A Dynamic Splint for Use After Total Wrist Arthroplasty

(active-assistive therapy, post-operative splinting, rheumatoid arthritis)

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Total wrist arthroplasty has been performed at the Mayo Clinic for the past 5 years. The procedure has necessitated the development of a dynamic wrist splint for post-operative care. This article provides a step-by-step outline for construction of this splint.

Total wrist arthroplasties were first done at the Mayo Clinic in 1974 (1). Since that time, operative and post-operative experience has resulted in technical improvements that have implications for the occupational therapist. A dynamic wrist splint used in a post-operative therapy program has been instrumental in the success of total wrist arthroplasty. In this article, the function of the wrist, the wrist joint affected with rheumatoid arthritis, and total wrist arthroplasty are briefly described. The construction of a hinged wrist splint and its use in post-operative therapy are also described.

Normal Wrist Function
Occupational therapists know that wrist mobility is important for the
Figure 1

Figure 2
Splint is constructed from thermoplastic material and (at lower left) hinges made of plastic and loosely held together with rivets. Edges of hinges are notched to prevent slippage. Strips of thermoplastic material marked A are used to build up sides of splint under hinges. Strips marked B are used to secure hinges.

Positioning and power grasp of the hand. This is easily demonstrated in the natural tenodesis effect of the hand, in which wrist extension assists finger flexion and wrist flexion assists finger extension. Power grip is also significantly increased when the wrist is held in an extended position.

Normally, the second and third metacarpals are fixed at the base and remain stable and immobile, whereas the first, fourth, and fifth metacarpals are mobile so that different-sized objects can be grasped on descent of the fourth and fifth metacarpals and opposition of the thumb.

In addition to dorsiflexion and palmar flexion, the normal wrist has radioulnar motion. Also, cir-
cumduction motion of the wrist (important in fine positioning of the wrist and hand for using tools) is possible with forearm pronation and supination.

**Wrist Function in Rheumatoid Arthritis**

In the wrist with rheumatoid arthritis, dorsal subluxation or dislocation of the distal portion of the ulna and ulnar and volar subluxation of the carpus are commonly present. Rheumatoid arthritis can be associated with spontaneous arthrodesis and complete loss of wrist mobility or wrist malposition and instability. Patients often have wrist pain and instability and difficulty in performing daily living skills such as feeding and personal hygiene. In addition, patients generally have disease in other parts of the extremity, particularly the metacarpophalangeal joint of the fingers, where ulnar drift and palmar subluxation may be secondary to the deformed wrist (2).

**Treatment Alternatives**

Arthrodesis has been one of the more common treatments for the rheumatoid wrist. Although arthrodesis relieves pain and provides stability to the wrist joint, the shoulder and elbow must exert compensating effort to position the hand. This increased energy demand on adjacent joints can be difficult for the arthritic patient with multiple upper extremity joint involvement (3).

As an alternative to arthrodesis, several types of prostheses have been developed in recent years to provide for wrist mobility and to relieve pain. One is the Meuli prosthesis, which is a ball and socket joint developed in 1973 by Professor Hans Christoph Meuli (4) (Figure 1). The primary indication for this prosthesis is painful bilateral wrist disease.
Surgical Procedure
The wrist is exposed through a dorsal incision. The distal ends of the radius and ulna are resected. The proximal portion of the carpus and half of the distal portion are removed to allow room for the prosthesis. The Meuli prosthesis is cemented in the second and third metacarpals (a single-stem component is used in the third metacarpal) and the distal part of the radius. It may be necessary to release the flexor carpi ulnaris or transfer the extensor carpi ulnaris tendon to provide for proper wrist balance (5).

Postoperative Splinting Principles
A bulky dressing is worn for 3 to 7 days after the operation. Then the patient is fitted with a night resting splint that holds the wrist in an extension of 20° to 30°. In addition, the dynamic hinged wrist splint, which may include an extension assist, is made.

The dynamic wrist splint maintains the proper wrist position and guards against the tendency for the wrist to return to the preoperative position of ulnar deviation. The splint keeps the wrist in proper alignment while allowing for early protected motion as the capsule forms around the prosthesis and the radial wrist extensors (which are stretched) regain strength and tone.

Constructing the Dynamic Splint
The splint is constructed from thermoplastic material and uses plastic hinges, made of Nyloplex and copper rivets. These hinges are not available commercially. The steps for construction of the splint are:

1. Start with a piece of low-temperature thermoplastic material, about 25 cm (10 inches) by 15 cm (6 inches) depending on the size.
of the patient, and cut a hole for the thumb. Use eight small strips of the splinting material and two plastic hinges (Figure 2).

2. Place the thumb through the hole, snug the material around the wrist, and wrap with an Ace bandage. Mold the splint with the wrist in the extension desired for the patient.

3. Have the patient extend the wrist carefully while it is in the splint to determine the axis of motion. Mark the axis with dots on the splint on both the radial and the ulnar sides, slightly inferior to the midpoint of the anteroposterior diameter (Figure 5).

4. Remove the splint and with small strips of thermoplastic material (marked A in Figure 2), build up areas distal and proximal to the axis marks on both the radial and the ulnar sides, as shown in Figure 4.

5. Place the axis of the hinge over the axis mark on the splint and secure the hinge in place with pieces of thermoplastic material (marked B in Figure 2). (Hinges may need to be heated with a heat gun and bent to fit the curves on the splint.) (Figure 5)

6. Cut the splint along the line of axis of motion (Figure 6). The total area cut out determines the amount of flexion-extension the patient will have. If the patient is to have full motion in flexion, the splint must be cut wide enough to allow complete motion. If the patient is to be limited in flexion, the volar aspect of the splint should be flared to stop flexion at the desired point (Figure 7). If extension is to be limited, the radial and ulnar dorsal edge should be left longer to limit extension.

7. Strap the splint. D-ring straps at the wrist hold the wrist more securely. A strap on the hand portion can be secured by a small piece of thermoplastic material pushed...
through a hole in the strap (rivets are difficult to put through several layers of the material).

8. If the patient has weak wrist extensors, use rubber band assists, as shown in Figure 8A. Moleskin can be added to the edges for comfort and appearance. A thick felt pad under the straps will help to alleviate swelling between the straps (Figure 8A and B).

Using the Splint

After the dynamic and resting splints have been made, begin active assistive range of motion in the dynamic wrist splint. The bilateral hinges allow for early mobility only in a flexion-extension plane, and they prevent ulnar and radial deviation. Start active-assistive normal range to the shoulder, elbow, and fingers at this time. Avoid substitution patterns, and place emphasis on wrist extension. Give the patient activities requiring simultaneous wrist and finger motions and emphasizing the pattern of the automatic hand (finger extension with wrist flexion and vice versa) (Figure 9). The patient wears the dynamic splint during all exercises and while doing light self-care activities.

Ten to 12 days after the operation, active-assistive motion is started without the splint. Care is taken to keep the wrist tracking only in a straight flexion-extension plane; ulnar deviation is avoided. The therapist continues with neuromuscular retraining of the wrist extensors, watching carefully to eliminate substitution patterns. Range of motion of the shoulder, elbow, and fingers is continued. The patient still wears the dynamic splint while doing functional hand and self-care activities when not under the supervision of the therapist.

After about 2 weeks of supervised in-hospital therapy with the splints, a home treatment program is written for the patient. Permanent restrictions are placed against lifting heavy objects (e.g., a suitcase) and impact activities (e.g., sports and pounding) (1). The patient is instructed to wear the dynamic wrist splint continuously for 3 months, removing it only for specified exercises and bathing. At night, the resting splint is worn. During follow-up visits at 6 weeks and 3, 6, and 12 months, splints are modified and exercise programs are revised as necessary.

Summary

This article briefly describes wrist anatomy, anatomic considerations in the wrist affected by rheumatoid arthritis, and total wrist arthroplasty. A dynamic post-operative wrist splint that appears to be instrumental in the ultimate success of the surgical procedure was described in detail. Construction techniques and basic design were outlined, and use of the splint was explained. The splint has been used for 3 years at the Mayo Clinic.

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References