Roping Injuries in the Hand: Mechanism of Injury and Functional Results

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Twenty-two patients with roping injuries to 38 digits, including 19 patients injured while team roping, are discussed. Ten digits in nine patients were successfully revascularized or replanted. Seven digits in three patients failed after initial success. One patient is included in both categories. The failure rate is 41 percent for all 17 digits. Average follow-up is 18 months.

The dominant hand was injured in 83 percent of team roping injuries; the thumb is the most commonly injured digit. Average interphalangeal motion for thumb replants is zero; for revascularizations, it is 47 degrees. There was 43 percent return of pinch strength for thumb replants compared to 83 percent return for a single thumb revascularization.

The most common mechanism of injury was catching the roping thumb in the "thumb up" position during dallying. There are good motion and pinch strength with thumb revascularizations provided tendons and the interphalangeal joint are intact. Reconstruction of the flexor pollicis longus in the replanted thumb gave poor results. Primary tenodesis or arthrodesis is recommended.

Roping injuries with injuries to thumb and fingers are common. The spectrum of injury can vary from partial finger loss to multiple-digit amputation. Injury is invariably associated with roping horses or cattle. This paper studies the mechanism of injury and the results of treatment.

Methods

Patients whose digits were replanted or revascularized between January of 1975 and January of 1985 were included in the study. Successful repairs were placed into two groups: group 1, replantation, the restoration of a completely amputated part; and group 2, revascularization, the restoration of an incompletely amputated part.

Indications for replantation included all thumbs proximal to the nail bed and multiple-digit injury. Indications for revascularization were the same but included single digits if the flexor tendons and digital nerves were intact.

Results

Twenty-two patients sustained injuries to 38 digits (16 thumbs and 22 fingers). Nineteen patients were injured while roping. The remaining three patients were dismounted at the time of injury (Table I).

The mechanisms of injury in these 19 patients injured during team roping are shown in Table II. The most common mechanism of injury was catching the thumb of the dominant roping hand in a coil of rope released from the other nonroping hand. The mechanism of injury in dismounted subjects was a sudden tug on reins or rope wrapped around the thumb or fingers.

The average age was 28.8 years. Seventy-seven percent of all patients were between the ages of 20 and 40. There was no correlation between age and survival of digits.

The dominant hand was injured in 76 percent of all patients and in 83 percent of team roping injuries. The thumb was the most frequently injured digit (16 of 38, or 42 percent of all digits). In patients who were mounted when roping, 93 percent of injured thumbs belonged to the dominant roping hand. Either thumb (dominant,

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TABLE I
Details of Patients in Series

Patient No.	Age	Sex	Dom	Mech	Occupation	Units Complete Amputation	Units Incomplete Amputation
1	17	M	D	TD	Manual laborer	Thumb	I, M, R, S
2	33	M	D	Coil	Highway maintenance	—	Thumb
3	19	F	D	Coil	Student	Thumb	—
4	18	M	D	Coil	Student	Thumb	—
5	43	M	?	Coil	Carpet consultant	—	Thumb
6	29	M	D	R	Manual laborer	Thumb	—
7	29	F	D	Coil	Unknown	—	Thumb, I (NVI)
8	15	M	D	Coil	Student	—	Thumb
9	22	M	D	Coil	Carpenter	Thumb	—
10	34	M	D	R	Feed Co. executive	Thumb	—
11	31	M	D	R	Rancher	Thumb, M	—
12	46	M	D	TD	Heavy equip operator	—	Thumb
13	55	M	D	Coil	Sheet metal worker	—	Thumb
14	24	F	ND	R	Biologist	Thumb	—
15	31	M	D	R	Car dealer	—	Thumb
16	12	M	ND	DM	Student	Thumb	—
17	32	F	ND	*	Clothing sales	Middle	R (NVI), S
18	41	M	D	Coil	Rancher	M, S	Ring
19	22	F	ND	†	Bookkeeper	Small	M (NVI), R
20	14	F	ND	DM	Student	—	I, M, R, S
21	30	M	D	*	Manual laborer	Small	Ring
22	51	F	D	DM	Housewife	—	Index

Note: Key to abbreviations:
D = dominant; ND = nondominant; I = index finger; M = middle finger; R = ring finger; S = small finger
NVI = no vascular injury; TD = thumb down; Mech = mechanism of injury; DM = dismounted; R = roping, mechanism unknown; Coil = coil of rope from nondominant hand snaring dominant hand
* Caught fingers between rope and saddle horn.
† Coil tightened around hand when lost daily during turning of steer.

nondominant) was injured alone in 63 percent and with other digits in 16 percent of team roping injuries (Table III).

There were 14 single-digit injuries, 13 thumbs and 1 index finger. There were 8 patients with multiple-finger injuries, one with injuries to all five digits.

The most frequent site of injury was the proximal phalanx: 56 percent of thumbs and 50 percent of fingers. Multiple level injury was seen in one patient with an incomplete amputation of the ring finger at the distal interphalangeal joint associated with a closed fracture of the proximal phalanx.

There were 7 thumbs and 15 fingers incompletely amputated. Flexor tendons and digital nerves were intact in 86 and 61 percent of patients, respectively. Bones and arteries, however, were intact in only 1 and 16 percent of patients, respectively (Table IV). In the complete amputations, flexor tendons were avulsed in 66 percent of thumbs and 17 percent of finger amputations.

Ten digits in nine patients in both groups (six thumbs and four fingers) underwent successful revascularization or replantation. A further seven digits (six fingers and one thumb) in three patients failed after initial successful surgery. One patient was included in both successful and failed categories. Follow-up in successful cases averaged 18 months. The failure rate is shown in Table V.

There was no correlation between the use of primary vein grafts and success or failure.

TABLE II
Mechanism of Injury

Coil from nondominant hand	9
Fingers caught between coils or coils and horn	3
Dally thumb down	2
Roping, mechanism unknown	5
TOTAL	19

TABLE III
Thumb Injuries: Team Roping

Dominant	93%
Either thumb alone	63%
With other digits	16%

TABLE IV
Structures Intact in Incomplete Amputations

Flexor tendons	86%
Digital nerves	61%
Extensor tendons	54%
Skin/dorsal veins	44%
Digital arteries	16%
Bone	1%

Secondary Procedures in Successful Cases

There were four procedures in three patients. Two patients had tendon transfers using the ring finger flexor digitorum superficialis, as part of a staged reconstruction of the flexor pollicis longus. Both these procedures were combined with sural nerve grafts to both digital nerves. One of these patients later had a fusion of the interphalangeal joint. A third patient had revision of skin flaps.

Complications in Successful Cases

There were four complications in three patients. The two patients with a staged tendon reconstruction of the flexor pollicis longus developed a flexion contracture of the thumb interphalangeal joint. One of these patients developed a flexion contracture of the proximal interphalangeal joint of the donor ring finger.

The third patient developed a nonunion of a middle phalanx in a complete amputation with bone loss.

Functional Results

Digits successfully replanted or revascularized were evaluated for range of motion and grip and pinch strength.

Three replanted thumbs underwent fusion or tenodesis of the interphalangeal joint either as a primary or a secondary procedure. A fourth developed a fixed flexion contracture of the interphalangeal joint following tendon reconstruction. Their average motion was therefore zero. The average interphalangeal motion in the two revascularized thumbs with intact tendons was 47 degrees. The single replanted finger in group 1 had a total active motion of 155 degrees. The average total active motion for the three revascularized fingers was 194 degrees (Table VI). Return of grip and pinch strength for each group is shown in Table VII. Pinch strength was markedly decreased in thumb replants (group 1). Grip strength was decreased in fingers in both groups (Tables VII and VIII).

TABLE V
Failure Rate

Group 1	17%
Group 2	55%
Thumbs	14%
Fingers	60%
Overall	41%

TABLE VI
Average Motion (Each Group)

Thumbs	IP joint	Fingers	Total Active Motion
Group 1	0°	Group 1	155°
Group 2	47°	Group 2	194°

One of eight digital nerves repaired developed a two-point sensibility rating of less than 15 mm. No patient with nerve grafts was available for measurement. There was no correlation between return of sensibility and age or ischemia time.

Cold intolerance was present in all successful patients and 62 percent of amputations available for follow-up. Symptoms persisted for periods up to 7½ years. There was no correlation between age and severity of symptoms.

Time to return to work averaged 11 weeks for successful patients and 6 weeks for amputations. All patients available for follow-up returned to their preinjury occupation.

Discussion

In team roping, a steer is released from an enclosure and the "header" ropes the steer around its horns. After roping the horns, the header "dallies."

When the steer is released from the box (Fig. 1), the header is on the left of the steer and the "heeler" is on the right (Fig. 2). The header ropes the steer by the horns and immediately wraps the rope around the saddle horn using the horse to slow the steer down (Fig. 3). Then

TABLE VII
Average Return of Pinch and Grip Strength

			Grip	Pinch
Group 1:	Thumb	(4)	75%	43%
	Finger	(1)*	65%	97%
Group 2:	Thumb	(1)	91%	83%
	Finger	(3)*	51%	83%

Note: Number of patients in each group in parenthesis.
* One patient included in both categories (one replanted and one revascularized finger).

header starts to turn the steer so that the heeler can rope the heels (Fig. 4). Finally, the horns and heels are roped (Figs. 5 and 6).

The dominant hand is used to rope the horns and then dally. Dallying is the process of wrapping the tail of the rope around the saddle horn (Fig. 7). The roping hand is in neutral forearm rotation with the thumb extended. A right-handed contestant dallies counterclockwise, and a left-handed contestant dallies clockwise. The nonroping hand holds the tail of the rope in coils, feeding rope to the roping hand.

Dallying with the roping hand fully pronated, or "thumb down," will cause it to be caught between the dallying loops and the horn (Fig. 8). This is well described in the rodeo roping literature,[1] and ropers are trained to rope with the thumb up.

The thumb is also vulnerable in the "thumb up" position because it presents a "second horn" for a coil of rope to fall over (Fig. 9). This was the most common mechanism of injury, and not

TABLE VIII
Average Return of Pinch and Grip Strength (Both Groups)

	Grip	Pinch
Thumb (5)	83%	63%
Finger (4)	58%	90%

Note: Number of patients in each group in parenthesis.

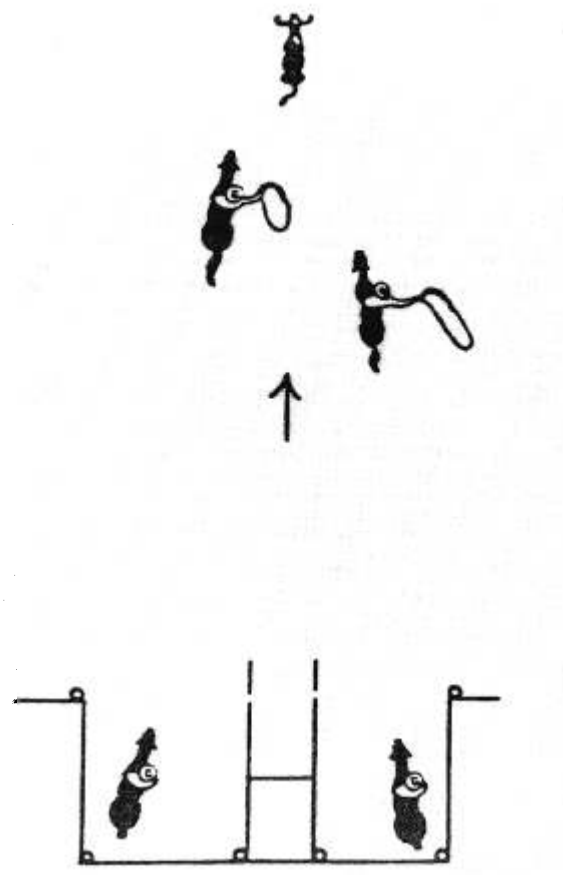

FIG. 1. The steer is released from the box. (Reprinted from L. Camarillo, *Team Roping, Fundamentals and Fast Times*. Western Horseman, Inc., 1982, by permission).

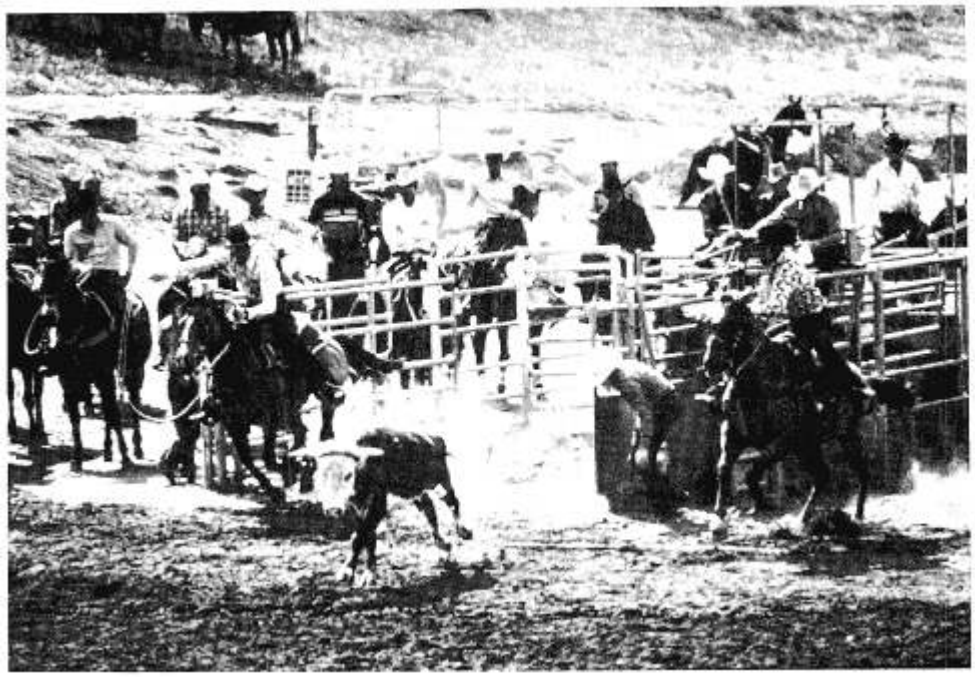

FIG. 2. The header is on the left of the steer and the heeler is on the right.

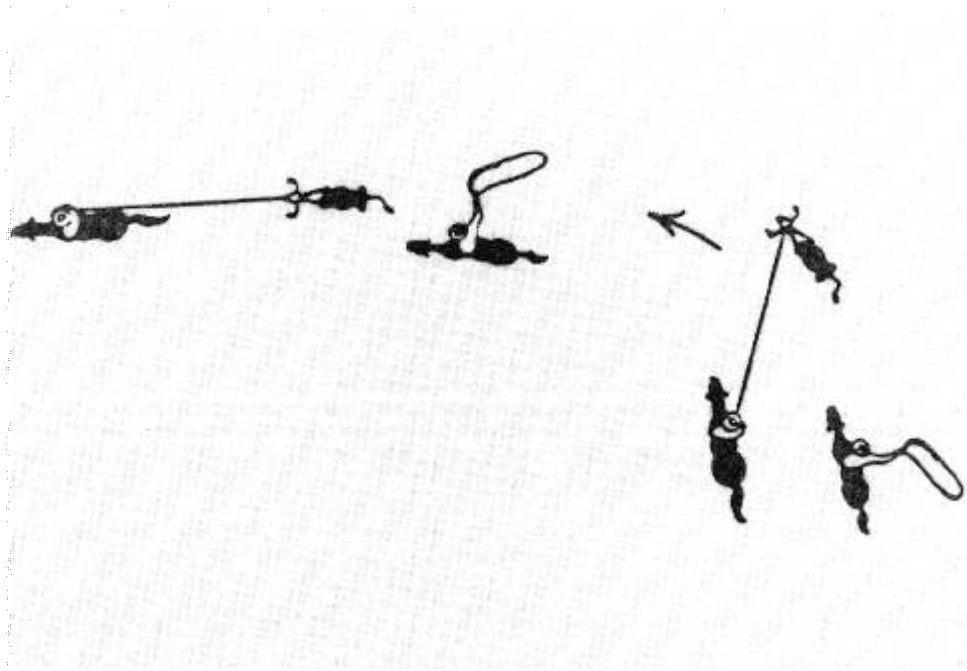

FIG. 3. The header ropes the steer and slows it down using his dominant right hand. (Reprinted from L. Camarillo, *Team Roping, Fundamentals and Fast Times*. Colorado Springs: Western Horseman, Inc., 1982, by permission).

FIG. 4. The header starts to turn the steer so that the heeler can rope the heels.

dallying thumb down, as previously reported.[1] Trapping of fingers between rope and horn causes multiple finger injuries.

Previously reported failure rates for thumb injuries are 31 percent[2] (all injury types) and 58 percent[3] (crush avulsion injuries only) (Table IX). Our failure rate of 14 percent was lower than either of these. No explanation is given for this.

Failure rates for avulsion injuries to fingers have been reported as 12.5 and 68 percent[4,2] as compared to 60 percent in this study (Table X).

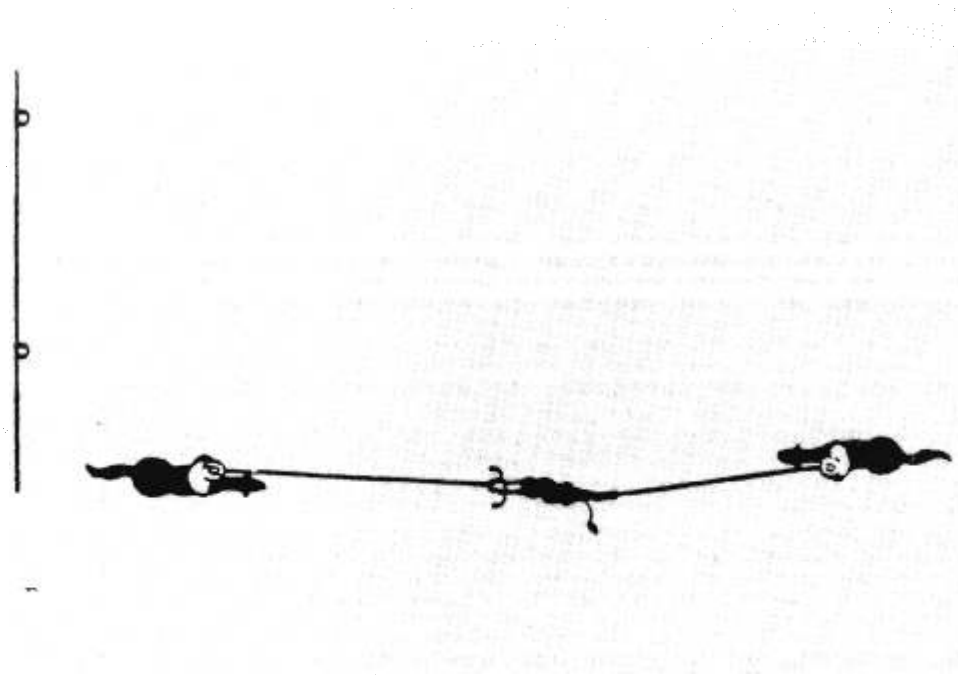

FIG. 5. Finally, the horns and heels are roped (Reprinted from L. Camarillo, *Team Roping, Fundamentals and Fast Times*. Colorado Springs: Western Horseman, Inc., 1982, by permission.)

FIG. 6. The horns and heels roped.

All our failures occurred in two patients who lost three fingers each due to a prolonged warm ischemia time.

The proximal phalanx was the most common level of injury, and this correlated with previous studies[3,5] (Table XI).

Tendons and nerves were most resilient to avulsion injury. Bone and arteries were least resilient (see Table III). This implies a potentially good result in cases of revascularization versus replants where all structures are severely injured. This impression was confirmed in our series. There was better return of motion in the thumb and finger revascularizations, which agrees with

FIG. 7. Dallying with the dominant hand. The other hand holds the tail of the rope in coils feeding rope to the roping hand.

FIG. 8. Mechanism of injury when dallying thumb down. The thumb is caught between rope and horn.

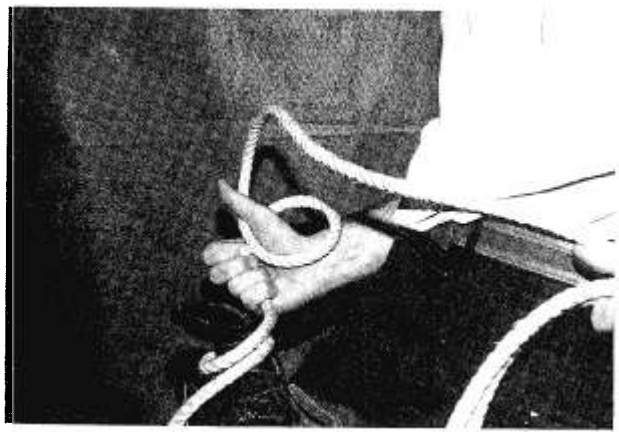

FIG. 9. The most common mechanism of injury. A coil catches and tightens around the thumb, which acts as a "second horn."

a previous study[4] (Tables VI and XII). There was improved return of pinch strength in thumb revascularizations (see Table VII).

Avulsion of tendons was common in complete amputations due to the nature of the injury (Fig. 10). In the case of thumb replants with flexor tendon avulsion or severe tendon injury, primary insertion of a Silastic tendon rod has been recommended.[5] However, the results of staged flexor pollicis longus reconstruction (return of motion) were poor in this series. In contrast, thumb revascularizations with intact tendons and interphalangeal joint developed an average range of motion of 47 degrees (Table VI).

TABLE IX
Failure Rate: Thumb Avulsion

Schlenker	58% (26% overall)
Hamilton	31% (overall)
Kirwan	14%

Tendon reconstruction in thumb replants is not recommended. The function of the thumb as a post is not impaired by an immobile interphalangeal joint, although pinch strength is decreased. Tendon reconstruction in finger replants should still be attempted because of the importance of motion for functional activities. No instances of tendon reconstruction in fingers occurred in this series, and no conclusion can be reached as to likely results.

Our figures agree with a previous study[5] in showing diminished return of pinch strength in thumb versus finger injuries. Pinch strength was particularly poor in the replanted thumbs with fixed interphalangeal joints (Table VII). In contrast, a single thumb revascularization with intact tendons and good active flexion of the interphalangeal joint developed a return of pinch strength *twice* that of the replants (Table XIII).

The average grip strength for fingers was particularly low because of one case in which the patient sustained injuries to the thumb and four fingers. Only the ring finger survived.

CONCLUSION

In conclusion, the most common mechanism of injury was a coil of rope snaring the thumb of the roping hand, which presents as a "second horn" for a coil of rope to close over, not roping thumb down as previously reported.[1]

TABLE X
Failure Rate: Finger Avulsion

Urbaniak	12.5%
Hamilton	68%
Kirwan	60%

TABLE XI
Percentage Injuries at Proximal Phalanx Level

	Thumb	Finger
Schlenker	39%	—
Scott	60%	45%
Kirwan	56%	50%

The incidence of these injuries is higher than indicated by our figures over the past 10 years. Many cowboys will opt for nonmicrosurgical methods of treatment. The operation that will get them back to work as quickly as possible is the one they prefer. Once they have had a repair, they will mobilize the injured parts aggressively and often without supervision. In addition, although the thumb is considered to be 40 percent of the function of the whole hand, dallying may be easier without it.

Tendons and nerves are usually intact in the incomplete amputations; therefore, revascularizations can be expected to do better than replants. Good motion and pinch strength can be expected with thumb revascularizations, provided the tendons and interphalangeal joint are intact. However, reconstruction of the avulsed or badly damaged flexor pollicis longus in the replanted thumb is not worthwhile. Primary arthrodesis or tenodesis is recommended in these patients.

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TABLE XII
Average TAM for Complete and Incomplete Amputations

	TAM (Group 1)	TAM (Group 2)
Urbaniak	145	206
Kirwan	155	194

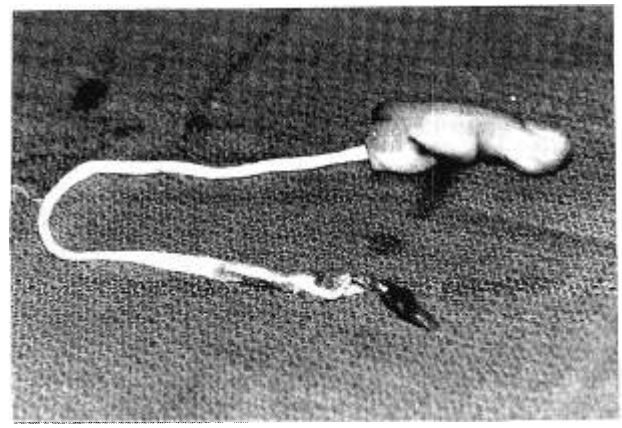

FIG. 10. Avulsion of the flexor tendons of the finger.

TABLE XIII
Pinch Strength in Thumb Injuries

Group 1 (4 thumbs)	43%
Group 2 (1 thumb)	83%

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REFERENCES

1. Morgan, R. F., Nichter, L. S., Friedman, H. I., and McCue, F. C. Rodeo roping thumb injuries. *J. Hand Surg.* 9A:178, 1984.
2. Hamilton, R. B., O'Brien, B. McC., Morrison, W. A., and MacLeod, A. M. Replantation and revascularization of digits. *Surg. Gynecol. Obstet.* 151: 508, 1980.
3. Schlenker, J. D., Kleinert, H. E., and Tsai, T. M. Methods and results of replantation following traumatic amputation of the thumb in sixty-four patients. *J. Hand Surg.* 5: 63, 1980.
4. Urbaniak, J. R., Evans, J. P., and Bright, D. S. Microvascular management of ring avulsion injuries. *J. Hand Surg.* 6: 25, 1981.
5. Scott, F. A., Howar, J. W., and Boswick, J. A. Recovery of function following replantation and revascularization of amputated parts. *J. Trauma* 21: 204, 1981.