

# MANAGEMENT AND FUNCTIONAL OUTCOMES OF COMBINED INJURIES OF FLEXOR TENDONS, NERVES, AND VESSELS AT THE WRIST

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A retrospective review of 42 patients with spaghetti wrist lacerations operated on by the author between June 1997 and May 2005 was completed. A total of 31 males and 11 females, average age of 17.1 years (range, 2–40 years), sustained spaghetti wrist injuries. The most frequent mechanisms of injury were accidental glass lacerations (55%), knife wounds (24%), and electrical saw injuries (11%). An average of 9.16 structures was injured, including 6.95 tendons, 1.4 nerves, and 0.8 arteries. The most frequently injured structures were median nerve (83%), flexor digitorum superficialis 2-4 tendons (81%), flexor digitorum profundus 2-4 tendons (66%), ulnar nerve and ulnar artery (57%), and flexor pollicis longus (40%). Combined flexor carpi ulnaris, ulnar nerve, and ulnar artery (ulnar triad) injuries occurred in 31%, while combined median nerve, palmaris longus, and flexor carpi radialis injuries (radial triad) occurred in 43%. Simultaneous injuries of both median and ulnar nerves occurred in 40.5%. Simultaneous injuries of both ulnar and radial arteries occurred in 14%. Neither artery was injured in 30.9%. Follow-up has ranged from 1 to 8 years, with an average of 46 months. Only four patients have been completely lost to follow-up. Range of motion of all involved digits (tendon function) was excellent in 34 patients, good in 3 patients, and poor in only 1 patient. Opposition was excellent in 31 patients, good in 5 patients, and poor in 2 patients. Intrinsic muscle recovery was subjectively reported to be excellent in 29 patients, good in 7, and fair to poor in 2 patients. Minor deformity (partial clawing) was reported in 4 patients and 1 patient has major deformity (total clawing). Sensory recovery was reported, excellent in 32 patients, good in 5 patients, and fair in only 1 patient. © 2007 Wiley-Liss, Inc. *Microsurgery* 27:536–543, 2007.

The superficial location of tendon, nerve, and vessel in the volar wrist puts these structures in jeopardy with any penetrating injury. The more extensive of these injuries have been referred to commonly as spaghetti wrist injury<sup>1,2</sup> (Fig. 1). One tendon laceration or even two may have little disabling importance. However, complete transection of either median or ulnar nerve is crippling, and when three or more tendons are injured, functional disability becomes quite marked. Spaghetti wrist can be devastating in nature, involving as many as 16 different structures, including 12 tendons, 2 nerves, and 2 arteries.<sup>3</sup> Although the three-structure minimal limit was selected by Puckett and Meyer,<sup>1</sup> spaghetti wrist injuries were defined as lacerations occurring between the distal wrist crease and the flexor musculotendinous junctions involving at least three completely transected structures, including at least one nerve and often a vessel. Furthermore, there is no standard definition in the current literature as to what constitutes a spaghetti wrist, ranging from a minimum of three completely transected structures (nerve, artery, and tendon)<sup>1</sup> to at least 10 divided structures inclusive of both median and ulnar nerves.<sup>4–6</sup> Despite their relatively frequent occurrence, few data are available in the literature to categorize these injuries and even less is known about functional outcome.<sup>1,3–6</sup> The goals of pres-

ent study are to 1) present common patterns of spaghetti wrist injuries, 2) describe different operative approaches according to site and shape of the wound, 3) present new functional outcome score able to evaluate the results of both tendon and nerve repair, and 4) compare and contrast our findings with those in the literature.

## MATERIALS AND METHODS

A retrospective review of 42 patients with spaghetti wrist lacerations operated on by the author between June 1997 and May 2005 was performed (Table 1). Thirty one were males and 11 females, with an average age of 17.1 years (range, 2–40 years). The cause of injury was glass in 25 patients, knife stabs in 10 patients, electrical saw in 5 patients, and dog bite in 2 patients. The right hand was involved in 28 patients. An average of 9.16 structures was injured, including 6.95 tendons, 1.4 nerves, and 0.8 arteries. The most frequently injured structures were median nerve (83%), flexor digitorum superficialis 2–4 (81%), flexor digitorum profundus (66%), ulnar nerve and ulnar artery (57%), and flexor pollicis longus (40%). Combined flexor carpi ulnaris, ulnar nerve, and ulnar artery (ulnar triad) injuries occurred in 31%, while combined median nerve, palmaris longus, and flexor carpi radialis injuries (radial triad) occurred in 43%. Simultaneous injuries of both median and ulnar nerves occurred in 40.5%. Simultaneous injuries of both ulnar and radial arteries occurred in 14%. Neither artery was injured in 30.9%. In one patient carpal bones had also been fractured (Fig. 2). The mean length of follow-up was 46 months, with a range of 12–96 months. The end results were assessed by the author using five criteria (Table 2);

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Figure 1. Patient no. 21, with 10 transected structures; seven tendons, median and ulnar nerves, ulnar artery. [Color figure can be viewed in the online issue, which is available at [www.interscience.wiley.com](http://www.interscience.wiley.com).]

(tendon function, opposition, intrinsic function, deformity, and sensation). Tendon function was assessed as excellent (when individual tendon function was evident with 85% to full range of motion or finger flexion to 1.0 cm or less from the distal palmer crease), good (70–84% total normal range of motion or 2.0 cm from the distal palmer crease), fair (50–69% total normal range of motion), or poor (fixed contractures or adhesions). Opposition was assessed as excellent (when the tip of the thumb moves freely over the three phalanges of the other four fingers), good (when the tip of the thumb touches only the tip of the other four fingers), and poor (when the tip of the thumb cannot reach the tip of the other four fingers). Intrinsic functions were assessed as excellent (when the patient can do both finger abduction and adduction with –ve Froment sign), good (when the patient can do both finger abduction and adduction with +ve Froment sign), fair (when the patient can do either finger abduction or adduction with +ve Froment sign), poor (when the patient cannot do finger abduction or adduction with +ve Froment sign). Deformities were assessed as major if there is both clawing and ape hand, minor if there is either clawing or ape hand. Sensation was assessed as excellent (when the two-point discrimination is less than 10 mm), good (when the two-point discrimination is 10–20 mm), fair (when the two-point discrimination is more than 20 mm with light touch and pain prick sensation), and poor (when there is trophic changes or skin ulceration).

**Technique**

Spaghetti wrist injuries can be daunting even to the experienced hand surgeon. Sometimes the size of the wound does not match the number of injured structures. Small-sized wound may have almost all structures injuries, as in stab wound, while superficial cut wound may have small number injuries.

**Table 1.** Summary of Injuries

Patients	Age	No. of tendons	Nerves	Arteries	Total no. of structures
1	23	12	M,U	R,U	16
2	30	8	M	–	9
3	19	1	U	U	3
4	27	7	M	R	9
5	8	10	M,U	U	13
6	20	9	M	–	10
7	11	9	M,U	U	12
8	26	10	M	R	12
9	8	11	M	–	12
10	9	8	U	U	10
11	11	8	M	–	9
12	7	8	M	–	9
13	13	9	M	–	10
14	20	12	M,U	R,U	16
15	18	5	M	–	6
16	17	9	M,U	U	12
17	2	5	M	–	6
18	25	12	M,U	R,U	16
19	21	5	M	–	6
20	24	2	M	–	3
21	17	7	M,U	U	10
22	7	11	M,U	U	14
23	13	6	M,U	U	9
24	37	1	U	U	3
25	28	12	M,U	R,U	16
26	24	5	M	–	6
27	36	1	U	U	3
28	20	6	M,U	R,U	10
29	22	6	M	R	8
30	40	6	M	–	7
31	18	12	M,U	R,U	16
32	40	1	U	U	3
33	6	7	M,U	U	10
34	12	6	M,U	U	9
35	7	1	U	U	3
36	5	1	U	U	3
37	7	4	M	–	5
38	23	7	M,U	U	10
39	16	9	M,U	U	12
40	15	5	M	R	7
41	13	6	M	R	8
42	12	12	M,U	R,U	16

A systemic approach can simplify the problem. Under tourniquet control, extensile exposure is obtained. The extension of the exposure depends upon depth, size, shape, and site of the wound. Extensile exposure is obtained for deep wound involving major wrist injuries. It is obtained by cruciate incision for the transverse wound or by extending the laceration in proximal and distal fashion using transverse incision in oblique wound. The carpal tunnel is opened when the laceration occurs at the distal wrist crease. Structures are identified from deep-to-superficial, and a checklist of lacerated structures is recorded. Knowledge of the cross-sectional anatomy of the wrist is the key to expedient identification of the injured structures. Both injured and noninjured structures



Figure 2. Patient no. 31, with 16 transected structures, 12 tendons, median and ulnar nerves, radial and ulnar arteries. [Color figure can be viewed in the online issue, which is available at [www.interscience.wiley.com](http://www.interscience.wiley.com).]

are identified by their anatomic locations and characteristic appearances. The proximal and distal ends of the injured structures are marked and caught by syringe needles as they are identified (Fig. 3). Nerves that are whitish-gray in appearance with longitudinal ridges and fascicles on end, soft in consistency, often with an artery running longitudinally along its length; they can be oriented by the angle of the cut ends, the anatomic location (its volar and dorsal surfaces) by avoiding the twist, the matching of the corresponding fascicles as regard the numbers and the size and the location of the nutrient artery, if present (Fig. 4). Tendons are whiter in appearance and firmer in consistency and can be identified, through their actions, by pulling on the distal ends. The proximal ends of the lacerated tendons can be more difficult to identify. They can be matched to their respective distal ends by anatomic location, size, obliquity of the cut, and degree of slack on approximation of the ends. Finger flexor tendons are repaired in deep-to-superficial fashion with 4-0 ethibond, using a modified Kessler technique and reinforced with either a 6-0 proline or 6-0 nylon continuous epitendinous suture. Neurovascular structures are repaired next under the operating microscope, using either 9-0 or 10-0 nylon interrupted sutures in epineural fashion (Fig. 5). Wrist flexors are the final structures to be reapproximated and should be repaired with the wrist in significant flexion using 3-0 ethibond in modified Kessler technique.

#### Postoperative Rehabilitation Protocol

After surgery, patients are placed in a dynamic dorsal splint with the wrist in 20–45° of flexion, the metacarpophalangeal joints in 40–60° of flexion, and the interphalangeal joints allowed to extend fully. The rehabilitation

protocol is performed under direct supervision of the author. At 0–4 weeks, active extension and passive finger flexion is performed. At 4–6 weeks, the splint is removed, and the patient begins protective early motion. At 6–8 weeks, tendon gliding exercises are initiated, and light activity of daily living exercises encouraged. At 8 weeks, blocking and light-resistive exercises begin; full resistance is prohibited. At 12 weeks, there is return to full activity.

#### RESULTS

Forty-two patients were reviewed. Follow-up has ranged from 1 to 8 years, with an average of 46 months. Only four patients have been completely lost to follow-up, and a limited follow-up was available in these. Range of motion of all involved digits (tendon function) was excellent in 34 patients, good in 3 patients, and poor in only 1 patient. In 38 patients with sufficient follow-up (range, 12–96 months; average, 46 months), opposition was excellent in 31 patients, good in 5 patients, and poor in 2 patients (Fig. 6). Intrinsic muscle recovery was subjectively reported to be excellent in 29 patients, good in 7, and fair to poor in 2 patients (Fig. 7). Minor deformity (partial clawing) was reported in 4 patients and 1 patient has major deformity (total clawing). Sensory recovery was reported excellent in 32 patients, good in 5 patients, and fair in only 1 patient (Tables 3 and 4). Twelve patients with excellent sensory recovery (two-point discrimination is less than 10 mm) had sustained simultaneous injury to both median and ulnar nerves (Fig. 8, Table 5). Pinch and grip strengths were significantly decreased (average 50%) in three patients in comparison with the opposite hand. In 25 wrists, one or both arteries were divided. Arterial repair was insignificant if one artery was intact. The radial and ulnar arteries were simultaneously injured in seven wrists, and so the radial artery was repaired in seven patients (Fig. 9). The patency rate was 100%. Neither neurolysis nor tenolysis was necessary. Tendon ruptures were not observed in any of the 38 patients available for follow-up.

#### DISCUSSION

Spaghetti wrist describes a volar wrist laceration in which at least 10 structures are divided inclusive of tendons, at least one major nerve, and usually one major vessel.<sup>7</sup> This combination has received little attention in the literature and published series have been small. In the series reported by Puckett and Meyer,<sup>1</sup> only 11 patients satisfied the aforementioned criteria. Rogers et al.<sup>5</sup> reported 26 patients, but only 8 were available for clinical review. Widgerow<sup>4</sup> reported 19 cases using a definition of at least 10 injured structures, including at least one major nerve and usually one major vessel. Hudson

**Table 2.** The Author Evaluation System for Follow-up of Results of Spaghetti Wrist

	Tendon function	Opposition	Intrinsics	Deformities	Sensation
Excellent	Individual tendon function was evident with 85% to full range of motion or finger flexion to 1.0 cm or less from the distal palmer crease	When the tip of the thumb moves freely over the three phalanges of the other four fingers	When the patient can do both finger abduction and adduction with –ve froment sign	Major if there is both clawing and ape hand	When the two-point discrimination is less than 10 mm
Good	70–84% total normal range of motion or 2.0 cm from the distal palmer crease	When the tip of the thumb touches only the tip of the other four fingers	When the patient can do both finger abduction and adduction with +ve froment sign		When the two-point discrimination is 10–20 mm
Fair	50–69% total normal range of motion	When the tip of the thumb cannot reach the tip of the other four fingers	When the patient can do either finger abduction or adduction with +ve froment sign	Minor if there is either clawing or ape hand	When the two-point discrimination is more than 20 mm with light touch and pain prick sensation
Poor	Fixed contractures or adhesions		When the patient cannot do finger abduction or adduction with +ve froment sign		When there is trophic changes or skin ulceration



Figure 3. Patient no. 18 with 16 transected structures, 12 tendons, median and ulnar nerves, radial and ulnar arteries. [Color figure can be viewed in the online issue, which is available at [www.interscience.wiley.com](http://www.interscience.wiley.com).]



Figure 4. Patient no. 24 with three transected structures, ulnar nerve, ulnar artery, and FCU. [Color figure can be viewed in the online issue, which is available at [www.interscience.wiley.com](http://www.interscience.wiley.com).]

and de Jager<sup>6</sup> analyzed the results of treatment in 15 patients with simultaneous laceration of the median and ulnar nerves and flexor tendons at the wrist. Chin et al.<sup>3</sup> reported 60 patients, but only 19 patients were available for clinical review. Yui et al.<sup>8</sup> reviewed 52 patients who had flexor tendons divisions in zone 5. Yuksel et al. explored 28 patients with spaghetti wrist injuries who were previously operated. Other reports<sup>9–11</sup> refer to the treatment of injuries before the use of magnification. Puckett and Meyer<sup>1</sup> reviewed their series of 38 spaghetti wrist injuries. Ninety-seven percentage of patients had good or excellent range of motion. No patient required tenolysis or suffered tendon rupture. Of these patients, 19 patients had moving two-point discrimination better than 12 mm; 8 patients had only protective sensation; and 1 patient had no useful sensation. Only six patients had



Figure 5. The same previous patient after ulnar nerve repair. [Color figure can be viewed in the online issue, which is available at [www.interscience.wiley.com](http://www.interscience.wiley.com).]

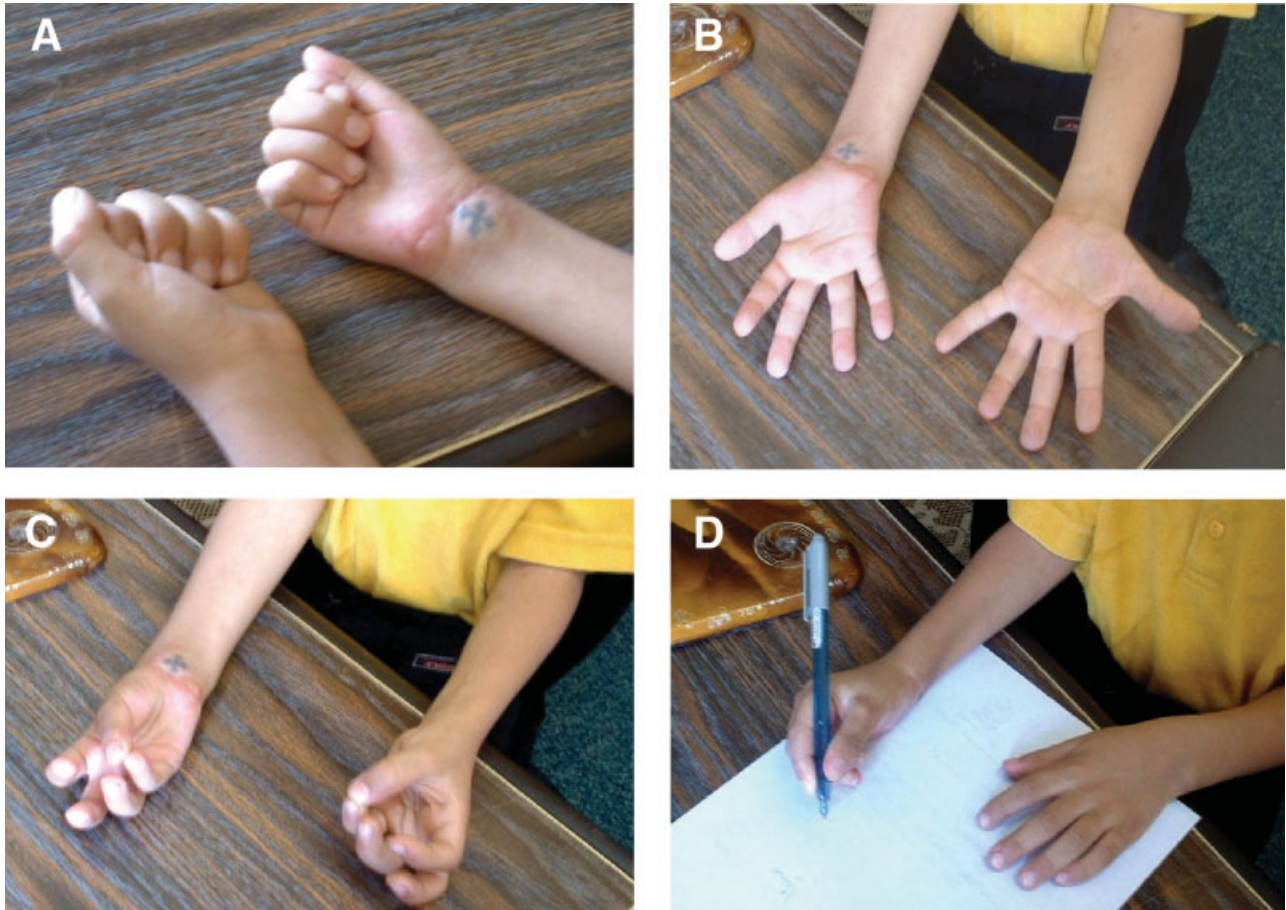


Figure 6. Patient no. 12, with 9 transected structures, 8 tendons, and median nerve. **A.** Excellent tendon function 12 months' follow-up. **B.** Complete fingers extension and abduction. **C.** Normal opposition. **D.** Normal fine function. [Color figure can be viewed in the online issue, which is available at [www.interscience.wiley.com](http://www.interscience.wiley.com).]

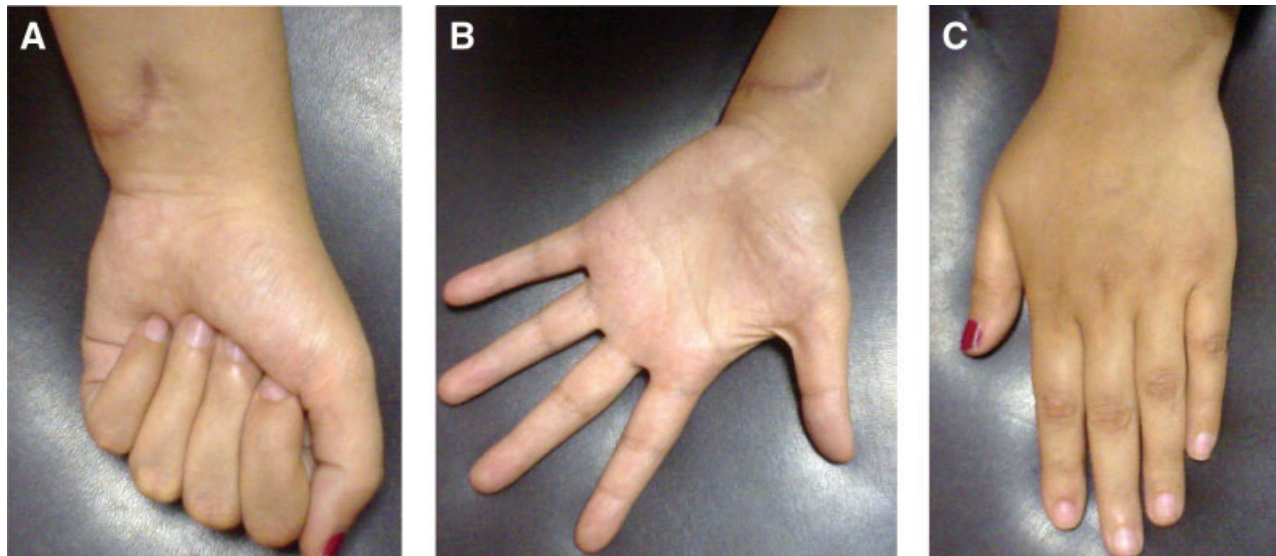


Figure 7. Patient no. 3 with three transected structures, FCU, ulnar nerve and ulnar artery. **A.** Complete fingers flexion 19 months' follow-up. **B.** Complete fingers abduction and extension. **C.** Normal fingers adduction. [Color figure can be viewed in the online issue, which is available at [www.interscience.wiley.com](http://www.interscience.wiley.com).]

**Table 3.** Summary of Results

Patient	Tendon function	Opposition	Intrinsics	Deformity	Sensation
1	Excellent	Excellent	Excellent	No	Excellent
2	Good	Good	Excellent	No	Excellent
3	Excellent	Excellent	Good	Minor	Excellent
4	Excellent	Excellent	Excellent	No	Excellent
5	Excellent	Excellent	Excellent	No	Excellent
6	Excellent	Excellent	Excellent	No	Excellent
7	Excellent	Excellent	Excellent	No	Excellent
8	Excellent	Excellent	Excellent	No	Good
9	Excellent	Excellent	Excellent	No	Excellent
10	Excellent	Excellent	Good	No	Excellent
11	Excellent	Excellent	Excellent	No	Excellent
12	Excellent	Excellent	Excellent	No	Excellent
13	Excellent	Excellent	Excellent	No	Excellent
14	Excellent	Excellent	Excellent	No	Excellent
15	Excellent	Excellent	Excellent	No	Excellent
16	Excellent	Excellent	Excellent	No	Excellent
17	Excellent	Excellent	Excellent	No	Excellent
18	Good	Poor	Fair	Minor	Good
19	Excellent	Good	Excellent	No	Good
20	Excellent	Good	Excellent	no	Excellent
21	Excellent	Good	Good	Minor	Good
22	Poor	Poor	Poor	Major	Fair
23	Excellent	Excellent	Excellent	No	Excellent
24	Excellent	Excellent	Good	Minor	Excellent
25	Excellent	Excellent	Excellent	No	Excellent
26	Excellent	Excellent	Excellent	No	Excellent
27	Excellent	Excellent	Excellent	No	Excellent
28	Excellent	Excellent	Excellent	No	Excellent
29	Excellent	Excellent	Excellent	No	Excellent
30	Good	Good	Excellent	No	Good
31	Excellent	Excellent	Excellent	No	Excellent
32	Excellent	Excellent	Good	No	Excellent
33	Excellent	Excellent	Excellent	No	Excellent
34	Excellent	Excellent	Excellent	No	Excellent
35	Excellent	Excellent	Good	No	Excellent
36	Excellent	Excellent	Excellent	No	Excellent
37	Excellent	Excellent	Good	No	Excellent
38	Excellent	Excellent	Excellent	No	Excellent

significant return of intrinsic muscle activity. Widgerow<sup>4</sup> reported 19 cases. Ninety-five percentage of patients had good or excellent range of motion. Of these patients, six patients demonstrated return of only protective sensation. The remaining patients had discernible levels of two-point discrimination; however, these were not within normal limits, except for the three youngest patients in the series. Of 11 patients with combined nerve lesions, 7 patients (64%) recovered only protective sensation. Of 14 patients with ulnar nerve injuries, 5 patients demonstrated clawing. Opposition returned convincingly in 10 of 15 patients. Rogers et al.<sup>5</sup> reported 26 simultaneous lacerations of the median and ulnar nerves and the flexor tendons at the wrist, with follow-up of only 8 patients. Almost half of the fingers had full active range of motion; however, a number had significant fixed deformities usually occurring in those poorly compliant with

postoperative therapy. All patients except one regained some protective sensibility; however, recovery of two-point discrimination was almost uniformly poor and in no patient was this restored to all digits. Hudson and de Jager<sup>6</sup> studied 15 patients with simultaneous lacerations of both median and ulnar nerves. Of 76 repaired tendons, there were 36 excellent, 5 good, 20 fair, and 15 poor results. Nine patients had fixed flexion deformities of one or more fingers, which were attributed to poor patient compliance. Interestingly, only the flexor digitorum profundus tendons and the wrist flexors were repaired. Poor functional outcomes were noted after ulnar nerve injuries: function of the first dorsal interosseous muscle was markedly impaired in 9 of 15 patients, and clawing occurred in 7 of 15 patients. With median nerve lesions, nine patients achieved full opposition. After median nerve injuries, two-point discrimination ranged between 10 and 15 mm in seven patients with protective sensation in eight patients. After ulnar nerve injuries, two-point discrimination was less than 10 mm in only two patients, both children, and ranged between 10 and 15 mm in two patients, with protective sensation in nine patients. Chin et al.<sup>3</sup> reported 60 patients, but only 19 patients were available for clinical review. Good-to-excellent range of motion of all involved digits was observed in all 19 patients, including 5 patients with 10 or more injured flexor tendons, 4 of whom had involvement of both median and ulnar nerves, fair-to-poor recovery of intrinsic muscle function, especially after ulnar nerve injuries. Sensory recovery was intermediate with respect to these studies,<sup>1,4,6</sup> with the younger patients generally demonstrating the best outcomes. In this study of 38 patients with sufficient follow-up (range, 12–96 months; average, 46 months), range of motion of all involved digits (tendon function) was excellent in 34 patients, good in 3 patients, and poor in only 1 patient. Opposition was excellent in 31 patients, good in 5 patients, and poor in 2 patients. Intrinsic muscle recovery was subjectively reported to be excellent in 29 patients, good in 7, and fair-to-poor in 2 patients. Minor deformity (partial clawing) was reported in 4 patients out of 22 ulnar nerve injuries and 1 patient had major deformity (total clawing). Sensory recovery was reported excellent in 32 patients, good in 5 patients, and fair in only 1 patient. Twelve patients with excellent sensory recovery (two-point discrimination is less than 10 mm) had sustained simultaneous injury to both median and ulnar nerves. Pinch and grip strengths were significantly decreased (average 50%) in 3 patients in comparison with the opposite hand. Most studies demonstrated good-to-excellent recovery of range of motion after multiple flexor tendon lacerations (up to 12) in zone 5.<sup>1,4</sup> This finding is consistent with the findings in this study. This finding seemed to be irrespective of whether the median and/or ulnar nerve(s) were injured.

**Table 4.** The Percentage of Results

	Tendon function (%)	Opposition (%)	Intrinsics (%)	Deformity (%)	Sensation (%)
Excellent (no deformity)	89.5	81.6	76.5	87	84.5
Good (minor deformity)	8	13	18.5	10.5	13
Fair	0	0	2.5	0	2.5
Poor (major deformity)	2.5	5.4	2.5	2.5	
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>

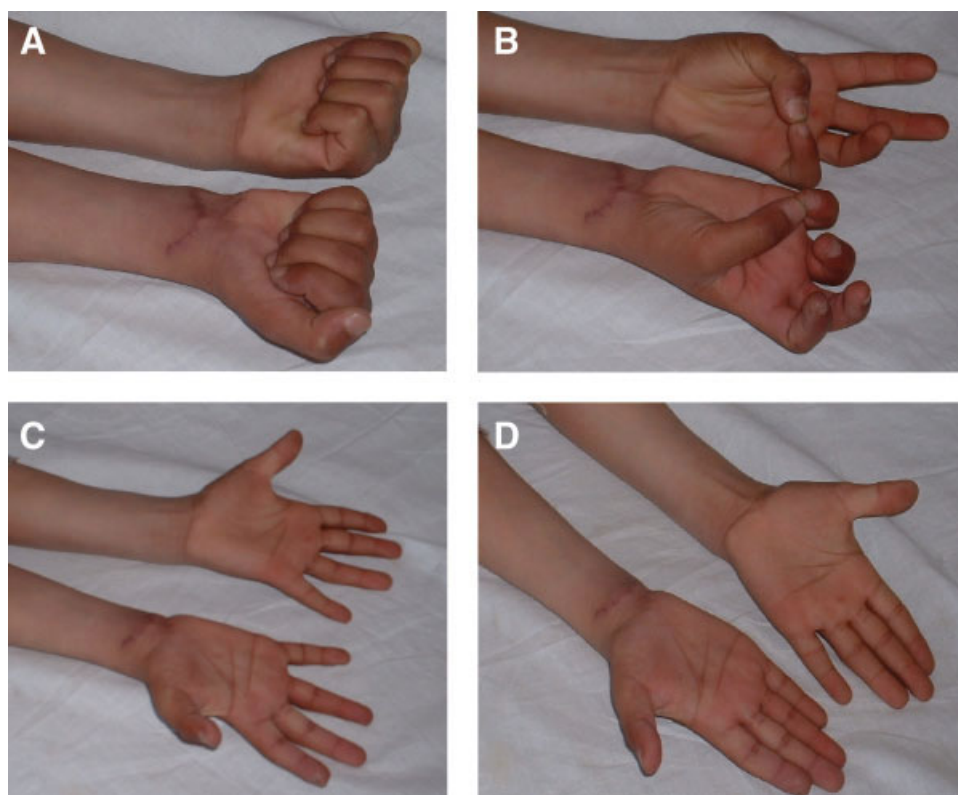


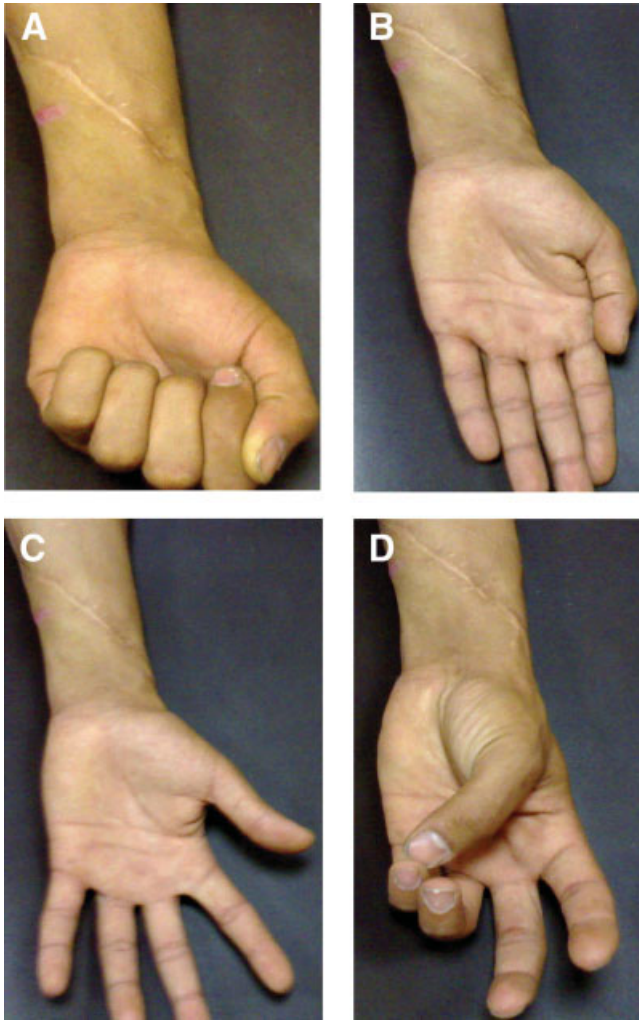
Figure 8. Patient no. 7 with 12 transected structures, 9 tendons, median and ulnar nerves, and ulnar artery. **A.** Excellent tendon function 38-month postoperatively. **B.** Normal opposition. **C.** Complete fingers extension and abduction. **D.** Normal fingers adduction. [Color figure can be viewed in the online issue, which is available at [www.interscience.wiley.com](http://www.interscience.wiley.com).]

**Table 5.** Summary of Results of Spaghetti Wrist with Simultaneous Median and Ulnar Nerve Injuries

	Tendon function (%)	Opposition (%)	Intrinsics (%)	Deformity (%)	Sensation (%)
Excellent (no deformity)	86.6	80	80	80	80
Good (minor deformity)	6.7	6.5	6.7	13.5	13.5
Fair	0	0	6.7	0	6.5
Poor (major deformity)	6.7	13.5	6.7	6.5	
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>

Furthermore, no patient suffered tendon rupture or required tenolysis. Most investigators would agree that the most important prognostic indicator for the return of overall function is not the number of transected tendons, but whether or not the ulnar nerve, median nerve, or both is involved.<sup>3</sup> Isolated nerve injuries have been studied by

many groups who have concluded that primary nerve repair produced improved results over delayed repair and grafting.<sup>12,13</sup> Others have sought to optimize the results by investigating the relative merits of a fascicular versus an epineurial repair, but found no significant differences.<sup>14–16</sup> They also found that the return of ulnar motor



**Figure 9.** Patient no. 1 with 16 transected structures, 12 tendons, median and ulnar nerves, and radial and ulnar arteries. **A.** Excellent tendon function, 36 months' postoperatively. **B.** Complete fingers adduction. **C.** Complete fingers abduction. **D.** Normal opposition. [Color figure can be viewed in the online issue, which is available at [www.interscience.wiley.com](http://www.interscience.wiley.com).]

function was poorer than it was for the median nerve. Median nerve injuries produced less-functional disability, because many patients with isolated injuries can oppose their thumbs reasonably well using the ulnar or dual-innervated muscles.<sup>4</sup> Most studies would agree that combined median and ulnar nerve lesions showed the least favorable outcome.<sup>3,4</sup> In this study, all the nerves were primarily repaired. Epineurorrhaphy was the standard technique using the microscope with nylon 9/0 or 10/0. The results of nerve repair were better than those reported by the aforementioned authors. Both ulnar and radial arteries had been completely transected in seven

patients and only the radial artery had been repaired. The patency rate was 100%. Vascular status was assessed clinically to be normal in all patients. Cold intolerance was not associated with any pattern of injury. When all parameters were considered, including tendon, nerve, and arterial repair results, along with return to work status and patient satisfaction with hand function, 35 patients were considered to have good results and to be functioning well with their injured hand. The three patients with unsatisfactory results were due to inadequate tendon function. There are no differences between the results of associated isolated median or ulnar nerve repair or that of simultaneous median and ulnar nerve repair. The results of median nerve repair were nearly the same as that of ulnar nerve repair.

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