INTRODUCTION

Fractures of the phalanges of the fingers are common injuries. The average accident and emergency department will see several hundred each year (Benke & Stableforth, 1979). Causal factors include falls, road traffic accidents and commonly sport, especially football and cricket (Barton, 1977). About 18% of all phalangeal fractures extend into a joint, usually the proximal interphalangeal joint and 8% are associated with comminution (Barton, 1984). Such injuries are associated with considerable morbidity, the main problem being stiffness and deformity. Fractures involving the proximal interphalangeal joint for example often lead to dorsal subluxation of the base of the middle phalanx. Although they are stable in flexion, it is undesirable to immobilize the joint in this way as stiffness will result (James, 1970). The stiffness is a particular problem with the proximal joint whose normal range of movement exceeds that of the distal interphalangeal joint contributing considerably to the grip strength. Displaced comminuted phalangeal fractures or intra-articular fractures, especially where more than 40% of the joint surface is involved, present the greatest difficulties. Even if immobilized in extension, the finger may become stiff in extension later. Early mobilization is appropriate for minor avulsions and other stable fractures but for the more complicated injuries, a more aggressive approach is required.

Various different techniques have been advocated but treatment of these difficult fractures is often complex and inconvenient for the patient. Closed reduction with zimmer splintage or volar slab will not always prevent recurrent displacement and also risks later stiffness. Not infrequently, open reduction and internal fixation becomes necessary after failure of splintage to maintain reduction (Steel, 1988). Single large fragments may be held by K-wire fixation introduced either percu-
taneously or at open operation or by AO screws. The surgery is complex however with risks of tendon adherence, ligament and capsule fibrosis and avascular necrosis of the fragment. Trans-articular K-wire fixation precludes early mobilization and further damages the healthy articular surface. Results for more comminuted or severely compound injuries are frequently poor (Barton, 1977; Benke & Stableforth, 1979; Steel, 1988). For intra-articular unstable fractures with comminution and a depressed fragment there is often no satisfactory treatment, requiring the patient to accept the inevitable deformity and later referral for corrective osteotomy, arthrodesis or even joint replacement.

METHODS

The Stockport Serpentine Spring System or S Quattro (Surgicraft) is a flexible mini external fixator designed to treat comminuted unstable intra-articular phalangeal fractures. It works on the principle of ligamento-taxis, reduction being achieved and maintained by tension in the joint capsule and ligamentous structures produced by dynamic distraction. The system is flexible and therefore allows early active mobilization and guards against tendon adherence. The components of the system are illustrated in Fig. 1. It consists of two modified K-wires and two serpentine springs. The unthreaded notched wires are introduced percutaneously into the normal phalangeal bone on either side of the injured joint. The springs are then clipped onto the wires, the stiffer spring is applied first and more closely to the digit to act as a fulcrum. The second spring is now applied and provides the necessary distraction (Fig. 2). The device is secured with adhesive ('plastic padding') and further protection is afforded by gauze dressing and a cling bandage. The system can be applied to achieve distraction or compression of the fracture as appropriate or in the neutral format. If distraction is required, the pins should be in a diverging

Fig. 1. Components of the S Quattro system.
Fig. 2. Application of device to digit.

direction from blunt to pointed ends in the final position and vice versa if compression is the aim. Tension in the ligaments and capsule not only maintains the reduction but also prevents rotation. Early controlled mobilization restores the congruity of the joint surface preventing stiffness and later arthritis (Salter et al., 1980, 1981). The movement of other joints is unimpaired and the hand remains in use whilst the device is in situ.

Application of the S Quattro is a relatively easy operation, often carried out under local anaesthetic and within a short operative time. The pins are inserted, ideally with a single pass, and usually via the dorsal approach. For the proximal interphalangeal joint a longitudinal slit is made through the extensor tendon for the proximal wire, and the distal wire is inserted in the bare area distal to the central slip of the extensor tendon. For the distal joint, the proximal wire is inserted into the bare area and the distal pin into the terminal phalanx just proximal to the nail bed. Where the metacarpo-phalangeal joint is involved the pins are inserted either side of the joint by longitudinal slits in the extensor tendon. Alternatively a mid-lateral approach can be used which does not interfere with the tendons but is technically more difficult and will not allow the distal interphalangeal joint to be placed in 30° flexion, the optimum position.
RESULTS AND DISCUSSION

The S Quattro has been used mainly for comminuted unstable intra-articular fractures, principally affecting the proximal interphalangeal joint with comminution of the base of the middle phalanx. Its use in 20 such cases was reported by Fahmy (1990). In most cases the fixator was applied in the first week following fracture, the longest interval from injury to application was 21 days. The device was left in place for 2–6 weeks. In two early cases the procedure was combined with open reduction and K-wire fixation for the depressed central fragment but further experience showed that such fragments would usually be reduced by traction alone. At least 6 months follow-up was possible in all patients and after this time a mean range of movement of 81% was possible in the affected joints. The majority of patients were painfree and all but one were satisfied with the result. There were no pin-track infections or backing out of the pins and only one case where one of the pins cut through the bone.

In another study of this device (Fahmy & Harvey, 1991) a further 15 cases were described including five mal-uniting intra-articular phalangeal fractures presenting at a mean 31 days post-injury. The mean total deformity (angular, flexion and rotation) at the start of treatment was 70°. The mean residual deformity after an average 11.4 months follow-up was 14°. Good results were also seen in five cases of comminuted condylar fractures and five compound phalangeal fractures, all severe injuries.

The S Quattro is a versatile device with an increasing range of applications. Good results have already been achieved in the Stockport Hand Unit following trapeziectomy or excision arthroplasty of the proximal interphalangeal joint. However, its principal indication remains the displaced comminuted intra-articular phalangeal fractures. It is particularly suitable where fragments are too small to fix and where comminution affects the joint surface. The device achieves and maintains excellent reduction, prevents deformity and allows early mobilization of the affected joint. The procedure is short and straight forward, complications are few, and functional results are surprisingly good considering the severity of these injuries and the inadequacy of other treatment.

In Stockport there is good liaison between the A&E Department and the District Hand Unit. A weekly Hand Injury Clinic has input from both services. A Consultant Orthopaedic Surgeon with an interest in hand injuries is available for consultation by senior A&E staff at any time. This relationship has proved invaluable in aiding the correct identification and management of complex finger injuries, which is essential if subsequent morbidity is to be minimized (Barton, 1984).

The development of the S Quattro is an added incentive for A&E staff to refer suitable injuries and an increasing number of these fractures are being considered for the procedure. All intra-articular phalangeal fractures are now referred to the combined Hand Injury Clinic. The device has been used in over 60 patients so far with 95% satisfactory results in this district. With increasing interest from hand surgeons elsewhere and large number of extra-district referrals attending the clinic, the S Quattro can be expected to be even more widely used in hand treatment in the future.
REFERENCES

The S Quattro: a new system for the management of difficult intra-articular fractures of the phalanges.

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