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A prospective randomised comparison of fixation methods in Tamai's zone I amputation

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KEYWORDS
Replantation;
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Summary *Background:* The treatment of choice for fingertip amputation is replantation to restore function and aesthetics. The purpose of this study was to compare the success rates and salvage periods between patients with Tamai's zone I amputation injuries treated with bony fixation and suture fixation.
Methods: Fifty-five patients with Tamai's zone I amputations with bony involvement were included in this study. The patients were allocated randomly to two groups treated by bony fixation with Kirschner (K-)wire and suture fixation, respectively. In the bony fixation group ($n = 21$), the distal phalangeal bone was fixed with K-wire; in the suture fixation group ($n = 34$), the amputated portion was fixed with sutures alone. The success rate was defined as the percentage of fully viable replanted cases, and the salvage period was defined as extending from the first postoperative day to the cessation of salvation.
Results: The success rates for the bony and suture fixation groups were 90.0% and 91.1%, respectively, with no significant difference. The average salvage period was longer in the bony fixation group than in the suture fixation group (8.7 ± 1.25 *vs.* 6.4 ± 0.98 days; $P = 0.01$). No case of non-union of the distal phalangeal bone, limitation of motion, or disfigurement was observed in either group.
Conclusion: The average salvage period was significantly longer for the bony fixation group, but the success rates did not differ between groups. We suggest that bony fixation is not mandatory in the treatment of Tamai's zone I amputation.

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Introduction

Recently, the number of patients suffering amputation of the distal finger, especially of the fingertip, has increased compared with more proximal amputation, due to changes in behavioural patterns and a reduction in the number of people engaged in hard labour.[1,2] Microsurgical techniques, especially super-microsurgery for the replantation of digits, are among the most advanced reconstructive surgical procedures performed in the modern era. Thus, the treatment of choice for fingertip amputation is replantation to restore hand function and aesthetics.[3–5] Arterial anastomosis is the most important factor for the survival of distal finger replantations, and venous anastomosis can also contribute to the success of the outcome.[6] However, venous anastomosis is often impossible when the amputation is distal to the distal interphalangeal (DIP) joint, due to crushing or avulsion injury of the veins and the small calibre of the fingertip veins; very difficult microsurgery must be performed in such cases. Under such circumstances, replantation with artery-only anastomosis is often adopted to preserve venous outflow. Numerous methods are used, including external bleeding with the fish-mouth drip method,[3] systemic heparin administration,[7] the application of medical leeches,[8] intra-replantation subcutaneous administration of heparin, and use of a heparinised saline solution drip.[9] External bleeding and medical leeches are used most commonly for venous drainage in fingertip replantation. These methods are maintained until the establishment of venous neovascularisation and the disappearance of venous congestion. When the amputated portion includes bone (Tamai's zone I amputation), bony fixation using a Kirschner (K-)wire is frequently used, but the advantages of bony fixation are questionable because the use of K-wires might undermine venous outflow from the bone marrow cavity.

In this study, we compared the success rates and time taken for the resolution of venous congestion between patients treated with bony fixation and suture fixation, respectively, with artery-only anastomosis for replantation of single-digit amputations in Tamai's zone I.

Patients and methods

This prospective, randomised, controlled study was approved by the Institutional Review Board of the Catholic University of Korea. All data were analysed anonymously and according to the principles of the Declaration of Helsinki (1975, revised in 2008). All authors have read and complied with the CONSORT guidelines.

This single-institute prospective study of patients with single-digit amputations was conducted from March 2007 to December 2014. Patients with Tamai's zone I (distal to the nail base) amputations with bony involvement of the amputated portion requiring artery-only anastomosis were included. The amputated portions did not include the flexor or extensor insertion. Success was defined as full viability of the replanted part based on the refill time, prick test at the time of discharge, and lack of secondary operation, such as stump revision or debridement, over >12 months follow-up.

Patients were assigned randomly to undergo K-wire bony fixation or suture-only fixation, regardless of other factors, using a random number table. Patients with concomitant injuries of other parts of the body or hand who underwent other operations during the salvage period were excluded. In addition, cases of severe crushing amputation, in which the surgeon could not find the vessel to anastomose, were excluded. To account for surgeons' learning curves, the first five cases treated by each surgeon were also excluded. Of 128 patients who underwent replantation surgery for single-digit Tamai's zone I amputations, 68 patients met the inclusion criteria. During the follow-up period, data from 55 patients were utilised for the analysis. Patients who failed to present during the follow-up period, were excluded from the study after randomisation. At the end of the study, data from 21 patients (15 males, 6 females) who received K-wire fixation and 34 patients (24 males, 10 females) who received suture fixation were available for analysis. Figure 1 is a CONSORT diagram of the study. The mean ages in the bony and suture fixation groups were 42.9 (range: 25–56) and 40.5 (range: 27–61) years, respectively. Other demographic data for the patients, including age, gender, follow-up duration, and mechanism of amputation, are presented in Table 1.

Surgical techniques

All surgeries were conducted under general anaesthesia. Cleansing of the amputated finger and stump and debridement of severely contaminated bony and soft-tissue debris were performed when needed. Suitable transected digital arteries were found in the stump and amputated portion and tagged with #11-0 Ethilon sutures. When no feasible artery was found in the amputated portion, veins were tagged for arteriovenous anastomosis. In the bony fixation group, fixation

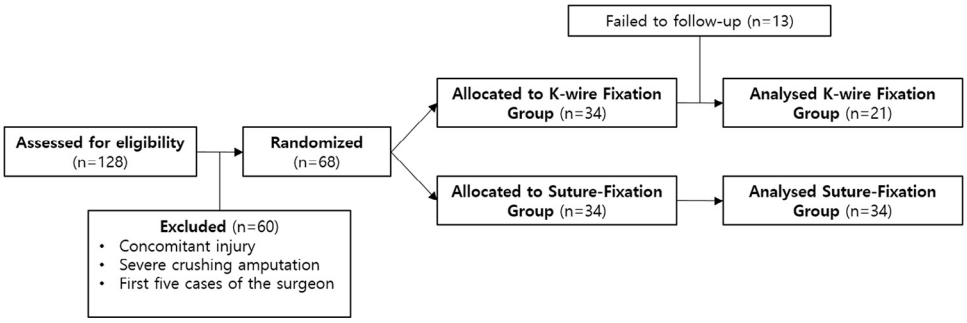

Figure 1 CONSORT diagram of study flow.