CLOSED RUPTURE OF THE FLEXOR TENDONS CAUSED BY CARPAL BONE AND JOINT DISORDERS

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We analysed 21 patients with closed rupture of the flexor tendons caused by carpal bone and joint disorders. The tendon that ruptured depended on the location of the bone perforation into the carpal tunnel. Radiocarpal arthrography was performed in 13 patients and capsular perforation was demonstrated by contrast medium leakage into the carpal canal in 11 patients. This proved a useful diagnostic test. The flexor tendon(s) were reconstructed with free tendon graft in 17 patients, cross-over transfer of flexor tendons from adjacent digits in two and buddying to an adjacent flexor tendon in one patient. Postoperative total active range of motion in the fingers after 13 free tendon graft reconstructions averaged 213° (range 170–265°). The active range of motion of the thumb-interphalangeal joint after free tendon graft reconstruction in three cases improved from 0° to 33° on average (range 10°–40°).

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Although not common, closed flexor tendon ruptures caused by hidden pathologies of the carpal bones and joints have been reported frequently, viz fracture of the hook of the hamate (Bishop and Beckenbaugh, 1988; Boyes et al., 1960; Clayton, 1969; Crosby and Linscheid, 1974; Foucher et al., 1985; Futami et al., 1993; Hartford and Murphy, 1996; Milek and Boulas, 1990; Minami et al., 1985b; Stark et al., 1989; Takami et al., 1983; Teissier et al., 1983; Yamazaki et al., 2006; Yang et al., 1996), Kienbock's disease (James, 1949; Masada et al., 1987; Ribbans, 1988), scaphoid non-union (McLain and Steyers, 1990; Saitoh et al., 1999), pisotriquetral osteoarthritis (Lutz and Monsivais, 1988; Saitoh et al., 1997; Takami et al., 1991), pisotriquetral instability (Corten et al., 2004), a rough surface of the hook of the hamate (Okuhara et al., 1982), lunate fracture (Minami et al., 1985a) and chronic lunate dislocations (Johnston and Bowen, 1988; Stern, 1981). Boyes et al. (1960) reported that ten of 80 flexor tendon ruptures (12.8%) had occurred in the carpal tunnel and that two of the ten had associated abnormalities of the carpal bones. Folmar et al. (1972) reported that the flexor pollicis longus (FPL) tendon and the flexor digitorum profundus (FDP) tendon of the little finger were most frequently affected in ten patients with flexor tendon ruptures.

The mechanism of these tendon ruptures is attrition from passage back and forth over a rough bone surface, the latter having perforated the dorsal wall of the carpal canal (Ertel et al., 1988; Folmar et al., 1972; Hallett and Motta, 1982). It is difficult to identify the underlying pathological lesions causing the tendon ruptures using plain radiographs, especially in the elderly or in manual labourers who have pre-existing abnormal lesions, including osteoarthritis, instability of the carpus and radiographic evidence of previous trauma. Carr and Burge (1992) reported the usefulness of arthrography in identifying a risk of extensor tendon rupture as a result of osteoarthritis of the distal radioulnar joint. Although we demonstrated capsular perforation in patients with scaphoid non-union by arthrography (Saitoh et al., 1997), the usefulness of this technique in detecting carpal pathologies intruding into the carpal tunnel and endangering the flexor tendons is not widely recognised.

The divided tendons invariably have frayed stumps, with a long defect between the ends. Tendon reconstructions have included cross transfer of flexor tendons from adjacent fingers, buddying to adjacent flexors and free tendon grafting. To our knowledge, there has been no description in the literature of the effectiveness of any of these techniques.

This study reviews 21 cases of flexor tendon rupture as a result of pathological conditions of the carpal bones and joints, identifying the relationship between the affected part of the carpus and specific digits. The role of radiocarpal arthrography in identifying the underlying pathology is examined and the results of free tendon grafting recorded.

PATIENTS AND METHODS

Between 1979 and 2005, we treated 21 hands of 21 patients with closed ruptures of flexor tendons, caused by pathological conditions of a carpal bone or joint (Table 1). The mean patient age was 68 (range 35–89) years. Fourteen patients were men and seven were women. Fifteen of the 21 patients were manual labourers. The affected digit was the thumb in four patients, the index finger in one patient, the ring and

Table 1—Patient data, tendon(s) ruptured and the results of arthrography

Patient no.	*Age (yrs)/ gender*	*Hand*	*Disorder*	*Occupation*	*Involved finger(s)/ ruptured tendon(s)*	*Site of contrast medium leakage on radiocarpal arthrography*
1	35/male	Right	Hamate hook non-union	Ski guide	Little/FDP	Not examined
2	51/male	Right	Hamate hook non-union	Carpenter	Little/FDP	Not examined
3	55/male	Right	Hamate hook non-union	Farmer	Little/FDP, FDS	Not examined
4	58/male	Right	Hamate hook non-union	Stone mason	Little/FDP	Not examined
5	63/male	Left	Hamate hook non-union	Woodcutter	Little/FDP, FDS	Triquetrohamate joint
6	73/male	Left	Hamate hook non-union	Farmer	Little/FDP, FDS	Not examined
7	50/female	Right	Hamate hook projection	Factory worker	Little/FDP, FDS	Not examined
8	76/male	Left	Hamate hook projection	Farmer	Little/FDP, FDS	No leakage
9	67/female	Right	Pisotriquetral osteoarthritis	Cook	Little/FDP	Pisotriquetral joint
10	70/female	Left	Pisotriquetral osteoarthritis	House wife	Little/FDP	Pisotriquetral joint
11	70/male	Left	Pisotriquetral osteoarthritis	None	Little/FDP	Pisotriquetral joint
12	73/female	Right	Pisotriquetral osteoarthritis	Farmer	Little/FDP	Pisotriquetral joint
13	73/female	Left	Pisotriquetral osteoarthritis	House wife	Little/FDP	Pisotriquetral joint
14	80/female	Left	Pisotriquetral osteoarthritis	Farmer	Little/FDP, FDS	Pisotriquetral joint
15	89/male	Right	Pisotriquetral osteoarthritis	Craftsman	Little/FDP	Pisotriquetral joint
16	65/male	Right	Scaphoid non-union	Woodcutter	Thumb/FPL	Not examined
17	72/male	Left	Scaphoid non-union	Salesman	Thumb/FPL	Non-union site
18	72/male	Right	Scaphoid non-union	Teacher	Thumb/FPL	Non-union site
19	83/male	Right	Scaphoid non-union	Farmer	Thumb/FPL	Non-union site
20	76/female	Right	Kienbock's disease	Farmer	Little, ring/FDP	Radiolunate joint
21	71/female	Right	Intraosseous ganglion of the lunate	Construction worker	Index/FDP, FDS	Radiolunate joint

FDP: flexor digitorum profundus; FDS: flexor digitorum superficialis; FPL: flexor pollicis longus.

little fingers together in one patient, and the little finger in 15 patients.

Patients with tendon rupture caused by direct invasion by synovitis associated with rheumatoid arthritis or infection were excluded from this study.

The pathological conditions included non-union of the hook of the hamate in six patients (Yamazaki et al., 2006), pisotriquetral joint arthritis in seven patients (one of these seven cases was reported by Saitoh et al., 1997), non-union of the scaphoid in four patients (Saitoh et al., 1999), the presence of a rough surface of the hook of the hamate in two patients (one of these two cases was reported by Okuhara et al., 1982), Kienbock's disease in one patient and the presence of an intraosseous ganglion of the lunate in one patient (Yamazaki et al., 2007).

Radiocarpal arthrography was performed in 14 of the 21 patients. Arthrography was carried out in all seven patients with pisotriquetral joint arthritis, in three of four patients with scaphoid non-union, in one patient with Kienbock's disease, in one patient with an intraosseous ganglion, in one of six patients with hamate hook non-union and in one of two patients with a rough surface of the hamate hook.

Tendon reconstruction was performed in 20 patients (95%) (Table 2). A free palmaris longus or plantaris tendon graft was interposed between the proximal and distal stumps of the ruptured tendon in 17 patients. Tendon transfer of the flexor digitorum superficialis (FDS) tendon of the ring finger to the FDP tendon of the little finger was performed in two patients. End-to-side tendon transfer using the FDP tendon of the long finger with interposition of the palmaris longus tendon to the FDP tendons of the little and ring finger was performed in one patient. After tendon reconstruction grafting, modified Kleinert mobilisation was used for 3 to 4 weeks. In two patients who underwent tendon grafting (cases 6 and 12), tenolysis was necessary at 14 and 9 months, respectively. Follow-up was maintained for a mean of 3 years and 4 months (range 1–13 years and 6 months).

We performed long tendon grafting to prevent adhesion of the tendon stump within the carpal tunnel. The distal tendon junction was placed within the palm and proximal to the A1 pulley, which often needed to be released. The proximal remnant of the tendon within the carpal tunnel was trimmed to place the proximal tendon junction with the graft in the distal forearm and away from the carpal tunnel, to reduce the possibility of adhesion formation. The tendon graft was sutured to the tendon ends with an end weave interlacing suture method. Routinely, we divided the transverse carpal ligament to release the carpal tunnel and for exposure of the hook of the hamate, the pisotriquetral joint, the scaphoid and the proximal and distal tendon stumps. This also allowed us to check the next adjacent tendon, which is sometimes frayed. One patient in whom the transverse carpal ligament was resutured developed carpal tunnel syndrome subsequent to surgery and we now recommend that this is not done.