Journal of Hand Therapy 27 (2014) 309–316

Contents lists available at ScienceDirect

Journal of Hand Therapy

journal homepage: www.jhandtherapy.org

JHT Read for Credit Article #322.
Scientific/Clinical Article

Swing traction versus no-traction for complex intra-articular proximal inter-phalangeal fractures

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ARTICLE INFO

Article history:
Received 24 March 2014
Received in revised form
15 July 2014
Accepted 15 July 2014
Available online 23 July 2014

Keywords:
Dislocation
Finger
Fracture
Orthosis
Traction

Introduction: Traction orthoses are thought to optimize recovery from intra-articular finger fractures by restoring joint space and allowing early motion. Evidence to date has, however, consisted only of case series.
Purpose of the study: To compare swing traction versus no-traction management of complex fractures of proximal inter-phalangeal (PIP) finger joints. We hypothesized that there is no long-term (i.e. >12 month) difference between swing traction and no-traction (with or without surgical fixation) in terms of motion, pain, function, patient satisfaction, or treatment cost.
Methods: Adults with a history of complex PIP fractures affecting ≥30% of articular surface injury were identified from database searches at three public hospitals and a private clinic and invited to participate. X-rays taken at the time of injury were graded by two blinded assessors, and participants attended a clinic for measurement of range of motion (ROM) and self-reported function, pain, and satisfaction at least one year post injury. Participant data were then were grouped by treatment provided. One group ($N = 17$) was treated with swing traction and the other group ($N = 14$) had no-traction. The primary outcome was combined motion of the PIP and distal inter-phalangeal (DIP) joints, expressed as both total active motion and Strickland score. Secondary outcomes were physical function and symptoms as measured by the Disabilities of Arm, Shoulder and Hand (DASH), patient satisfaction, pain, complication rates, and cost of treatment, based on mean resource consumption per group.
Results: Patients treated with swing traction had greater finger motion than those in the no-traction group, which was statistically and clinically significant. There were no differences in patient ratings of function, pain or satisfaction. Complications, such as swan-neck deformity, cold sensitivity, malunion, infection, or adhesions occurred in over half of both groups of participants. During the treatment phase, the swing traction group attended hand therapy an average of 13.3 times, and the no-traction group attended 11.7 times. Average costs for swing traction were less than for surgical fixation with no-traction.
Discussion: The significantly different range of motion found in our study did not translate to better DASH scores. The DASH is designed to measure global upper limb physical functioning and symptoms, but lacks sensitivity in populations with finger injuries.
Conclusions: Patients treated with the swing traction protocol had greater range of motion in the finger, however this did not translate to improved patient ratings of function, pain or satisfaction. A basic cost comparison indicated that swing traction may be less expensive than other forms of surgical repair.
Level of evidence: 3.

Grant & financial support: 2009 Victorian Occupational Therapy Trust Research Grant ($4,000AUD). We certify that no party having a direct interest in the results of the research supporting this article has or will confer a benefit on us or on any organization with which we are associated. The manuscript submitted does not contain information about medical device(s).

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0894-1130/$ – see front matter
http://dx.doi.org/10.1016/j.jht.2014.07.003

Introduction

Intra-articular fracture dislocations of the finger commonly involve the base of the middle phalanx usually in impaction, dislocation, and pilon types of injuries.[1] The typical injury mechanism is a direct force applied to the fingertip with hyperextension and axial loading of the proximal inter-phalangeal (PIP) joint causing impaction of the articular surface of the middle phalanx onto the condyles of the proximal phalanx. The incidence of these injuries is estimated at 19% of phalangeal fractures, with comminuted or large-fragment PIP joint injuries comprising 2.2% of the total.[2]

Unstable PIP joint dislocations, and those with significant comminution or fragment displacement, are usually treated surgically.[3] Surgical options include internal fixation (usually screws into fracture fragments, with or without bone grafts[4]) percutaneous pinning,[5] or external fixation and traction.[4] Internal fixation is technically difficult, time consuming, and can result in significant complications.[6,7] Traction is less technically demanding as it can require as little as one percutaneous k-wire. As it does not require a surgical incision, the potential for complication and development of scar tissue is also reduced. Traction is thought to work by reducing the fracture by capsulo-ligamentotaxis, defined as the realigning of fracture fragments as a result of tension applied across the fracture by the surrounding soft tissue[8] and preventing shortening of collateral ligaments. Early motion aims to minimize adhesions in and around the joint, and promote cartilage healing.[4]

Several different types of traction devices that allow movement at the affected joint have been described. For ease of discussion these can be classified as either finger-based frames (such as the Suzuki frame,[9–14] or the S-quattro,[6,15]) or dynamic orthoses with a forearm or hand component. Of the latter group, the original "banjo" orthosis was first described in 1946,[16] with several improvements since described, including the Schenck design[17] which allowed passive mobilization between two points on a circular frame. More recently, "swing" orthoses which hinge at the level of the injured joint have been recommended, with designers claiming that their smaller size minimally impacts on daily routine, improves compliance and allows pain-free rehabilitation.[18,19] These assertions have, however, been challenged in a qualitative study of patients undergoing this treatment.[20] A review of all publications on swing traction undertaken for this study found that, apart from two case series of 14 and 5 patients respectively,[19,21] all are practice forums which describe the orthosis' design and fabrication, but do not present any patient data. Apart from a small 1991 study[7] (comparing open reduction ($N = 9$), banjo traction ($N = 6$), Schenck orthosis ($N = 1$), and no-traction ($N = 4$) at an average of 25 months post injury) and a conference abstract for a single-center retrospective analysis of 41 patients treated with either a Suzuki frame or a modified Banjo orthosis,[22] there are no published clinical trials comparing any of the skeletal traction treatments with an alternative treatment. Neither study described how participants were allocated to treatment, nor did they provide statistical analyzes between groups. Also, with the exception of one case series that reviewed patients at an average of 56 months post injury,[9] no studies have included the long-term follow up of patients necessary to identify the impact of post-traumatic arthrosis on finger pain, stiffness, and function.

Given the injury's low incidence, and resulting difficulty recruiting adequate sample sizes, it is not surprising that there are no prospective clinical trials into the efficacy of traction treatment. In similarly rare health conditions, there is a growing trend to use observational studies, often referred to as comparative effectiveness research (CER) to directly compare the results of different treatment regimens.[23] Whilst observational studies lack the statistical purity of randomized controlled trials, results can be both scientifically rigorous and more relevant to clinicians than a standard clinical trial providing key variables in comparison groups are either matched at baseline or controlled for in analysis.

Our study aimed to compare outcomes by treatment type in patients who had sustained complex PIP fractures at least one year previously. One group of patients (from one hospital) were treated with swing traction; the other (including patients from the first hospital and three other centers) had no-traction. We hypothesized that there would be no difference between groups in terms of motion, pain, function, patient satisfaction, and incidence of complications.

Materials and methods

This cohort study involved patients from three public hospitals and one private clinic located in Melbourne, Australia. Data was collected between 2009 and 2014 and the study was approved by the Ethics Committees of Monash University, the Alfred Hospital, and Monash Health. Potentially eligible participants were identified by searches of all involved centers' hand surgery databases using ICD codes specific to finger fractures and dislocations. The first or third author then checked patients' x-rays and medical files to ensure inclusion criteria were met. Those eligible were contacted by mail and telephone (where possible) and invited to participate. Informed consent was obtained in writing prior to data collection.

Inclusion criteria

Patients eligible for this trial were adults aged >18 years with a diagnosis of complex, comminuted, or unstable intra-articular fracture of the PIP joint sustained at least one year previously. They also needed to be able to give informed written consent in English.

Exclusion criteria

Those with co-existing rheumatologic illness were excluded.

Interventions at the time of injury

Swing traction group. All participants in this group came from only one of the study hospitals (the others did not offer traction at the time of the patient's injury). Prior to surgery, the hand therapist fabricated a thermoplastic forearm/hand component with a movable hinged outrigger attached at the level of the injured joint. The outrigger was covered at the distal end with thermoplastic material in which two dressmaker's hooks were embedded. After surgical placement of a K-wire through the bone distal to the injured joint, the orthosis was applied to the patient, with rubber bands attaching the K-wire to the hooks in the outrigger, thus providing a distraction force. Early designs were dorsally applied, however in later cases, a volar design was used as it provided greater stability (Figs. 1 and 2). The treating surgeon checked reduction radiographically to ensure traction was sufficient to restore normal joint space. Distraction forces were not routinely measured, as this would be considered unreliable due to the tendency for rubber bands to attenuate after prolonged stretch. X-rays were repeated weekly, and traction adjusted by changing the size and number of rubber bands required to maintain joint space. The hand therapist instructed the patient to complete 10 passive flexion/extension exercises of the injured joint each hour, and this was commenced immediately post-surgery. At the end of the first week the aim was to produce 45° of motion, with incremental increases of 5° per week for the next five weeks. The patient was instructed to wear the orthosis continuously until the surgeon removed the k-wire. K-wires were removed between 30