patient was instructed to keep the hand in a resting position to avoid any distortion of

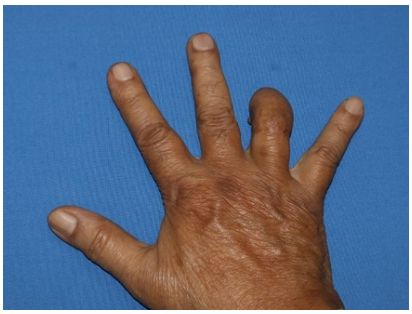

Figure 1: Pre-operative photograph

Figure 2: Primary impression

Figure 3: Primary cast

Figure 4: Wax pattern with artificial nail

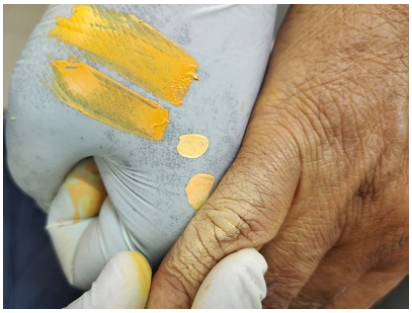

Figure 5: Shade matching

Figure 6: Flasking

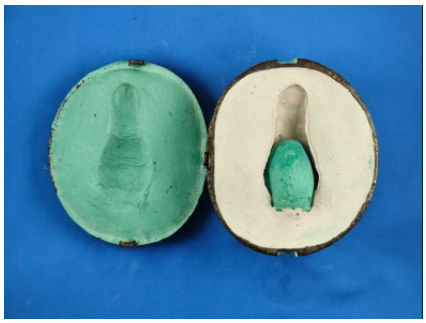

Figure 7: Dewaxing

Figure 8: Final prosthesis

the impression. Once the material had set, the impression was removed and poured into dental stone to create the primary cast, with the use of a vibrator to eliminate any air voids and ensure accurate detail capture.(Figure 3)

Following the primary impression, a wax try-in was performed. A wax finger template was positioned on the residual finger, and retention rings were evaluated to ensure proper fit and stability. During the try-in, size, shape, and fit were carefully assessed to ensure comfort and proper alignment with the patient's anatomical structures. An artificial nail was fabricated using clear auto-polymerizing acrylic resin, carefully shaped, and polished to mimic the natural with aesthetic appearance. (Figure 4) The nail was then bonded to the silicone surface using cyanoacrylate adhesive. The wax pattern was modified as needed, and the patient was asked to check the fit and comfort of the prosthesis during wax try-in stage.

The next step involved shade matching to achieve a natural look for the prosthesis. This was done under natural day light, with the appropriate color matching occurring between 11:00 AM and 1:00 PM IST, when the ambient lighting conditions were most consistent. Intrinsic colors were manipulated to closely replicate the dorsal and palmar surfaces of the natural real life like finger, ensuring that the prosthesis closely matched the patient's skin tone and texture.(Figure 5)

Once the wax pattern and shade were finalized, the next step was flasking and dewaxing. The wax pattern was carefully flasked, ensuring no undercuts that could interfere with the counter flasking process. (Figure 6) A separating medium was applied between the dorsal and ventral surfaces of the finger to ensure accurate separation of the mold. Following this, the dewaxing process was carried out, (Figure 7) and the mold was allowed to cool before silicone rubber was injected into the mold. The silicone material underwent a final polymerization process for one hour at 45°C in hot water, after which it was left to cure overnight at room temperature.

The final prosthesis was carefully retrieved after the curing process. Any flash around the edges was smoothed using fine sandpaper, and the prosthesis was carefully trimmed with a sharp knife to achieve a precise and comfortable fit. The final prosthesis was then secured with a custom finger ring, providing a reliable retention mechanism for the patient. (Figure 8) This custom retention ring ensured that the prosthesis remained stable during daily use and allowed the patient to complete various tasks with ease.

Following the fitting of the personalized finger prosthesis, the patient experienced a significant improvement in both the functionality and appearance of his right hand. His self-confidence was restored, and he found it much easier to perform daily tasks such as gripping objects and using his hand for various activities. Subsequent follow-up appointments confirmed the prosthesis's durability, and the patient expressed satisfaction with the results. He reported improved quality of life and felt much more comfortable in social settings, thanks to the restoration of both the aesthetic and functional aspects of his hand.

3. Discussion

Personalized prosthetic devices play a crucial role in the rehabilitation of patients with finger loss, significantly improving their functional ability and aesthetic appearance. For individuals, who lost their finger due to squamous cell carcinoma and underwent surgical excision followed by radiotherapy, the impact of finger loss extends far beyond just the physical consequences.[2,3] While the loss of a digit may seem minor to some, it can lead to significant, reduced self-esteem, social isolation, psychological distress, and functional limitations in daily life. This case demonstrates the significant benefits of a well-crafted custom finger prosthesis, which addresses both the physical and emotional challenges associated with finger amputation.

The novelty of this case lies in its approach to providing a custom prosthetic that not only restored the patient's physical appearance but also offered functional enhancement for daily life tasks, such as holding objects and gripping. Although silicone prostheses are typically limited in replicating dexterity, and fine motor skills the successful outcome in this case highlights the importance of personalized design in achieving optimal patient satisfaction. In this case, the use of silicone elastomers for the prosthesis fabrication played an important role in both function and appearance restoration. Silicone materials are particularly advantageous in prosthetic design due to their flexibility, realistic appearance, and durability. Silicone prostheses mimic the natural skin texture and color of the finger, making them an ideal choice for aesthetic restoration.[14,15] Additionally, silicone offers a level of comfort that more rigid materials cannot match, and its inherent flexibility provides a functional benefit, allowing for some degree of passive motion in the prosthetic. This was essential for patient, as the prosthesis was designed to enhance the patient's life to perform everyday tasks, such as gripping and holding objects.

While the prosthesis addressed many of the aesthetic and functional challenges, it is important to recognize the limitations inherent in finger prosthetics.[16–18] Unlike upper-limb prostheses that can incorporate motorized components for more functional dexterity, finger prostheses typically lack motorized capabilities, meaning they cannot provide the dexterity or grip strength of a natural finger. As a result, patient was able to regain basic functionality, such as gripping lighter objects and performing everyday tasks, the prosthesis could not fully replicate the fine motor skills needed for more delicate tasks, such as writing or

performing intricate manual labor.[17,18]

Additionally, the durability of silicone, although generally high, remains a concern. Over time, exposure to the environment, frequent use, and factors such as sun exposure or humidity can cause silicone prostheses to degrade, which may necessitate replacements.[19–21] In this case, the patient was informed of the need for periodic evaluation and potential replacement of the prosthesis to ensure continued comfort and functionality. The high cost of custom prostheses, which involve specialized craftsmanship and material selection, can also be a limitation for many patients, especially in low-income settings or in countries with limited healthcare resources.[21]

In addition to the functional limitations, the psychological adaptation to a prosthetic device can be challenging for some patients. While patient reported positive outcomes with the prosthesis in terms of self-confidence and daily function, other patients may struggle with the adaptation process. For some, the emotional trauma of losing a finger can make it difficult to accept the prosthetic, even though it significantly improves their quality of life. This process may be complicated by discomfort due to scar tissue or sensitivity in the remaining limb, as well as by concerns about the fit and appearance of the prosthetic. Patient's emotional support and regular follow-up care are significant for ensuring successful adaptation.

Another challenge with finger prostheses is the difficulty in replicating the color, contour, skin texture, and translucency of a natural real life like finger.[21]While great care was taken in color matching and texture replication for finger prosthesis, it remains challenging to match the dynamic changes that occur with skin tones over time, especially due to sun exposure, aging or post radiotherapy. In some cases, adjustments may be required to ensure that the prosthesis continues to match the patient's skin color and texture.[21,22]

Despite these limitations, the personalized finger prosthesis enhanced patient's quality of life and positive emotional regain. The prosthesis allowed him to regain confidence in his appearance, facilitated improvements in function, and helped him return to his daily routine. While it did not fully replicate the real life dexterity of a natural finger, the prosthesis was designed to meet the patient's most important needs — aesthetic restoration, basic functionality, and psychological relief. The success of the case highlights the importance of custom prosthetic solutions for patients with finger loss due to carcinoma, which can significantly improve both emotional well-being and physical function.

In conclusion, while finger prosthetics cannot entirely replicate the functionality of a natural finger, they offer substantial benefits in terms of appearance, psychological support, and restoring basic function. As prosthodontists, it is important to acknowledge both the strengths and limitations of these devices, ensuring that patients receive the best possible outcome while managing expectations about the functional capacities of the prosthesis. Regular follow-up care, patient education, and emotional support are key components in achieving successful adaptation and maximizing the benefits of prosthetic rehabilitation.

4. Conclusion

Custom finger prosthetics offer a valuable solution for patients experiencing finger loss by addressing both functional and aesthetic needs. This case study for those who lost their finger due to squamous cell carcinoma and underwent surgical excision and radiotherapy, demonstrates the significant positive impact of personalized prosthetic solutions. The successful handling of his case involved meticulous shade matching, texture replication, and functional design to enhance both appearance and daily function. The use of silicone elastomers ensured a realistic look and comfortable fit, improving both self-confidence and functional ability.

Looking to the future, advancements in prosthetic materials and fitting techniques may further improve the functionality and realism of finger prostheses. Future innovations could include more durable materials, improvements in skin texture replication, and the integration of advanced technologies to provide greater dexterity. Furthermore, 3D scanning and customized fabrication are expected to streamline the process and reduce costs, making prosthetics more accessible to a wider population.[22] This case serves as an example of how personalized prosthetics can significantly enhance quality of life for patients, offering a hopeful outlook for future improvements in prosthetic rehabilitation.

5. Source of Funding

None.

6. Conflict of Interest

None.

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