ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2015;96:1913-23

REVIEW ARTICLE (META-ANALYSIS)

Custom-Made Finger Orthoses Have Fewer Skin Complications Than Prefabricated Finger Orthoses in the Management of Mallet Injury: A Systematic Review and Meta-Analysis

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Abstract

Objective: To investigate which orthosis results in (1) fewer complications; (2) the least extensor lag; and (3) the highest rates of treatment success according to the Abouna and Brown criteria for soft tissue mallet injury in adults.

Data Sources: Electronic databases AMED, CINAHL, Embase, MEDLINE, PubMed, OTseeker, and PEDro were searched from the earliest available date until September 16, 2014.

Study Selection: Controlled trials evaluating orthosis type in the conservative management of mallet injury were included. Database searching yielded 1024 potential studies, of which 7 met inclusion criteria with a total of 491 participants.

Data Extraction: Data were extracted using an author-designed extraction form by one reviewer, and accuracy was assessed by a second reviewer. The PEDro scale was used to assess methodological quality.

Data Synthesis: Results were pooled using a random-effects model with inverse variance methods. Dichotomous outcomes are expressed as risk ratios (RRs) and 95% confidence intervals (CIs) and continuous outcomes as standardized mean differences and 95% CIs. There is moderate quality evidence that prefabricated orthoses had 3 times the risk of developing skin complications as compared with all other orthoses (RR, 3.17; 95% CI, 1.19−8.43; $I^2=47\%$) and nearly 7 times the risk of developing skin complications as compared with custom-made thermoplastic orthoses (RR, 6.72; 95% CI, 1.59−28.46; $I^2=0\%$). Treatment outcomes were found to be similar for treatment success when prefabricated orthoses were compared with custom-made orthoses (RR, .99; 95% CI, 0.80−1.22; $I^2=39\%$; very low quality evidence), as well as for extensor lag when custom-made thermoplastic orthoses were compared with other orthoses (standardized mean difference, .03; 95% CI, −.29 to .36; $I^2=0\%$; moderate quality evidence).

Conclusions: Prefabricated orthoses were found to increase the risk of developing skin complications as compared with custom-made orthoses, but there were no differences in treatment success, failure, or extensor lag.

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Mallet injury is a common injury affecting extension of the distal interphalangeal (DIP) joint of the fingers.[1] Mallet injury occurs when either continuity of the tendon is lost or there is a bony avulsion of this tendon.[2-4] Mallet injury can occur after a forced flexion injury, crush trauma, or laceration or as a result of a seemingly innocuous incident such as making a bed or pulling up a pair of socks.[5,6] Mallet injuries have been reported to have a higher incidence in men than in women and usually occur in men at least 10 years earlier than in women.[2,7] An increased incidence of injury has been reported in ulnar digits than in radial digits.[2,7]

The terminal tendon is made of fibers from the lateral bands (extensor digitorum communis, interossei, lumbricals).[2,8] This terminal tendon is responsible for the extension of 45° to neutral, and the retinacular ligaments are responsible for extension from 90° to 45° of flexion. When a mallet injury occurs, the ligaments are not under tension and therefore not affected and only the terminal tendon is disrupted, resulting in a loss of DIP joint extension of 0° to 45°.[8] With discontinuity of the terminal tendon, there is proximal and dorsal migration of the extensor apparatus

Disclosures: none.

0003-9993/15/$36 - see front matter © 2015 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2015.04.026

and subsequent increase in force of the central slip, and in the presence of volar plate laxity, it may result in the development of a swan neck deformity.[2,4,9] It has been suggested that the greater the degree of extensor lag on presentation, the lower the chance of effectively managing the lag.[10] If left unmanaged, the terminal tendon length may be affected (ongoing lag) and the finger can be caught during functional use, be painful, have poor aesthetics, and result in further deformity.[11-13] Mallet injury has also been reported to affect a person's ability to participate in productive and leisure activities for up to 6 weeks after injury in at least a quarter of those affected.[11,14]

A variety of literature exists about the management of mallet injury both surgically and conservatively. Surgical management may include tenodermodesis or use of Kirschner wires, tension band wiring, or screws, whereas conservative management involves application of an external orthosis.[1,9,15] Surgical management is most commonly reserved for open tendon laceration, large avulsion fracture, dislocation, lag reoccurrence, and chronic presentation of injury.[16-18] Conservative management of closed tendon mallet injuries and small avulsion fractures is recommended because of an increased incidence of more severe or long-term complications with surgery (eg, pain, reduced range of motion, and infection).[5,11,19,20] Conservative management has been associated with short-term complications of reduced severity, such as maceration, pain, ulceration, and nail deformity.[19,20]

Conservative management of soft tissue mallet injury aims to approximate the tendon ends to promote healing without pseudotendon formation or gap formation, which will result in ongoing extensor lag.[9,21] Orthosis types most commonly reported in the literature include the following: a prefabricated polythene orthosis called a Stack orthosis, which is available in 8 sizes and positions the finger into extension; a padded aluminum orthosis, which is cut to size and adjusted into the required position; and a thermoplastic orthosis, which is custom fabricated to fit finger size as well as the required position. Consensus in the literature[22-24] on the DIP joint position in the orthosis is neutral to slight hyperextension without the presence of blanching. The vasculature to the dorsal skin is vulnerable when the degree of extension is excessive, leading to skin complications and compromised tendon healing.[8,25] Although not commonly used in current practice, the proximal interphalangeal (PIP) joint has historically been included in the orthosis, with some authors advocating that the PIP joint should be included up to 60° of flexion to reduce tension on the lateral bands and the terminal tendon to facilitate healing.[1,19,21]

A Cochrane review[26] of interventions for treating mallet finger injuries was inconclusive about which orthosis type is most effective for the conservative management of tendon mallet injuries. Since the publication of the Cochrane review, 3 additional randomized controlled trials (RCTs)[27-29] have been published. One literature review[11] found that uncomplicated mallet injuries can be successfully managed conservatively rather than surgically; however, it did not identify the most effective orthosis type, whereas another review[30] considered the ideal time frame for full-time and protective orthosis wear and adherence to orthosis wear, again without consensus on these factors.

The purpose of this review was to evaluate orthoses used in the management of zone 1 tendon mallet injury to determine which orthosis results in (1) fewer skin complications; (2) the least extensor lag; and (3) the highest rates of treatment success according to the Abouna and Brown criteria for soft tissue mallet injury in adults (box 1).

List of abbreviations:

CI	**confidence interval**
DIP	**distal interphalangeal**
PIP	**proximal interphalangeal**
RCT	**randomized controlled trial**
RR	**risk ratio**
SMD	**standardized mean difference**
VAS	**visual analog scale**

Methods

This systematic review was registered with the PROSPERO database (registration no.: CRD42014014154).

Study identification

The following electronic databases were searched from the earliest available date until September 16, 2014: AMED, CINAHL, Embase, MEDLINE, PubMed, OTseeker, and PEDro. The search included population and intervention keywords (*mallet injury* and *splint*, respectively) as well as synonyms of these terms (supplemental appendix S1, available online only at http://www.archives-pmr.org/). A manual review of the included studies and previous systematic review references was completed to ensure all appropriate studies were identified. The search was restricted to studies published in English because translation resources were not available to the authors.

Study selection

Titles and abstracts were screened, and 2 reviewers (E.J.W., C.L.P.) independently applied the inclusion and exclusion criteria to identify potentially included studies. Any differences in the identified studies were discussed between the reviewers until consensus was reached. Full-text articles were obtained and again reviewed independently (E.J.W., C.L.P.) to ensure they met the inclusion and exclusion criteria.

Inclusion and exclusion criteria

Studies needed to be controlled trials, with most of the included participants being adults with rupture of zone 1 extensor tendon. Trials were required to compare different orthoses used in the conservative management of the injury. Exclusion criteria were surgical intervention, laceration, coexisting medical condition, or hand injury and most of the participants with fracture mallet or chronic injury (presentation >3mo).[24]

Quality assessment

The PEDro scale (Physiotherapy Evidence Database available at: www.pedro.org.au) was used to assess methodological quality of the included studies because it is a reliable and valid quality assessment tool for clinical trials.[31] The PEDro scale is a 10-point scale assessing random allocation, concealed allocation, group similarity at baseline, participant/therapist/assessor blinding, dropout number, intention to treat, between-group difference, and point estimate and variability. Two reviewers (E.J.W., C.L.P.) independently assessed the studies according to the PEDro scale