

Experiences with pins and rubber band traction in the treatment of proximal interphalangeal joint contracture

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BACKGROUND: Proximal interphalangeal joint (PIPJ) contracture is a difficult problem to treat regardless of etiology. Although numerous interventions have been recommended, published results are mediocre at best.

OBJECTIVE: The authors describe their experience and results of using a modification of pins and rubber band traction (PRBT) – applying a dynamic extension apparatus to a contracted PIPJ using the constant traction force in a stretched rubber (elastic) band.

METHOD: A retrospective review of patients treated with this method was performed, and the results are presented. The technique itself is described, and clinical photographs illustrate the method.

RESULTS: Mean PIPJ flexion contracture before PRBT was 82° (range 60° to 110°). The full correction of eight contracted PIPJs in seven patients was achieved, in a mean of 17.8 days (range 14 to 31 days). At one month postremoval of PRBT, the mean PIPJ flexion contracture was 22.8° (range 0° to 46°).

DISCUSSION: The method is compared with previously described methods of PIPJ contracture correction, whether surgical or splinting; the latter may be static, dynamic or a combination of the two. The results of previously published studies are discussed and compared with the method described.

CONCLUSION: The present method is a powerful and effective simplification of a previously described method of correcting PIPJ contractures. This technique is simple, 'low-tech' and can be applied under local anesthetic; the authors believe it offers a useful adjunct to surgical release.

Key Words: *Distraction; Joint contracture; Pins and rubber band traction; Proximal interphalangeal joint*

Proximal interphalangeal joint (PIPJ) contracture is a difficult problem to treat. Andrew (1) reported that in a series of seven digits amputated due to refractory contracture caused by Dupuytren disease, both the accessory collateral ligaments and the volar plate had to be released to achieve full extension. This can have consequences for the stability of the joint and the functional status of the hand. Various regimens have been described including static splinting (2), dynamic splinting (3-5) or a combination of the two (6). We describe our experience of using a modification of pins and rubber band traction (PRBT) – a method of applying a dynamic extension apparatus to a contracted PIPJ that makes use of the constant traction force in a stretched rubber (elastic) band as described by White et al (7), and report our results in the treatment of contracted PIPJs in the hand. We believe that the PRBT method of PIPJ distraction offers a simple and cost-effective way to treat this condition, and describe some simple modifications to the technique.

METHODS

The authors performed a retrospective review of a series of patients treated with this technique. Under aseptic conditions, the patient's affected digit is anaesthetized with local anesthetic and four points are marked: the dorsum of the proximal and middle phalanges either side of the PIPJ in the axial midline (Figure 1). Four 1.1 mm K-wires are driven through the underlying phalanx at each point, making sure to

Des expériences de traction par des tiges et des ancres pour traiter la contracture de l'articulation interphalangienne proximale

HISTORIQUE : Quelle qu'en soit l'étiologie, la contracture de l'articulation interphalangienne proximale (AIPP) est difficile à traiter. Même si de nombreuses interventions sont recommandées, les résultats publiés sont pour le moins médiocres.

OBJECTIF : Les auteurs décrivent leur expérience et les résultats de l'utilisation d'une traction par des tiges et des ancres (TTA), soit l'application d'un appareil d'extension dynamique sur une AIPP contractée à l'aide d'une force de traction constante par une bande élastique étirée.

MÉTHODOLOGIE : Les auteurs présentent une analyse rétrospective des patients traités par cette méthode et les résultats du traitement. Ils décrivent la technique et l'illustrent pas des photos cliniques.

RÉSULTATS : La flexion moyenne de la contracture de l'AIPP avant la TTA était de 82° (plage de 60° à 110°). Huit AIPP contractées ont été complètement corrigées chez sept patients, sur une période moyenne de 17,8 jours (plage de 14 à 31 jours). Un mois après le retrait de la TTA, la flexion moyenne de la contracture de l'AIPP était de 22,8° (plage de 0° à 46°).

EXPOSÉ : La méthode est comparée à des méthodes par chirurgie ou attelle déjà décrites pour corriger la contracture de l'AIPP. L'attelle peut être statique, dynamique ou combinée. Les résultats d'études déjà publiées sont exposés et comparés à la méthode décrite.

CONCLUSION : La présente méthode simplifie avec puissance et efficacité un moyen décrit antérieurement pour corriger les contractures de l'AIPP. Elle est simple, peu complexe et peut être effectuée sous anesthésie locale. Les auteurs sont d'avis qu'elle constitue un ajout utile à la libération chirurgicale.

engage the opposite cortex. Stability of the wires is confirmed manually, and a loop is fashioned in the protruding ends of each wire (Figure 2), to which rubber bands are attached (Figure 3). This is performed as a same-day procedure, and the patients are discharged home with wound care advice. They are reviewed twice weekly, during which the degree of correction is documented and the bands are adjusted. Once full correction is achieved (Figure 4), the wires are removed – either at the time of surgery, which is usually two weeks after complete correction, or in the out-patient clinic two to four weeks after correction of any residual postoperative deformity.

RESULTS

Seven patients have been treated with this technique. There were six men and one woman, ranging in age from 43 to 68 years (mean 64.4 years). Five of the patients' PIPJ contractures were the result of Dupuytren disease (of whom four had undergone previous surgical correction), one was from spastic paresis and one from trauma. Because one patient underwent PRBT to two digits on the affected hand, there were a total of eight contractures treated. The patients' demographics are presented in Table 1.

Mean PIPJ flexion contracture before PRBT was 82.7° (range 60° to 110°). Complete correction was achieved in all patients. The mean time to full correction of the deformity was 17.8 days (range 14 to 31 days) and the mean total duration of treatment was 25.1 days

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(range 14 to 49 days). At one-month postremoval of PRBT, the mean PIPJ flexion contracture was 22.8° (range 0° to 46° degrees).

Four of the patients underwent regional fasciectomy on completion of the PRBT – two at pin removal, one four weeks later and one six weeks later. Mean length of follow-up was 8.3 months (range three to 17 months). Two patients' contractures recurred significantly over the follow-up period; patient 1 developed a recurrent PIPJ flexion contracture of 42° and 44° in both digits over a 17-month period; patient 5 developed a recurrent PIPJ flexion contracture of 86° over a 10-month period. The mean PIPJ contracture at the end of follow up was 33° (range 0° to 58°) – yielding an mean improvement of 47.9°. The outcomes are also presented in Table 1. One patient (patient 5) reported that one of his pins became loose over the course of the PRBT; however, this did not affect the duration or efficacy of the treatment. There were no other complications.

DISCUSSION

There have been several previous articles describing the treatment of refractory PIPJ contractures. Rajesh et al (3) reported a series of 34 patients with PIPJ contracture caused by Dupuytren disease. These were treated with a fasciotomy combined with release of the accessory collateral ligaments and, if necessary, the collateral ligaments, and then placed into an S-Quattro fixator (Osteotec Ltd, United Kingdom) in distraction mode, with a second spring added to the fixator after two weeks. After four to six weeks, the patients underwent a fasciectomy, and then night splinting for six months. They obtained a mean correction of 67° at 30 months of follow-up, with no complications.

More comparable with the technique we used is one employed by Houshian et al (4). They also used a dynamic external appliance without additional surgical intervention on a patient group of mixed etiology. In total, 27 fingers were treated in 21 individuals. They applied a Compass Hinge External Fixator (Smith & Nephew Richards, Inc, USA) using Kirschner wires under fluoroscopic guidance. This is gradually extended at a rate of 5° a day by means of a 'worm gear', and remains in place for three weeks after full extension. They gained a mean improvement in extension of 38°, and a flexion-extension arc of 42°. However as the authors stated, the Compass fixator can be complicated by a pin site infection rate of 30% to 40%, although their own incidence was lower; they report that septic loosening of pins occurred in two patients, but only affected the outcome in one. Three of the patients returned to their pretreatment contracture and three more lost between 20° and 35° of extension.

Craft et al (5) described using the 'Digit Widget' (Hand Biomechanics Lab, Inc, USA) – a dynamic extension device applied using regional anesthesia and fluoroscopic guidance. They compared this device with releasing the check-rein ligaments in addition to a fasciectomy in patients with a PIPJ contracture due to Dupuytren disease. Their patients treated with surgery gained an increase in extension of 27.7°, while those in the Digit Widget treatment group gained 54.7°, over a six-week period. The authors advocate the use of gradual extension to avoid applying a sudden stretch to shortened digital arteries, leading to arterial spasm and digital ischemia.

White et al (7) described an additional method for correcting these deformities, and we use a modification of this method. In their published study, two mini-external fixators are applied under fluoroscopic guidance to the dorsum of the middle and proximal phalanges, and elastic (rubber) bands are passed between these two constructs. The "rubber band traction" generated exerts an extension force across the interphalangeal joint. They treated 38 digits in 27 patients with this method, and achieved a mean correction from 75° of contracture to 37°. Their patients were then all treated with a dermofasciectomy to treat the PIPJ contracture. Even then, 30% of their patients developed a "significant relapse". They also reported a complication rate of 32%, although eight of these 12 events were superficial infections that had no lasting sequelae.

These regimens can be contrasted against a purely surgical approach to correcting this problem, as reported by Ghidella et al (8).

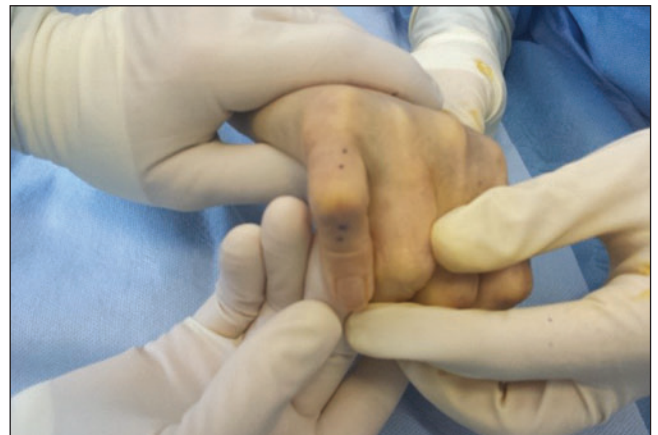


Figure 1) The markings are made after the preparation of the hand and administration of local anesthetic



Figure 2) The four K-wires are driven in at each marked point, ensuring with each to engage the opposite cortex of bone, and a loop/hook formed at the end of each



Figure 3) The rubber bands are applied to provide a constant extension force and adjusted as needed



Figure 4) Full correction of the contracture has been obtained

TABLE 1
Demographics and outcomes of the patients treated using rubber band traction (RBT) for proximal interphalangeal joint contracture

Patient	Age, years/sex	Etiology of deformity	Finger involved	Deformity Pre RBT	Previous surgery	Time to full correction	Duration of RBT	Deformity Post RBT	Further surgery	Deformity at one-month post-RBT	Latest review and deformity
1	68/male	CVA	Right index & middle	90° & 90°	No	14 days	24 days	0° & 0°	No	0° & 0°	17 months 44° & 42°
2	54/male	Trauma	Right little	60°	Yes – K wire fixation of fracture	14 days	26 days	0°	No	45°	5 months 36°
3	68/male	Dupuytren disease	Left ring	86°	Yes – two previous DDF	31 days	49 days	0°	Yes – DDF at removal	14°	8 months 0°
4	60/female	Dupuytren disease	Left ring	88°	Yes – one previous DDF	14 days	14 days	0°	Yes – DDF at 1/12	46°	10 months 58°
5	74/male	Dupuytren disease	Left little	110°	No	14 days	22 days	0°	Yes - DDF at removal	40°	8 months 20°
6	43/male	Dupuytren disease	Left little	72°	Yes – one previous DDF	21 days	21 days	0°	Yes - DDF at 6/52	38°	8 months 40°
7	84/male	Dupuytren disease	Left ring	66°	Yes – one previous DDF	21 days	21 days	0°	Yes – repair of subluxing EDC (7/12)	0°	10 months 24°

CVA Cerebrovascular accident; DDF Dupuytren disease fasciectomy; EDC Extensor digitorum communis tendon

They report a series of 68 PIPJ contractures of varying etiologies – the authors excluded Dupuytren disease, congenital malformations, flexor tendon injuries, replantations and previous implant arthroplasty, and included collateral ligament injuries, fractures, dislocations, reflex sympathetic dystrophy, severe crush and revascularizations. These patients were treated with surgical release of the soft tissues surrounding the joint – from skin, to extensor and flexor tendons, capsule, collateral ligaments, volar plate and check rein ligaments – they report a mean increase in arc of motion of 7.5°. However, when they stratified the injuries into simple (collateral ligament injury, laceration, fracture, dislocation and postimmobilization contracture) and complex (complex regional pain disorder, crush and revascularization), the increases were 17.2° and 0.5°, respectively. As noted, they excluded Dupuytren patients, and focussed on traumatic injuries and post-traumatic sequelae.

For our patients, mean PIPJ flexion contracture before PRBT was 82.7° and complete correction was achieved in all patients. Full correction was achieved in a mean of 17.8 days and the mean total duration of treatment was 25.1 days. However, in reality, the true times are likely to be shorter – the patients were seen once or twice weekly as outpatients and this may have led to the late recognition of some corrections. At one-month postremoval of PRBT, the mean PIPJ flexion contracture was 22.8° (range 0° to 46°).

Our mean length of follow up was 8.3 months and two patients' contractures recurred significantly over the follow-up period; patient 1 developed a recurrent PIPJ flexion contracture of 42° and 44° in both digits over a 17-month period; patient 5 developed a recurrent PIPJ flexion contracture of 86° over a 10-month period. The mean improvement of the PIPJ contractures was 47.9°. This compares favourably with the 38° gained by the patients treated with the Compass Hinge External Fixator (4), and reasonably with the 'Digit Widget' (5). Furthermore, it has been shown that the degree of intraoperative deformity in Dupuytren disease is a significant predictor of both correction at follow-up (9) and the recurrence of the contracture (10).

Chronic joint contractures are difficult problems for hand surgeons and therapists to treat. The technique outlined is a simple and powerful method to address this issue. All patients achieved full correction of the deformity over a short period of time, even in patients with recurrent Dupuytren disease. It is 'low tech', does not require bulky and expensive external fixators, and can be applied without fluoroscopic guidance or regional anesthesia, unlike some other methods described

(3-5,7). We believe that this modification offers the advantages of the method described by White et al (7), while being easier and less resource intensive than the original description. It remains to be determined, however, as to how best to utilize this powerful technique to optimize long-term results.

DISCLOSURES: The authors have no financial disclosures or conflicts of interest to declare.

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