Delayed Repair of Ulnar Artery at the Distal Forearm

HAND
2017, Vol. 12(2) 150–153
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Hand Surgery 2016
DOI: 10.1177/1558944716643275
hand.sagepub.com

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Abstract

Background: The purpose of this study was to evaluate the rate of patency after delayed repair of the ulnar artery following primary ligation. **Methods:** Adult patients with primary ligation of the injured ulnar artery at the forearm who had a delayed repair of the artery were included. Postoperative arterial patency was determined by either physical examination or color Doppler ultrasonographic imaging. Postoperative complications and Disabilities of the Arm, Shoulder and Hand score were recorded. **Results:** Eight consecutive patients during a 3-year period were included. The mean age was 35 years. Four cases were women. The surgery was performed at a mean of 5 days after the injury and ligation. At a mean follow-up of 22 months, 7 patients had a patent artery. One patient suffered a hematoma. **Conclusions:** A high rate of patency can be obtained after delayed repair of the ulnar artery at the forearm.

Keywords: ulnar artery, ligation, arterial injury, forearm, delayed repair

Introduction

Injuries of the radial or ulnar arteries are common in distal forearm lacerations. Most of these injuries are associated with nerve and flexor tendon injuries. Although it has been noted that the final results of these injuries are mainly dependent on the associated injuries, loss of ulnar or radial perfusion to the hand can lead to cold sensitivity, muscle and bone atrophy, and loss of strength.³

Classically, when either the radial or the ulnar artery is injured in a well-perfused limb, ligation of the injured artery has been recommended to avoid thrombosis of the repaired vessel. However, in recent years, some studies have shown that a high rate of patency could be obtained by repairing an isolated injured radial or ulnar artery.^{5,13}

Although the evidence for whether or not to repair an isolated arterial injury is somewhat contradictory, forearm arterial lacerations and the associated injuries present a problem for surgeons. One of the problems of these injuries is about the timing for these to be resolved, as it is considered that they should be repaired emergently. Most of these lesions are associated with tendon and nerve injuries that do not require emergency (<6 hours) repair and can be referred to an experienced specialist surgeon. However, it is considered that arterial repair should be resolved acutely, either by ligation or repair.

The purpose of this study was to evaluate the rate of patency after secondary repair of the forearm artery following primary ligation.

Material and Methods

The institutional review board approved the retrospective review of the medical charts.

For the purpose of this study, we searched for patients who had an isolated arterial injury of the forearm. Inclusion criteria for this study were as follows: (1) adult patients (18 years of age or older), (2) primary ligation of the injured artery, and (3) secondary repair of the artery during the treatment of the associated lesions. Exclusion criterion for this study was as follows: (1) repair of the artery with an interposed vein graft.

All associated lesions were recorded as well as the treatment performed. All operations were performed or directly supervised by the senior author, a surgeon with more than 10 years' experience in hand and microsurgery.

Postoperative arterial patency at follow-up was determined by either physical examination or color Doppler ultrasonographic imaging. Physical examination was performed with the 3-digit Allen test.² The radial and ulnar arteries were located by palpation at the proximal skin

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Table 1. Demographic Distribution.

Patient	Age	Gender	Smoking	Mechanism of injury	Associated nerve injury	Associated tendon injury	Associated bone injury	Days from injury to repair	Surgeon
1	67	F	N	Grinder	Median-ulnar	FPL-FDP II to V-FDS II to V-FCU-EDC II to V-EDQ-EIP-ECU	Ulna	1	SA
2	31	F	N	Glass	Median-ulnar	FDP-FDS-FCU	—	4	SA
3	44	M	Y	Glass	Median-ulnar	FPL-FDS IV and V-FDP II to V-FCR	—	6	SA
4	20	M	Y	Glass	Ulnar	FCU	—	8	SA
5	21	F	N	Glass	Ulnar	FCU-FDP IV-V	—	1	SA
6	22	M	N	Glass	Ulnar	FCU-FDS III to V-FDP III to V	—	4	SA
7	47	M		Glass	Median	FCU-FDP III to V-FDS III to V	—	4	DS
8	29	F	N	Glass	Median-ulnar	FDP III to V-FDP III to V	—	15	SA

Note. F = female; M = male; N = no; Y = yes; FPL = flexor pollicis longus; FDP = flexor digitorum profundus; FDS = flexor digitorum superficialis; FCU = flexor carpi ulnaris; EDC = extensor digitorum communis; EDQ = extensor digiti quinti; EIP = extensor indicis proprius; ECU = extensor carpi ulnaris; SA = senior author; FCR = flexor carpi radialis; DS = direct supervision of the senior author. Fingers are expressed in roman numbers (eg, II index).

crease of the wrist and then compressed with 3 digits. With both arteries compressed, the patient was asked to clench and unclench the hand 10 times. The hand was then held open, ensuring that the wrist and fingers were not hyperextended. The radial artery was released and the time taken for the palm, finger, and thumb to become flush was noted. This was repeated with the ulnar artery. If the capillary refill time was greater than 6 seconds, we considered the test positive.

Complications during and after the index surgical procedure were recorded. At the latest follow-up, cold sensitivity was registered as a dichotomous variable (yes/no) according to the subjective patient report. The Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire was used to evaluate subjective function in performing everyday activities, in which 0 is the best result and 100 the worst.

Results

We identified 9 consecutive patients with secondary artery repair during a 3-year period. One patient was excluded because a vein graft was performed to repair the ulnar artery. The remaining 8 patients fulfilled the inclusion criteria. In all cases, the ulnar artery was injured. The mean age of the patients at the time of surgery was 35 years (range, 20-67 years). Four cases were women.

In all but 1 case, the mechanism of injury was a clean cut with a glass. Two patients were smokers. The surgery was performed at a mean of 5 days (range, 1-15 days) after the injury and ligation. All patients were added to the operating room schedule as an elective surgery (Table 1).

Operative Procedure

The senior author (JGB) performed 7 out of the 8 repaired arteries, and the other artery was repaired under his direct supervision.

The repairs were done under either general or regional anesthesia. All arteries were repaired in an end-to-end fashion under magnification, and 9-0 Nylon was used to perform separate stitches. Associated median and/or ulnar nerve injuries were repaired with an epineural suture with 10-0 Nylon. Flexor tendons were repaired with a 4-strand suture and a peripheral suture. In the case of injury in the tendinous muscle junction, peripheral suture was not performed (Figure 1).

Postoperative Management

After surgery, a below-elbow splint was used for the first 6 weeks. At 2 weeks, the sutures were removed.

Low-molecular-weight heparin (enoxaparin 40 mg subcutaneous/day for 3 weeks) and aspirin (100 mg orally/day for 6 weeks) were administered as antithrombotic agents.

Clinical Evaluation, Patency, and Color Doppler Ultrasonographic Imaging

At a mean follow-up of 22 months (range, 6-48 months), just 1 out of 8 patients reported cold intolerance. All but 1 patient had a negative Allen test. This was in accordance with the color Doppler imaging that showed 1 case of arterial thrombosis. All the other cases showed patent arteries. The median DASH score was 34 (range, 24-50; Table 2).

Figure 1. (a) Intraoperative view of the injured ulnar artery and nerve, and flexor carpi ulnaris tendon. (b) Intraoperative view of the repaired ulnar artery and nerve.

Complications

One patient suffered a hematoma related to the secondary repair of the ulnar artery in the immediate postoperative period. The hematoma was drained and the suture of the artery was redone. However, this patient did not have a patent artery at final follow-up.

Discussion

Our results show that a high rate of patency can be obtained in secondary repair of the ulnar artery after a primary ligation of the vessel, even at, on average, 5 days after the initial injury.

Injury of one of the major arteries (radial and ulnar) of the forearm occasionally may lead to ischemia of the hand or fingers. In cases of ischemia, immediate repair should be performed to avoid necrosis. However, in most cases, the hand and fingers have no signs of ischemia. In these cases, ligation or repair of the injured artery could be performed.^{1,6} Although some authors have recommended ligation in cases with no ischemia as a safe and cost-effective management strategy, others have reported that ligation may be associated with cold intolerance, muscle and bone atrophy, and wound-related complications.^{1,3,12,13}

Although functional results of these injuries are mainly related to the associated nerve and tendon lesions,¹³ the multiple variables that could affect the results make it difficult to know the degree of involvement of each of them. However, in a prospective study of prognostic factors for median and ulnar nerve injuries in the forearm, Hundepool

et al¹¹ found that the injury of the arteries had a negative prognosis for motor recovery. Moreover, Gelberman et al⁷ found that patients with combined arterial and nerve injuries had the most significant symptoms of cold intolerance and pain.

One of the problems of these lesions regards the timing of repairing all of the involved structures. As nerves and tendons can be repaired electively, arteries should be managed as an emergency, either by suture or ligation. Recently, Park et al¹⁵ found no differences in functional outcome in patients who underwent emergency surgery compared with those who underwent surgery in a delayed manner (average 38 hours). However, they did not perform any vascular imaging and only used palpation of the pulse. Repairing all the injured structures in an elective manner allows referral of the patient to an experienced surgeon. Surgeon experience has been associated with fewer complications and better outcomes in different procedures.^{9,14,16}

The limitations of this study include its retrospective nature and the lack of a control group. However, to answer the purpose of this study about the patency rate of the delayed repaired arteries in the forearm, an observational study is an adequate method.^{4,10} As a retrospective study, we were not able to assess the severity of cold intolerance by a validated questionnaire. Another limitation is related to the variability in treatment related to the anatomical structures involved. However, all patients were treated according to the principles of care of tendon and nerve injuries. Finally, another limitation regards the external validity of this study. As all the patients had the ulnar artery repaired, our results could not be applied to the radial artery.

The success rate for isolated radial or ulnar artery repairs is somewhat contradictory in the literature. Although the reasons for the reduced patency rates in some studies are not well understood, the hypothesis that back pressure through the arches of the hand leads to increased turbulence and poor flow through the repaired artery has some acceptance but has had little scientific documentation. We have found a high patency rate when repairing the ulnar artery in a delayed manner. Even though we have not evaluated the pressure of the artery stumps, we can infer that success in the ulnar artery is related to the low pressure in the distal artery stump.

Gelberman et al,⁸ in an experimental study in dogs, found that blood pressure at the proximal ulnar artery stump underwent no significant change throughout the 4-week period after the ligation. However, the distal stump showed a decrease in blood pressure 1 minute after laceration to increase significantly by the second week. This could explain the results of the present study, as all the arteries were repaired during the first 2 weeks after ligation, but before the distal stump pressure had increased.

Table 2. Results and Complications.

Patient	DASH	Cold intolerance	Allen test	Eco Doppler imaging	Complications	Follow-up, months
1	30	N	Negative	Patent	—	24
2	50	N	Negative	Patent	—	28
3	24	N	Negative	Patent	—	16
4	30	N	Negative	Patent	—	6
5	28	N	Negative	Patent	—	36
6	40	N	Negative	Patent	—	48
7	42	Y	Positive	Occlusion	Hematoma	6
8	30	N	Negative	Patent	—	15

Note. DASH = Disabilities of the Arm, Shoulder and Hand; N = no; Y = yes.

Conclusions

Treatment of the arterial injury in the forearm is somewhat controversial whether the vascularization of the hand is not compromised. However, there is no information about the delayed repair after a ligation of the artery. According to our results, we recommend repair of the ulnar artery in a delayed fashion, even if it was previously ligated.

Ethical Approval

The institutional review board approved the retrospective review of the medical charts.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration, as revised in 2008.

Statement of Informed Consent

All patients gave signed informed consent before the treatment.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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