Elastic Cable Assisted Five Finger Movement Dynamic WRIST HAND ORTHOSIS (WHO)

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***Abstract*: Orthotic management for the individual with a hemiplegic gait pattern secondary to a stroke is an important consideration for any treatment plan for this patient population. Patient evaluation, gait analysis, previous management, medical team cohesion, and patient expectations are elements necessary to establish the orthotic goals for the patient. These goals are the basis by which an orthotic treatment plan can be established as well as a measure for future outcome. Therefore, the purpose of this discussion is to describe the steps necessary to determine the most effective method of orthotic management and to identify orthotic design indications and contraindications.**

***Keywords*: Radial Nerve Palsy, Dynamic Wrist hand Orthosis, Wrist drop**

Introduction:
Wrist drop is a disorder caused by radial nerve palsy. Because of the radial nerve's innervation of the extensor muscles of the wrist and digits, those whose radial nerve function has been compromised cannot actively extend them. As such, the hand hangs flaccidly in a position of flexion when the patient attempts to bring the arm to a horizontal position. Causes of wrist drop can range for penetrative trauma to external compression (Saturday night palsy) to systemic nutritional deficiencies. Treatment can range from none to surgery, depending on the nature and extent of the injury to the radial nerve.

Design Consideration:
A **dynamic splint** uses a tension spring that is integrated into a brace, usually via a mechanical hinge. The spring provides mild, long duration stress on the restricted joint to facilitate tissue remodeling. The tension spring can be adjusted for more or less tension to achieve range of motion goals with less pain.
Subsequently, what is a static progressive splint? **Static progressive splinting** is the use of inelastic components, such as hook-and-loop tape, **static** line, **progressive** hinges, turnbuckles, screws, and gears, to apply torque to a joint to increase passive range of motion. **Static progressive splints** allow adjustable tension and changes in joint position at any time.

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- Indicated for the wrist drop
- The dynamic wrist, hand and finger Orthosis is designed for use with the neurologically impaired upper extremity.
- The Orthosis is used to hold the user's impaired wrist, hand and fingers generally in an extended position, with the thumb in palmer abduction. This position places the impaired hand in the functional position for grasping.
- The orthosis also has a dynamic component that offers varying degrees of substantial resistance to all digits, unlike current dynamic splints.
- The thumb has its own tensioner, and the other four digits, i.e., the fingers, have a combined tensioner, or can have individual tensioners as needed. It is this dynamic force that assists with releasing the object once grasped.
- The dynamic orthosis includes digit caps that can transfer the force of resistance without moving proximally on the finger, and are then able to be opened with the assistance of tensioners. The orthosis of the invention allows a neurologically impaired upper extremity, including the hand to work on repetitive grasp and release activities while participating in task specific arm training.

Components used are:

- Forearm splint
- Hand splint
- Digit cap
- Finger lead mount
- Finger spring
- Wrist mount
- Thumb spring
- Thumb mount
- Thumb lead mount
- Thumb line guide

In order to correctly position the tips relative to the support, and to properly align the leads, the dynamic splint also includes a plurality of guides, one for each tip, that extend from the support to adjacent the tips. Each guide includes a lead opening, such as a grommet, with each lead being threaded through a grommet. The guides are preferably longitudinally adjustable, as well as rotatable

or laterally adjustable, so that the distal ends of the guides can be positioned to locate the tips at desired positions, taking into account the size of the user's hand and fingers. For example, each guide can be attached to the support with a screw that fits within a longitudinal slot.

The forearm section of the support is a generally rigid band, e.g., a curved plastic sheet that is sized to fit substantially around a user's forearm. An attachment means, such as one or more hook-and-loop straps are attached to the forearm section to secure the section to the user's forearm. The inner surface of the forearm section is lined with padding material for comfort. The hand section of the support is a rigid plate that is sized to cover a substantial portion of the dorsal part or back of the hand. A releasable attachment means, such as a hook-and-loop strap is used to secure the hand section to the back of the hand. The inner surface of the hand section is also padded.
The thumb tip guide used to position the thumb-tip cap is preferably a rod that is rotatable mounted on the support, so that thumb tip guide is positioned at the appropriate angle. Just like, the thumb tip guide is formed of a rod with proximal and distal sections that are at an angle. The proximal section may be rotatable mounted in substantial longitudinal alignment with the longitudinal axis of the forearm section, so that the distal section of the thumb tip guide is angled outwardly, enabling the distal end of the guide to be positioned over the thumb-tip cap.

In operation, the dynamic splint creates rearward directed forces that urge the fingers and thumb into an open hand, fingers extended position. Specifically, the finger tensioner constantly pulls on each finger tension line connected to the fingertip caps urging each finger into an extended position.

Fig. Medial View of Orthosis

Fig. Top View of Orthosis

Aim: To design dynamic wrist-hand Orthosis.

Objectives:

1. Mobilization orthosis or dynamic orthosis have movable parts and are designed to apply force across joints. Mobilization orthosis use constant or adjustable tension, or both, to achieve one of the following goals
2. Substitute for loss of muscle function
3. Correct deformities caused by muscle-tendon tightness or joint contractures
4. Maintain active or passive range of motion
5. Provide controlled motion after tendon repair or joint arthroplasty
6. Aid in fracture alignment and wound healing

Procedure:

1. Taking the profile of the patient and cut the template according to the patient hand.
2. Cut the LTTP (Orfit) Sheet and drape over the patients hand, forearm, dorsal splint and fingers cap, cut the trim lines accordingly.
3. Cut the metal strips for the thumb spring, thumb mount and thumb line guide and wielded it according to shape.
4. Finger lead mount and finger spring is wielded and was attached to finger cap and dorsal plate.
5. Attach all the components simultaneously.
6. Fingers cap were all attached to a cable by ball and terminal and cable altogether attached to a rubber string which further connected to a spring in forearm.
7. Tension is provided by spring which will increase the range of wrist joint eventually and prevent the contracture,
8. It will also help with fingers to be in grasping position for doing various prehension in functional position.

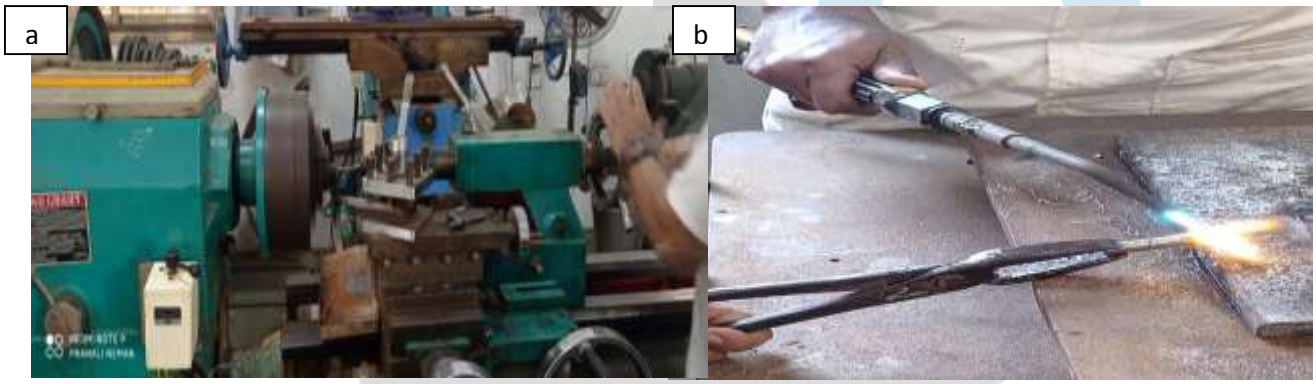

Fig. a) Milling Machine, b) Welding the component

Fig. Drilling Machine, Shaping the component, LTTP Components molding on Subject

Functions:

- **Maintains the patient's involved arm and hand in a functional position.**
- **Offers a dynamic component that assists with thumb and finger extension so grasp and release tasks can be accomplished.**
- **Offers a dynamic elbow extension system to facilitate functional reaching.**
- **With the ability to perform grasp and release activities, patients can perform highly repetitive, task-oriented arm training. Evidence based research supports this training as critical to recovery.**

Features:
- Spiral forearm design that secures the wrist in a functional position
- Tensioners are located at the IP joints (interphalangeal joint) of the fingers and thumb to assist with extending the digits following grasping.
- Individual Tensioners can be removed to customize assistance based on the client's needs.
- Numerous sized Tensioners included accommodating various finger lengths.
- Full joint finger motion possible to maximize functional performance.
- Silicone covered finger tips to improve traction during grasping.
- Non-slip liner to minimize migration.
- Glove includes Lycra material for expandability.
- Palm exposed to increase breathability and ease of donning.
- Lightweight and comfortable.

Functional dynamic orthosis are specifically designed for individuals suffering from a neurological injury such as a stroke, head injury and incomplete spinal cord injury.

Result:

"Elastic cable assisted five finger movement dynamic wrist hand orthosis maintains the patient's involved arm and hand in a functional position.

- **It has a dynamic component that assists with thumb and finger extension so grasp and release tasks can be accomplished. Force is adjustable through tightening and loosening of elastic band. Forearm shell with good ventilation and hygiene. Fabrication procedure is time efficient and effortless. It is easy to wear and special experience is not required and caretaker also can fit the orthosis to patient.**

Conclusion:

- **Grasping training assisted with dynamic wrist-hand orthosis can improve upper limb and hand function of motor and release spasticity in hemiplegics after chronic stroke.**
- **The person must also be educated on the importance of monitoring the splint for signs of pressure areas and skin breakdown, as well as how to don and doff the Orthosis properly.**

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