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Modified Wrist Driven Flexor Hinge Splint for C6 Quadriplegic Patients

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ABSTRACT

The wrist-driven flexor hinge orthosis (WDFHO) is a mechanical device used to restore hand function in persons with quadriplegia caused due to lower cervical spinal injury (C6, C7, C8) spinal cord injury by furnishing three-point prehension[1]. We have studied the effectiveness and biomechanical properties of a modified wrist driven flexor hinge splint in person with C6 (lower cervical) cervical spinal injured patient. This study introduces a mechanical operating model to assess the efficacy of the WDFHO (Wrist Driven Flexor Hinge Splint). The improvement seen during the entire course of patient treatment procedure was overwhelming. An indirect Pinch strength test was conducted in two phases by assessing the capacity of the patient to lift the weight with and without the orthosis. With the orthosis patient was able to lift 3 times more weight as compared to patient without the orthosis. This remarkable improvement in pinch strength may be due to the improved three jaw chuck prehension pattern due to the wrist driven flexor hinge splint. Along with that improvement in various hand dexterities were seen as the subject was able to hold cylindrical objects, key and pencil in his hand.

Keywords: WDFHO (wrist driven flexor hinge splint), quadriplegia, three jaw chuck prehension (or) Three point prehension.

INTRODUCTION

Injury to the spinal cord resulting in tetraplegia changes the life of the person permanently. A Comprehensive rehabilitation plan should be employed to achieve for most independent life[2]. Every year approximately 20,000 new cases of SCI (Spinal cord injury patients) are added SCI population among which 60 to 70% population belong to the illiterate poor section of the society and most of them sustain an injury by fall of height[3].Patients with tetraplegia who have strong 6th cervical neurologic C6 function are the strong Candidate for wrist driven flexor hinge splint (or) Tenodesis Splint[4]. There are verities of design of wrist driven flexor hinge splint available in the market but no design provides the arrangement for functioning of splint in different range of motions. This project is dedicated to the development of an indigenous wrist driven flexor hinge splint with dial lock arrangement which will provide functioning of splints in different range of motions of anatomic wrist. This arrangement will encourage maneuvering the wrist in different positions.

METHODS

Subject

A sample of convenience age-22, sex- female, with C6 complete Spinal cord injury (American Spinal Injury Association Impairment Scale (AIS) grade A) and paralysis or severe weakness of the hands reported to the institution. The subject scored at least grade 3 (3/5) on an MMT for wrist extensor. Any interferes with hand grasp function were checked.

Wrist driven flexor hinge splint

We took the challenge to fit a modified wrist driven flexor hinge splint with dial lock This Orthosis was custom made to fit the subject from the radial side of the second MCP joint to the distal tip of the radial styloid and to match the subject's available range of motion (ROM) at the MCP joint. The interphalangeal (IP) joints of the index and middle fingers are stabilized along with the IP and MCP joints of the thumb. When a subject extends his or her wrist, the posted thumb and index and middle fingers are pushed together to attain a grasp motion. Conversely, wrist flexion causes the hand to open. There are five levels in the gear slot selector that between four linkages. Regulate the angle of wrist extension. Pressing the spring-loaded button of the gear slot selector locks the notched actuating lever into the desired position.

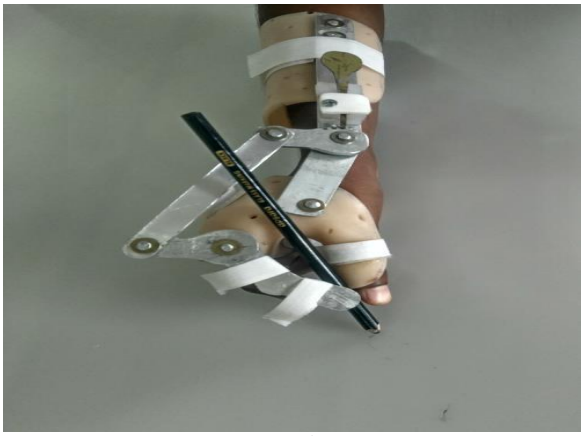


Figure: 1 wrist driven flexor hinge splint

Procedure

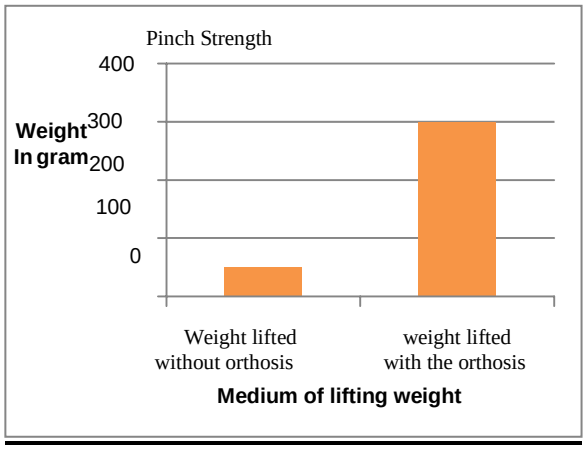
The subject invited was given a detailed explanation of the procedure and information consent form was signed by the patient. Prior to the enrolment of patient for data collection there were no major health issues persisting with him except for C6 Spinal cord injury Patient was fitted with the modified wrist driven flexor hinge splint prepared by the clinical team and pinch strength was measured indirectly by capacity to lift the weighing stones. Measurements were taken in two phases with and without the Orthosis. Without the Orthosis patient was asked to lift various weight stone (50gm, 100gm, and 200gm) and to lift a cylindrical object, pencil and a key. After that the same patients was asked to repeat the same procedures but with the orthosis. Lifting capacity of the patients with and without Orthosis was recorded. By holding the cylindrical object, pencil and the key, hand dexterity was checked.

RESULT

The improvement was seen during the entire course of patient treatment procedure. Pinch strength test was conducted in two phases. Without the Orthosis patient is able to lift only 50 gm. of weight. While a dramatic improvement was seen in pinch strength (Graph 1) and the patient was able to lift a series of weight i.e. 50 gm. – 300 gm. (Table 1). This remarkable improvement in pinch strength may be due to the improved three jaw chuck prehension pattern due to the wrist driven flexor hinge splint. Promoting functional hand activities is a crucial rehabilitation goal for persons with tetraplegia spinal cord injury (SCI). Some people with mid- to low-level cervical (C) SCI achieve useful tenodesis grasp, which is opposition of the thumb and the index and middle fingers through reciprocal wrist extension and finger flexion, with the aid of a wrist-driven flexor hinge orthosis.

Table 1: weight lifted with and without the orthosis

Weight lifted without Orthosis	Weight lifted with Orthosis
50gm	300gm



Graph1: pinch strength

DISCUSSION

Some people with mid- to low-level cervical (C) SCI achieve useful tenodesis grasp, which is opposition of the thumb and the index and middle fingers through reciprocal wrist extension and finger flexion, with the aid of a wrist-driven flexor hinge Orthosis (WDFHO) [5,6]. Generally, persons with C6 and C7 tetraplegia can use a WDFHO for a variety of daily activities, such as eating, dressing, using the toilet, grooming, and writing[7,8,9] .The WDFHO enables persons with tetraplegic SCI to attain a functional tenodesis grasp that creates enough passive tension in the paralyzed thumb and finger flexor muscles (such as flexor pollicis longus,

Flexor digitorum superficialis, and flexor digitorum profundus) with active wrist extension by contraction of the innervated extensor carpi radialis brevis (ECRB) and extensor carpi radialis longus (ECRL). Therefore, the WDFHO is an ideal device for persons with C6 or C7 tetraplegia who have wrist extensors with muscle strength of grade 3 or above on the manual muscle test (MMT) and who have either flickers or no finger movement to furnish their prehension effectively[10].

CONCLUSION

Functional Potential of every neurologically severed patient should be explored and a comprehensive rehabilitation plan should always be instituted as early as possible. So that psychological scarring of the patient can be minimized. Comprehensive rehabilitation goal should always include orthoses as an inevitable part of treatment supplemented by physical therapy, occupational therapy and clinical psychology. Wrist driven flexor hinge splint has tremendous caliber to improve the quality of life of a person affected by low level cervical injury having 3+ muscles strength. After successfully serving the poliomyelitis patient in late 19 Century, the wrist driven flexor hinge splint is currently serving the patient with C6, C7, and C8 level of spinal injuries. The population of spinal injured patient is gradually experiencing a stiff increase with the development of technology and this number will go on increasing with advancement of time .this draws a serious need for the advancement of current design of wrist driven flexor hinge splint.

Learning from this article

In a less resourced setting where the availability and affordability of the components and materials poses a challenge, the best possible attempt is to be made for service delivery to the patient with available resources without compromising the safety of patient.

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Authors' contributions

The entire clinical course of functional fracture bracing service delivery was done by Mr. Prasanth towards the fulfilment of bachelor degree research project under the supervision of Mr. Bapina Kumar Rout. Subsequent data collection and manuscript preparation is done by Mr. Bapina Kumar Rout. All the clinical service delivery to patient and research study was carried out in the premises of Ishwar Institute of Prosthetics and Orthotics, an institute that imparting learning and patient service delivery.

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