Our aim in this prospective study was to evaluate a minimally invasive technique for percutaneous arthrodesis of the small joints in the hand. Thirteen arthrodeses were undertaken in 11 patients, eight women and three men. After the percutaneous removal of articular cartilage, the bony surfaces were aligned in a predetermined position and stabilised using a percutaneous screw system. The mean follow-up was 38.6 months (36 to 56). Bony union was achieved in 12 cases (ten patients) between nine and 12 weeks after surgery. In one patient a second operation was required to obtain union and another developed a painless nonunion after premature removal of the implants.

Pain and degenerative changes of the joints of the fingers causing impairment of pinch and grip may be due to trauma, osteoarthritis and rheumatoid and psoriatic arthritis. The effects of conservative treatment using anti-inflammatory agents or local steroid injections are usually short-lived. The indications for arthrodesis of the interphalangeal joints of the fingers are pain, instability or deformity.

Arthrodesis may be difficult to achieve as indicated by the variety of techniques described in the literature. These include the cup-and-cone, the convex-concave, the dowell fusion, end-on-mitting, the AO, the tension-band, intraosseous wiring and the intramedullary peg techniques.

The reported rate of failure ranges from 2% to 15% and complications include infection, malunion and pseudarthrosis. We describe and evaluate a minimally invasive percutaneous technique for arthrodesis of the interphalangeal joints in the hand.

Patients and Methods

We prospectively studied a group of patients who had undergone surgery between November 1996 and May 1999. The indications for surgery included pain, instability and arthritis with or without deformity. One patient had a longstanding, neglected rupture of a deep flexor tendon, one a rupture of an extensor tendon and one had had a traumatic amputation of the thumb treated by replantation. Thirteen arthrodeses (seven DIP, three PIP, two IP and one MPJ) were undertaken in 11 patients. There were eight women and three men with a mean age of 59 years (27 to 76). Seven patients with rheumatoid arthritis had received conservative treatment including prednisolone, indomethacin and methotrexate. One patient suffered from amyloidosis. Two patients were smokers.

Operative technique. All patients gave informed consent and all operations were performed by the senior author.
(DP). The remaining articular cartilage was removed percutaneously using a large FFS implant of 2.2 mm diameter inserted horizontally into the joint (Fragment-Fixation-System; Orthofix Ltd, Guildford, Surrey, UK, Fig. 1). The debris was left in situ as an autologous graft. The joint was positioned in a predetermined position and held with forceps through the tip of the finger. A medium implant (diameter 1.6 mm) was passed obliquely across the joint in a retrograde manner (Fig. 2). A second medium or small implant (diameter 1.2 mm) was introduced from the opposite side in order to control rotation (Fig. 3). The implants were trimmed to length and left subcutaneously. Postoperatively, patients wore a short, moulded finger splint for six days. The implants were removed under local anaesthesia using a special extractor (Orthofix Ltd) when fusion had been achieved.

Results

The mean duration of the operation was 11.8 minutes (8 to 15) and the mean follow-up was 38.6 months (36 to 56). No patient was lost to follow-up. There was no postoperative infection, no failure of hardware and no loss of position. Follow-up radiographs showed progressive fusion. Successful fusion was defined by obliteration of at least 75% of the joint space on the anteroposterior and lateral radiographs and the mean time to union was 10.8 weeks (9 to 12). Ten patients with 12 arthrodeses (92%) achieved fusion. One required a second operation to obtain union. There was non-union in one patient in whom the implant was removed prematurely at six weeks. A painfree fibrous union developed and no further surgery was required.

Since there is not a validated score for arthrodesis of small joints, we recorded the functional result as the total active range of movement (TAM) of the finger. The mean total active range of movement of the operated finger in 11 of 12 patients was 82% demonstrating an excellent functional result. One patient who had a successful arthrodesis of the IP joint after a previous replantation of the thumb developed digital arterial insufficiency with algodystrophy and persistent pain and requested amputation.

Discussion

Degenerative changes in the small joints of the hand may be accompanied by severe pain, and in order to restore function arthrodesis is required. Bunnell described a technique for arthrodesis consisting of resection of the articular surfaces and securing of the joint with two Kirschner (K) wires. We describe a minimally invasive method with percutaneous removal of the articular surfaces and insertion of two oblique FFS implants. This method reduces soft-tissue trauma and is time-saving. Høgh and Jensen described arthrodesis using a cerclage wire followed by external immobilisation for six weeks. Our patients were only immobilised for six days and thereafter received physiotherapy to the adjacent joints. Engel, Tsaur and Farin indicated that using K-wires facilitates fusion of the joint with the desired amount of flexion, but that the subsequent external immobilisation which is required prevents early return to work. Our technique allows not only fusion at an appropriate angle of flexion but also compression by means of the fine thread and shoulder of the implant which is used.

The implant is drilled through areas of high resistance in the cortex of the phalanges or metacarpals, thus compressing the joint line. A conventional compression screw is very difficult to insert in flexion and may have little or no purchase in the middle phalanx. For the DIP joint, fusion in extension is unsuitable for function. It should be fused in 10° to 20° of flexion. The PIP joint should be fused in 30° to 40°, increasing from the index to the little finger. These
angles may be easily achieved using the percutaneous technique.

In a biomechanical study, Kovach et al\textsuperscript{21} reported superior results for figure-of-eight tension-band wiring compared with crossed K-wires and intraosseous wiring. Wyrsch et al\textsuperscript{18} showed that the Herbert screw gave more strength to the arthrodesis than tension band wiring and reported that a compression technique is superior to both crossed K-wire and tension-band techniques. This is in agreement with the clinical findings of Buck-Gramcko\textsuperscript{22} in a series of 363 arthrodeses over a period of nine years. Non-union occurred in 8\% of patients after arthrodesis using a screw, compared with 30\% after K-wire arthrodesis. Both clinically and biomechanically, screw arthrodesis seems to be the most effective due to the effect of compression. We obtained compression using the FFS implant.\textsuperscript{22} Relative to the diameter of their threads, the fine screws are superior to standard cancellous and cortical screws when used in cancellous bone.\textsuperscript{23}

In our opinion, percutaneous arthrodesis of the small joints of the fingers is a straightforward, reliable technique which gives good results.

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References