Use of a Resting Hand Orthosis for the Hemiparetic Hand After Stroke

CASE SCENARIO

A 50-year-old right-handed man has been admitted to your stroke service after sustaining a left middle cerebral artery stroke. This is his first stroke. After an acute hospital stay of 5 days, he was admitted to inpatient rehabilitation. On admission to the rehabilitation unit, he presented with an essentially flaccid right arm, which demonstrated some synergistic movements (Fugl-Meyer, 8/66). Right upper extremity range of motion was well preserved, with no evidence of pain with passive movement. Sensation was diminished throughout the right side, with decreased perception of sharpness and extinction with double simultaneous stimulation to light touch. Proprioception was impaired in the fingers and wrist. After 3 weeks, improvements are noted in the proximal right upper extremity because he can now easily move the arm synergistically as well as demonstrate some shoulder flexion and abduction out of synergy. There now is concern over the possibility of loss of range of motion in the hand and wrist because passive range of motion is more difficult (Ashworth score, 2), with some evidence of pain near the end range, especially when extending the wrist and fingers. There is some active flexion of the wrist and fingers synergistically, but no active extension is noted. The occupational therapist recommends the use of a resting wrist-hand orthosis. Do you agree?

Guest Discussants:

Nathaniel H. Mayer, MD
Motor Control Analysis Laboratory, MossRehab, Elkins Park, PA; Department of Physical Medicine and Rehabilitation, Temple University School of Medicine, Philadelphia, PA
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Richard L. Harvey, MD
Department of Physical Medicine and Rehabilitation, Northwestern University Fienberg School of Medicine, Chicago, IL; Stroke Rehabilitation, Wesley and Suzanne Dixon Stroke Chair, The Rehabilitation Institute of Chicago, Chicago, IL
Disclosure: nothing to disclose

Feature Editor:

Thomas K. Watanabe, MD
Department of Physical Medicine and Rehabilitation, Temple University School of Medicine, Philadelphia, PA; Drucker Brain Injury Center, MossRehab, 60 Township Line Road, Elkins Park, PA 19027. Address correspondence to: T.K.W.; e-mail:watanabt@einstein.edu
Disclosures: grants (payment to author), SPR Therapeutics; honorarium for educational presentations, AAPM&R

Richard L. Harvey, MD, Responds

This case study presents a patient with signs and symptoms that indicate the need for a resting hand splint, which is an important component to the overall rehabilitation of the patient with hemiplegia. In particular, within the first 3 weeks of recovery, this patient has developed mild hypertonicity of finger and wrist flexors, and still lacks voluntary wrist and finger extension. In addition, he has developed pain with range of motion. To prevent the development of poorly controlled spasticity, joint contracture and worsening pain, splinting becomes one critical component of the multifaceted care of the hemiplegic upper limb and should be used early with patients with severe paralysis, such as in this case.

After acute stroke, 60% of patients will develop a contracture during the first year [1]. In the upper limb, there are several joints and muscle groups at particular risk for contracture, including shoulder and shoulder adductors; the elbow and elbow flexors; and the wrist and finger joints, with associated flexor muscles of the forearm and hand. In severe hemiplegia, there is notable wrist stiffness at 3 weeks after stroke, with contractures fully developed at 12 weeks [2]. Pain with joint range of motion also increases over the first 3 months, with severe upper limb paralysis, and pain can contribute to further immobilization [2]. Severity of paralysis is the strongest risk factor for development of contractures and should trigger efforts at targeted prevention [2,3]. Spasticity, as defined by the classic definition of velocity-dependent resistance to stretch, also is an important risk factor for later development of contracture but does not bear as significant a risk as paralysis [3]. Less understood is the impact of spastic dystonia on contracture risk. Spastic dystonia was first described by Denny-Brown and constitutes a hypertonia present at rest [4,5]. This hypertonia results in typical hemiplegic posture in the upper limb characterized by an adducted and internally rotated shoulder, flexed elbow, pronated forearm, and flexed wrist and fingers. The hypertonicity associated with spastic dystonia is altered with changes in posture such that muscle length shortens with transitions from lying to sitting and from sitting to standing (action-induced spastic dystonia) [5]. Thus, patients frequently report spastic dystonia to be least active while in bed during rest and sleep. Rehabilitation focuses on the consequences of upper limb hemiplegia through functional retraining and management of spasticity

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and spastic dystonia. In this context, the classic resting hand splint provides a means of controlling wrist and finger position at rest and during dynamic activities, and thus prevents prolonged flexed postures of the fingers and wrist. Splinting also serves to protect joints and to reduce the risk of joint pain.

Soft-tissue changes in muscles and joints begins early after onset of hemiplegia, and such changes contribute to later contractures. Protein synthesis within muscle fibers is reduced within 6 hours after the limb is immobilized, and shortening of muscle-fiber length occurs within 24 hours. Increases of collagen in the perimysium appear approximately 2 days after immobilization [6]. When rehabilitation is applied early, the hemiplegic upper limb can be appropriately positioned at rest and regularly mobilized. But once hypertonicity appears, it becomes more difficult to mobilize limbs due to stretch resistance and associated pain. Positioning then may become difficult to maintain. Still, in the early care of the patient with hemiplegia, 30 minutes of shoulder positioning in maximal external rotation or abduction during the day can prevent stiffness of shoulder internal rotators and adductors 6 weeks after stroke [7,8].

The use of botulinum toxin injection in the presence of spasticity, spastic dystonia, and severe weakness can assist the patient, caregiver, or clinician in maintaining or improving functional joint range of motion [9,10]. Reduction in joint torques associated with spastic dystonia can improve splint fit and tolerance. Injection of botulinum toxin when hypertonicity of finger flexors first appears can prevent wrist and finger stiffness 6 months after treatment [11]. The combination of botulinum toxin injection with dynamic splinting for a spastic elbow can improve elbow range of motion better than with botulinum toxin alone [12].

It is reasonable to expect that the above findings related to the management of the spastic hemiplegic upper arm (with and without the use of botulinum toxin) may be seen when splinting is used to address soft-tissue changes, spasticity, and weakness in the wrist and hand because the pathophysiological elements are similar. It should also be noted that the effects of splinting extend beyond changes in muscle fibers to include alterations in the properties of tendons and the musculotendinous junction. Changes, for example, in the stiffness of the tendinous component of the muscle unit may be critical to the function of the spastic joint. A study by Couppe that examined the effects of immobility on normal human joints support this assertion [13].

Therefore, it is recommended that resting hand splints should be used for patients with severe upper limb paralysis early after stroke before the appearance of finger and wrist hypertonia. Splints should be worn especially during the daytime hours when spastic dystonia is more problematic. For example, a typical daytime wearing schedule would be 2 hours on and 2 hours off. Splinting should provide optimal wrist and finger positioning (10° wrist extension; 20° finger flexion at the metacarpophalangeal joint) to prevent muscle-fiber shortening and loss of sarcomeres. Hypertonia should be treated early as well, preferably with focal treatment by using botulinum toxin injection, to optimize splint fit and to improve joint range. This approach also will reduce pain and allow the patient to tolerate joint range when not splinted. When pain appears, it should be carefully treated to prevent voluntary immobilization of the upper limb. This multifaceted approach seems the most logical based on current evidence, but it needs to be further tested in clinical trials.

Lannin et al [14] published a randomized clinical trial that demonstrated the lack of efficacy of 2 types of resting hand splints for prevention of wrist and finger contractures after stroke. These researchers concluded that “the routine practice of hand splinting to prevent muscle contracture during acute rehabilitation after stroke should be discontinued” [14]. Their study included 82 patients who participated in rehabilitation after stroke. They were enrolled an average of 30 days poststroke onset. Many of these patients reported upper limb pain as a limiting factor to function, and many patients already had signs of spasticity and reduced extensibility in the affected wrist and hand. Splints were applied to the experimental group at night (average of 9 hours) rather than during the daytime. Splints were worn for 4 weeks, and there was an immediate and 6-week posttreatment measure of outcome. Of importance is that all the subjects were permitted to perform only 10 minutes of isolated finger and wrist extension practice per day, and no stretching was allowed. At follow-up, all the subjects had lost wrist and finger range of motion, there was reduced extensibility of muscles, and spasticity was worse. There was no statistical difference between splint wearing and control groups.

The lack of efficacy of resting splints in this trial is not surprising: splints were worn at night when they are of least benefit, spasticity was not addressed, minimal mobilization of wrist and hand was permitted, and splint treatment was started in the late acute period when soft-tissue changes and hypertonia were already present [15,16]. These patients were densely weak at baseline and at follow-up, and so they likely had spastic dystonic posturing during sitting, which would contribute to a flexed wrist and finger posture throughout the day. They would have been better served by earlier application of splints with scheduled use during the daytime hours when dystonic postures were more evident. Given the efficacy of daytime positioning of the hemiplegic shoulder in the prevention of shoulder stiffness, multiple short sessions of wrist and finger positioning with a splint may be superior to nighttime use [15].

Clearly, more work must be done to fully determine the efficacy and proper application of resting splints in acute stroke. But current evidence does suggest an important role in the comprehensive care of the hemiplegic upper limb. Future research should also consider the dynamic nature of the spastic limb, including changes in spasticity angle, hypertonicity, and dystonic posture associated with changes