



Orthosis

Static-progressive orthosis for hand closure

Danila Toscano^{a,*}, D. Arena^a, S. Cerchio^a, L. Giuliano^a, L. Sarzi^a, G. Massazza^a, M. Stella^b

^a S.C. (MFRU) Physical Medicine and Rehabilitation University, (CTO) Orthopedic and Trauma Center Dir. G Massazza-Città della Salute e della Scienza of Turin, Italy

^b Burn Center, Orthopedic and Trauma Center (CTO)-Città della Salute e della Scienza of Turin, Italy



1. Abstract

Introduction: With limited resources for rehabilitation, burn therapists throughout the world rely on local resources, professional creativity and community relationships to create solutions to help their patients recover. The demands of helping a burn survivor achieve an optimal outcome drive the burn therapist to create tools and strategies that effectively solve common problems after burn injury.

Methods: The International Society for Burn Injury (ISBI) invited burn therapists from around the world to describe the innovations that they have created to solve burn rehabilitation problems. The submissions were provided through an online form and inclusion of photographs was encouraged. Each submission was reviewed in a blinded manner by an expert panel of three independent rehabilitation therapists from the ISBI Rehabilitation Committee. The submissions were reviewed for originality, utility, quality and safety, then edited and compiled to be shared and disseminated throughout the world.

Results: A total of 77 innovations were submitted for review. 71 were accepted for publication (92%) and given the opportunity to publish in *Burns Open*. Clinicians from 15 countries submitted innovations. The innovations were categorized as: Orthosis, Scar Management, Techniques, Activities of Daily Living Devices, Educational Tools and Prostheses. Nineteen submissions were translated from Spanish to English.

Discussion: Creative and innovative ideas using local resources are turned into patient solutions by experienced burn therapists around the world. However, because such innovations don't reach widespread investigation or production, the ideas remain in a silo in the local area when they could be of use to therapists in other cultures. This project resulted in a book of "Innovative Solutions in Burn Rehabilitation from Around the World," that was printed and is now available as this Special Edition in *Burns Open*. Future work would include expanding on the book with more innovative solutions and translating it into multiple languages to improve access and usability throughout the world.

2. Description of innovation

This two-shell orthosis facilitates fist-closure of the hand in the post-acute phase to improve scar outcome. The orthosis is comfortable to

wear while preventing the skin from friction. It elongates scars on the dorsum of the hand and can be donned independently by the patient.

3. Materials needed for fabrication

A highly perforated thermoplastic sheet without memory (the height must not be less than 5 cm and not more than 12 cm).

Elastic female Velcro™ (5 cm height, and appropriate length for the dimension of the hand).

Inelastic female Velcro™ (2.5 cm height, 5 cm length).

Adhesive hook Velcro™ (5 cm height, appropriate length for the dimensions of the orthosis).

Adhesive cotton padding (appropriate for the dimensions of the orthosis).

Hand/finger dressing cotton.

Two way stretch tubular bandage (appropriate for the dimension of the forearm).

Protection film

Scissors*

Pliers*

Thermostat tank*

Heat gun*

PVC work surface*

PVC rolling pin*

Tape measure*

Permanent Marker*

Water

*Specific equipment for orthosis fabrication, as illustrated.

4. Step by step instructions for making innovation

- Fill up the thermostat tank/orthosis bath with water to 2/3 of its capacity.
- Set the temperature to 70 °C.
- Prepare the work surface and all the necessary materials for making of the thermoplastic orthosis.
- Overlap two layers of thermoplastic material.

* Corresponding author.

E-mail address: danilastravalida@libero.it (D. Toscano).

<https://doi.org/10.1016/j.burnso.2021.08.003>

- -Use a tape measure to measure the circumference of the wrist with the forearm in pronation (landmark: ulnar styloid).
- -Use the tape measure to measure the forearm, with the forearm positioned in pronation (landmarks: from 5 cm to 12 cm along the ulnar diaphysis approximately 1/3 of the forearm length).
- -Take a permanent marker and mark the double layer thermoplastic sheet with the measurements twice, in order to have two equal pieces.
- -Take the scissors and cut the thermoplastic sheets.
- -Soak the thermoplastic pieces in the orthosis bath until ready.
- -Extract the thermoplastic with pliers/paddle and stretch it out on the work surface.
- -Use a rolling pin (possibly made of polyvinyl chloride or PVC) to consolidate the two slabs.
- -With the scissors, round the corners.
- -Soak 2 adhesive pieces of hook Velcro™ into the thermostat tank until ready.
- -Extract the Velcro™ with the pliers/paddle and place them on one of the surfaces of the thermoplastic material.
- -Use the rolling pin to help secure the Velcro™ on each thermoplastic material slab.
- -Protect the forearm and wrist with a protective film/covering.
- -Soak the two pieces in the orthosis bath, and when ready remove the first one.
- -Apply the thermoplastic with the Velcro™ facing out to the dorsal side of the distal pronated forearm (proximal to the ulnar styloid).
- -Wait for the orthosis to cool and firm to the shape. You have the first shell.
- -Extract the second piece from the heat bath and place it, with the Velcro™ facing out, on the palmar side of the distal supine forearm (proximal to the wrist flexion fold) checking that it can be superimposed on the previous piece.
- -Wait for the orthosis to cool and firm to the shape (your second shell) then remove it.
- -Cut two pieces of adhesive cotton padding of the suitable dimensions to entirely cover the internal surface of the two pieces.
- -Remove the orthosis from the patient and with a heat gun, heat the adhesive side of the padding to activate the glue.
- -Remove the protective film from the cotton padding. Place one piece of padding on the inside of each shell (the opposite side to the one where the Velcro™ was placed) making it stick on the whole surface and covering all the borders and overturn on the opposite face to at least 5 mm.
- -Cut two pieces of inelastic Velcro™ and smooth the corners.
- -Cut two pieces of elastic female Velcro™ that we will need to fix the fingers in appropriate position.
- -Complete the orthosis by pairing the two shells and fixing them on the external surface with the two inelastic pieces of female Velcro.™

5. Description of problem solved by innovation

The scar retraction of the dorsal side of the hand and fingers is often the cause of difficulty in closing the hand and making a closed fist. This orthosis counteracts this retraction and the reduction of the ROM (Range of Motion), favoring both the hand closed into a fist with long fingers and opposition and flexion of the thumb.

Furthermore, it is ambidextrous, so the same orthosis can be worn on both hands at different times which saves material and construction time. It is worn easily, without the risk of damaging the scars.

The use of the orthosis promotes:

- Preparation of the hand of the patient before the passive mobilization by the burn therapist.
- Tension and extensibility of the scars, achieved during the therapeutic treatment.



Fig. 1. Materials for construction.

- Prevents loss of ROM, especially at the level of the MCP (Metacarpophalangeal) joint and PIP (Proximal interphalangeal) joint.
- Optimizes the treatment times through the simultaneous use of the orthosis during other rehabilitation practices of other body areas.
- Facilitates home therapy.

6. Instructions for use and care

Use: Educate the patient and/or the caregiver to wear the cotton jersey glove with the seams facing out and the cotton jersey tubular to protect the skin from possible friction before wearing the orthosis. Educate the patient to place the splint at 1/3 of the distal level of the forearm and to fix it with the inelastic female Velcro™ on both sides. Fix the elastic female Velcro™ on the hook Velcro™ of the dorsal shell.

Apply suitable tension to allow the progressive closing of each finger one at the time, placing the opposite extremity of the elastic female Velcro™ on the hook Velcro™ of the palm side of the shell. Recommended to keep the obtained tension for at least 5 min up to a maximum of 10 consecutive minutes, at least three times a day every day. When the patient feels a reduction of the tension, the tension can be increased by modifying the position of the elastic female Velcro™ on the hook Velcro™ of the palm side. For the thumb, fix the elastic female Velcro™ on the back-radial side, pass it over the thumb, and anchor it on the hook Velcro™ at the ulnar side.

Verify that the entire process is well understood, making the patients remove and replace the orthosis themselves. The burn therapist has to verify periodically the correct placement and the times of usage.

Care: Clean plastic regularly. Periodically it is possible to substitute the padding and the Velcro™ to ensure hygiene. Do not expose the orthosis to heat sources.

7. Precautions or contraindication for consideration

Not recommended in the early course of burn recovery and in the uncompliant or unsupervised patient, in patients with poor skin



Fig. 2. Wrist skin protected by film.



Fig. 4. Usage of the splint.



Fig. 3. Full splint with loop elastic Velcro.



Fig. 5. PT wearing cotton protections.

integrity, blistering, with peripheral nerve damage, if there is suspected and/or verified extensor tendon injuries or with severe edema and/or vascular dysfunction.

It is recommended to remove off the pressure garments before applying the orthosis to avoid skin damage.

Apply a suitable amount of lotion to moisturize the skin and prepare the skin for the tension.

Use the Hand/finger dressing cotton and two way stretch tubular bandage to protect the skin from possible abrasions (Figs. 1–8).

8. Declaration of Competing Interests

Conflict of Interest: No

Funding: None

Patient Consent: Yes



Fig. 6. Bracelet set.

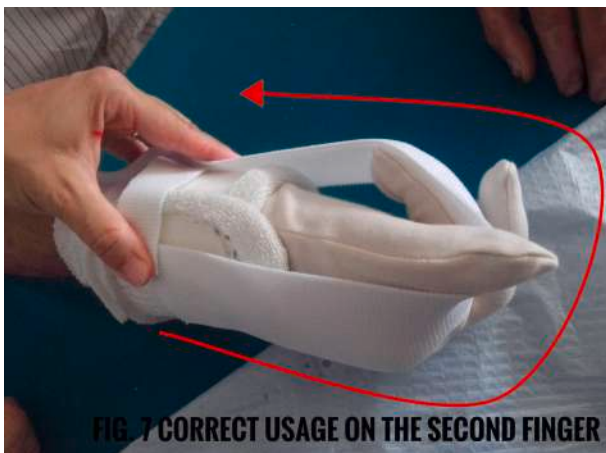


Fig. 7. Correct usage on the second finger.



Fig. 8. Correct usage on second thumb.

- Children after Burn Injury to Determine Practice Guidelines. *J Burn Care Res* 2020; 41(3):503–34. <https://doi.org/10.1093/jbcr/irz150>.
- [2] Choi JS, Mun JH, Lee JY, Jeon JH, Jung YJ, Seo CH, et al. Effects of modified dynamic metacarpophalangeal joint flexion orthoses after hand burn. *Ann Rehabilitation Med* 2011;35(6):880. <https://doi.org/10.5535/arm.2011.35.6.880>.
- [3] Brychta P. European practice guidelines for burn care: Minimum level of burn care provision in Europe. In: *Handbook of Burns*. Vienna: Springer Vienna; 2012. p. 97–102. https://doi.org/10.1007/978-3-7091-0348-7_6.
- [4] Hettiaratchy S, Papini R. Initial management of a major burn: II—assessment and resuscitation. *BMJ (Clinical research Ed)* 2004;329(7457):101–3. <https://doi.org/10.1136/bmj.329.7457.101>.
- [5] Sudhakar G, Le Blanc M. Alternate splint for flexion contracture in children with burns. *J Hand Therapy* 2011;24(3):277–9. <https://doi.org/10.1016/j.jht.2010.10.008>.
- [6] Smith M, Doctor M, Boulter T. Unique considerations in caring for a pediatric burn patient: a developmental approach. *Critical Care Nursing Clinics North America* 2004;16(1):99–108. <https://doi.org/10.1016/j.ccell.2003.10.002>.

Further Reading

- [1] Parry IS, Schneider JC, Yelvington M, Nedelec B, et al. Systematic Review and Expert Consensus on the Use of Orthoses (Splints and Casts) with Adults and