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Practice Forum

Effects of a dynamic orthosis in an individual with claw deformity

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These authors describe their utilization of a dynamic orthosis to correct a strong claw deformity in a patient with a median and ulnar laceration. After 4 weeks of wearing the dynamic orthosis, these authors noted that the patient was able to actively extend all his fingers orthosis-free, with no evidence of claw. —Victoria Prigane, PhD, OTR, CHT, CLT, Practice Forum Editor.

Introduction

The intrinsic muscles are critical structures of the hand.[1] Disturbance to intrinsic muscles can produce a biomechanical disadvantage by disrupting the muscle balance and function of some structures within the hand.[2] Static dorsal metacarpophalangeal (MCP) joint block orthosis or "Lumbrical bar" is widely used in hand therapy to correct claw deformity and/or to prevent overstretching of the denervated intrinsic muscles. Even though this approach might be effective in the management of the claw, static orthoses may limit the total range of motion. Limitation of MCP joint extension varies considerably depending upon the degree of MCP joint flexion needed to extend interphalangeal (IP) joints. In minor claw deformities a slight MCP joint flexion is enough to assist the IP joints extension. However, when the patient displays a heavy claw deformity, a higher degree of MCP joint flexion is needed to perform the same movement. In such case, this restriction may disable the patient to grasp objects of different shapes and sizes, negatively affecting the patient functionality.

The orthosis we fabricated (Fig. 1) aimed to promote full MCP and IP joint extension in a patient with strong claw deformity by restoring appropriate biomechanical balance between intrinsic and extrinsic finger extensors. This orthosis also encouraged the patient to perform functional activities, since it did not offer any rigid mechanical restriction. The orthosis is a modification of the ulnar palsy leather splint cited by Colditz.[3]

Case report

The patient was an 18-year-old left-hand-dominant male who was severely injured after machete accident. He accidentally cut his left arm near the wrist (Verdan's zone 5) resulting in a complete laceration of the radial artery, the ulnar and median nerve, and all flexor tendons. At 15 weeks post-surgery, the patient began to use the "Lumbrical bar" orthosis in an attempt to correct the claw deformity. However, the restriction of MCP joint extension imposed by inflexible orthosis was producing significant functional limitations. The patient was unable to grasp larger objects. That was the major reason why we considered a different approach. The lumbrical bar orthosis was discontinued at the beginning of 16th week after surgery. At that time, the claw deformity remained quite evident (Fig. 2A). The patient began to use the dynamic orthosis — customized to meet patient's needs — by the end of the 16th postoperative week.

Dynamic orthosis

The orthosis design is very simple. A thermoplastic half moon shape piece was fabricated over the palmar region of the wrist. A curved piece of thermoplastic, resembling a hook, was fabricated and attached to the area of the scaphoid tubercle on the surface of the half moon piece to serve as an anchor for rubber bands. A piece of strapping with Velcro® hooks was wrapped around the wrist and secured back onto itself. A finger cuff was placed on the shaft of the proximal phalanx of the third, fourth, and fifth fingers and at the thumb metacarpal, along with one ordinary rubber band (thumb) and two ordinary rubber bands (remaining fingers). These rubber bands linked up the fingers to the hook. The orthosis was applied to all his fingers except for the index, which had developed a minor

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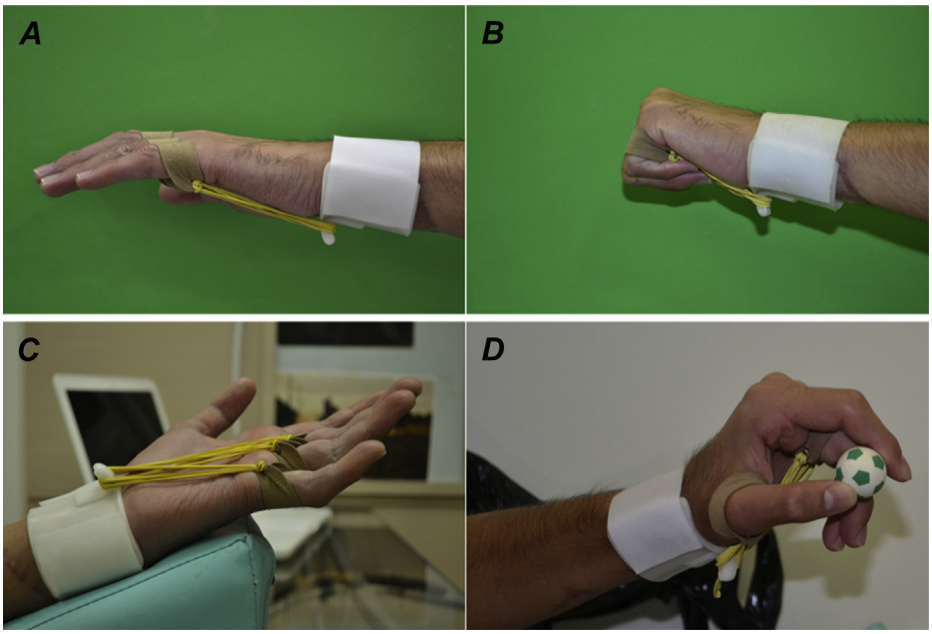

Fig. 1. Dynamic MCP orthosis. (A and B) Lateral view. (C) Volar view. (D) Patient showing the ability to pinch a mini soccer ball.

claw deformity. The index adopted the desire posture by itself after the orthosis has been applied to the remaining fingers. Although the design of this orthosis resembles the static ulnar palsy orthosis developed by Judy Colditz,[3] its approach is slightly different. The major purpose of our orthosis was to reeducate the patient to extend MCP and IP joints in a stable posture through the dynamic resistance; instead of focusing only on the interruption of the claw posture through static lines.

Dynamic orthosis usage and the home exercise program (HEP)

The dynamic orthosis was worn for short intermittent periods during the day while performing functional tasks as well as in the home exercise program. The HEP was performed by moving the MCP and IP joints into extension from a flexed position for 10–15 slow, gentle repetitions 5–8 times/day. Exercises progressively extending the MCP and PIP joints against a dynamic resistance, guided the patient to extend MCP and IP joints in a stable posture. The same exercise program was prescribed for the thumb, however on it the HEP was performed by moving the MCP and IP joint into extension from a CMC (carpometacarpal) joint palmar abduction position. This orthosis allowed the optimal range of motion. In the beginning, the rubber band tension was stronger in order to facilitate the proper movement. The stronger rubber band tension, the easier it is to perform the exercise properly. Throughout the following days, the rubber band tension was gradually reduced in order to develop the inner stability of the patient. We continually sought an optimal rubber band tension based on the response of the patient. When claw posturing was about to become apparent the rubber band tension was slightly raised. The patient was challenged repeatedly to execute the movement as much as possible without developing claw (Video 1). The dynamic orthosis was discontinued after 4 weeks of use.

After 4 weeks of wearing the dynamic orthosis (20 weeks post-surgery), the patient was able to actively extend the MCP and IP joints of all his fingers orthosis-free, with no evidence of claw (Fig. 2E and Video 2).

A re-evaluation was performed four and eight weeks after the orthotic device has been discontinued. The patient was no longer displaying any residual sign of claw.

Discussion

Muscle reinnervation versus functional recovery

Neurophysiological testing, such as needle electromyography and nerve conduction studies, are capable to identify reinnervation potential after peripheral nerve injury.[4] Unfortunately the authors did not have these methods available for use. Therefore, the authors cannot assert whether such muscles were fully reinnervated or not. The authors present two hypotheses to explain the outstanding outcome of this patient.

The "Torque Transfer Hypothesis"

Assuming that the intrinsic muscles were denervated, the patient would have developed a remarkable ability to transfer torque from the EDC to the IP joints, without MCP joint hyperextension. According to Strauch,[5] when MCP joint hyperextension is prevented, EDC is capable of extending MCP, PIP, and DIP joints even in the absence of intrinsic muscle function. It can be seen on Bouvier's test, where the MCP joints are taken out of hyperextension and the extrinsic extensors are then allowed to apply their force through the central slip in order to extend the IP joints.[6]

The "Neuromuscular Reeducation Hypothesis"

Given the post-surgery time and the expected axon growth rate, it seems feasible the intrinsic muscles were partially reinnervated at 16th week post-surgery. Even then, the patient was not able to extend both MCP and IP joints without production of claw posturing. Muscle reinnervation does not mean return of the muscle function. Recovery of synergistic function involves much more than just axonal regeneration and connectivity. Restoring appropriate biomechanical balance between intrinsic and extrinsic finger extensors may require specific muscle training. In this