

Immediate Versus Overnight-Delayed Digital Replantation: Comparative Retrospective Cohort Study of Survival Outcomes

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Purpose Ischemia time has been traditionally considered a critical factor in replantation survival rate. The objective of this study was to compare the survival rate between immediate and overnight-delayed digital replantation.

Methods We performed a retrospective cohort study of all digital replantations performed at our clinic between 2005 and 2016. The survival rate was compared between the immediate digital replantation group (immediate replantation group) and those that were replanted the morning after they were admitted to the hospital (overnight-delayed replantation group). The decision to delay the replant was made in cases admitted in the evening with less than 12 hours of previous ischemia time and without farm-related contamination.

Results Five hundred ninety-seven digital replantations (456 patients) were analyzed. One hundred eighty-five (31%) digital replantations were performed the following day (delayed replantation group) and 412 (69%) digital replantations were performed the same day that they were admitted to the hospital (immediate replantation group). The overall survival rate was 91.9% (549 of 597). In the immediate replantation group, the survival rate was 91.2% (376 of 412) and in the delayed replantation group, the survival rate was 93.4% (174 of 185). There were no statistically significant differences between the immediate and the delayed replantation groups with respect to age, zone of amputation, or presence of multiple amputations.

Conclusions Our study suggests that overnight delay is a safe approach for digital replantation when performed by experienced microsurgeons. (*J Hand Surg Am.* 2018; ■(■):■—■. Copyright © 2018 by the American Society for Surgery of the Hand. All rights reserved.)

Type of study/level of evidence Prognostic IV.

Key words Replantation, digit, amputation, ischemia, survival rate.

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SINCE THE FIRST REPORTED SURGICAL reattachment of an amputated thumb in 1967,¹ replantation has become routine in many centers around the world. Survival rates in digital replantation range between 53% and 96% according to a recent meta-analysis.² Although other factors play a role, it is accepted that proper surgical technique is a critical factor for a successful digital replantation.³ Consistently high success rates in digital

replantation can be achieved only in high-volume microsurgery centers.

Ischemia time has been traditionally considered a critical factor in the survival rate but 2 recent meta-analyses found ischemia time does not have a significant influence on the survival of digits replanted after amputation.^{2,4} Another recent study found that only warm ischemia time less than 6 hours and 30 minutes and replantations done during daylight hours influenced digit survival.⁵ That study suggested that replantations done in daylight hours, when feasible, with rested personnel and a fully staffed operating room, were more likely to be successful, although the overall success rate of the series was only 70%. Based on this same observation, the senior author (P.C.C.) has been using an overnight-delayed approach for digital replantation for the last 11 years. This approach consists of delaying the replantation of amputated fingers in patients admitted to the hospital after 6 PM, provided the previous cold ischemia time is less than 12 hours (6 hours if warm), until the next morning at 8 AM. We hypothesized that the survival rate is not affected by the extra time of cold ischemia incurred. The objective of this study was to compare the survival rate between immediate digital replantation and delayed digital replantation.

METHODS

A retrospective analysis of institutional medical records was undertaken to identify all digital replantations performed at the unit between January 2005 and December 2016. The inclusion criterion was a complete amputation of 1 or more digits distal to the palmar-digital crease. All amputated fingers whose replantation was delayed overnight were kept in the refrigerator at 4°C to 6°C.

A post hoc power calculation was done to determine if the sample assembled was sufficiently large to address the research question. Rate of survival in the 2 groups was considered the primary outcome variable used to establish the power. The number of predictor variables was determined by the number of occurrences of interest, replant failures, which was a total of 48. According to this, up to 6 predictor variables could be modeled. According to the sample size calculation, the minimum sample size to achieve a minimally acceptable level of statistical power was 400.⁶

For each finger, the following variables were identified: zone of amputation, the age of the patient, and single- or multiple-digital amputation, which was considered a surrogate for injury severity.

Typically, more severe injuries might be associated with a greater number of digits amputated. At least 1 arterial and 1 venous anastomosis were done in each digit. All these variables were considered independent. The dependent variable was survival (failure or success).

Statistical methods

A multivariable analysis was performed using logistic regression comparing the survival rate between the immediate digital replantation group and the overnight-delayed replantation group. A forced entry method was used with a judicious choosing of the variables based on a thorough review of the literature. The survival rates were adjusted by 3 independent variables and these were presented as odds ratios with 95% confidence intervals. Only 3 independent variables were included in the model to avoid overfitting. A *P* value less than .05 was considered statistically significant.

The overnight-delay replantation protocol

Patients with amputated digits admitted to the hospital later than 6 PM are replanted the following morning at 8 AM. In general, only ischemia-sensitive replants are performed immediately if admitted at night. These include transmetacarpal or more proximal upper limb amputations, lower limbs, digits with extended previous ischemia times (> 6 hours warm or 12 hours cold ischemia), digital amputations associated with more proximal crushing and heavily contaminated injuries, or farm-related digital amputations. The amputated digits are kept at 4°C to 6°C in a refrigerator. The goal is to not exceed 24 hours of total cold ischemia before restoration of arterial circulation, assuming about 2 hours of operative time per digit, which is the standard time for our team. In cases of in-continuity zone I amputations connected only by the flexor digitorum profundus tendon or a stretched and damaged digital nerve (traction injuries), the amputation was completed at the bedside (with local anesthesia instillation if necessary) and the part kept refrigerated overnight. Given the minimal active distal interphalangeal joint flexion and extension after replantation in zone I, the morbidity added by this maneuver was considered to be negligible. In zone II amputations with flexor tendon in continuity, the replant was performed immediately because there is no practical way of cooling the digit without sectioning the flexor tendon.

In order to keep the operative times low (~ 2 hours per digit), an artery-last sequence of repairs is

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