“S” Quattro external fixation for complex intra-articular thumb fractures

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INTRODUCTION

Thumb dexterity is an important part of hand function, especially in opposition for pinch and grip movements. The simple Bennett fracture and the comminuted Rolando fracture are 2 common...
patterns with intra-articular extension into the carpometacarpal joint. In Bennett fractures, the shaft of the first metacarpal is radially dislocated by the unopposed pull of the abductor pollicis longus while the medial fracture fragment remains in place due to the attachment of the volar oblique ligament. In Rolando fractures, the more complex Y- or T-shaped patterns at the base of the thumb metacarpal do not result in diaphyseal displacement.

Good outcome depends on maintaining anatomic reduction and thereby preventing post-traumatic arthritis. Malunion can cause stiffness, pain, and weakness of pinch and grip. Reduction should be achieved with ≤1 mm displacement to prevent the risk of arthritis. Fractures of the base of thumb are easy to reduce but difficult to maintain in position. Even with initial reduction and immobilisation, such fractures require close monitoring to prevent secondary displacement by the deforming forces acting in the trapeziometacarpal joint region. Uncomplicated extra-articular thumb metacarpal fractures can be managed by closed reduction and maintained by temporary splinting or casting. However, displaced intra-articular fractures, open fractures, and unstable fractures failing conservative treatment are indications for surgery.

The Stockport Serpentine Spring System (“S” Quattro) was developed to maintain fracture reduction by capsuloligamentotaxis. Distraction reduces fracture fragments using the tension of the capsule and ligamentous structures surrounding the injured joint. The system functions in neutralisation or compression mode, thus applied forces can be adapted to individual injuries. It functions as a dynamic system by enabling a controlled limited range of movement, while the surrounding uninjured joints have a free range of active movement (to avoid tendon adherence and joint stiffness). The limited range of movement of the injured joint enables articular cartilage moulding, restores joint congruency, reduces joint stiffness, and potentially decreases the incidence of early osteoarthritis.

We report outcomes of 10 patients who underwent dynamic “S” Quattro external fixation for complex fractures of the base of thumb.

### MATERIALS AND METHODS

Between 1996 and 2003, 9 men and one woman aged 18 to 69 (mean, 31; standard deviation [SD], 14) years underwent “S” Quattro external fixation (Surgicraft Ltd, Redditch, UK) for complex fractures of the base of thumb (Table 1). The dominant hand was involved in 8 patients. Three patients had Bennett fractures, 5 had Rolando fractures, one had an open multi-fragmented

### Table 1

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Sex/age (years)</th>
<th>Injury mechanism</th>
<th>Fracture type</th>
<th>Associated injuries</th>
<th>Referral</th>
<th>Prior treatment</th>
<th>Interval to “S” Quattro (days)</th>
<th>Treatment (weeks)</th>
<th>Follow-up (months)</th>
<th>Total active movement loss</th>
<th>DASH* score</th>
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<tbody>
<tr>
<td>1</td>
<td>F/18</td>
<td>Motor vehicle accident</td>
<td>Bennett</td>
<td>5th metacarpal fracture, carpula fracture</td>
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<td>Splint, Kirschner wires</td>
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<td>6</td>
<td>12</td>
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<td>Sports fracture-subluxation</td>
<td>Rolando</td>
<td>-</td>
<td>-</td>
<td>Kirschner wires</td>
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<td>6</td>
<td>10</td>
<td>10°</td>
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<td>Sports</td>
<td>Rolando</td>
<td>5th metacarpal fracture</td>
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<td>Kirschner wires</td>
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<td>4</td>
<td>9</td>
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<td>4</td>
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<td>Sports</td>
<td>Open comminuted fracture</td>
<td>Bennett</td>
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<td>8</td>
<td>4</td>
<td>21</td>
<td>20°</td>
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<tr>
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<td>-</td>
<td>Splint</td>
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<td>7</td>
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<tr>
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<td>0°</td>
<td>0.0</td>
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<tr>
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<td>M/30</td>
<td>Fall</td>
<td>Bennett</td>
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<td>M/69</td>
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<td>Rolando</td>
<td>-</td>
<td>-</td>
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<td>6</td>
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* DASH denotes Disability of the Arm, Shoulder and Hand questionnaire.
fracture, and one had a fracture-subluxation. The injury mechanism were sports (n=7), fall (n=2), and motor vehicle accident (n=1).

Four patients were referrals from other hospitals without a dedicated upper limb or hand surgeon. Three of them had failed treatment with splint immobilisation and/or Kirschner wiring. One patient had an unsatisfactory reduction following Kirschner wiring in our hospital (Fig. 1). In the remaining 6 patients, “S” Quattro external fixation was the primary treatment modality because of the higher degree of fracture displacement and instability (Figs. 2 and 3).

Prophylactic antibiotics were administered intravenously. The operative technique was similar to that described by Fahmy. A pneumatic tourniquet was applied after exsanguination. Manual traction was performed under image intensification and general anaesthesia. The first pin was placed in the metacarpal diaphysis and the second in the trapezium using a percutaneous dorsal approach. Care was taken to avoid transfixing the extensor tendon. Distraction was obtained by manipulating the wires and positioning of the proximal serpentine spring. The distal spring was attached to maintain position when the degree of distraction was satisfactory. Stability was ensured by passing each of the pins through 2 bone cortices and cementing the junctions between the wires and the springs. Free gliding of the extensor and flexor tendons of the uninjured joints was ensured before dressing the wound by checking the passive range of movement.

Patients were discharged when they achieved a satisfactory functional range of movement without much discomfort. Radiographs were obtained prior to discharge to ensure that the external fixator had not dislodged. They were followed up in an out-

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**Figure 1** Anteroposterior and lateral radiographs of the Rolando fracture in patient 3: (a) before surgery, (b) unstable fixation with a single Kirschner wire, and (c) “S” Quattro external fixation with the proximal pin placed in the trapezium and the distal pin placed in thumb metacarpal diaphysis.

**Figure 2** Anteroposterior and lateral radiographs of the Bennett fracture in patient 8: (a) before and (b) after “S” Quattro external fixation.
patient setting every 2 weeks until bone union and removal of the external fixator, and 3 monthly thereafter. Rehabilitation was supervised by a physiotherapist.

According to the total active movement (TAM) classification, the finger flexor function following tendon injuries was classified. The TAM of the injured trapeziometacarpal joint was compared with the contralateral thumb.

Patients were contacted by telephone to assess subjective outcome satisfaction and complete the Disability of Arm, Shoulder and Hand (DASH) questionnaire. The questionnaire is a self-administered, region-specific tool to measure upper extremity dysfunction. The DASH scores range from 0 to 100; higher scores indicate more disability.

**RESULTS**

The mean interval to definitive treatment with the “S” Quattro external fixator was 7.7 (SD, 4.5) days. The long interval was due to delay in presentation, late referrals, initial treatment by other modalities, and lack of acute surgical beds in our unit. Nonetheless, this did not affect the functional outcomes. The external fixator was applied for a mean of 4.8 (SD, 1.2) weeks. No pin-site infection, malunion, or non-union was encountered.

Patients were followed up for a mean of 10.7 (SD, 3.7) months. The mean loss of TAM at the carpometacarpal joint was 7.5° (SD, 7.9°). Five patients lost ≥10°, 2 of whom lost 20° (one with an open comminuted fracture and one was elderly). Four patients regained full TAM and 6 attained >75% TAM (Table 2).

After a mean of 41 (SD, 24) months of treatment, the mean DASH score was 3.4 (SD, 5.4). Four patients reported no functional disability. Poorer outcomes were reported in 2 patients, one with an open comminuted fracture and one was elderly.

**DISCUSSION**

Treatment modalities for intra-articular thumb fractures include closed reduction and maintenance by bulky dressings, oblique traction, open reduction with plate fixation, and closed reduction with Kirschner wiring. The most common modality for Bennett fractures is closed reduction with percutaneous Kirschner wiring. Rolando fractures are treated with either open reduction and internal fixation or external fixation, depending on the size of the fracture fragments. Combining an external fixator to restore length and align the comminuted fragments with tension band wiring to provide stability is recommended. For severely comminuted fractures, a combination of external fixation, limited internal fixation, and bone grafting provides good functional results after short-term follow-up, despite persistent joint irregularities. Extensive soft tissue dissection to reduce the tiny comminuted bony fragments has the potential to cause avascular necrosis of the fracture fragments, fibrosis of the collateral ligaments, and tendon adhesion, which result in unsatisfactory functional outcomes despite intensive rehabilitation.

The use of the “S” Quattro external fixator has been reported in a spectrum of hand traumas, from intra-articular comminuted phalangeal fracture-dislocations to malunited phalangeal fractures. Modifications of the device have been used for treating neglected dorsal interphalangeal dislocations and chronic subluxation at the proximal interphalangeal joint. The device is a light, dynamic, and versatile system, which enables distraction of the injured joint and controlled movement of uninjured joints so as to improve joint congruency and reduce post-traumatic...
stiffness and early osteoarthritis.

This novel dynamic external fixator enables anatomic reduction by capsuloligamentotaxis, and provides stability for fracture healing with early active digital movement. Compared to traditional treatment modalities such as splinting and Kirschner wiring, the “S” Quattro device is superior at maintaining anatomic reduction of displaced and extremely comminuted fractures. In cases where open reduction and internal fixation is indicated, this device overcomes the need for extensive soft tissue dissection for fracture fragment fixation, and avoids ensuing complications such as avascular necrosis. It is recommended as a primary and definitive treatment modality when conservative and other surgical interventions have failed.

REFERENCES