



Clinical case

Custom-made silicone hand prosthesis: A case study

Prothèse de main en silicone sur mesure : à propos d'un cas

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Received 21 January 2016; received in revised form 16 March 2016; accepted 20 May 2016
Available online 21 July 2016

Abstract

Up to now, a cosmetic glove was the most common method for managing transmetacarpal (TMC) and carpometacarpal (CMC) amputations, but it is devoid of markings and body color. At this amputation level, it is very difficult to fit a functional prosthesis because of the short available length, unsightly shape, grafted skin, contracture and lack of functional prosthetic options. A 30-year-old male came to our clinic with amputation at the 1st to 4th carpometacarpal level and a 5th metacarpal that was projected laterally and fused with the carpal bone. The stump had grafted skin, redness, and an unhealed suture line. He complained of pain projected over the metacarpal and suture area. The clinical team members decided to fabricate a custom-made silicone hand prosthesis to accommodate the stump, protect the grafted skin, improve the hand's appearance and provide some passive function. The custom silicone hand prosthesis was fabricated with modified flexible wires to provide passive interphalangeal movement. Basic training, care and maintenance instructions for the prosthesis were given to the patient. The silicone hand prosthesis was able to restore the appearance of the lost digits and provide some passive function. His pain (VAS score) was reduced. Improvement in activities of daily living was found in the DASH questionnaire and Jebsen-Taylor Hand Function test. A silicone glove is a good option for more distal amputations, as it can accommodate any deformity, protect the skin, enhance the appearance and provide functional assistance. This case study provides a simple method to get passively movable fingers after proximal hand amputation.

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Keywords: Carpometacarpal amputation; Silicone prosthesis; Cosmetic; Function; Psychology; VAS; DASH

Résumé

Le gant cosmétique était jusqu'à présent la méthode la plus commune pour l'appareillage d'amputation transmétacarpiennes (TMC) et carpo-métacarpiennes (CMC) qui ne se préoccupaient pas des caractéristiques et de la couleur corporelles. À ce niveau d'amputation, il est très difficile d'adapter une prothèse fonctionnelle en raison de la longueur disponible, de la forme inesthétique, de la présence de peau greffée, de la raideur et de l'indisponibilité de l'option prothétique fonctionnelle. Un jeune homme de 30 ans fut transféré à la clinique pour une amputation CMC du 1^{er} au 4^e rayon alors que le 5^e métacarpien était déplacé latéralement et fusionné avec le carpe. Le moignon présentait une zone de peau greffée, une rougeur, et la ligne de suture n'était pas bien cicatrisée. Il se plaignait de douleurs projetées sur les métacarpiens et la zone de suture. Les membres de l'équipe clinique décidèrent de fabriquer une prothèse de main en silicone faite sur mesure, qui s'adaptait au moignon, protégeait la zone de peau greffée, améliorait l'esthétique et remplissait aussi quelques fonctions passives. La prothèse a été fabriquée avec les câbles flexibles modifiés pour fournir des mouvements interphalangiens passifs. Une formation de base sur l'utilisation, le soin et l'entretien de la prothèse a été donnée au patient. La prothèse faite sur mesure de main de silicone pouvait reconstituer les qualités cosmétiques du segment de membre perdu et rendre certaines fonctions passives. La douleur évaluée sur l'EVA était améliorée. Le questionnaire DASH et le Jebsen-Taylor Hand Function test montraient une amélioration des activités de la vie quotidienne. La prothèse de main en silicone est une bonne option pour une amputation plus distale, car elle est capable de s'adapter aux défauts de forme, protège la peau, améliore les caractéristiques esthétiques et

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peut fournir une aide fonctionnelle. Cette étude fournit une méthode simple pour obtenir des doigts mobiles passivement après amputation proximale de main.

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Mots clés : Amputation carpo-métacarpienne ; Prothèse en silicone ; Cosmétique ; Fonction ; Psychologie ; EVA ; DASH

1. Introduction

Partial hand amputation accounts for the majority of upper limb amputations [1]. Individual suffering from partial hand loss have reduced grip strength and also suffers considerable psychological and emotional trauma. Challenges associated with partial hand prosthetic fitting can be considerable and contribute to a high clinical rejection rate. Difficulty in fitting is mostly due to the need to accommodate limb length, projected stumps, scar areas and desensitized skin [2]. Any of the partial hand alternatives must be considered by the degree to which they satisfy the prosthetic goals such as protection, two-handed activities, body image, minimal harnessing, maximal suspension, gripping security and number of grip patterns [2,3]. These functional goals are often balanced with the cosmetics of the hand. The current options are the passive prosthesis, body-powered prosthesis, external-powered and task-specific prosthesis. The appropriate one depends on the patient's history, personality, stage of life, social support network, physiological condition and psychological factors [4]. Though various options are available for the management of partial hand amputation, it is difficult to fit a device in some of the cases due to the unwanted shape. Advances in material science and technology have helped patients, but in some cases function is compromised to restore appearance [5]. In this case study, the goal of prosthesis fitting was to restore the hand's appearance without compromising its passive function.

2. Case description and method

A 30-year-old male was referred to the clinic at India's National Institute for the Orthopedically Handicapped in October 2014 with amputation at the 1st to 4th carpometacarpal level and a 5th metacarpal that was projected laterally and fused with the carpal bone on right side (Fig. 1). He was a machine operator by occupation and was injured in August 2014 when his right hand got pushed inside the machine. After his accident, he had undergone two separate surgeries involving skin grafting and management of a bone spur. He was psychologically strong and wanted to undergo another surgery to reshape the remaining stump but this was not possible due to vascular issues.

Evaluation of the residual limb revealed grafted skin, redness, unhealed suture line and an immovable, deviated 5th metacarpal. He complained of pain projected over the metacarpal and suture area. A comprehensive evaluation was carried out including muscle strength, range of motion, sensory examination, consistency of soft tissue, activities of daily living (ADL) and patient expectations. Wrist, elbow and shoulder

muscle power, range of motion and sensation were normal. Restricted motion was found in the carpometacarpal joint due to scarring and the 5th carpometacarpal joint was immobile. The ADLs were assessed using the DASH questionnaire; he was unable to do activities that required fine movement. His pain on a visual analog scale (VAS) was 6/10. The patient's expectation was better appearance of his hand and the ability to ride a motorcycle. The limb's condition was not suitable for use of a functional prosthesis. It was decided to provide him with a custom-made silicone prosthesis with passive phalanx movement that would satisfy the patient's expectations.

The silicone prosthesis was started by casting with alginate impression material; a wax model and mold were prepared from a normal hand of a person matching with the patient's normal hand and the patient's amputated hand, respectively (Fig. 2). Wax alignment was done and a split die was prepared with stone plaster. Medical grade silicones were mixed in a 1/1 ratio. During the die pouring, two 4-mm copper wires wound to each other were kept inside the mixed silicone to allow for passive movement (Fig. 3). The die was kept for 24 hours at room temperature for curing of the silicone. The prosthesis was grinded to remove extra material. The final prosthesis was delivered to the patient and has was given training on how to put it on, take it off, and care for it (Fig. 4).

The follow-up was done after 3 months, at which point the DASH, Jebsen-Taylor Hand Function Test and VAS were measured again. These elements were evaluated at two time points (2 days and 3 months after being fit with the prosthesis) except the VAS score, which was in three time points. The DASH questionnaire can usually be completed in approximately 10 minutes. All activities are rated on a scale of 1 (no difficulty) to 5 (unable to do). For the Disability/Symptom score, at least 27 out of the 30 items must be completed for a



Fig. 1. Palmar and dorsal views of the stump.

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