Evaluation of Static Progressive Stretch for the Treatment of Wrist Stiffness

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Purpose Decreased wrist flexion and/or extension after trauma or surgery can be a challenging problem. Physical therapy, orthoses, and additional surgical interventions may not restore the desired range of motion or functionality. The purpose of this study was to assess the total arc of motion and the satisfaction scores of patients who had wrist stiffness and who were treated with a bidirectional, patient-directed orthosis that used the principles of static progressive stretch.

Methods Forty-seven patients who experienced posttraumatic or postsurgical wrist stiffness were treated with a patient-directed orthosis. Treatment consisted of a 30- to 60-minute stretching protocol performed 1 to 3 times per day. Compliance with the device, treatment duration, mean total arc of motion, patient satisfaction, and complications were evaluated.

Results The total arc of motion increased by a mean of 35° (range, 5° to 100°) after a mean of 10 weeks of treatment (range, 5 to 26 weeks). The mean flexion and extension increased by 18° (range, 1° to 50°) and 17° (range, 3° to 50°), respectively. Assessment of age, gender, and time before commencement of treatment showed that these factors did not significantly affect the magnitude of improvement or the final arc of motion. The mean patient satisfaction score was 8.2 points on a scale of 0 to 10 points. All patients completed the treatment, and there were no complications reported with use of the device.

Conclusions All of the patients who used this protocol improved their total arc of motion. A splinting device that uses the principles of static progressive stretch is a useful treatment for patients who have posttraumatic or postsurgical wrist stiffness and whose progress has plateaued after a course of conventional physical therapy. *(J Hand Surg 2008;33A:1498–1504. Copyright © 2008 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic IV.

Key words Splint, static progressive stretch, wrist fracture, wrist rehabilitation, wrist stiffness.

THE LOSS OF MOTION due to wrist stiffness can lead to marked impairment of function. It can be caused by soft tissue adhesions and/or contractures, which may be caused by inflammation or immobility of the joint, which often occur as a result of disease, hemiplegia, trauma, or surgery.[1] Physical therapy, manipulation under anesthesia, and surgical release have been used to treat wrist contractures, but these treatments can be costly as well as time-consuming for the patient, and operative treatments may carry additional risks.[1–4]

Splinting devices are occasionally used for the treatment of wrist stiffness, but they have received little attention in the literature. Some splinting devices use dynamic or creep loading, in which a constant force is applied through use of springs or elastic bands to stretch the joint as the tissues gradually lengthen.[5–7] However, creep loading has several potential disadvantages: the device may have to be used for up to 6 to 12 hours per

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day for marked gains to occur,[5–7] the treatment might be painful,[6,7] and it may risk articular surface damage by compressing the joint for prolonged periods of time.[8] For these reasons, compliance with use may be decreased.[6]

Stress relaxation is a stretching technique that involves maintaining a tissue at a fixed length for an extended period of time. The mechanism for this is not well understood, but it is thought that stretching the tissue in this way may break some of the disulfide bonds between irregularly arranged collagen bundles, which may increase the length of the tissue without causing damage.[9–11] Taylor et al.[9] directly compared innervated with denervated rabbit muscle-tendon units and concluded that the muscle lengthening after stretching was the result of viscoelastic properties only, with nervous or reflex input having little or no contribution. Static and turnbuckle splints, two types of splints that are commonly used for wrist injuries, use stress relaxation by maintaining the wrist at the maximum degree of flexion or extension for prolonged periods of time. Unless the splints are regularly adjusted by the physician or therapist, these treatments may result in no overall improvement or may even lead to a decrease in total arc of motion of the wrist.[11]

An adjunct to stress relaxation is the technique of static progressive stretch (SPS), which consists of incrementally maintaining the joint near the end range of motion while increasing the displacement at regular intervals in an attempt to attain long-term remodeling.[9,12,13] Orthoses that apply the principles of SPS have been used to treat stiffness of the elbow,[12,13] knee,[14] and ankle,[15] although this technique has not been examined for the wrist. Previous studies of SPS were limited by small study groups and lack of control groups, but they did find improvements in range of motion and function.

The purpose of the current study was to assess the use of a patient-directed, bidirectional wrist orthosis that utilized the principles of SPS to treat patients who had deficiencies in wrist flexion and/or extension secondary to trauma or surgery. We evaluated the duration of treatment, preoperative and postoperative ranges of motion, compliance, and patient satisfaction.

MATERIALS AND METHODS

Between September 2005 and January 2007, we prospectively evaluated 47 consecutive patients who developed wrist stiffness after trauma or surgery and who experienced a plateau in total arc of motion after a mean of 12 weeks (range, 6 to 28 weeks) of physical therapy based on the assessments of their therapists. The patients subsequently began treatment with an orthosis that incorporated the principles of SPS. All of the patients who were included in the treatment group had wrist stiffness that was refractory to conventional therapy as determined by an independent physical therapist. Patients who had heterotopic ossification or other osseous deformities that were limiting motion were excluded. The duration of treatment, total arc of motion, compliance, satisfaction, and complications were assessed for each patient at the completion of the treatment. This study was approved by the institutional review board, and each patient gave informed consent.

The patients included 20 men and 27 women who had a mean age of 49 years (range, 18–78 years). Six of the patients had undergone wrist surgeries for nontraumatic lesions and had developed subsequent joint contractures. The trauma etiologies included distal radius fractures (24 patients), carpal bone fractures (6 patients), both bone (radius and ulna) fractures (3 patients), wrist sprains (3 patients), radial shaft fractures (3 patients), and a crush injury to the wrist (1 patient). Five of the patients who had distal radius fractures were treated nonoperatively, and the other 32 patients who had fractures received operative treatments for their injuries. All of the patients developed wrist stiffness that impaired their activities, so they began physical therapy for a mean duration of 12 weeks (range, 6–28 weeks). Conventional physical therapy techniques were employed, including stretching, range of motion therapy, ultrasound, cryotherapy, and transcutaneous electrical nerve stimulation. When it was independently determined by each patient's physical therapist that they were no longer gaining motion and would not improve with standard therapeutic modalities, the patients were discharged from physical therapy and referred for treatment with the orthosis.

A wrist device (JAS Wrist device; Joint Active Systems, Effingham, IL) was used for this study (Fig. 1). It consisted of a padded forearm cuff and a padded hand plate, both of which were attached to a metal base. To apply the orthosis, the cuff was placed over the patient's forearm, then the hand plate was placed over the hand, and the straps were secured. An adjustable knob altered the angle of the device.

All of the patients received the same information regarding use of the device. They were instructed to place the orthosis on the affected extremity, adjust the angle until they felt a gentle, pain-free stretch, and hold that position for 5 minutes. After this, they reassessed the intensity of the stretch, and if it had subsided, they readjusted the angle until they perceived a gentle, painless stretch again. They continued this reassessment and