Acta Orthop. Belg., 2013, **79**, 154-158

ORIGINAL STUDY

Distal interphalangeal joint arthrodesis in extension using a headless compressive screw

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The aim of this study was to review the clinical outcome and complications in patients who underwent distal interphalangeal joint (DIPJ) fusion in extension using an axial screw with variable thread pitch (Mini-Acutrak® screw Acumed, LLC, Hillsboro, OR, USA). Thirty-eight cases of DIPJ or thumb IPJ were performed and assessed through patient satisfaction (hand function and pain) and radiographs. The quick-DASH scores were assessed at a mean follow up of 8 months (range : 6 to 12 months).

Ninety-three per cent of participants reported good or excellent functional outcome, with Quick DASH scores of less than 30. There were five complications noted (one superficial wound infection ; two fractures ; two screw cut-outs). All cases progressed to radiographic bony union at six months.

Keywords : DIPJ fusion ; mini-Acutrak ; arthodesis ; compression arthrodesis.

INTRODUCTION

Arthrodesis of the distal interphalangeal joint (DIPJ) and thumb interphalangeal joint is an effective surgical procedure for restoring hand function and joint stability in patients with osteoarthritis (*2,3,13*). Common indications include degenerative or traumatic arthritis, rheumatoid arthritis, chronic mallet finger injury and chronic flexor digitorum profundus injury (*13*). Arthrodesis can correct deformity, improving both the function and appearance of the joint (*3*).

Several surgical techniques for achieving fusion of the DIPJ and IPJ have been described in the literature (*3,6,13*). Techniques include the use of bioresorbable pins (*13*), intraosseous cerclage wires (*13*), Kirschner wires (*13*), lag screws (*12*) tension band wiring (*16*) and headless compressive screws (*3*). Each has been shown to have varying clinical outcome, morbidity and complication rates. Recognised complications of the procedure include hardware protrusion and migration (*14*), loosening (*14*), non-union (*3*), pin track infections (*3*), dorsal skin necrosis (*14*), osteomyelitis (*14*) and joint paraesthesia (*14*).

Non-union rates for DIPJ and IPJ fusion vary between 0-20%. Stern and Fulton compared the use of Kirschner wires, inter-fragmentary wire, longitudinal Kirschner wire and Herbert screw in

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No benefits or funds were received in support of this study. The authors report no conflict of interests.

139 patients undergoing DIPJ fusion. They reported non-union rates of 11-12% regardless of the type of fixation used (*14*). According to the authors, non-union was a result of inadequate bone stock, inadequate bone resection, premature pin removal and infection (*14*). However in this study, Kirschner wire techniques were associated with high complication rates (20% major and 22% minor) including osteomyelitis and deep wound infection (*14*). Moreover, use of Kirschner wires has been reported as inconvenient for patients as they often catch on clothing, become infected and prohibit showering (*3*).

The purpose of our study is to assess clinical and functional outcome following arthrodesis of the DIPJ in extension using a headless compression screw with variable thread pitch. We also reviewed the complication and revision rates of the headless compression screw (Mini Acutrak®).

PATIENTS AND METHODS

The study was discussed with the Institutional Review Board and approval was not considered necessary.

Patients who underwent the procedure between June 2006 and December 2011 were included in this study. The study involved 35 patients (three patients underwent bilateral joint arthrodesis). Participants included 26 females and 9 males. Mean age of the participants was 59 years (range : 30-83). Twenty-seven arthrodeses of a distal interphalangeal joint (DIPJ) and eleven thumb interphalangeal joint arthrodeses were performed using the Mini-Acutrak® screw. The treated digits included : thumb (11), index (14), middle (5), ring (4) and little (4).

All participants involved in the study presented to the hand unit with pain and functional impairment. All patients were counselled for surgery and due to severity of symptoms, non-operative management was not an option. The diagnosis was painful osteoarthritis in 29 cases and traumatic osteoarthritis in 9 cases (Fig. 1).

Twenty-eight of the 35 patients participated in the Disability of the Shoulder, Arm and Hand questionnaire survey (a measure of clinical and functional outcome).

Surgical technique

All procedures were performed as day surgery cases under general anaesthetic.

A dorsal skin incision was made over the DIP joint. The articular surfaces were prepared for bony apposition by denuding any cartilage or soft tissue up to the bone surface using bone nibblers.

Fig. 1. — Anterior posterior and lateral radiographs of the left hand of a patient before DIPJ arthrodesis of the index and middle distal interphalangeal joints.

The prepared articular surfaces were then secured using a guide wire passed from the distal tip of the terminal phalanx to the middle third of the middle phalanx (Fig. 1). Neutral flexion and rotation was achieved. The position was verified using fluoroscopy on the operating table. This also enabled choosing the correct length of the screw required for arthrodesis. The Mini-Acutrak® was then inserted over the guide. The skin wound was closed and dressed with gelonet, blue gauze, wool and crepe. All patients were given intra-operative antibiotics (second generation cephalosporin ; cefuroxime).

In the immediate post-operative period, the patient was advised to elevate the hand. The dressings were reduced at 48 hours and changed to a simple adherent dressing. At two weeks the patients were assessed to review wound healing and any early post operative complications. They were then provided with custom made thermoplastic splints, which allow active mobilisation of other joints of the hand while immobilising the arthrodesis. Splintage was discontinued after six weeks. Routine radiographs were reviewed at six and twelve weeks to assess bony union.

Assessment

Patients were followed up until radiological union was confirmed on plain films and a desired functional result was achieved. Minimum follow-up was six months (range : 6-12 months). Union was determined based on clinical and radiographic assessment. Clinically, patients were assessed for symptoms of pain and examined for painless stability. Radiographic union was assessed on

plain radiographs with two views perpendicular to each other (antero-posterior and lateral). Two observers looked at the radiographs and union was confirmed as bridging of at least three cortices in the presence of painless clinical stability of the arthrodesis. Outcome was thus assessed at final follow-up using radiographs, patient satisfaction and Quick DASH scores. Any intra-operative complications such as delay in wound healing, infection, delayed union, mal-union or need for revision was assessed at final follow-up.

All patients were contacted individually by telephone and questioned using the Quick DASH survey (*2*). The Quick DASH survey comprised of eleven questions that assessed the severity of patients' symptoms and their ability to perform specific daily activities following the surgery. Quick DASH scores were calculated using an online electronic scoring system and transformed into a score from 0-100. A higher score indicated greater disability, a score less than 30 indicated good functional outcome and a score less than 20 indicated excellent functional outcome.

RESULTS

Twenty-seven cases of distal interphalangeal joint (DIPJ) arthrodesis and eleven cases of thumb interphalangeal joint arthrodesis were performed using the Mini-Acutrak® screw. The treated digits included 11 thumbs, 14 indices, 5 middle fingers, 4 ring fingers and 4 little fingers.

DASH scores were available in 28 of the 35 patients. Of the 7 patients who were not included in the study, one patient required screw removal and the rest were not available at the time of the study.

The immediate post operative recovery was unremarkable in all patients. Clinical and radiological bone union was noted in all patients at six months follow-up (Fig. 2). The average follow-up was nine months (range : six to twelve months).

Of the 28 participants in the Quick DASH study, 26 reported scores of less than 30 (92%), 25 reported scores of less than 20 and 20 reported scores of less than ten. Two participants in the study had Quick DASH scores between 30 and 50. Both of these patients were noted to suffer from severe arthritis prior to surgery and thus their ability to perform the daily tasks in question was already limited. Average Quick DASH score in our study was 8.6 (range : 0.0-45.5).

Fig. 2. — Anterior posterior and lateral radiographs of the left hand of the same patient after DIPJ arthrodesis of the index and middle finger distal interphalangeal joints.

Five complications were noted from clinic notes and telephonic interview. In one case a fracture of the distal phalanx was noted. This was managed non-operatively by thermoplastic splinting and bone union was observed at three months. In a second case, bone fracture and proximal screw migration were noted on plain radiographs at twelve weeks post-procedure. This was managed by close observation and bone union was noted at six months. In two cases the screw cut out and required revision to a Kirschner wire due to lack of adequate bone stock to allow for revision with another screw. In the final case, the screw was removed due to wound infection at four weeks. This was subsequently treated in a thermoplastic splint and progressed to union with conservative management.

DISCUSSION

The results of our study suggest that use of the headless compressive screw (Mini-Acutrak®) is an effective method in achieving successful arthrodesis in the DIP and thumb IP joints. We report good to excellent results in 92% of patients and average time to fusion of three months (range : 2-6 months).

Recent studies have reported that techniques which achieve better compression of joint surfaces improve union rates and reduce time taken to return to work (*10*). Compression is thought to provide mechanical stability, thus promoting bony union and minimising non-union rates (*1,2*). Compressive arthrodesis was first described by Micks and

Hager (*11*) using the modified Charnley clamp (*4*), an external compressive device that allowed for reliable bony contact and fusion. Procedures which allow for compression include the lag screw and the headless or variable pitch compression screw (*3,5,7, 13*).

Several studies analysed the use of the Herbert screw in DIPJ arthrodesis. In a biomechanical model, Wyrsch *et al* (*16*) reported that compared to the tension band wire, the Herbert screw demonstrated increased anterior posterior bending strength and axial plane torsional rigidity which was of clinical significance. Three articles have reported good outcome with the Herbert screw. El Hadidi *et al* (*6*) reported 1 case of non union in their study of 15 patients and Faithfull and Herbert reported 100% union in 13 cases. Similarly, Lamas Gomez *et al* (*9*) reported good union rates in their study of 20 patients. However, complications included a case of severe skin necrosis leading to secondary amputation. Whilst use of the Herbert screw is associated with good rates of union, there is only one study available in the literature which allows for comparison with the Mini Acutrak® screw.

Brutus *et al* (*3*) studied 27 cases of DIPJ arthrodesis using the Mini Acutrak® screw. Their results showed that union rates with the Mini Acutrak® screw were superior to those with the Herbert screw. In their study, twenty-three patients achieved bony union. Reasons for non-union included infection in two cases, distal screw migration in one case and in the last case, the patient had psoriatic arthritis, which was associated with high complication rates. According to Brutus *et al* (*3*), advantages of the technique were ease of execution, buried hardware and early mobilisation. To date, no studies have assessed clinical and functional outcome of the headless compression screw (Mini Acutrak®) using both radiographic images and qualitative clinical outcome measures (Quick DASH).

Our method describes arthrodesis using a fully threaded, conically shaped implant with variable thread pitch (Mini Acutrak®, Acumed LLC, Hillsboro, OR, USA). As it is threaded there is a larger surface area for fixation between the bone and the screw. The Mini Acutrak® screw is manufactured from implant grade titanium and has a length ranging from 10 to 26 mm and a diameter ranging from 2.8 to 3.5 mm. Being small in size allows the hardware to be fully buried, thus eliminating the problem of having prominent metal work outside the distal phalanx. In addition, according to Faran *et al* (*8*) use of the headless screw achieves solid fixation and better compression of joint surfaces. The headless compressive screw also reduces the chance of nail bed damage, minimises scars and causes less damage to the dorsal venous system and extensor tendon. Our study demonstrates good functional outcome (DSH score) using percutaneous screws with variable pitch.

We noted five complications ; two patients required conservative management, two patients suffered screw cut out and required revision to Kirschner wire and the final case required screw removal for infection. However, despite the above complications, all cases progressed to union at 6 months follow up.

Contraindications for using headless screws for arthrodesis are active infection (*5*), reduced bone stock and where the desired angle of DIPJ fusion is greater than 10 degrees (*13*). In such cases Kirschner wires would be a more appropriate method of fixation (*15*). According to Tomaino *et al* (*15*), in rheumatoid patients, where bone quality is compromised, Kirschner wire insertion is a more appropriate method of fixation than the use of a screw. Ruchelsman *et al*'s study in 2010 similarly reported that closed DIPJ arthrodesis was recommended in only a select group of patients. Their indications included hypertrophic osteoarthropathy, passive correctable DIPJ deformity or patients at risk of complications associated with open arthrodesis (*13*).

Elective screw removal was not necessary after fusion was achieved. In one patient, screw cut-out was noted ; revision was undertaken to a Kirschner wire. In the absence of complications, we believe that removal of hardware is not necessary.

Use of the Mini Acutrak® (Acumed) screw for distal interphalangeal joint and thumb interphalangeal joint fusion led to good clinical and functional results in this cohort. Morbidity rates were lower than those previously reported with use of non-compressive techniques including the Kirschner wire. No cases of prominent hardware or skin

necrosis were seen. Thus from our study, we propose that the headless compressive screw with variable thread pitch should be used as a safe and effective alternative to other methods of DIPJ arthrodesis, when no more than 10° of flexion is needed.

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