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Metacarpophalangeal and interphalangeal joint arthrodesis: a comparative study between tension band and compression screw fixation

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Abstract

A retrospective, comparative cohort study was performed of metacarpophalangeal or proximal interphalangeal joint arthrodesis with either tension band (*n* = 28) or compression (Acutrak Mini) screw (*n* = 29) methods. We compared rate of union, healing time, complications, and re-operation rate. Union was achieved in 26/28 (92.8%) of the tension band group (9.4 weeks) and 24/28 (85.7%) of the compression screw group (9.8 weeks). Only 28 patients in the screw group were assessed for union as one patient in the screw group sustained a fracture at the time of insertion and was converted to tension band fixation. The complication rate was 8/28 (28.6%) in the tension band group and 8/29 (27.6%) in the compression screw group. Re-operation rate was 9/28 (32.1%) in the tension band group and 1/29 (3.6%) in the compression screw group. Our findings indicate that bone healing, healing time, and complications are similar in both groups. The tension band technique had a significantly higher re-operation rate (hardware removal), but was the technique for salvage following failure of the screw technique.

Keywords

Finger arthrodesis, screw, tension band, fusion

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Introduction

Frequent indications for metacarpophalangeal and interphalangeal joints arthrodesis are injuries involving joint (post-traumatic and primary osteoarthritis) and soft tissue (stiffness, instability, etc.), which cause pain and loss of function in the hand (Bishop, 1993). Although this surgery sacrifices joint mobility, it relieves pain and fixes it in a stable and functional position for hand activities.

The goal in fusion of finger joints is to achieve adequate contact and compression between bones providing a stable fixation to allow early mobilization of the adjacent joints and obtain rapid bone healing. Several techniques using wires, screws and plates have been described with similar union rates and no major difference in functional results (Jones and Stern, 1994). Tension band with K-wires are commonly used, providing adequate compression and stability with good clinical and radiological results (Stern et al., 1993). An important drawback of this procedure is the prominence of the implants on the dorsum of the finger leading to frequent hardware removal (Stern and Fulton, 1992; Uhl and Schneider, 1992). The headless compression screw technique also provides adequate compression and stability, with good clinical results (Adla et al., 2005; Leibovic, 2007).

The aim of our study was to compare tension band and compression screw techniques for finger joint arthrodesis in terms of achievement of union, healing time, complications, and re-operation rate.

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Methods

An observational, retrospective, comparative cohort study was performed. We analyzed a cohort of patients with finger arthrodesis performed with tension band wire or compression screw between 2007 and 2010 by hand surgeons at our institution. The study included patients with primary arthrodesis of the metacarpophalangeal, proximal interphalangeal, and thumb interphalangeal joints, who underwent surgery with tension band technique (K-wire and cerclage) or compression headless screws with Acutrak I Mini or Acutrak I (Acumed, Hillsboro, Oregon, USA). The selection of the method was made according to the preference of each hand surgeon. Patients requiring bone graft, with previous local infections, or with inadequate soft tissue coverage were excluded. Data were collected using electronic medical files. Variables studied included achievement of union, healing time, and complications such as infection, delayed union, and subsequent operations.

Arthrodesis using K-wires and a tension band was performed using a dorsal approach. The articular cartilage was removed with a bone jigsaw and stabilization was performed with two parallel K-wires and a figure of eight wire band, deep to the extensor tendon (Figure 1).

Joint arthrodesis with the headless compression screw was performed using a dorsal approach, articular cartilage was removed with a bone jigsaw and the screw was inserted in an antegrade fashion. The ideal screw position maintains its proximal end at the level of the bone surface with the tip of the screw in the medullary canal. Careful attention was paid to the finger rotation and adequate bone surface compression. For metacarpophalangeal joints, Acutrak I screws were used. Acutrak I Mini screws were used for proximal interphalangeal and thumb interphalangeal joints due to their smaller diameter (Figure 2).

For 2 to 3 weeks post-operatively, all patients were protected with a digital splint at the fused joint while global hand mobility was encouraged.

Radiographs were taken every 2 weeks after the first month and analyzed by two hand surgeons (authors of this study). Union was defined by the presence of bone trabeculae crossing the fusion site in more than 50% of the area.

Ordinal and nominal variables were compared using Fischer's exact test. Numerical continuous variables were evaluated with the Shapiro–Wilk test to identify their distribution. None had normal distribution and were compared using Mann–Whitney test. Proportions were compared using a binomial test. Significant differences between groups were considered with a p value 0.05 or less, with a power sample calculation of 80%.

Figure 1. Proximal interphalangeal joint arthrodesis with tension band.

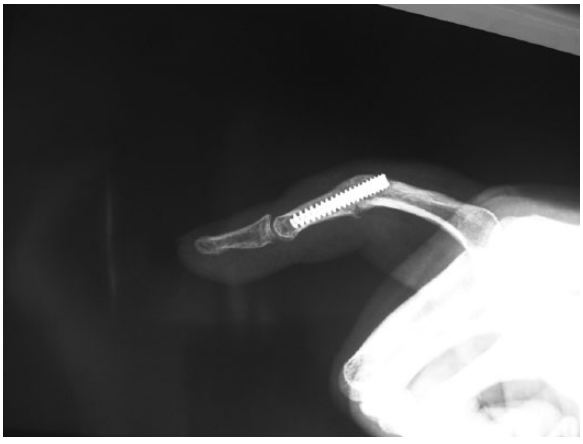

Figure 2. Proximal interphalangeal joint arthrodesis with Acutrak Mini screw.

Results

Fifty-seven patients who met the inclusion criteria were identified. The average age of patients was 37.9 years and 52 were male. The tension band group included 28 patients and the compression screw group, 29. The main indication for arthrodesis in both groups was post-traumatic arthritis (28 patients), followed by joint stiffness due to soft tissue damage (22 patients) (Table 1). Mean follow-up was 29 months.

At time of surgery, there was one case of a fracture of the dorsal edge of the proximal phalanx in the screw group converted to tension band technique. The patient achieved union at 10 weeks. For the statistical analysis, this patient was included in the screw group only for general and complications analysis and not for the union analysis.

Table 1. Patients and indications of arthrodesis.

	Tension band	Screw
N	28	29
Age, years (SD)	38.6 (14.5)	37.2 (13.7)
Male (%)	24 (85.7)	28 (96.5)
Follow-up, months (SD)	30.9 (10.2)	26.5 (11.5)
Joints		
MPJ	4	4
PIPJ	24	17
Thumb IPJ	0	8
Fingers		
Thumb	8	4
Index	5	11
Long	7	5
Ring	4	6
Small	4	3
Indications		
Post-traumatic arthritis	11	17
Stiffness	14	8
Chronic instability	3	4

IPJ = interphalangeal joint; MCPJ = metacarpophalangeal joint; PIPJ = proximal interphalangeal joint; SD = standard deviation.

Bone healing was obtained in 26 of 28 patients in the tension band group in 9.4 (range 5–24) weeks and in 24 of 28 patients in the compression screw group in 9.8 (range 6–20) weeks. There was no statistical difference between groups in bone healing and time to healing ($p > 0.05$). The overall rate of complications was similar in both groups, with eight patients in each group (Table 2).

With regards to complications, in the tension band group there were two cases of nonunion and three cases of delayed union (> 12 weeks). Both nonunion cases were atrophic and the patients achieved union after a second procedure. There were five cases of superficial infection treated successfully with antibiotics. In the compression screw group, there were four cases of nonunion and three cases of delayed union. Two cases of nonunion were secondary to an inadequate position of the screw (Figure 3). Both cases were asymptomatic and did not require another procedure. The third nonunion case occurred after an acute infection that required surgical debridement 2 weeks after the arthrodesis, but without evidence of bone infection. A revision arthrodesis was performed after 24 weeks and union was achieved. No causal or related events were detected in the fourth nonunion case; this patient was asymptomatic and didn't require a secondary procedure. There was a second case of infection (superficial) in this group, treated successfully with oral antibiotics.

With regards to subsequent surgery (hardware removal or revision arthrodesis), there was a significant difference between the groups ($p = 0.003$). In the screw compression group, there was only one patient who needed a revision arthrodesis and no patient needed screw removal; whereas in the tension band group, nine patients needed a second intervention. Two patients underwent revision arthrodesis and seven patients had hardware removal (Table 2).

Discussion

Finger arthrodesis is a widely performed surgery and tension band wire is one of the most common techniques due to its predictable outcomes, simplicity, and low costs. Nevertheless, the tension band has problems related to the prominence of the wires causing swelling and pain, often requiring removal once union has been achieved. The use of compression screws is an appealing alternative for finger arthrodesis (Ayres et al., 1988; Katzman et al., 1993; Leibovic, 2007; Leibovic and Strickland, 1994), because they provide stable fixation and good compression of bone segments without prominence on the dorsum of the finger and no disturbance to the dorsal skin and extensor tendon. There are several reports that showed good results with the use of Herbert headless screws in finger arthrodesis (Zimmer, Warsaw, USA) (Ayres et al., 1988; El-Hadidi and Al-Kdah, 2003; Katzman et al., 1993; Lamas et al., 2003; Wyrsch et al., 1996). There are a few reports of finger arthrodesis with the Acutrak and Acutrak Mini screw with good results. These reports showed overall healing rates that are comparable with other techniques and has the advantages of fully buried hardware and early mobilization; however, it requires a meticulous technique to avoid complications in some little fingers (Brutus et al., 2006; Song et al., 2012)

Our results show that the tension band wire and compression screws have similar outcomes related to union rates and healing time. These results and complications are comparable with others reports in the literature (Allende and Engelem, 1980; Hogh et al., 1982; Ijsselstein et al., 1992; Khuri 1986; Teoh et al., 1994), except the nonunion rate of the compression screw group (14.3%), which was higher than the 0–4% of others published series (Ayres et al., 1988; Katzman et al., 1993; Leibovic and Strickland, 1994; Teoh et al., 1994). We believe this difference is related to the learning curve of a new surgical procedure.

Removal of metal shows an important and statistically significant difference between both techniques: 25% vs. 0% ($p = 0.002$). This is due to the prominence of the K-wires and band wire that often causes pain

Table 2. Results, complications, and new procedures.

	Tension band	Screw	p
Union rate			
N/total (%)	26/28 (92.9)	24/28 (85.7)	0.39
Time, weeks (SD)	9.4 (4.3)	9.8 (3.6)	0.78
Complications	10	10	
Patients (%)	8/28 (28.6)	8/29 (27.6)	0.84
No union (%)	2/28 (7.1)*	4/28 (14.2)*	0.39
Late union (%)	3/28 (10.7)	3/28 (10.7)	0.5
Infection (%)	5/28 (17.9)*	2/28 (7.1)*	0.23
Intraoperative fracture	0/28	1/29 (3.4)	0.56
New procedures	9/28 (32.1)	1/28 (3.6)	0.03
Hardware removal (%)	7/28 (25)	0/28 (0)	0.02
Re-arthrodesis (%)	2/28 (7.1)	1/28 (3.6)	0.42

*Two patients presented no union and infection at the same time in each group.

Figure 3. Small finger metacarpal joint arthrodesis with Acutrak screw. (A) Post-operative radiograph showing an incorrect technique: retrograde direction, arthrodesis in extension, and insufficient bone restrain in the dorsum of proximal phalanx. (B) Four months follow-up showing no union.

on the dorsum of the fingers, a complication that has not been observed with compression screws as they are headless and fully inserted into the bone.

With regards to economic costs, compression screws have a higher material cost in comparison with tension band wire material. However, the tension band technique is often followed by a second operation to remove hardware, which also represents a cost. Further studies would be required in order to compare the cost-effectiveness of these two procedures.

This paper is a retrospective study with a limited number of patients and no randomization in the selection of the technique. With regards to the surgeons, all of them are experienced hand surgeons, but for most of them the screw technique was a new procedure. For the determination of the union of arthrodesis, the radiograph is not the most accurate method but is the standard at our centre.

Conflict of interests

The author declares that there is no conflict of interest.

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