CLOSED CONTINUOUS IRRIGATION IN THE TREATMENT OF HAND INFECTIONS

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We report our experience with a closed continuous irrigation system in 12 patients with hand infections: six cases of flexor tenosynovitis, three cases of septic arthritis and three palmar abscesses. Four of these patients had undergone previous surgical débridement and peroperative washout without elimination of the infection. The continuous irrigation system consists of two fenestrated tubes placed within the infected space, with the tip of the smaller calibre inlet tube positioned just inside the larger outlet tube. Resolution of infection was achieved in all 12 cases and all regained complete functional recovery. The closed continuous irrigation system is easy to manage, with no leakage of fluid; hand therapy may be started early and the patient is mobile throughout.

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Current established principles for the treatment of hand infection include urgent drainage, débridement and peroperative washout combined with postoperative splintage, elevation and parenteral antibiotics. Various postoperative irrigation systems have also been used without as yet gaining widespread acceptance.

Dickson Wright (1943) first described catheter irrigation of tendon sheath infections. A ureteric catheter was placed in the tendon sheath and flushed with saline intraoperatively; this was followed with daily instillation of 1 or 2 ml of dilute penicillin solution for up to 7 days. Since then, many authors have advocated a wide variety of systems, including intermittent or continuous injection of antibiotic via a single catheter (Besser, 1976; Carter et al., 1966; Pollen, 1974), infusion of larger volumes of fluid via a single catheter and drainage from the wound (Juliano and Eglseder, 1991; Neviaser, 1978) and continuous inlet and outlet tube systems (Delsingnore et al., 1986; Gosain and Markison, 1991; Nemoto et al., 1993). Despite this diversity of techniques, all appear to improve the outcome compared with established treatment regimes. Delsignore et al. (1986) performed a retrospective analysis of closed continuous catheter irrigation versus wide incision and drainage. The irrigation method provided a rapid elimination of infection, decreased the length of hospital stay, reduced the incidence of re-infection, had fewer resultant complications and subsequent procedures, and showed more rapid and complete return to function. Despite this, no single system has achieved universal acceptance by hand surgeons because of the associated practical difficulties. The irrigation fluid can leak from open wounds (Juliano and Eglseder, 1991) or drains (Gosain and Markison, 1991; Neviaser, 1978), necessitating frequent dressing changes. Blockages often occur from soft tissue occluding the drain (Carter et al., 1966; Neviaser, 1978), and hand therapy is not usually possible until the system has been removed (Burt, 1946; Carter et al., 1966; Gosain and Markison, 1991; Juliano and Eglseder, 1991; Neviaser, 1978; Pollen, 1974). Intermittent irrigation may also be extremely painful due to the high pressures generated by manual instillation (Gosain and Markison, 1991; Juliano and Eglseder, 1991; Pollen, 1974).

In attempting to overcome these problems, we have used a system in which the tip of a small, perforated infant feeding tube is placed inside a larger perforated tube and enclosed within the infected space. The placement of the inlet tube within the outlet tube means that the system remains patent, and the smaller tube can slide within the larger, allowing hand therapy whilst in position. The concept has been reported previously by Nemoto et al. (1993). However, we have modified the system so that the tubes can be positioned within the flexor sheath using minimal access and have used it in hand infections in several different anatomical locations. We report its use in 12 patients, four of whom had failed to respond to earlier débridement and peroperative washout.

PATIENTS AND METHODS

A retrospective review of 12 patients treated with this system (Table 1) at Mount Vernon Hospital and Charing Cross Hospital between February 1994 and December 1997 was undertaken. All data were obtained from patient records and recall appointments. The mean age was 40 years (range, 21–77), with nine men and three women. There were six cases of flexor tenosynovitis, three cases of palmar abscess and three cases of septic arthritis. Surgical débridement and peroperative washout had been done in four patients but recurrence necessitated the use of the closed continuous irrigation system.

Total active motion (TAM) was assessed in all patients as the sum of the angles formed by the MP, PIP and DIP joints, and compared with the contralateral normal digit. Outcome was then expressed as suggested by Kleinert and Verdan (1983): *Excellent* – normal; *Good* – TAM greater than 75% of the normal side; *Fair* – TAM greater than 50% of the normal side; or *Poor* – less than 50% of the normal side.

Table 1—Patients

Case	*Age (years)*	*Site*	*Aetiology*	*Previous surgery*	*Bacteria*	*Duration (days)*	*Outcome*
1	21	Ring MCPJ	Human bite (punch)	1 & D – 2 days	ND	2	Excellent
2	34	Middle/ring web space	Unknown		*Staphylococcus aureus*	5	Excellent
3	48	Middle/ring web space	Penetrating injury		*S. aureus*	5	Excellent
4	35	Middle flexor sheath	Penetrating injury		*S. aureus*	2	Excellent
5	64	Ring flexor sheath	Dog bite		*S. aureus*	5	Good
6	32	Middle PIPJ	Human bite (punch)		*S. epidermidis*	3	Excellent
7	26	Ring PIPJ	Iatrogenic	I & D – 10 days	*S. aureus*	4	Fair
8	29	Index flexor sheath	Cat bite		ND	2	Excellent
9	23	Thumb/index web space	Penetrating injury	I & D – 3 weeks	*S. aureus* and diptheroids	2	Excellent
10	77	Middle flexor sheath	Iatrogenic		ND	5	Fair
11	33	Middle flexor sheath	Penetrating injury		ND	3	Excellent
12	61	Little flexor sheath	Unknown	I & D – 1 day	Coliforms	3	Excellent

I & D – incision and drainage, including debridement and peroperative washout; ND – none detected.

Operative technique

Exploration was done under tourniquet control. Débridement of debris, pus and dead tissue was undertaken at all sites of infection and samples sent for microscopy, culture and analysis for antibiotic sensitivities. In flexor tenosynovitis, a transverse incision was made over the distal phalangeal joint crease of the affected digit. The tendon sheath was then carefully incised between the A4 and A5 pulleys. A second incision was made at the distal palmar crease and the tendon sheath entered at the proximal border of the A1 pulley. A 4-French Gauge (FG) infant feeding tube (outside diameter 1.3 mm) was then inserted into the tendon sheath via the distal incision, after cutting off the closed tip and making small perforations for irrigation along its length (Fig 1a). This catheter was passed through the tendon sheath to exit at the proximal incision. Passage could be difficult due to its small size, resistance in the sheath and the inherent flexibility causing it to buckle. This problem was overcome by passing the catheter over a previously placed spinal catheter guide wire as described by Hoffman et al. (1997) (Fig 1b). Once through the proximal incision, an 8-FG feeding tube (outside diameter 2.6 mm) cut in the same way, was placed over the smaller catheter (Fig 1c) and both were manoeuvred back into the wound so that all irrigation holes were covered (Fig 1d). Intraoperative irrigation was done before closure of both wounds around the catheters, using interrupted nylon sutures (Fig 2).

In abscesses and infected joints, the infected space was completely opened and the irrigation system placed under direct vision. All irrigation holes were confined to the infected space. The wounds were then closed over the system, ensuring a water tight seal.

Continuous irrigation

The inner tube was connected to an infusion bag of normal saline via an intravenous giving set to adjust the flow rate. Approximately 500 ml of irrigation fluid were used every 12 hours, and drained through the outer tube to a bile bag drain positioned below the hand. Wound checks were made daily and irrigation continued until there was resolution of the swelling and erythema, usually by 2 to 3 days. The hand was splinted with an anterior plaster cast and elevated. Hand therapy exercises were started during irrigation and the patients were free to mobilize. Intravenous antibiotics were given and a sample of the drainage fluid could be collected for further microbiological culture. The catheters were easily removed.

RESULTS

The mean irrigation period was 3.5 days (range, 2–5 days), and hand therapy was started after less than 48 hours in all cases. Resolution of infection was achieved in all patients and only one patient required a further operative procedure. Patients were followed up for a mean of 14 months (range, 1–48 months). Nine patients achieved a full range of active motion and all 12 achieved complete functional recovery (Fig 3).

In the three patients with limitation of movement (cases 5, 7 and 10), the average reduction in TAM was 32%. All three patients underwent irrigation for a minimum of 4 days. Case 5 was a 64-year-old woman, who presented with flexor tenosynovitis 4 days after a dog bite to the ring finger. She was discovered to be a non-insulin dependant diabetic during admission and at operation pus was drained from the sheath. Case 7 was a 23-year-old man, who had operative repair of a traumatic, boutonnière deformity of the ring finger. Three weeks later he presented with septic arthritis of the PIPJ, treated by drainage and peroperative washout. He took his own discharge the following day after 24 hours of intravenous antibiotic treatment and 10 days later presented with a recurrence of the septic arthritis. This was then successfully treated with the irrigation system.

The patient who required additional surgery was a 77-year-old man (case 10) suffering from chronic lymphocytic leukaemia. He developed tenosynovitis following a

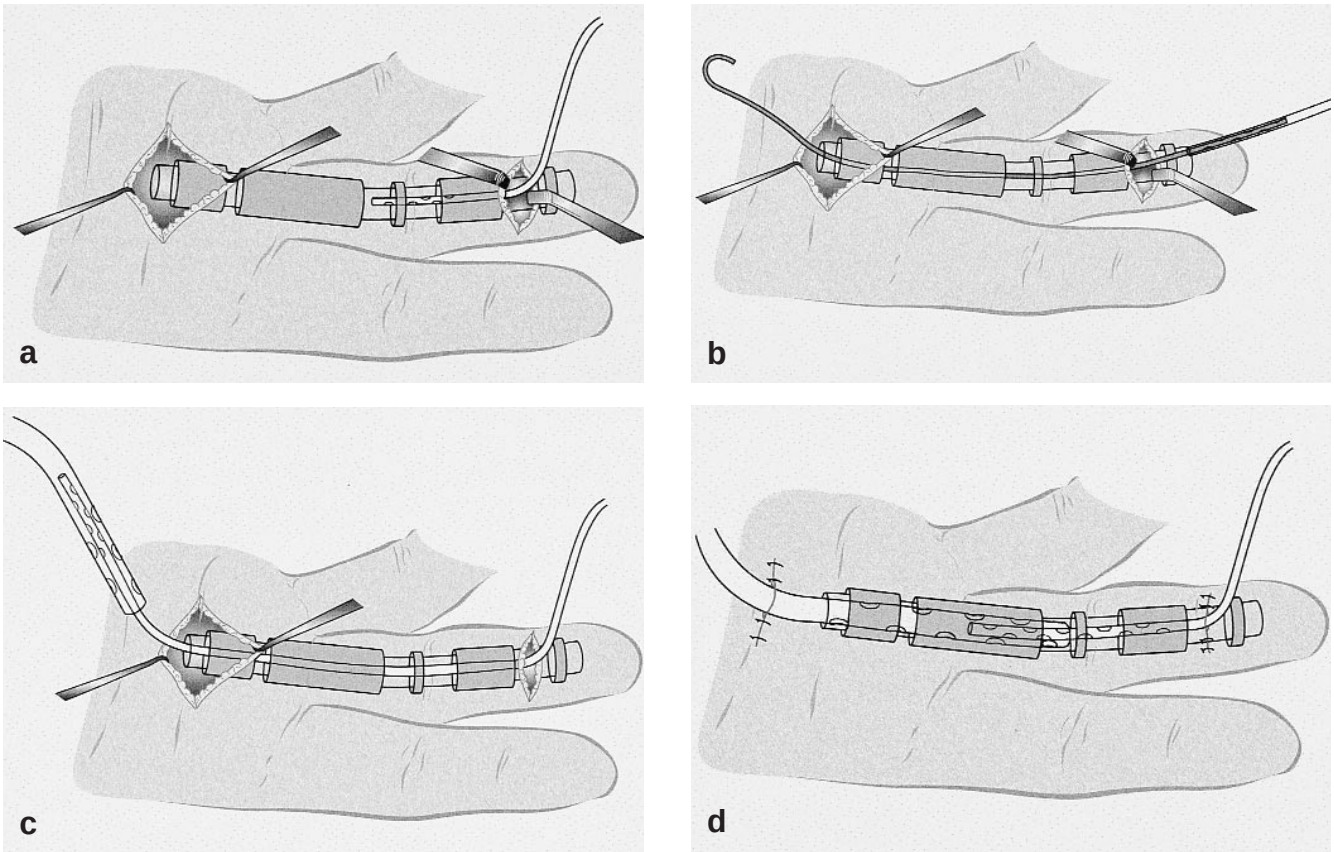

Fig 1 (a) Passage of 4-FG perforated inlet along the flexor sheath. (b) If difficult, the catheter can be railroaded along a semi-rigid spinal catheter guide wire. (c) The 8-FG perforated outlet is then placed over the tip of the inlet and (d) both are slid back to position all perforations within the sheath. The wounds are then closed around the tubes to achieve a water tight seal.

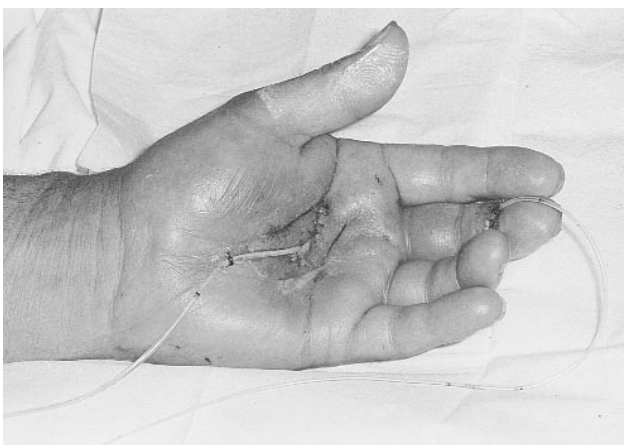

Fig 2 Irrigation system 3 days after insertion for a middle finger flexor tenosynovitis (case 10). The inlet tube enters at the distal phalangeal joint crease incision and the outlet emerges from the palm. The outlet tube is held in place with a single suture to the skin.

steroid injection to the base of the left middle finger for a Dupuytren's nodule at another hospital. At operation frank pus was drained from within the sheath and after 5 days of continuous irrigation, a further collection proximal to the irrigation system became evident in the palm. Following operative drainage of this palmar abscess, a chronic sinus developed which only resolved after the leukaemia was treated successfully. One year after operation, clinical examination revealed some tethering of the FDP limiting full extension, and an incomplete wind-up with a finger-tip to distal palmar crease distance of 3 cm (Fig 4).

DISCUSSION

Nemoto et al. (1993) reported the concept of placing a narrow inlet tube inside a larger outlet tube. In their system, only the outlet tube was perforated and in tenosynovitis, the flexor sheath was completely exposed at operation with the irrigation system placed alongside. In smaller sites of infection, such as joints, only one tube

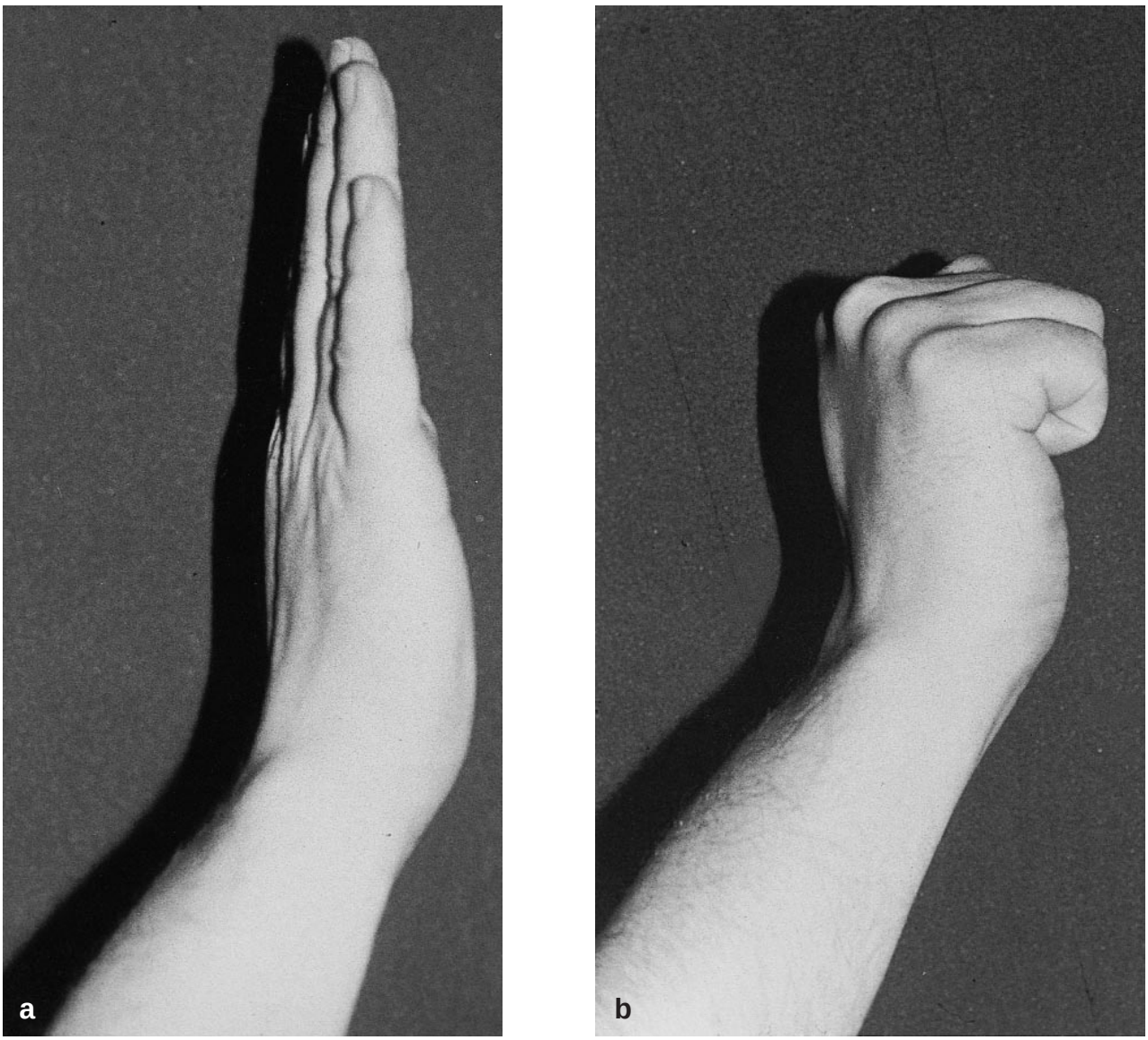

Fig 3 (a, b) Six-month follow-up result after 2 days irrigation treatment for a middle finger flexor tenosynovitis (case 11), demonstrating a complete range of active motion.

could be used as both inlet and outlet, eliminating many of the advantages of the double tube system. Exposure of the entire synovial sheath is unsatisfactory, since it disseminates an infection that is contained within the tendon sheath. Treating infective tenosynovitis by catheter irrigation using limited skin incisions avoids the possible complication of neurovascular injury (Carter et al., 1966), and the additional surgical trauma, with resultant swelling and prolonged rehabilitation. Limited synovial sheath dissection also preserves the synovial environment, thus reducing adhesion formation and allowing rapid return of function. By reducing the diameters of the catheters we could place the system within the sheath using small incisions, and use the complete system for treating septic arthritis of both the MCP and PIP joints.

The small calibre and flexibility of the tubes allow them to be introduced easily into the confines of the fibro-osseous flexor sheath without unduly increasing the pressure in the sheath, as shown by the ability of patients to flex and extend the digits. The inlet tube can move inside the drainage tube. Hand therapy can therefore start soon after surgery to reduce adhesion formation and improve long-term mobility.

The catheters are usually placed so that the irrigation fluid flows in a proximal direction, since the hand is elevated and gravity will enhance this flow. The sheath is also able to accommodate the larger calibre outlet tube

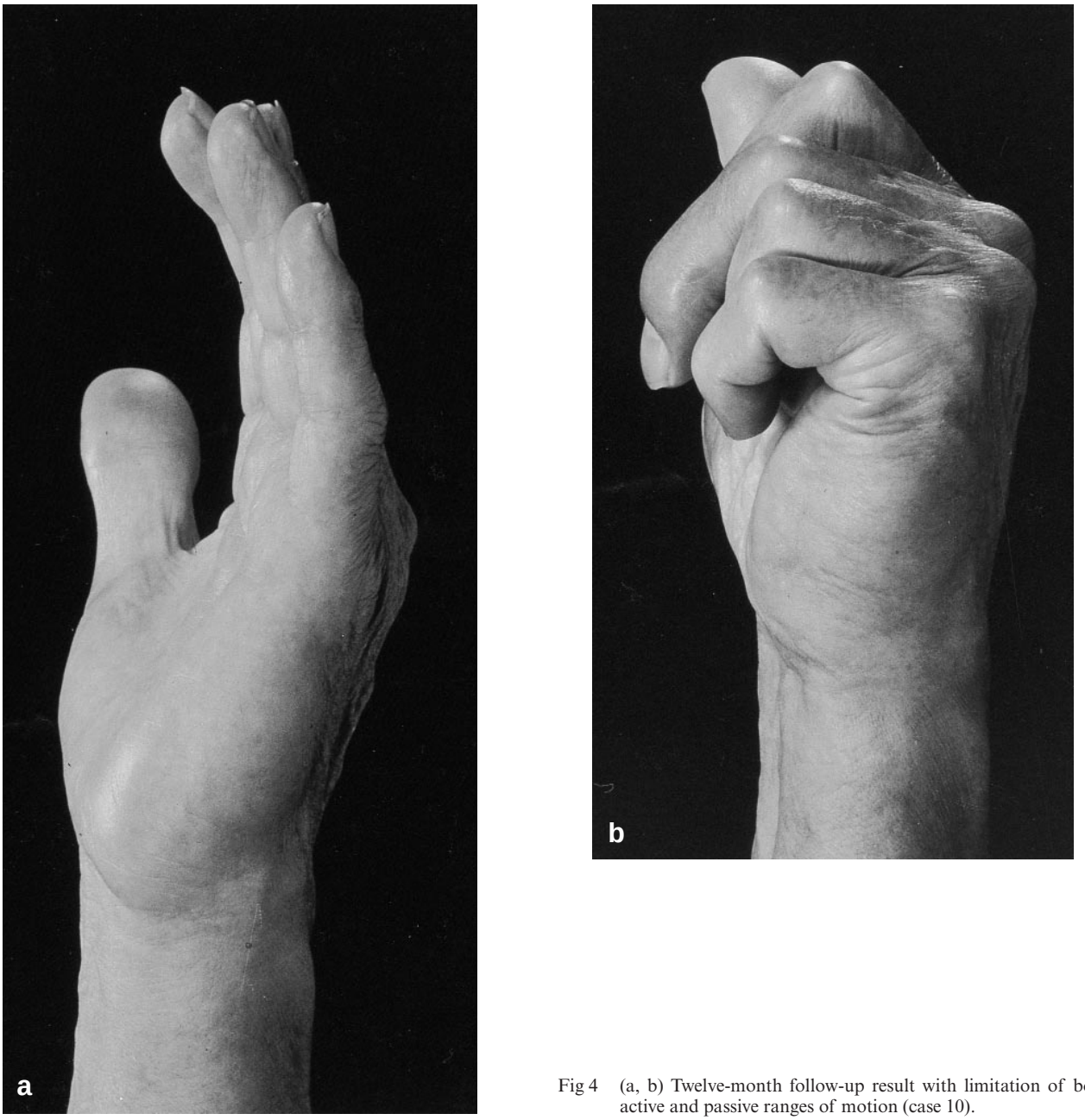

Fig 4 (a, b) Twelve-month follow-up result with limitation of both active and passive ranges of motion (case 10).

more easily at the proximal end. Negative pressure suction to the drainage tube has been advocated (Delsingnore et al., 1986). However, we have found that suction drains frequently become blocked with soft tissue and, if combined with continuous irrigation, limit the mobility of the patient.

Although systemic antibiotics have a definite role in the treatment of hand infections, the value of adding topical antibiotics to the irrigation fluid has been debated for many years. However, the beneficial effects of irrigation alone indicate that the action of mechanical lavage is more important. Although there are no controlled clinical studies, experimental data suggest that normal saline is as effective as antibiotic solutions in removing bacteria from the surfaces of orthopaedic prostheses and cortical bone (Anglen et al., 1996). The results in this series, using only normal saline, support this concept. Furthermore, since neither cultures nor sensitivities are available at the time of operation, the correct antibiotic is frequently not selected.

The decision to stop irrigation and remove the system is undertaken on the basis of reduction in pain, swelling and erythema. The length of irrigation required may be an indicator of the severity of infection; all those

patients with a final reduction in total active motion from this series had at least 4 days irrigation. Gosain and Markison (1991) reported a similar finding in their series of closed space infections of the hand, suggesting that after 3 days of continuous irrigation, further operative exploration should be considered.

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