



JHT READ FOR CREDIT ARTICLE #416.

Special Issue: Wrist

Dart-throwing motion with a twist orthoses: Design, fabrication, and clinical tips

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ARTICLE INFO

Article history:

Received 28 October 2015

Received in revised form 1 December 2015

Accepted 21 December 2015

Available online 26 February 2016

Knowledge gained from the scientific literature over the past decade has allowed for a better understanding of individual carpal bone motions in 3-dimensional (3D) space,¹⁻⁷ load dynamics through the wrist,⁸⁻¹⁰ relative motion within the different joint spaces in the wrist,¹¹⁻¹⁶ and neuromuscular control of the wrist.¹⁷⁻¹⁹ The literature has also shown that during many functional activities the hand and wrist are moving in a 3D functional dart-throwing motion (DTM) arc.^{6,20,21} Together, this evidence is informing a notable shift in wrist rehabilitation practices, shifting away from focusing on the measurement and prescription of motion and strengthening exercises within anatomic motion planes to focusing more on supporting a person's recovery of functional wrist mobility, strength, proprioception, and dynamic stability after injury.¹⁹

One aspect of this shift in practice is the emergence of DTM orthoses designs recommended primarily in the management of scapholunate injuries.²²⁻²⁴ We present a new design for a DTM orthosis, which we refer to as DTM with a twist (DTMtw), where the twist represents the addition of a third rotational (ie, supination and pronation) axis of motion into the design. The design is founded in the recognition that when a hand is positioned or moving within a functional arc of DTM during functional activities, the posture and motion of the hand relative to the forearm is 3D^{6,17-21}; moving in a linked flexion, ulnar deviation, and pronation 3D arc of motion (ie, throwing the dart motion) or moving in a linked extension, radial deviation, and supination 3D arc of motion (ie, cocking the dart motion). Previous DTM orthoses designs constrain motion into a 2-dimensional (2D) diagonal–planar DTM, whereas

coupling only flexion and ulnar deviation or extension and radial deviation motions of the hand relative to the forearm.²⁵

The purpose of this article is 2-fold. First, we offer details on the design, fabrication, and clinical uses for DTMtw orthosis as an option for hand therapists to consider in the management of radial-sided soft tissue or bony injuries in the wrist. Second, we present our observations from an exploration of the DTM with a twist motion in a single, thawed, nonpreserved cadaveric wrist dissection with a complete S–L ligament transection; a simulated dynamic S–L ligament injury.^{26,27}

Static orthotic design, fabrication, and clinical tips

The static DTMtw orthotic pattern (Fig. 1A) we use is a modification of a pattern commonly used to make a forearm-based thumb spica orthosis. However, any pattern for a forearm-based thumb spica can be used as long as the orthosis includes the first metacarpal phalangeal joint and enough material to wrap dorsally over the ulnar border of the hand. Any thermoplastic material can be used to fabricate the orthosis depending on therapist experience, preference, and patient need for more or less support depending on the acuity of the injury.

Fabrication tips

A unique approach in the fabrication of the static orthosis includes positioning the forearm in 30–45° of pronation. During fabrication, the material over the forearm should be molded with a twist running on the radial side from distal–volar on the hand to proximal–dorsal on the forearm. Similarly, on the ulnar side, the material should be molded running from distal–dorsal on the hand to proximal–volar on the forearm. The final static DTMtw orthosis

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Fig. 1. (A) The top row of images show our preferred base orthosis pattern for the DTMTw orthosis. (B) The bottom row illustrates the positioning of the forearm in 30–45° of pronation with the hand in a dart-throwing posture during fabrication of the static DTMTw orthosis. DTMTw = dart-throwing motion with a twist.

can be trimmed, finished, and held in place with standard strap placement (Fig. 1B).

Clinical tips

Initial positioning of the hand at rest

A general principle we follow with an acute joint injury is resting the injured joint tissues opposite to the mechanism of injury through the joint.²⁸ For example, for wrist injuries resulting from a hyperextension/radial deviation/supination mechanism of injury, we recommend that the hand be positioned in the static DTMTw orthosis in a slight dart-throwing posture at rest (eg, slight flexion/ulnar deviation/pronation) in the early phases of healing to provide comfort and reduced tension in the injured wrist volar and radial capsular ligamentous structures.^{29–31} As healing progresses, the orthosis can then be remolded into more

of a dart-cocked posture (eg, extension/radial deviation/supination) for use during heavier occupational or sporting functional activities. Alternately, the static DTMTw orthosis can be converted to a dynamic orthosis.

Dynamic orthosis design, fabrication, and clinical tips

To progress from a static to dynamic orthosis, the static orthosis can be cut into 2 pieces (Fig. 2). If a static orthotic is not required for rest and support of an acute injury, the dynamic orthotic can be fabricated by starting with separate hand and forearm components. However, when first learning to make the dynamic orthosis, it is easier to start with the fabrication of the 1-piece static orthosis and use it for initial placement of the pipe-cleaner guides before cutting into 2 components.

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