Journal of Hand Therapy 28 (2015) 319–324

Contents lists available at ScienceDirect

Journal of Hand Therapy

journal homepage: www.jhandtherapy.org

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Practice Forum

Zone III flexor tendon injuries – A proposed modification to rehabilitation

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In this manuscript, these authors have utilized years of clinical experience to suggest rehabilitation modifications for Zone III flexor tendon injuries. – Victoria Prigane, PhD, OTR, CHT, CLT, Practice Forum Editor.

Introduction

The classification of flexor tendon injuries, as defined by the International Federation of Societies for Surgery of the Hand Committee on Tendon Injuries, divides the flexor tendons into 5 zones based on tendon anatomy.[1] Of these 5 zones, zone III injuries have received little attention.

When therapeutically managing zone III injuries, most therapists implement rehabilitation approaches created for zone II repairs by either using passive, early active, or a combination of these mobilization methods.[2] However, we have seen complications that may arise with zone III injuries depending upon the location of the injury. Distal zone III injuries may produce limitations in PIP and DIP joint extension, whereas proximal zone III injuries may produce limited independent motion of the digits. These complications can significantly affect overall hand function and we suggest modifying zone III flexor tendon rehabilitation based on the specific location of injury within this zone.

In order to substantiate our clinical observations and to provide an understanding of the pathomechanics involved with such complications we simulated tendon adhesions in different locations within zone III on a cadaveric model. Our cadaveric experiment provides a biomechanical understanding of the consequences of reduced tendon gliding within this zone. Based on these observations we propose certain modifications be made to the traditional management of zone III injuries.

Zone III anatomy

Zone III lies between the distal border of the transverse carpal ligament (TCL) and the proximal edge of the fibrosseus sheath. Contents of this zone include the tendons of FDS and FDP, the lumbricals and neurovascular structures (Fig. 1). The four tendons of FDS and FDP travel deep to the TCL. Proximally, the tendons of the long and ring fingers are superficial to those of the index and small. Distally, all four tendons diverge and pass with their respective FDP tendon to the fibrous digital sheath. The origin and bellies of the four lumbrical muscles lie in zone III. All muscle bellies of the lumbricals arise from the FDP tendons close to the distal border of the TCL. The neurovascular structures in zone III include the superficial palmar arch and palmar metacarpal arteries and the common palmar digital branches of the median and ulnar nerves.

Traditional post-operative rehabilitation following zone III flexor tendon repair

The traditional dichotomy of rehabilitation protocols consists of the passive-motion protocol versus an active-motion regime.[3–5] These rehabilitation approaches were specifically designed for zone II, however, are typically applied in the same manor following zone III repair. A dorsal blocking orthosis which places the wrist in 30–45° of flexion and the MCP joint in 40–70° of flexion is applied

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0894-1130/$ – see front matter
http://dx.doi.org/10.1016/j.jht.2014.11.008

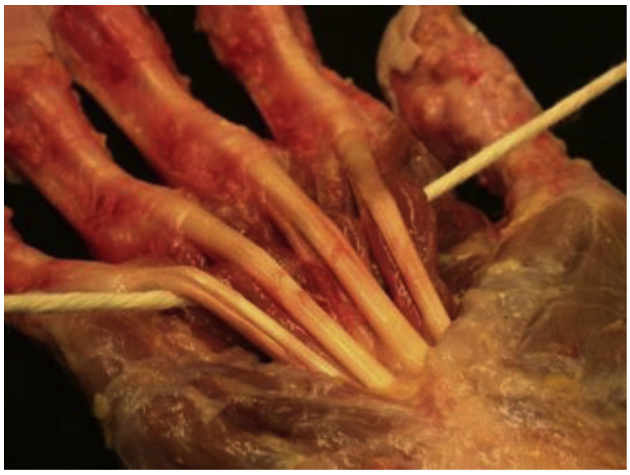

Fig. 1. A cadaveric specimen with the volar skin and fascia reflected exposing the flexor tendons and lumbrical muscles arising from FDP within Zone III.

for a period of 4–6 weeks.[6,7] The purpose of the orthosis is to provide protection to the recently repaired tendon(s) by placing them in a position of slack. It has been postulated that these tendon mobilization approaches produce sufficient tendon excursion in order to prevent dense adhesion formation to the surrounding structures permitting adequate tendon glide for full digital flexion and/or extension.

Complications observed clinically utilizing traditional rehabilitation protocols

Distal zone III injuries, just proximal to the A-1 pulley, can often produce dense adhesions between the flexor tendon and the lumbrical muscle belly. We speculate that because the MCP joints are positioned in flexion in the dorsal blocking orthosis, either passive or active motion of the digits inadequately produces distal excursion of the flexor tendons with the traditional tendon mobilization protocols. Subsequently, adhesion formation between the flexor tendons and lumbrical muscle may prevent gliding of the tendons distally past the A1 pulley causing limited digital extension. This can result in an inability to attain full composite digital extension leading to a flexion deficit at the PIP and DIP joints (Fig. 2). This inability to fully extend the interphalangeal joints can lead to a kinematic chain imbalance and the development of a secondary interphalangeal joint flexion contracture.

We have observed that proximal zone III flexor tendon repairs managed by traditional protocols produce limitations in composite digital extension, combined wrist and digital flexion, as well as limited independent digital flexion and/or extension. However, we have also observed that such complications are based on the specific region of zone III injury. We have noticed that proximal zone III injuries just distal to the TCL ligament can produce dense adhesions between adjacent flexor tendons, limiting combined active composite wrist and digital flexion, as well as independent FDS and FDP excursion. Furthermore, the flexors tendons of one digit can become tethered to the flexor tendon of the adjacent digit, resulting in limited independent motion of the affected and adjacent digits.

Traditional post-operative management of flexor tendon repairs does not suggest any alteration to orthotic positioning of the wrist or MCP joints, as well as the tendon mobilization techniques used in relation to the stages of tendon healing. We suspect that this may be the primary cause of adhesion formation producing such complications.

Simulated cadaveric experimentation

In order to substantiate our clinical observations, cadaveric experimentation was performed. The purpose of this experiment was to analyze the effect of tendon adhesions in proximal and distal zone III flexor tendon injuries. The first phase of this experiment consisted of simulating adhesions by suturing the FDS and FDP tendons to the lumbrical muscle in a long finger proximal to the A-1 pulley. Passive long finger extension demonstrated restricted digital extension at the PIP and DIP joints since the flexor tendons could not glide beneath the A1 pulley (Fig. 1B and C). Full passive long finger flexion was attainable.

The second phase of this experiment consisted of simulating adhesions by suturing the flexor tendons of both the long and ring fingers together in the proximal region of zone III (Fig. 3A). As the long finger flexor tendons were pulled proximally (simulating flexion), the ring finger was simultaneously pulled into flexion (Fig. 3B). Secondly, as we continued the pull to the long finger flexor tendons we attempted passive extension of the ring finger. This produced significant restriction in extension of the ring finger, (Fig. 3C) suggesting that if the tendons are tethered together by adhesion formation, independent extension or flexion of the digits is almost impossible.

Modifications to zone III flexor tendon rehabilitation

This cadaveric experiment was able to reproduce what we have observed clinically in certain cases. The literature is inadequate in describing specific rehabilitation methods and considerations when managing such injuries. If the traditional tendon mobilization protocols are followed for all injury patterns

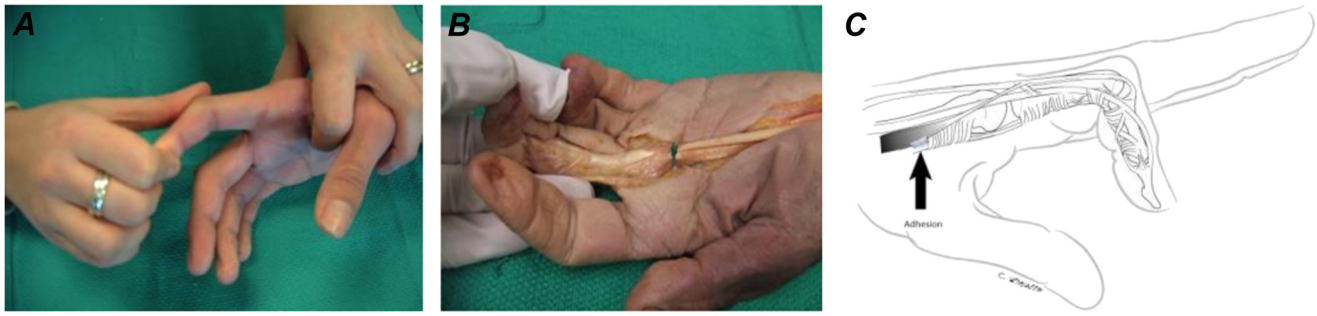

Fig. 2. Illustrating the loss composite digital extension due to adhesion formation, between the first lumbrical muscle and flexor digitorum profundus tendon, and limited distal excursion through the A1 pulley in distal zone III. A) Clinical observation. B) Simulation of adhesion in Zone III distally in a cadaver dissection. C) Diagrammatic presentation.