

The relative motion flexion splinting in the treatment of boutonnière deformity of the finger: presentation of the method and a review of the literature

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ABSTRACT

The rupture of the central slip of the extensor tendon of the finger causes a deformity, characterized by flexion at the proximal interphalangeal (PIP) joint and hyperextension at the distal interphalangeal joint (the boutonnière deformity). Various treatments are used in this condition, including conservative and operative methods, however, there is no standard treatment guideline. The idea the relative motion flexion splint method is based on an importance of keeping the metacarpo-phalangeal joint of the involved finger relatively flexed compared with these

joints of the adjacent fingers. This is done with a relative motion flexion splint. Flexion in the metacarpo-phalangeal joint allows the lateral slips of the extrinsic extensor tendon to pull the lateral bands dorsal to the axis of the PIP joint. It allows also the relaxation of the intrinsic muscles and the lateral bands so they can migrate dorsal to the axis of the joint. This article presents the method and provides literature review about outcomes of treatment of the condition.

Keywords: boutonnière deformity; extensor tendon injury; central slip tear; relative motion flexion splint.

INTRODUCTION

The rupture of the central slip of the extensor tendon of a finger causes a deformity, characterized by flexion at the proximal interphalangeal (PIP) joint and hyperextension at the distal interphalangeal (DIP) joint (boutonnière deformity) – Figure 1. When the central slip is injured, there is a loss of PIP joint extension, but the distal joint is not disturbed. Later, due to tearing of the transverse ligament and the expansion between the central and lateral slips, the lateral bands become displaced towards the front of the axis of the PIP joint and begin to hyperextend the DIP joint [1].



FIGURE 1. Boutonnière deformity of the index finger

Injury to the central slip itself or disruption of its attachment is not a sufficient cause of boutonnière deformity. As long as the lateral bands of the extensor remain in place, i.e. on the lateral sides of the finger, the consequence of the damage to the central

slip will only be a loss of extension in the PIP joint. The transverse retinacular ligaments hold the lateral bands of the extensor apparatus in a medial position on the lateral side of the joint during flexion and extension movements. Boutonnière deformity is caused by the rupture or stretching of fine transverse ligaments on both sides of the finger, which destabilizes the medial position of the lateral bands, allowing them to move in the palmar direction. The palmar-displaced and contracted lateral bands bend the finger in the PIP joint and induce hyperextension in the DIP joint, resulting in a characteristic deformity. Boutonnière deformity develops gradually, 2–3 weeks after the initial injury to the central slip. That is why the boutonnière finger is usually neglected, unlike, e.g., a fresh damage to the central slip, the symptom of which is only a deficit of extension in the PIP joint [1].

Boutonnière deformity is mostly seen after trauma (blunt or sharp), but atraumatic attenuation, in the course of rheumatoid arthritis, osteoarthritis, prolonged flexion contracture in Dupuytren's disease, flexor pulley disruptions and burns, is also a cause. Depending on the time that has passed since the damage and other factors, there are 2 types of boutonnière fingers: mobile and with fixed contracture. In the former form, the patient is able to perform a full flexion of the finger, and the extension attempt induces a characteristic position of the phalanges. In the latter form, the finger remains stiff, in a fixed "boutonnière" position. Conservative treatment of the condition is only possible with mobile type of the deformity. In fixed contracture of the PIP joint, first active flexion should be restored (by manual therapy) and next adequate treatment can be implemented. The Burton classification of the deformity is used, dividing severity of the condition in 4 stages (Tab. 1) [2].

TABLE 1. The Burton classification of boutonnière deformity

Stage	Description
Stage 1	subtle, passively correctable deformity
Stage 2	fixed contracture, contracted lateral bands, no joint involvement
Stage 3	palmar plate and collateral ligaments contracted, intraarticular fibrosis
Stage 4	palmar plate and collateral ligaments contracted, intraarticular fibrosis, PIP joint arthritis

CONSERVATIVE TREATMENT OPTIONS

Various treatment methods are currently utilized, including conservative treatment, anatomical reconstruction, tendon grafting, tendon transfers, central tendon shortening and lateral band reconstruction [3, 4]. However, there is no standard treatment guideline, and evidence regarding the various treatment outcomes is insufficient.

- The standard conservative care for such an injury has been prolonged immobilization of the PIP joint in extension, while allowing active DIP flexion.
- Another option has been use of Capener (Fig. 2, 3) or Bunnel (Fig. 4) splints which stabilizes finger in extension in the PIP joint and allows flexion in the DIP joint, what is desirable in this injury.
- Currently, however, there is increasing support for changing the way of treating this condition. If the boutonnière injury has a flexion contracture of the PIP joint, first passive PIP joint extension is regained, and then a relative motion flexion splint is used to place the injured digit in 15–20° more metacarpophalangeal (MCP) joint flexion than the adjacent digits. This position not only provides protection to the healing dorsal PIP joint structures, but it also facilitates active redirection to assist in regaining and maintaining full PIP joint extension (Fig. 5).

CONCEPT OF RELATIVE MOTION FLEXION SPLINT

The idea of this method is based on an importance of keeping the MCP joint relatively flexed compared with the adjacent MCP joint. This is done with a relative motion flexion splint (Fig. 5), that is worn at all times during boutonnière treatment. Flexion in this joint is good for boutonnière healing, because it allows the lateral slips of the extrinsic extensor tendon to pull the lateral bands dorsal to the axis of the PIP joint. It allows also the relaxation of the intrinsic muscles and the lateral bands, so they can migrate dorsal to the axis of the PIP joint. In contrast, MCP joint extension, and especially hyperextension, is harmful in this condition, because they allow laxity of the lateral slips of the long extensor tendon, which subsequently allows the lateral bands to slip palmar to the axis of the PIP joint. Moreover, it causes tightening of the intrinsic muscles and the lateral bands, which pulls them palmar to the axis of the PIP joint. The relative motion

flexion splint keeps the lateral bands dorsal to the axis of the PIP joint to permit the PIP extensor hood to heal. This results in correction of the boutonnière deformity and restoration of normal range of motion of the finger [5, 6, 7, 8].



FIGURE 2. Treatment of the boutonnière deformity of the little finger with Capener splint: a) baseline (relaxing) position of the finger; b) flexion of the proximal interphalangeal joint



FIGURE 3. Significant correction of the deformity after 4 weeks treatment with Capener splint



FIGURE 4. The Bunnel splint for boutonnière deformity



FIGURE 5. The relative motion flexion splint boutonnière deformity

The anatomic rationale for relative motion recognizes that altering relative positioning between adjacent MCP joints produces a protective favourable impact on interphalangeal forces during hand function using 15–20° greater MCP joint flexion. This provides dorsal and volar protective benefits, because the extensor digitorum communis tendon (EDC), a single muscle 4-tendon system, attaches to the intrinsic lateral band tendons. With greater MCP flexion, dorsal EDC force is increased, pulling lateral bands medially, while on the volar surface the downward pull of the lumbrical on lateral bands is relaxed due to origin from the flexor digitorum profundus tendon of the injured digit, also a single muscle 4-tendon system. The relative motion flexion splint permits protected active motion during functional activity with acute boutonnière deformity. In patients with chronic injury and adequate passive extension, the splint for 3 months also produces encouraging results [8, 9, 10].

Description of the treatment method

To apply this method in practice, a relative motion flexion splint is used (Fig. 5). Prior to start with the treatment, a “pencil test” is performed. This test consists in maintaining the involved finger in flexion in the MCP joint, relative to 2 adjacent fingers, what is maintained by a pencil (Fig. 6). When the patient with an acute boutonnière injury is able to keep the PIP joint in extension – result of the test is positive. If it does, the next step is temporary immobilization of the PIP joint in extension for a week and fitting of an adequate relative motion flexion splint. The custom-made splint is made of a thermoplastic material and is fitted to the individual size of patient’s fingers. Next, a pain-guided movement with RMFS is started and continued for 8 weeks or more [8, 10].



FIGURE 6. Idea of a “pencil test”

RESULTS OF CONSERVATIVE TREATMENT OF ACUTE BOUTONNIÈRE DEFORMITY

There are only single articles presenting results of conservative treatment of this injury. Arslan et al. reported outcomes of the treatment of 28 patients aged 13–62 years with chronic boutonnière deformity in stage 1, according to the Burton classification. All these patients showed positive pencil test. A relative motion flexion splint was used for a mean of 12 weeks (range 6–40 weeks). The mean initial extension lag of the PIP joint was 22° (range 5–55°) and improved to 12° (0–30°). The authors conclude that the use of relative motion flexion splints is effective in increasing PIP extension in patients with Burton stage 1 chronic boutonnière deformity [11].

Merrit and Jarrell reported results of the treatment of 23 patients, at a mean age of 42 years, with chronic boutonnière deformity lasting mean of 8 months (range 2 months – 3 years) [10]. There were 8 acute injuries and 15 chronic cases. All patients used a relative motion flexion splints for 3 months. At a final follow-up, improvement of PIP extension was noted in all patients with an extension deficit a mean 4° (range 0–20°). All achieved flexion of the affected fingers to their palm, and there were no recurrent progressive boutonnière deformities [12].

Hirth et al. reported results of treatment of 2 patients with the mentioned method. Both patients were splinted for 2 months and both achieved full extension in PIP joints at the final follow-up. The patients returned to unrestricted work [13].

Unfortunately, the literature is lacking with results of the conservative treatment of boutonnière deformity with other methods, which seems strange, because one might think that such treatment is relatively popular. However, boutonnière deformity is a rare condition, and there may not be much data on functional treatment with other methods. In contrast, publications on the outcomes of surgical treatment are relatively well represented in the literature, but it is not the subject of this study [3, 4]. Depending on the pattern of the injury and the resulting defects, a number of reconstructive techniques have been established. The functional results can be limited by tendon adhesions, imbalance within the reconstructed extensor apparatus and stiff joints that can all restrict the range of motion. Therefore, active rehabilitation protocols are mandatory for optimal results also after surgical reconstructions of this deformity.

In conclusion, review of the literature on conservative treatment of this rare condition using the relative motion flexion splints shows that this method is useful and effective in acute and chronic cases. The author believe that presentation of this method (which is not known among Polish hand surgeons) will result in its greater popularity, with the benefit of patients and satisfaction for doctors.

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