

Research Article

Digital Arterial Anastomosis as an Outpatient Surgery

Koichi Kobayashi^{1*}, Susumu Shinoura², Naoko Masuyama¹, Ken Nishimura¹, Runa Sugawara¹

¹Department of Orthopedic Surgery, Kanto Rosai Hospital, Kawasaki, Japan

²Department of Gastroenterology, International University of Health and Welfare, Narita, Japan

*Correspondence author: Koichi Kobayashi, Department of Orthopedic Surgery, Kanto Rosai Hospital, Kawasaki, Japan; Email: coach24xer@gmail.com

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Abstract

Background: In incomplete amputation with a skin bridge, patency of the artery indicates digit survival if sufficient venous return is secured. This study aimed to investigate the effectiveness of digital arterial repair on an outpatient basis without using intravenous anticoagulants.

Methods: We identified a total of 34 patients (34 digits) who underwent arterial repair for single vascular bundle injury between January 2000 and December 2022 on an outpatient basis. The following information were obtained from the patients' medical records: sex, age, comorbidities, active smoking status, number of affected digits, level of amputation, type of the fracture type, mechanism of injury, arterial diameter, needle used, requirement of vein graft and the outcome.

Results: Only a few fingertip injuries and severe injuries were included. Arterial patency was achieved in most patients after repair of an outpatient basis.

Conclusion: Outpatient arterial repair may be acceptable under inevitable circumstances or to cater to patients' preferences, when the injury is neither on the fingertip nor severe.

Keywords: Revascularization; Arterial Anastomosis; Microsurgery

Level of Evidence: Therapeutic IV

Introduction

Several factors have been reported to affect the survival of amputated digits after replantation/revascularization [1-4]. In cases of complete amputation, both the reconstruction of arterial circulation and the venous drainage are mandatory for survival. In contrast, in cases of

incomplete amputation with a skin bridge, the arterial patency may result in digit survival under the condition that sufficient venous drainage is secured.

Postoperative bed rest and continuous antithrombotic therapy for minimum one week are widely recommended after replantation or revascularization [5-12]. We hypothesized that postoperative hospitalization and intravenous anticoagulant use were not mandatory for the patency of anastomosed arteries. However, ethical conflict may arise if a randomized controlled trial is conducted in patient with a complete or incomplete finger amputation. This study aimed to investigate the effectivity of digital arterial repair on an outpatient basis without using intravenous anticoagulants.

Methodology

This single-center, non-interventional, retrospective cohort study was conducted at a general hospital between January 2000 and December 2022. The study included 34 patients (34 digits) who visited our emergency room or outpatient office and underwent arterial repair for a single vascular bundle injury on an outpatient basis (Fig. 1). Institutional Review Board approval (approval number: 2015-35) was obtained and each patient provided informed consent prior to the commencement of this study.

All patient details were amassed from operative reports and outpatient records. The following information was collected from the patient records: sex, age, comorbidities, active smoking status, the affected digit, number of affected digits, level of amputation, 13 types of fractures (none or simple/comminuted), mechanism of injury (shear force, avulsion or crush), diameter

of the artery (smaller diameter in case of a discrepancy), needle used (10-0, 11-0 or 12-0: Crownjun, Tokyo, Japan; smaller needle in case of using more than two different needles), surgery with or without vein graft and the outcome (patency or occlusion). Single vascular bundle injury was defined as a unilateral digital artery injury with adequate circulation from the contralateral digital artery. Arterial anastomosis in a single vascular bundle injury was indicated in cases of complications, such as fracture, tendon laceration or digital nerve injury. The comorbidities included diabetes mellitus; autoimmune diseases; and vascular disorders, including cerebral infarction, myocardial infarction and arterial sclerotic occlusion. Patients who stopped smoking more than one month preoperatively were not defined as active smokers. Inpatient or outpatient surgery was determined based on the patients' preference and bed capacity. The zone was determined based on the level of the arterial or distal arterial anastomosis when using a vein graft. Comminuted fractures were defined as fractures that included not only the bone edges but also the diaphyseal comminution. Injury mechanisms were classified as shear force, avulsion or crush injury. Avulsion injury was defined as an injury caused by mechanical avulsion by machines such as a belt conveyor, noodle machines, rollers or electric drills. Crush injury was defined as an injury with comminuted fracture or segmental soft tissue damage, excluding mutilated fingers and multiple-level injuries. Patients with simultaneous avulsed and crush injuries were considered having a crush injury. The arterial diameter was measured using a background sheet with a printed scale (Supermicrosheet®: Crownjun, Tokyo, Japan) under a high-magnification microscope (MM50/YOH® or MM51/YOH®; Mitaka Kohki, Tokyo, Japan). The outer diameter of the artery on the sheet was recorded at a magnification of 50x using videography. The researchers (KK, NM, KN and RS) reviewed the videos and measured the diameters before dilatation on the monitor. In cases of the disagreement, the diameter was subsequently determined by consensus. Patients with fingers resulted in atrophic pulps comprised the patent group, while those with fingers with an unexpected return to the operating room comprised the occlusive group, regardless of the final result. The exclusion criteria were warm ischemia > 24 h, 14 and smoking during the first postoperative week.

An axillary nerve block (ropivacaine [7.5 mg], 20 mL) was administered. The tourniquet was set at an additional blood pressure of 80 mmHg (minimum, 200 mmHg). Six surgeons performed the surgical procedures, all of whom were capable of anastomosing a practice silicon tube of 0.3 mm in diameter using a 12-0 needle within 20 minutes. Surgery was indicated based on the patient preference and performed in the following order: bone fixation, tendon suturing, nerve suturing and arterial anastomosis. We attempted to anastomose the arteries, even though their diameters were < 0.5 mm.

Upon completion of digital arterial anastomosis, 2000 units of unfractionated heparin were administered intravenously. Patients were administered bayaspirin (100 mg) daily during the first postoperative week. To evaluate the patency of the digital artery, the Doppler-monitored digital Allen test developed by Vilkkilä, et al., was used through an acoustic Doppler (ES-100VX®: Nihonkohden, Tokyo, Japan) [15]. Patency was evaluated preoperatively and two weeks postoperatively by four independent researchers (KK, NM, KN and RS).

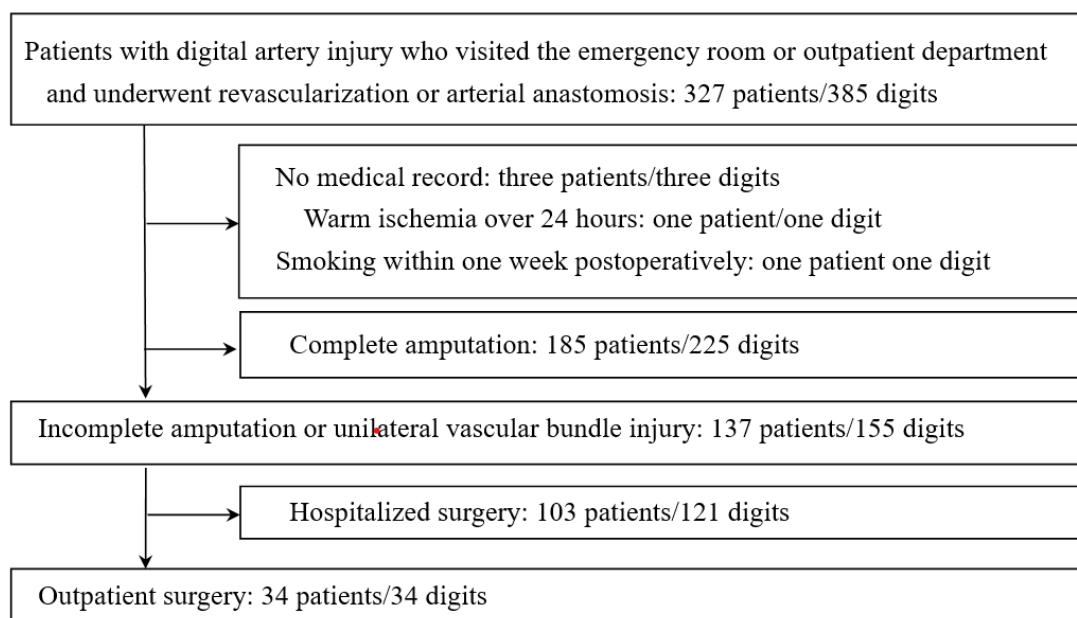


Figure 1: Study flowchart.

Results

Table 1 shows the clinical characteristics of the patients. Our cohort included few severe cases and few fingertip injuries and the digits were supposed to have a sufficient venous return. The arterial patency rate was 91.2%.

Variables	Patient=34 Digit=34
Sex, male/female (%)	23 (67.6)/11 (32.4)
Age, year (mean [SD])	44.4 (17.1)
Comorbidity (Yes/No) (%)	31 (91.2)/3 (8.8)
Smoking habit (Yes/No) (%)	25 (73.5)/9 (26.5)
Digit (T/I/M/R/L) (%)	10 (29.4)/10 (29.4)/6 (17.6)/6 (17.6)/2 (5.9)
Single/multiple digit injury (%)	34 (100)/0 (0)
Zone (I and II/ III, IV or V) (%)	1 (2.9)/33 (97.1)
Fracture type (N or Simple/Com) (%)	33 (97.1)/1 (2.9)
Mechanism (Sh/Av or Cr) (%)	34 (100)/0 (0)
Diameter (mm) (mean [SD])	0.8 (0.2)
Needle (10/11or 12) (%)	25 (73.5)/9 (26.5)
Vein graft (Yes/No) (%)	0 (0)/34 (100)
Patency/occlusion (%)	31 (91.2)/3 (8.8)
SD; standard deviation, T, thumb; I, index finger; M, middle finger; R, ring finger; L, little finger; Zone: Tamai zone; N, no fracture; Simple, simple fracture; Com: comminuted fracture; Single: single digit amputation; Fracture: type of the fracture; N: no fracture; Simple: simple fracture; Com, comminuted fracture; Sh: shear force; Av: avulsion injury; Cr: crush injury; 10: 10-0 needle; 11: 11-0 needle; 12: 12-0 needle	

Table 1: Clinical characteristics of the patients/digits.

Discussion

Postoperative bed rest and hospitalization after replantation or revascularization are not preferred in older patients and in those with a poor general condition. Hospitalization can aggravate psychological symptoms and infection and affect the general conditions of older patients [16].

In this study, the target group included patients with unilateral arterial injury. Two arterial anastomoses have been reported to be more preferable in replantation, which indicates that the digital arterial flow is not impaired by that of contralateral digital artery [17,18]. We assumed that arterial anastomotic patency after repair of unilateral arterial injury and that after incomplete amputation would be similar. Intact blood flow of the contralateral digital artery does not seem to affect the unilateral flow of the anastomosed digital artery. This study indicated that the patency in this cohort would be similar in regard to revascularization.

Use of unfractionated heparin, bayaspirin or prostaglandin postoperatively is controversial owing to the corresponding success rate [19-22]. Cigna, et al., reported that surgical technique and mechanism of injuries and not the anticoagulant used, were the main prognostic factors for the surgical outcome of replantation and revascularization [3]. Yamamoto reported that free tissue transplant and lymphaticovenular anastomosis could safely be performed without hospitalization or anticoagulant use [23,24].

Conclusion

Our study suggests that postoperative bed rest with continuous antithrombotic therapy may be comparatively less stringent than what was previously assumed. Arterial reconstructive microsurgery with less strict postoperative bed rest and oral antithrombotic agents instead of intravenous antithrombotic agents may be acceptable according to the patients' general condition or preference when the injury is neither severe nor on the fingertip.

This study had a few limitations. First, it was a retrospective study. Second, the arterial patency was not confirmed using clinical imaging and the efficacies of intravenous heparin, prostaglandin E1 and oral aspirin were not evaluated. Third, the sample size

was small, which may have reduced the statistical power. Therefore, other potential surgical predictors could not be identified; consequently, ethically controlled studies will be required to achieve a statistical accuracy. Fourth, this study included few severe cases and fingertip injuries. Finally, the study outcomes were determined based on patency or occlusion and functional, aesthetic or patient-related outcomes were not considered. Further prospective studies are warranted to generalize these findings. Despite these limitations, the present study implied that outpatient arterial repair may be acceptable under inevitable circumstances or patients' preference.

Conflict of Interests

The author declares that he has no conflict of interest in this paper.

Institutional Review Board Approval

Institutional Review Board approval (approval number: 2015-35) was obtained and each patient provided informed consent prior to the commencement of this study. No information (names, initials, hospital identification numbers or photographs) in the submitted manuscript could be used to identify the patients.

Funding

None

Declaration of Informed Consent

No information (names, initials, hospital identification numbers or photographs) in the submitted manuscript that can be used to identify the patients.

Authors' Contributions

All authors contributed equally in this paper.

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