

# Prosthetic Rehabilitation of Lower Limb with RTV Silicone Using Prosthodontic Clinical and Laboratory Techniques - A Case Report

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## ABSTRACT

Amputation of all or part of a limb may be due to systemic disease, vascular disease, infection, local injury or trauma. Partially amputated lower limbs present a variety of unique clinical and prosthetic challenges, because of distinctly different amputation levels of the lower limb. A female patient with history of Partial Foot Amputation (PFA) surgery at metatarsophalangeal joint level, due to crush injury reported for prosthetic rehabilitation. This case was successfully rehabilitated using Room Temperature Vulcanizing (RTV) medical grade silicone for fabrication of foot prosthesis. Though limited in its function, it amply proves that the clinical and laboratory techniques used in fabrication of maxillofacial prosthesis can be effectively adapted for the fabrication of body prosthesis like toes and feet to enhance the quality of life of the patients. The patient was reviewed every year for three years.

**Keywords:** Foot prosthesis, Metatarsophalangeal disarticulation, Prosthesis, Prosthetic treatment, Silicone

## CASE REPORT

A 40-year-old female patient reported to the dental private practice with amputated phalanges and metatarsophalanges of the right foot for prosthetic rehabilitation. History revealed surgical resection was done following a crush injury six months back. On examination it was found that the amputated site was grafted and healed completely. There was no restriction of movement in the ankle joint [Table/Fig-1]. It was planned to fabricate a silicone prosthesis which could be retained with a foot wear to restore the aesthetics and function. The treatment plan was discussed with the patient and she readily consented to the same.

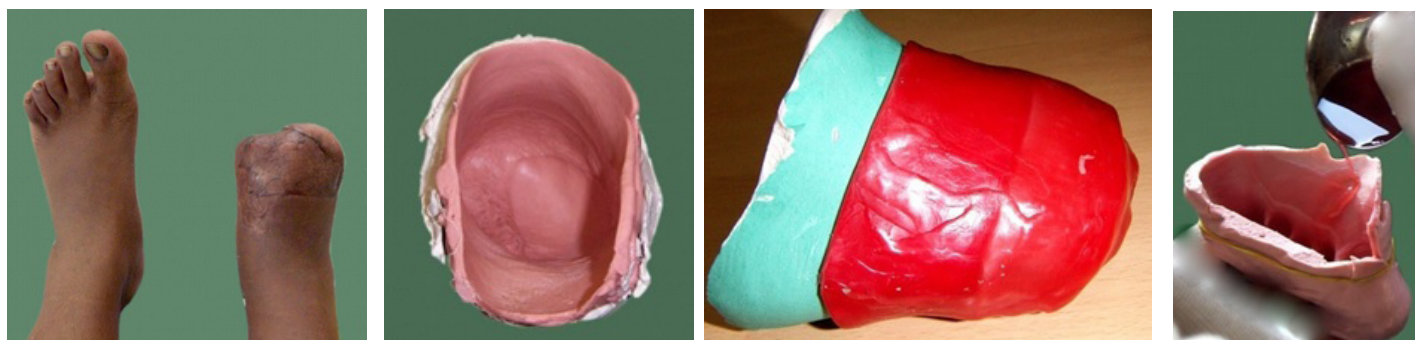
### Step by Step Fabrication of the Silicone Prosthesis

**Impression making:** Affected and the unaffected feet were cleaned using aseptic technique before making the impression. The impression was made using irreversible hydrocolloid (Zelgum, DPI, Mumbai, India). The irreversible hydrocolloid was mixed as per manufactures instructions and painted on to the surface of one foot at a time. The irreversible hydrocolloid impression was covered by surgical gauze [Table/Fig-2]. To reinforce the whole assembly it was covered with a layer of dental plaster (White gold, Asian Chemicals, Vadodara, India). After the dental plaster had completely set, the impression was removed using slow rocking movements. Dental stone (Gyprock, Asian Chemicals, Vadodara,

India) was poured into impression of the affected foot and master cast was obtained free of voids or defects. The impression of the unaffected foot was made to serve as a mould to depict the morphology and aid in the fabrication of the wax pattern.

**Fabrication of wax pattern:** The anterior aspect of the cast was covered with two sheets of modeling wax and a wax coping (sleeve) was made [Table/Fig-3]. In order to duplicate the toes, molten wax was poured into the impression of the unaffected foot [Table/Fig-4] and a wax pattern was fabricated. Each toe was then sectioned and modified to adapt to the affected side [Table/Fig-5]. Each toe was then attached to the posterior margin of wax sleeve coping extending up to the ankle of the amputated foot. A try in was carried out and necessary adjustments were made to match with the unaffected foot to alter and match the appearance as right toe, consent was obtained for the finished wax pattern [Table/Fig-6].

**Shade matching of silicone prior to packing:** The silicone base and activator paste was mixed in equal proportion, intrinsic stains (Factor II Staining Kit, Arizona, USA) were added to the mix, first white color was added to make the mix opaque then red followed by yellow colour which was added to achieve the colour of flesh, finally burnt umber was added to mimic the skin colour. Lightness and dark colour was achieved by altering the burnt umber. This was compared with the patient skin. Different shade of the color



[Table/Fig-1]: Affected and unaffected feet. [Table/Fig-2]: Impression of the affected foot. [Table/Fig-3]: Wax coping. [Table/Fig-4]: Pouring molten wax into the impression of unaffected foot.



[Table/Fig-5]: Sectioned toe.

of the skin was identified and marked to make the skin light and dark to help in layering the silicone during packing. Silicone was mixed with different pigments to match the dorsal and ventral portion of the foot separately. While packing, the two mixes were appropriately placed and they were allowed to cure together. A separate addition of acrylic nail was not planned and placed as the nail was also planned to be layered during packing to match color in silicone prosthesis.

**Fabrication of the silicone prosthesis:** A flask less mold was planned for investing the wax pattern. A two piece mold was made in dental plaster and dental stone was used as coring to record the finer details. A key and keyway was placed on two sides in the two piece mould for checking complete re-seating of the two halves during packing. After complete setting of the plaster the two pieces of the mold were separated and wax pattern was removed. Separating medium was applied on both the halves of the mold [Table/Fig-7]. Room Temperature Vulcanization (RTV) silicone (Factor II A 2000, Arizona, USA) was mixed in equal proportion; and the mold was packed with the stained silicone [Table/Fig-8]. The mold was kept under compression for 24hours as per the manufacturer's instructions. After 24hours the mold was opened and the prosthesis was retrieved [Table/Fig-9]. It was then finished by trimming the excess material. External staining was not done and the nails were also in silicone. This was done by packing clear silicone into the nail bed and finally the stained silicone was layered on top to mimic the natural nail. The foot wear was custom made to accommodate the amputated foot and the silicone prosthesis.

The retention of the prosthesis was insured by close approximation of the silicone prosthesis to the tissues and the suction generated between the prosthesis and the amputated foot. It was further reinforced by the custom made foot wear. The patient was instructed to wear the prosthesis along with the foot wear [Table/Fig-10]. The patient was followed up for three-five years after the prosthesis was fabricated.

**DISCUSSION**

Amputation is the removal of all or part of a limb or any other portion of the body by trauma or surgery [1]. The surgical removal is necessary when there is interruption of blood supply due to systemic or vascular disease, infection, local injury or trauma. Partially amputated lower limbs presents a variety of clinical challenges, because of distinctly different levels of amputation.



[Table/Fig-9]: Prosthesis after curing. [Table/Fig-10]: Finished prosthesis.

S.No.	Material	Advantage	Disadvantage
1	Silicone	<ul style="list-style-type: none"> <li>• Non-reactive</li> <li>• Thermally stable/ Non-combustible</li> <li>• Electrically insulating</li> <li>• Optical clarity</li> <li>• High permeability to gases</li> <li>• Radiation resistant</li> <li>• High purity</li> <li>• High elongation (typically 600 - 1000%)</li> <li>• Good tear strength</li> <li>• Unique modulus at typical elongation</li> <li>• Controllable softness</li> <li>• Low compression set</li> <li>• Oxygen permeability</li> <li>• Bio-inert</li> </ul>	Deterioration of properties on continued use
2	Carbon	High strength, Light weight, Chemically inert	Brittle, Expensive, low impact strength low shear modulus
3	Polyethylene	Low cost, Easy processibility, Freedom of odour and toxicity, Very good chemical resistance, Excellent insulator	Environmental stress cracking, poor scratch resistance, low tensile strength
4	Polyurethane	Excellent, tear and abrasion resistance, Low resilience, comparative, low cost	Difficult to pigment, Subject to attack by solvents, Poor thermal capability
5	Polystyrene	Free from odour and taste, Low cost, Good moldability, Low moisture absorption	Poor thermal stability, Environmental stress cracking, Subject to attack by solvents, Brittleness

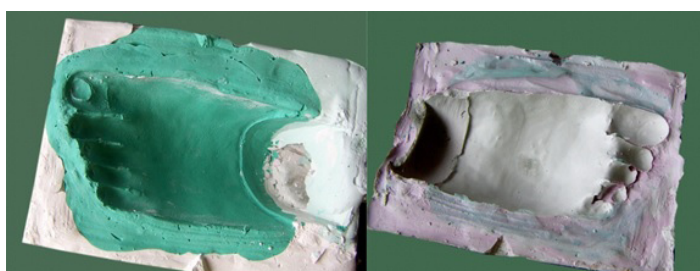
[Table/Fig-11]: Various prosthetic materials used along with advantages and disadvantages.

The various levels of amputation were based on the type of surgical resection as longitudinal and ray resection or transverse section techniques. The transverse amputation of the foot as per the levels is metatarsophalangeal disarticulation, transmetatarsal, tarsometatarsal (LISFRANC) and trans tarsal level (CHOPART) [2,3].

Medical literature suggest various interventions for managing different residual limbs using prosthetic, orthotics techniques and relevant materials [Table/Fig-11] [4,5]. These devices were fabricated using wood, leather, metal and recently foam that did not permit any movement. Polypropylene, polyester and polyurethane that were rigid with less weight were also used. Silicone elastomers used for prosthetic rehabilitation are soft and resilient material providing comfort (relieving pressure from sensitive areas), aesthetic (restoring the foot length) and provide a psychological sense of wholeness compared to the other materials [6-8]. The emphasis was always towards rigidity and prosthetic failure which occurred mainly due to skin breakdown. One of the



[Table/Fig-6]: Try In.



[Table/Fig-7]: Dewaxed mold.



[Table/Fig-8]: Packing with Silicone.

major challenges when treating PFA is to provide a prosthesis that balances the often conflicting requirements of walking function, skin protection, user comfort, and cosmetics. In addition, creating an appropriate prosthetic foot for different levels of amputation presents technical challenges.

Partially amputated limb is not easily rehabilitated because of its functional and aesthetic specificities. The material used should be easily mouldable and should not change the dimensions of the limb. Hence, silicone was used in this case. Stronger materials like titanium and carbon are used for total replacement of foot or the limb. The silicone material used in this case has not been tried before for similar situations.

To avoid the limb length inequality, a customized prosthetic shoe is to be fabricated owing to limited space between distal end and the regular shoe [9].

A well-crafted custom silicone prosthesis cannot only aid in scar tissue management and residuum protection but it can also restore the patients' self-confidence and psychosocial well-being [10]. The use of silicone improved the comfort of wearing the prosthesis. However, limited in function the prosthesis was well accepted by the patient.

The case was followed up for a considerable period of time (6 months). Techniques employed in this case are exclusively those commonly used in any dental clinic. Patients who cannot afford expensive prosthesis can be rehabilitated by a willing prosthodontist.

## CONCLUSION

In this case report the prosthodontic clinical and laboratory techniques have been adapted to fabricate foot prosthesis. Rehabilitation of PFA defect with the prosthesis not only resulted in improved social interaction, function and comfort of the patient it also contributed to the physical and mental well being of the individual in improving the quality of life of the patient.

## REFERENCES

- [1] Maheswari U, Mohamed K, Deora N, Elavia U, Padmanabhan TV. Flexible cosmetic silicone toe and foot prostheses in developing countries—case reports. *J Prosthet Orthop.* 2011;23(4):204-10.
- [2] Berke GM, Rheinstein JCP, Michael JW, Stark GE. Biomechanics of ambulation following partial foot amputation: A prosthetic perspective. *J Prosthet Orthop.* 2007;19(3S):85-88.
- [3] Dillon MP. Partial Foot Amputation: Aetiology, Incidence, Complications, Prosthetic Intervention and a characterization of gait. In Stone JH, Blouin M. editors. *International Encyclopedia of Rehabilitation*; Springer: 2010; New York. Available Online : <http://cirrie.buffalo.edu/encyclopedia/en/article/154/> accessed on January 9, 2016.
- [4] Silicone in prosthetics – Properties and Use. Available online : <http://www.ru.is/media/tvd/skjol/Silicone-in-prosthetics-HR-2016.pdf> Accessed online may 26, 2016.
- [5] Prosthetic Foot Design. Available online: [www.monash.edu.au/rehabtech/research/footmult.pdf](http://www.monash.edu.au/rehabtech/research/footmult.pdf). Accessed online may 26, 2016.
- [6] Strait E. Prosthesis in developing countries. *Prosthetic Resident 2006 (January)*. [www.oandp.org/publication/resident/pdf/Developing-Countries.pdf](http://www.oandp.org/publication/resident/pdf/Developing-Countries.pdf). Accessed January 9, 2016.
- [7] Craig J. Prosthetic feet for low-income countries. *J Prosthet Orthop.* 2005;17:47-49.
- [8] Stills ML. Partial foot prostheses/orthoses. *Clin Prosthet Orthot.* 1988;12:14-18.
- [9] Fillauer K. A prosthesis for foot amputation near the tarsal-metatarsal junction. *Orthot Prosthet.* 1975;29:02-09.
- [10] Putnam RD. Exploring the applications of semi custom silicone partial foot prostheses in a pediatric amputee population. *ACPOC News.* 2009;15(3):18-37.

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