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A Systematic Review of the Outcomes of Replantation of Distal Digital Amputation

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Abstract

Background—The aim of this study is to conduct a systematic review of the English literature on replantation of distal digital amputations to provide the best evidence of survival rates and functional outcomes.

Methods—A MEDLINE search using "digit, finger, thumb, and replantation" as keywords and limited to humans and the English language identified 1297 studies. Studies were included in the review if they: (1) present primary data; (2) report 5 or more single or multiple distal replantations; (3) present survival rates. Additional data extracted from the studies meeting the inclusion criteria included demographic information, nature and level of amputation, venous outflow technique, nerve repair, recovery of sensibility, range of motion, return to work, and complications.

Results—30 studies representing 2,273 distal replantations met the inclusion criteria. The mean survival rate was 86%. There was no difference in survival between zone I and zone II replantations (Tamai classification). There was a significant difference in survival between replantation of clean-cut versus the more crushed amputations (crush-cut and crush-avulsion). The repair of a vein improved survival in both zone I and zone II replantation. The mean 2-PD was 7mm (n=220) and 98% returned to work (n=98). Complications included pulp atrophy in 14% of patients (n=639) and nail deformity in 23% (n=653).

Conclusion—The common perception that distal replantation is associated with little functional gain is not based on scientific evidence. This systematic review showed a high success rate and good functional outcomes following distal digital replantation.

The replantation of a single digit amputated proximal to the insertion of the flexor digitorum superficialis (FDS) is contra-indicated in adults because this replanted digit usually leads to a stiff proximal interphalangeal joint (PIPJ) that interferes with overall hand function.[1–4] Replantation of distal amputations is analogous to the commonly performed distal interphalangeal joint (DIPJ) fusion that still maintains PIPJ motion. However, distal replantation is not commonly performed because it is a technically challenging operation and the loss of function due to a missing fingertip is perceived to be negligible. Despite over 40 years of effort in refining digital replantation surgery, a rigorous evaluation of the outcomes has not been performed. A randomized controlled trial is not possible because it would be unethical and unfeasible to randomize patients to replantation, revision

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amputation, or some form of reconstruction. A systematic review is the only possible research method to use best available evidence from the literature to determine the outcomes of digital replantation.

The specific aim of this study is to apply strict inclusion criteria to select publications with sufficient details in the data presentation in order to provide comparable data to assess outcomes of distal finger replantation. We hypothesize that replantation of distal digital amputations will have good outcomes.

MATERIALS AND METHODS

Literature Search

A MEDLINE database search, conducted in November 2010 to identify English language citations for original studies relating to distal digital replantations in humans published between 1965 and 2010 yielded 1,297 citations. The key words used for the search included: replantation, re-implantation, combined with digit, finger, or thumb. The abstracts from the 1,297 citations were screened for predetermined inclusion and exclusion criteria (Table 1). Citations in which content was unclear based on a review of the abstracts underwent formal article review. Study references were screened manually to identify potential citations not captured by the initial database search.

Definitions

The restoration of a completely amputated body part is defined as replantation, whereas revascularization is defined as the restoration of circulation to an incompletely severed part (irrespective of the nature or amount of tissue holding it together) that has lost circulation.[5, 6]

Data Extraction and Analysis

On formal article review, we extracted the data listed in Table 2.

Classifications

The following classifications were used in this review.

Nature of injury—An amputation was classified into three types based on the mechanism of injury. The types of injury are: clean-cut (resulting from a sharp object with no loss of tissue and minimal crushing of tissues beyond site of amputation), crush-cut (resulting from a blunt object with some loss of tissue and crushing of tissues beyond site of amputation), and crush- avulsion (resulting from severe crushing or avulsion of tissues or a rotatory component).[5] Ideally it would have been better to differentiate between crush and avulsion; however, it was difficult to segregate these data in many of the studies.

Level of amputation—We used the classification system proposed by Tamai to apply to the majority of the articles reviewed. In this classification, distal amputations are divided into zone I (tip of finger to the base of the nail) and zone II (base of nail to the DIPJ).[7] Other classifications systems have been proposed by Allen[8], Foucher et al.[9], Ishikawa et al.[10], and Hirase[11] (Figure 1).

Statistical Analysis

Studies in this review include retrospective case series with non-randomized design. This level of evidence contains inherent biases that make reliable statistical analysis difficult. We provided summary statistics including means, and p-values using the Chi-square test to

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highlight the outcomes differences in the treatment groups. Statistical significance was set at $p < 0.05$.

RESULTS

Demographic characteristics (Table 3)

Thirty studies representing 2,273 distal digital replantations met the inclusion/ exclusion criteria (Figure 2).[11–40] These studies were published between 1985 and 2010, and all used retrospective data. The majority of the studies were from the Orient (n=21, 70%) (Figure 3). Hahn et al. from South Korea presented the largest series of 510 distal digital replantations.[31] Eight other studies (seven from the Orient) reported more than 100 distal digital replantations each. Eleven studies had between 5 and 20, whereas 10 had between 21 and 99 distal digital replantations in their series. Twenty five studies mention the number of patients in their study (n=1,789), 24 studies have data with regards to the sex ratio (1267 men and 424 women), and 24 studies have data with regards to the average age (31years). The length of follow-up varied between and within studies and ranged from one month to 11 years.

Preoperative characteristics (Table 4)

Out of a total of 2,273 distal digital replantations, 1,404 (62%) were zone I replantations and 869 (38%) were zone II replantations. Data on which digit was amputated were available in 24 studies (n=1,797). These include 330 thumbs (18%), 555 index fingers (31%), 463 long fingers (26%), 300 ring fingers (17%), and 149 small fingers (8%). Data on the type of injury that resulted in the amputation were available in 21 studies (n=1633); 508 (31%) amputations were clean-cut, 515 (32%) were crush-cut, and 610 (37%) amputations occurred as a result of crush-avulsion injuries.

Intra-operative characteristics (Table 5)

Data with regards to method of venous outflow were available in 29 out of the 30 studies (n=2,066). The repair of one or more veins was done in 1,311 (63%) replantations. Other methods used to relieve venous congestion included external bleeding from a pulp/ nail bed incision maintained with a heparin pledget (n=538, 26%); ligation of one digital artery and its branches to shunt blood into the arteriovenous loop to improve outflow[34] (n=120; 6%); application of a leech (n=70, 3.3%), arterio-venous anastomosis (n=17, 0.8%), and placement in a dermal pocket (n=6, 0.3%). 27 studies (n= 2,033) report on the use of vein grafts. An inter-positional vein graft was used for arterial repair in 243 digits (12%), for venous repair in 114 digits (5%), and either arterial or venous repairs in 68 digits (3%). 16 studies have data concerning nerve repair (n=926). The repair of one digital nerve was performed in 224 digits (24%) and both digital nerves in 237 digits (26%). In 465 digits (50%), no nerve repair was carried out.

Post-operative characteristics

Early Outcome (Table 6, 7, and 8)—1,935 (85%) out of the 2,273 distal digital replantations survived fully. If we include the partial survivals (n=15), the success rate rises to 86%. 21 studies (n=1,107) report the success rate of zone 1 replantations (87%), while 19 studies (n=617) report the success rate of zone II replantations (87%). Data with regards to nature of injury and survival was available in 17 studies (n=885). The data with regards to survival in the various comparison groups and the statistical significance has been presented in Table 8.

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Late Outcome (Table 9)—Out of a total of 1,950 successful distal digital replantations (including partial successes), 1,119 replantations were followed up long term (> 6 months). The length of follow-up varied greatly amongst the studies (range 6 months to 11 years). The mean two-point discrimination was reported in 12 studies (n=220) and averaged 7 mm. Pulp atrophy was reported in 8 studies (n=639) and the prevalence averaged 14%. Nail deformity was reported in 8 studies (n=653) and the prevalence averaged 24%. Return to work status was assessed in 5 studies (n=105) and 97% returned to work.

DISCUSSION

This systematic review of replantation of distal digital amputations showed an overall survival rate of 86%. This is similar to the 80–90% survival rate reported in the literature for more proximal replantations.[1, 2, 6, 41–46] Dec W. published a meta-analysis of the success rates of digital replantation in 2006.[47] He analyzed 8 studies totaling 1,803 replantations in 1,299 patients. His study included all digital amputations and not just distal amputations and he did not differentiate between composite grafting, revascularization, and replantation. He reported a significant difference in survival between clean-cut amputations and the more crushed amputations types (crush-cut and crush-avulsion). We also found a similar difference in better survival rate for clean-cut amputations when compared with the more crushed amputations types. However there was no difference in survival between crush-cut and crush-avulsion amputation. This may be because of a selection bias in distal replantation in which the severely crushed digits were not replanted, and the so called crush-avulsion amputations were likely to have a narrower zone of injury. Dec W. divided the distal amputations in their study into distal phalanx and DIPJ groups, and reported a lower success rates for replants through the distal phalanx compared to replants at other levels. We were unable to find a significant difference in survival between zone I and zone II replantations.

Our study found that the repair of a vein improved survival in both zone I and zone II replantations. Previous studies have determined that venous repair improves survival in zone II replantations, but the data with regards to zone I replantations are contradictory.[27, 31, 33, 37, 48] Matsuda et al. reported that venous anastomosis did not influence survival in zone I amputation.[49] On the other hand, Lee et al. noted a higher survival rate in zone I replantations, when a vein repair was carried out.[50] The repair of a vein is almost impossible in an Ishikawa sub-zone I replantation and very difficult in a sub-zone II replantation. It is likely that the amount of tissue replanted in these zones is so small that just an arterial in-flow with some kind of egress of blood is sufficient until internal outflow is established. In zone 1 replantation (sub-zones I and II), a venous anastomosis may not be necessary, but the artery must be done well.

We found that even though one or both the digital nerves were repaired in less than half the subjects, the average 2PD was 7mm. Nerve repair is therefore not essential in distal replantation because protective sensation returns irrespective of nerve repair status. This has been confirmed by previous studies also.[32, 51, 52] Nerve recovery is believed to be good because of the short distance the regenerating terminal branches of the purely sensory digital nerves have to travel to reach the distal targets. Additionally, the phenomenon of adjacent and spontaneous neurotization may play a role especially in younger patients.[51] Our study found a 23% prevalence of nail deformity and a 14% prevalence of pulp atrophy. Nail regeneration in replanted digits depends on whether the sterile or germinal matrix is injured, the type of injury (clean-cut versus crushed amputations), and the post-operative circulatory conditions.[53] It is difficult to relate the level of nail bed injury to the level of amputation as both the Tamai zone I and the Ishikawa sub-zone II amputations include a small portion of the germinal matrix (the lunula). Pulp atrophy is believed to be related to type of injury and post-operative vascular complications.[54] In our review, the study by Hahn et al.[31]

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contributed the largest number of patients (n=469) to the late follow-up groups for both nail deformity (72%) and pulp atrophy (73%). Their study included only zone I amputations and they recommended repairing as many veins as possible to reduce these complications.

The papers by Weiland et al. and Morrison et al. are often quoted as supporting opinion for not doing distal replants.[1,2] In their evaluation of the functional results of 86 digital replantations in 1977, Weiland et al. advised against replanting single digit amputations, mentioning that it can result in significant social and economic morbidity.[2] In the same year, Morrison et al. also recommended against replanting single finger amputations and amputations distal to the middle of the middle phalanx (distal to FDS insertion).[1] They felt that a replanted single finger in an otherwise normal hand is rarely used because its function is taken over by adjacent fingers and the functional loss due to a distal amputation was insufficient to justify the replantation. Both these papers, however, do not present any data to support their objections to replantations distal to the insertion of the FDS. Urbaniak et al. in a study of the outcomes of 59 consecutive single finger replants in 1985 concluded that replantation of a single finger amputated distal to the FDS insertion was justified, but replantation of a single finger amputated proximal to the FDS insertion was seldom indicated.[4] Subsequent reports by Tark et al. (1989)[55], Boeckx et al. (1992)[56], Lebedev et al. (1993)[57], and Waikakul et al. (2000)[45] have reaffirmed that single digit amputations distal to the insertion of the FDS should be considered as an indication for replantation.

There has been only one study that has compared the functional outcomes of distal finger replantation versus revision amputation. Hattori et al. in 2006 studied 46 distal amputations in which half underwent replantation and the other half revision amputation.[58] There was no difference in grip strength between the two groups. Active flexion of the proximal interphalangeal joint was greater in the replantation group possibly due to a greater use of the replanted fingers for activities of daily living. Twenty patients in the replantation group always used the replanted finger for activities of daily living, whereas only 9 out of 23 patients in the amputation closure group always used the affected finger. The replantation group also had less pain and a better DASH symptom/disability score. They concluded by saying that replantation provided not only the best appearance, but also a better functional outcome.

Our systematic review shows that almost 70% of distal replants reported in the literature are from centers in the Orient that have experienced micro-surgeons doing distal replantations frequently. Surgeons from the Orient cite Confucian moral values and a greater emphasis on maintaining body integrity and physical appearance as a reason for doing these procedures.[22, 23, 25, 31, 54] Unlike proximal digital replantations, the outcome of a distal digital replantation depends mainly on survival. Bony fixation is simple and needs one or two longitudinal Kirschner wires. Tendon repair is not required because the amputation is distal to the tendons in zone I and the DIPJ is usually fused in zone II. Nerve repair is also not essential. Survival in distal replantation therefore depends on finding and repairing the artery and can be improved with a venous anastomosis. This requires a high level of microsurgical technique and this operation should not be performed by the occasional microsurgeon, but conducted by a microsurgeon who has devoted substantial training and commitment to this type of “super-microsurgery”.[59] An epidemiological study of finger replantation estimated that few hospitals in the U.S. perform replantation, with even fewer, approximately 2%, performing more than 10 replantations a year.[60] A vicious cycle is created when surgeons do not perform an adequate number of distal replantations to acquire the required skills, leading to less experience and more failures, ultimately abandoning the conduct of this operation. There is a need to develop specialty centers in the United States similar to those in the Orient. Because warm ischemia is less of a concern with distal

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amputations, patients can safely be transferred to such centers within a reasonable time frame.

This systematic review has several limitations. There was a huge variation in the quality and quantity of data presented in the 30 studies that were included in this review. Twelve studies included only cases in which a specific operative technique (vein graft, artery only, delayed venous repair etc.) was used[17, 20, 26, 28–30, 32, 34, 36–38, 40]. Five studies did not present the number of patients studied[11, 14, 18, 24, 25], 6 studies did not present data about which digit was amputated[11, 18, 19, 24, 32, 37], and 9 studies made no mention of the nature of injury that led to the amputation[11, 16, 18, 24–26, 30, 32, 37]. None of the studies had truly sufficient data about the functional outcomes. Less than half the digits were followed-up long term and there were great variations in the reporting of outcomes. A uniform method of presenting sensibility and range of motion data would be useful to compare studies. The fact that this systematic review showed a high success rate for a technically difficult procedure may mean that there is a publication bias and these studies represent the best results and not what may be achieved in routine clinical practice. We also felt that most classifications of amputations (Figure 1) use the nail base as a dividing line, but there is germinal matrix on both sides of this line making it difficult to compare long term outcome. Amputations through the middle phalanx that are distal to the FDS are excluded from most distal replant classifications and the use of the term ‘zone’ leads to confusion with the flexor zone of injury. We have proposed a new classification of amputations that includes amputations distal to the insertion of the FDS that may be more useful in determining outcomes after digital replantation (Figure 4).

We believe that irrespective of geographic location, most patients will want the finger replanted if it is possible with an expectation for reasonable functional gain. However, in this era of cost-conscious medical care, expensive interventions must also demonstrate superior outcomes. The popular perception is that distal digital replantation is an arduous procedure for the surgeon. For the patient, it requires hospitalization, therapy, and much time off of work resulting in increased cost for the patient with little functional gain. On the other hand, a revision amputation is thought to be simple, inexpensive, and associated with minimal functional loss. Nevertheless surgeons must be aware that there is little published evidence to support this perception. There are no outcomes data on revision amputation that have evaluated either functional or psychological outcomes. There have also been no economic analysis studies of distal digital replantation or revision amputation to provide evidence in guiding the currently accepted practices. This systematic review provided the most comprehensive data to date to assess the outcomes and complications for this common amputation pattern that was treated with replantation. Evidence-based medicine requires a careful consideration of outcomes data to support patient values. This study is such a first step in conducting evidence-based research for distal finger amputations.

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References

1. Morrison WA, O’Brien BM, MacLeod AM. Evaluation of digital replantation--a review of 100 cases. Orthop Clin North Am. 1977; 8:295–308. [PubMed: 331182]

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2. Weiland AJ, Villarreal-Rios A, Kleinert HE, Kutz J, Atasoy E, Lister G. Replantation of digits and hands: analysis of surgical techniques and functional results in 71 patients with 86 replantations. J Hand Surg. 1977; 2A:1–12.

3. Chen ZW, Meyer VE, Kleinert HE, Beasley RW. Present indications and contraindications for replantation as reflected by long-term functional results. Orthop Clin North Am. 1981; 12:849–70. [PubMed: 7322515]

4. Urbaniak JR, Roth JH, Nunley JA, Goldner RD, Koman LA. The results of replantation after amputation of a single finger. J Hand Surg. 1985; 67A:611–9.

5. Biemer E. Definitions and classifications in replantation surgery. Br J Plast Surg. 1980; 33:164–8. [PubMed: 7388205]

6. Kleinert HE, Jablon M, Tsai TM. An overview of replantation and results of 347 replants in 245 patients. J Trauma. 1980; 20:390–8. [PubMed: 7365852]

7. Tamai S. Twenty years' experience of limb replantation--review of 293 upper extremity replants. J Hand Surg. 1982; 7A:549–56.

8. Allen MJ. Conservative management of finger tip injuries in adults. Hand. 1980; 12:257–65. [PubMed: 7002744]

9. Foucher G, Henderson HR, Maneaud M, Merle M, Braun FM. Distal digital replantation: one of the best indications for microsurgery. International J Microsurg. 1981; 3:263–70.

10. Ishikawa K, Ogawa Y, Soeda H, Yoshida Y. A new classification of the amputation level for the distal part of the fingers. J Jpn Soc Microsurg. 1990; 3:54–62.

11. Hirase Y. Salvage of fingertip amputated at nail level: new surgical principles and treatment. Ann Plast Surg. 1997; 38:151–7. [PubMed: 9043584]

12. Gordon L, Leitner DW, Buncke HJ, Alpert BS. Partial nail plate removal after digital replantation as an alternative method of venous drainage. J Hand Surg. 1985; 10A:360–4.

13. Cheng GL, Pan DD, Yang ZX, Qu ZY. Replantation of digits amputated at or about the distal interphalangeal joint. Ann Plast Surg. 1985; 15:465–73. [PubMed: 3880195]

14. Suzuki K, Matsuda M. Digital replantations distal to the distal interphalangeal joint. J Reconstr Microsurg. 1987; 3:291–5. [PubMed: 3656253]

15. Goldner RD, Stevanovic MV, Nunley JA, Urbaniak JR. Digital replantation at the level of the distal interphalangeal joint and the distal phalanx. J Hand Surg. 1989; 14A:214–20.

16. DeSmet L. Digital reimplantation at the level of the distal interphalangeal joint and the distal phalanx: a good indication. Acta Orthop Belg. 1990; 56:583–6. [PubMed: 2075814]

17. Koshima I, Soeda S, Moriguchi T, Higaki H, Miyakawa S, Yamasaki M. The use of arteriovenous anastomosis for replantation of the distal phalanx of the fingers. Plast Reconstr Surg. 1992; 89:710–4. [PubMed: 1546084]

18. Foucher G, Norris RW. Distal and very distal digital replantations. Br J Plast Surg. 1992; 45:199–203. [PubMed: 1596659]

19. Yamano Y. Replantation of fingertips. J Hand Surg. 1993; 18B:157–62.

20. Ikeda K, Morikawa S, Hashimoto F, Tomita K. Fingertip replantation: pre-osteosynthesis vein graft technique. Microsurgery. 1994; 15:430–2. [PubMed: 7968468]

21. Malizos KN, Beris AE, Kabani CT, Korobilias AB, Mavrodontidis AN, Soucacos PN. Distal phalanx microsurgical replantation. Microsurgery. 1994; 15:464–8. [PubMed: 7968475]

22. Chen CT, Wei FC, Chen HC, Chuang CC, Chen HT, Hsu WM. Distal phalanx replantation. Microsurgery. 1994; 15:77–82. [PubMed: 8133774]

23. Kim WK, Lim JH, Han SK. Fingertip replantations: clinical evaluation of 135 digits. Plast Reconstr Surg. 1996; 98:470–6. [PubMed: 8700984]

24. Dubert T, Houimli S, Valenti P, Dinh A. Very distal finger amputations: replantation or "reposition-flap" repair? J Hand Surg. 1997; 22B:353–8.

25. Patradul A, Ngarmukos C, Parkpian V. Distal digital replantations and revascularizations. 237 digits in 192 patients. J Hand Surg. 1998; 23B:578–82.

26. Akyurek M, Safak T, Kecik A. Fingertip replantation at or distal to the nail base: use of the technique of artery-only anastomosis. Annals of Plastic Surgery. 2001; 46:605–12. [PubMed: 11405359]

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27. Hattori Y, Doi K, Ikeda K, Abe Y, Dhawan V. Significance of venous anastomosis in fingertip replantation. Plast Reconstr Surg. 2003; 111:1151–8. [PubMed: 12621185]
28. Lin TS, Jeng SF, Chiang YC. Fingertip replantation using the subdermal pocket procedure. Plast Reconstr Surg. 2004; 113:247–53. [PubMed: 14707643]
29. Matsuzaki H, Yoshizu T, Maki Y, Tsubokawa N. Functional and cosmetic results of fingertip replantation: anastomosing only the digital artery. Ann Plast Surg. 2004; 53:353–9. [PubMed: 15385770]
30. Koshima I, Yamashita S, Sugiyama N, Ushio S, Tsutsui T, Nanba Y. Successful delayed venous drainage in 16 consecutive distal phalangeal replantations. Plast Reconstr Surg. 2005; 115:149–54. [PubMed: 15622245]
31. Hahn HO, Jung SG. Results of replantation of amputated fingertips in 450 patients. J Reconstr Microsurg. 2006; 22:407–13. [PubMed: 16894484]
32. Ozcelik IB, Tuncer S, Purisa H, et al. Sensory outcome of fingertip replantations without nerve repair. Microsurgery. 2008; 28:524–30. [PubMed: 18683863]
33. Li J, Guo Z, Zhu Q, et al. Fingertip replantation: determinants of survival. Plast Reconstr Surg. 2008; 122:833–9. [PubMed: 18766047]
34. Zhang X, Wen S, Wang B, Wang Q, Li C, Zhu H. Reconstruction of circulation in the fingertip without vein repair in zone I replantation. J Hand Surg. 2008; 33A:1597–601.
35. Hasuo T, Nishi G, Tsuchiya D, Otsuka T. Fingertip replantations: importance of venous anastomosis and the clinical results. Hand Surg. 2009; 14:1–6. [PubMed: 19598314]
36. Yan H, Jackson WD, Songcharoen S, et al. Vein grafting in fingertip replantations. Microsurgery. 2009; 29:275–81. [PubMed: 19274650]
37. Ito H, Sasaki K, Morioka K, Nozaki M. Fingertip amputation salvage on arterial anastomosis alone: an investigation of its limitations. Ann Plast Surg. 2010; 65:302–5. [PubMed: 20733365]
38. Buntic RF, Brooks D. Standardized protocol for artery-only fingertip replantation. J Hand Surg. 2010; 35A:1491–6.
39. Shi D, Qi J, Li D, Zhu L, Jin W, Cai D. Fingertip replantation at or beyond the nail base in children. Microsurgery. 2010; 30:380–5. [PubMed: 20641096]
40. Hsu CC, Lin YT, Moran SL, Lin CH, Wei FC, Lin CH. Arterial and venous revascularization with bifurcation of a single central artery: A reliable strategy for Tamai zone 1 replantation. Plast Reconstr Surg. 2010; 126:2043–51. [PubMed: 21124144]
41. Bora A, Ada S, Ozerkan F, Tetik F. Replantations and their functional results: the Turkish experience. Microsurgery. 1993; 14:97–101. [PubMed: 8097013]
42. Cheng GL, Pan DD, Qu ZY, et al. Digital replantation. A ten-year retrospective study. Chin Med J. 1991; 104:96–102. [PubMed: 1874019]
43. Glas K, Biemer E, Duspiva KP, Werber K, Stock W, Herndl E. Long-term follow-up results of 97 finger replantations. Arch Orthop Trauma Surg. 1982; 100:95–8. [PubMed: 7138255]
44. Tamai S. Digit replantation. Analysis of 163 replantations in an 11 year period. Clin Plast Surg. 1978; 5:195–209. [PubMed: 679604]
45. Waikakul S, Sakkarnkosol S, Vanadurongwan V, Un-nanuntana A. Results of 1018 digital replantations in 552 patients. Injury. 2000; 31:33–40. [PubMed: 10716048]
46. Yoshizu T, Katsumi M, Tajima T. Replantation of untidily amputated finger, hand, and arm: experience of 99 replantations in 66 cases. J Trauma. 1978; 18:194–200. [PubMed: 642045]
47. Dec W. A meta-analysis of success rates for digit replantation. Tech Hand Up Extrem Surg. 2006; 10:124–9. [PubMed: 16974215]
48. Han SK, Lee BI, Kim WK. Topical and systemic anticoagulation in the treatment of absent or compromised venous outflow in replanted fingertips. J Hand Surg. 2000; 25A:659–67.
49. Matsuda M, Chikamatsu E, Shimizu Y. Correlation between number of anastomosed vessels and survival rate in finger replantation. J Reconstr Microsurg. 1993; 9:1–4. [PubMed: 8423556]
50. Lee BI, Chung HY, Kim WK, Kim SW, Dhong ES. The effects of the number and ratio of repaired arteries and veins on the survival rate in digital replantation. Ann Plast Surg. 2000; 44:288–94. [PubMed: 10735221]

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51. Faivre S, Lim A, Dautel G, Duteille F, Merle M. Adjacent and spontaneous neurotization after distal digital replantation in children. Plast Reconstr Surg. 2003; 111:159–65. [PubMed: 12496576]
52. Wong C, Ho PC, Tse WL, Cheng S, Chan DK, Hung LK. Do we need to repair the nerves when replanting distal finger amputations? J Reconstr Microsurg. 2010; 26:347–54. [PubMed: 20198562]
53. Nishi G, Shibata Y, Tago K, Kubota M, Suzuki M. Nail regeneration in digits replanted after amputation through the distal phalanx. J Hand Surg. 1996; 21A:229–33.
54. Hattori Y, Doi K, Sakamoto S, Yamasaki H, Wahegaonkar A, Addosooki A. Fingertip replantation. J Hand Surg. 2007; 32A:548–55.
55. Tark KC, Kim YW, Lew JD. Replantation and revascularization of hands: clinical analysis and functional results of 261 cases. J Hand Surg. 1989; 14A:17–27.
56. Boeckx W, Jacobs W, Guelinckx P, Kerckhove EVd. Late results in replanted digits. Is replantation of a single digit worthwhile? Acta Chir Belg. 1992; 92:204–8. [PubMed: 1414139]
57. Lebedev LV, Bogomolov MS, Vavylov VN, et al. Long-term follow-up of hand function after digit replantation. Ann Plast Surg. 1993; 31:322–6. [PubMed: 8239431]
58. Hattori Y, Doi K, KKI, Estrella EP. A retrospective study of functional outcomes after successful replantation versus amputation closure for single fingertip amputations. J Hand Surg. 2006; 31A: 811–8.
59. Koshima I. Atypical arteriole anastomoses for fingertip replantations under digital block. J Plast Reconstr Aesthet Surg. 2008; 61:84–7. [PubMed: 18068656]
60. Chung KC, Kowalski CP, Walters MR. Finger replantation in the United States: rates and resource use from the 1996 Healthcare Cost and Utilization Project. J Hand Surg. 2000; 25A:1038–42.

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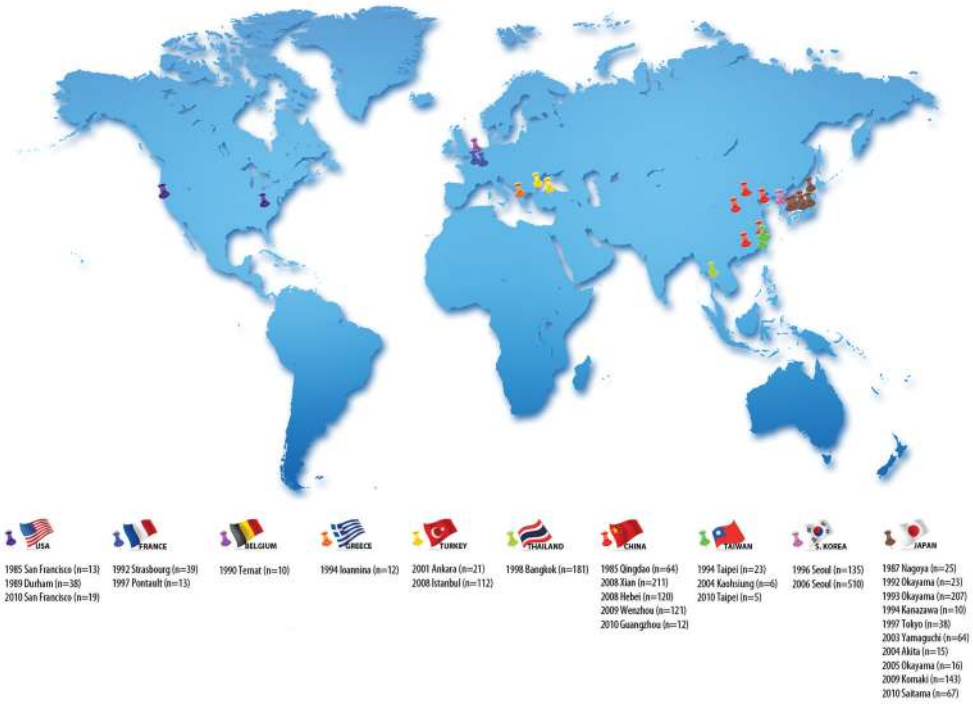

Figure 1.
Relating the vascular anatomy of the fingertip with the Tamai and Ishikawa classifications, and the commonly used Allen classification of fingertip amputations.

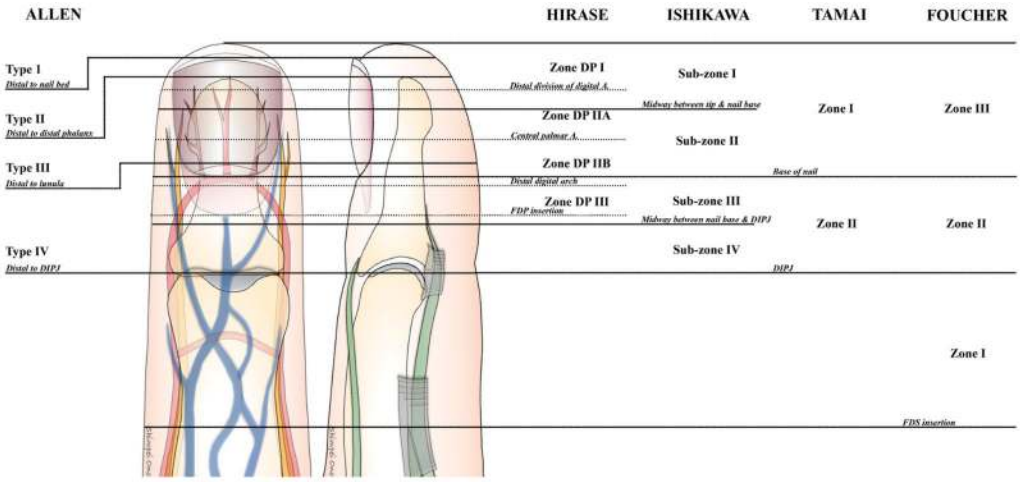

Figure 2.
Study attrition diagram

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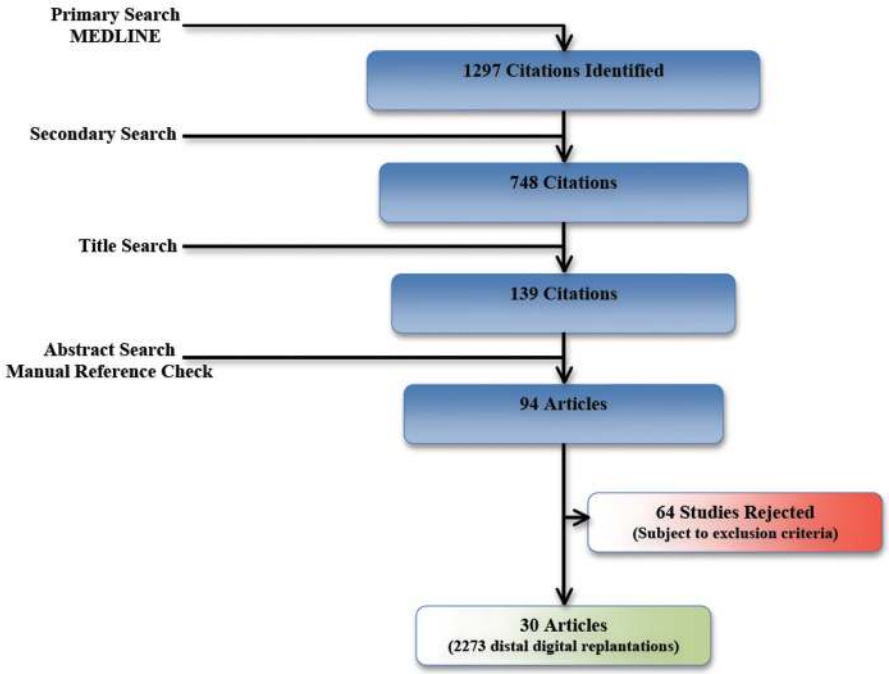

Figure 3.
Geographic distribution of the studies included in this systematic review

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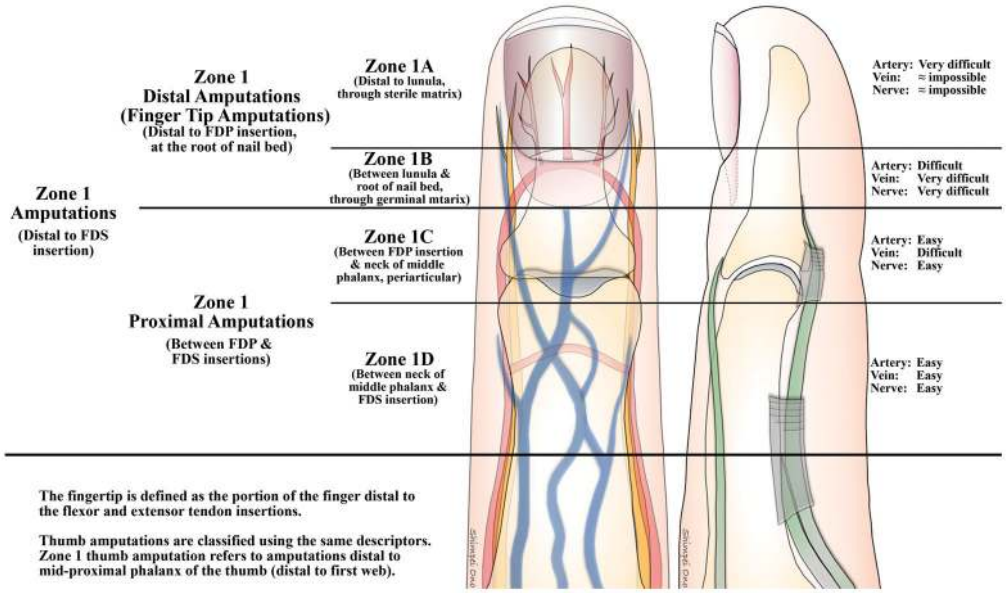

Figure 4.
A new classification system for digital amputations distal to the FDS insertion

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Table 1

Predetermined Inclusion and Exclusion Criteria

A. Inclusion criteria	
1	Human
2	Primary data
3	English language publication
4	Single/ multiple distal replantations (through or distal to distal interphalangeal joint)
5	Extractable survival data for distal replantations
B. Exclusion criteria	
1	Review or case report articles
2	Case series with less than 5 patients
3	Incomplete amputations or revascularization
4	Unclear injury diagnosis (total versus incomplete amputation)
5	Unclear procedure (unable to separate outcomes between replantation and revascularization)
6	Report only successful cases

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Table 2

Categories for data extraction from selected articles

Demographic	Pre-operative	Intra-operative	Post-operative	
			Early	Late
1 Ethnic origin	**1** No. of amputations	**1** Venous outflow technique	**1** Overall survival 1.	**1** Functional outcome
2 Age	**2** Level of amputation	**a.** Vein repair	**a.** Partial	**a.** Range of motion
3 Sex	**a.** Zone 1 (nail base to tip)	**b.** External bleeding	**b.** Complete	**b.** 2PD
	b. Zone 2 (DIPJ to nail base)	**c.** Leech application	**c.** Failure	**i.** ≥ 10mm
	3 Type of injury	**d.** Pocket-plasty	**2** Level of injury & survival	**ii.** <10mm
	a. Clean-cut	**e.** Distal artery to proximal vein	**a.** Zone 1	**c.** Pulp atrophy
	b. Crush-cut	**f.** Subcutaneous heparin inj.	**b.** Zone 2	**d.** Nail deformity
	c. Crush-avulsion	**2** Vein grafting	**3** Type of injury & survival	**e.** Return to work
	4 Digit involved	**a** For artery	**a.** Clean-cut	
	a. Thumb	**a** For vein	**b.** Crush-cut	
	b. Index	**b** For both	**c.** Crush-avulsion	
	c. Long	**3** Nerve repair		
	d. Ring	**a.** None		
	e. Small	**b.** One		
		c. Both		

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Table 3

Demographics characteristics of patients undergoing distal digital replantation

No.	Year	Authors	Place	No. of patients	Male	Female	Average age	No. of replantations
1	1985	Gordon et al	San Francisco, USA	13	12	1	30	13
2	1985	Cheng et al	Qindao, China	57	37	20	23.2	64
3	1987	Suzuki et al	Nagoya, Japan	-	-	-	26.4	25
4	1989	Goldner et al	Durham, USA	38	35	3	26.6	38
5	1990	DeSmet L	Ternat, Belgium	10	8	2	29.5	10
6	1992	Koshima et al	Okayama, Japan	16	15	1	34.7	23
7	1992	Foucher et al	Strasbourg, France	-	-	-	-	39
8	1993	Yamano Y	Okayama, Japan	188	133	55	32.7	207
9	1994	Ikeda et al	Kanazawa, Japan	10	8	2	36.9	10
10	1994	Malizos et al	Ioannina, Greece	12	10	2	28.4	12
11	1994	Chen et al	Taipei, Taiwan	23	17	6	24	23
12	1996	Kim et al	Seoul, S. Korea	119	102	17	-	135
13	1997	Hirase Y	Tokyo, Japan	-	-	-	-	38
14	1997	Dubert et al	Pontault, France	-	-	-	-	13
15	1998	Patradul et al	Bangkok, Thailand	-	-	-	-	181
16	2001	Akyurek et al	Ankara, Turkey	21	15	6	26	21
17	2003	Hattori et al	Yamaguchi, Japan	55	40	15	38.6	64
18	2004	Lin et al	Kaohsiung, Taiwan	6	6	0	51.1	6
19	2004	Matsuzaki et al	Akita, Japan	13	8	5	35.8	15
20	2005	Koshima et al	Okayama, Japan	14	11	3	36	16
21	2006	Hahn et al	Seoul, S. Korea	450	374	76	30.8	510
22	2008	Ozcelik et al	Istanbul, Turkey	98	-	-	-	112
23	2008	Li et al	Xian, China	211	117	94	26.2	211
24	2008	Zhang et al	Hebei, China	112	83	29	33	120
25	2009	Hasuo et al	Komaki, Japan	127	97	30	38	143
26	2009	Yan et al	Wenzhou, China	103	67	36	27.5	121
27	2010	Ito et al	Saitama, Japan	59	46	13	41.7	67

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No.	Year	Authors	Place	No. of patients	Male	Female	Average age	No. of replantations
28	2010	Buntic et al	San Francisco, USA	17	15	2	29	19
29	2010	Shi et al	Guangzhou, China	12	9	3	6	12
30	2010	Hsu et al	Taipei, Taiwan	5	2	3	30.2	5

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Table 4

Pre-operative characteristics of patients undergoing distal digital replantation

No.	Authors	No. of replantations	Side replanted		Digit replanted					Level of replantation		Type of Injury		
			Right	Left	Thumb	Index	Long	Ring	Small	Zone I	Zone II	Clean-cut	Blunt-cut	Crush- avulsion
1	Gordon et al.	13	6	7	3	5	3		2	0	13	3	7	3
2	Cheng et al.[#]	64	-	-	9	26	18	10	1	0	64	20	13	24
3	Suzuki et al.	25	-	-	10	15				10	15	2	12	11
4	Goldner et al.	38	11	27	18	5	7	3	5	0	38	-	25	13
5	DeSmet L	10	5	5	0	2	4	3	1	0	10	-	-	-
6	Koshima et al.	23	7	16	4	5	6	4	4	13	10	10	7	6
7	Foucher et al.	39	-	-	-	-	-	-	-	11	28	-	-	-
8	Yamano Y[*]	207	-	-	-	-	-	-	-	131	76	26	20	85
9	Ikeda et al.	10	5	5	3	2	3	2	0	10	0	4	3	3
10	Malizos et al.	12	-	-	4	5	1	0	2	5	7	5	0	7
11	Chen et al.	23	-	-	10	8	4	1	0	6	17	9	8	6
12	Kim et al.	135	75	60	22	55	31	22	5	64	71	48	54	33
13	Hirase Y	38	-	-	-	-	-	-	-	19	19	-	-	-
14	Dubert et al.	13	-	-	-	-	-	-	-	13	0	-	-	-
15	Patradul et al.	181	-	-	35	55	51	29	11	50	131	-	-	-
16	Akyurek et al.	21	-	-	6	3	5	5	2	21	0	-	-	-
17	Hattori et al	64	37	27	14	15	14	13	8	44	20	16	26	22
18	Lin et al.	6	3	3	2	1	1	2	0	6	0	6	0	0
19	Matsuzaki et al.	15	-	-	3	4	7	1	0	15	0	7	0	8
20	Koshima et al.	16	5	9	3	2	3	6	2	0	16	-	-	-
21	Hahn et al.[#]	510	-	-	78	152	128	94	58	510	0	163	107	180
22	Ozcelik et al.	112	-	-	-	-	-	-	-	112	0	-	-	-
23	Li et al.	211	-	-	34	66	69	29	13	90	121	65	54	92
24	Zhang et al.	120	62	58	27	36	30	19	8	120	0	89	21	10
25	Hasuo et al.	143	-	-	20	42	39	28	14	48	95	9	101	33

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No.	Authors	No. of replantations	Side replanted		Digit replanted				Level of replantation		Type of Injury		
			Right	Left	Thumb	Index	Long	Ring	Small	Zone I	Zone II	Clean-cut	Blunt-cut	Crush- avulsion
26	Yan et al.	121	-	-	16	41	32	21	11	66	55	19	41	61
27	Ito et al	67	-	-	-	-	-	-	-	31	36	-	-	-
28	Buntic et al	19	-	-	7	3	4	4	1	4	15	2	6	11
29	Shi et al	12	-	-	1	6	2	2	1	3	9	5	5	2
30	Hsu et al	5	2	3	1	1	1	2	0	2	3	0	5	0

[#]Type of injury data corresponds to patient and not digit

[*]Type of injury data available only for zone I amputations

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Table 5

Intra-operative characteristics of patients undergoing distal digital replantation

No.	Authors	No. of replantations	Method of venous outflow					Vein grafting			Nerve repair			
			Vein repair	External bleeding	Leech	AV anastomosis	Dermal pocket	Artery	Vein	Either	One	Both	Either	None
1	Gordon et al.	13	0	13	0	0	0	0	0	0	-	-	-	-
2	Cheng et al.	64	63	1	0	0	0	0	0	0	-	-	-	-
3	Suzuki et al.	25	13	12	0	0	0	0	0	0	-	-	-	-
4	Goldner et al.	38	35	3	0	0	0	7	0	0	10	20	0	8
5	DeSmet L	10	7	2	0	1	0	2	1	0	4	2	0	4
6	Koshima et al.	23	0	0	0	16	0	0	0	12	-	-	-	-
7	Foucher et al.	39	17	0	22	0	0	10	0	0	0	21	12	6
8	Yamano Y	207	-	-	-	-	-	-	-	-	-	-	-	-
9	Ikeda et al.	10	10	0	0	0	0	10	10	-	-	-	-	-
10	Malizos et al.	12	7	5	0	0	0	-	-	-	3	6	0	3
11	Chen et al.	23	23	5	0	0	0	0	0	0	4	15	0	4
12	Kim et al.	135	69	66	0	0	0	80	25	0	36	50	0	49
13	Hirase Y	38	17	7	8	0	0	0	0	0	0	0	26	12
14	Dubert et al.	13	2	9	0	0	0	0	0	0	7	2	0	4
15	Patradul et al.	181	151	30	0	0	0	10	0	0	-	-	-	-
16	Akyurek et al.	21	0	11	10	0	0	-	-	-	0	0	0	21
17	Hattori et al	64	59	5	0	0	0	18	7	0	-	-	-	-
18	Lin et al.	6	0	0	0	0	6	0	0	0	0	0	6	0
19	Matsuzaki et al.	15	0	15	0	0	0	0	0	0	0	0	0	15
20	Koshima et al.	16	10	0	0	0	0	4	6	0	-	-	-	-
21	Hahn et al.	510	485	25	11	0	0	0	0	56	-	-	-	-
22	Ozcelik et al.	112	0	112	0	0	0	0	0	0	0	0	0	112
23	Li et al.	211	158	53	0	0	0	41	0	0	0	0	94	117
24	Zhang et al.	120	0	0	0	0	0	10	0	0	0	120	0	0
25	Hasuo et al.	143	61	82	0	0	0	0	0	0	-	-	-	-
26	Yan et al.	121	94	9	0	0	0	46	60	0	0	0	15	106

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No.	Authors	No. of replantations	Method of venous outflow					Vein grafting			Nerve repair			
			Vein repair	External bleeding	Leech	AV anastomosis	Dermal pocket	Artery	Vein	Either	One	Both	Either	None
27	Ito et al	67	25	42	0	0	0	0	0	0	-	-	-	-
28	Buntic et al	19	0	19	19	0	0	0	0	0	-	-	-	-
29	Shi et al	12	0	12	0	0	0	0	0	0	7	1	-	4
30	Hsu et al	5	5	0	0	0	0	5	5	0	-	-	-	-

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Table 6

Early outcome (survival) of patients based on level of injury and venous repair

No.	Authors	No. of replantations	Overall survival			Survival based on level of Injury					
			Complete	Partial	Failure	Zone I			Zone II		
						Vein repair	No vein repair	Overall	Vein repair	No vein repair	Overall
1	Gordon et al.	13	9	0	4	0/0	0/0	0/0	0/0	9/13	9/13
2	Cheng et al.	64	62	0	2	0/0	0/0	0/0	61/63	1/1	62/64
3	Suzuki et al.	25	16	0	9	1/2	7/8	8/10	8/11	0/4	8/15
4	Goldner et al.	38	34	0	4	0/0	0/0	0/0	31/35	3/3	34/38
5	DeSmet L	10	9	0	1	0/0	0/0	0/0	7/8	2/2	9/10
6	Koshima et al.	23	20	0	3	11/12	1/1	12/13	8/9	1/1	9/10
7	Foucher et al.	39	26	0	13	0/0	7/11	7/11	11/17	8/11	19/28
8	Yamano Y	207	166	0	41	-	-	-	-	-	-
9	Ikeda et al.	10	9	0	1	-	-	-	-	-	-
10	Malizos et al.	12	9	2	1	2/2	2/3	4/5	5/5	2/2	7/7
11	Chen et al.	23	18	0	5	6/6	0/0	6/6	12/17	0/0	12/17
12	Kim et al.	135	106	4	25	-	-	48/64	-	-	62/71
13	Hirase Y	38	35	0	3	0/0	18/19	18/19	16/17	1/2	17/19
14	Dubert et al.	13	10	0	3	-	-	10/13	0/0	0/0	0/0
15	Patradul et al.	181	162	0	19	19/24	20/26	39/50	121/127	2/4	123/131
16	Akyurek et al.	21	15	1	5	0/0	16/21	16/21	0/0	0/0	0/0
17	Hattori et al	64	54	1	9	34/39	3/5	37/44	18/20	0/0	18/20
18	Lin et al.	6	6	0	0	0/0	6/6	6/6	0/0	0/0	0/0
19	Matsuzaki et al.	15	13	0	2	0/0	13/15	13/15	0/0	0/0	0/0
20	Koshima et al.	16	13	0	3	0/0	0/0	0/0	9/10	4/6	13/16
21	Hahn et al.	510	469	0	41	452/485	17/25	469/510	0/0	0/0	0/0
22	Ozcelik et al.	112	76	7	29	0/0	83/112	83/112	0/0	0/0	0/0
23	Li et al.	211	172	0	39	-	-	-	-	-	-
24	Zhang et al.	120	115	0	5	0/0	115/120	115/120	0/0	0/0	0/0
25	Hasuo et al.*	143	111	0	32	3/3	28/35	31/38 (36/48)	40/56	20/26	60/82(75/95)

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No.	Authors	No. of replantations	Overall survival			Survival based on level of Injury					
			Complete	Partial	Failure	Zone I			Zone II		
						Vein repair	No vein repair	Overall	Vein repair	No vein repair	Overall
26	Yan et al.	121	107	0	14	-	-	-	-	-	-
27	Ito et al	67	58	0	9	1/1	26/30	27/31	24/26	7/10	31/36
28	Buntic et al	19	19	0	0	0/0	4/4	4/4	0/0	15/15	15/15
29	Shi et al	12	11	0	1	0/0	2/3	2/3	0/0	9/9	9/9
30	Hsu et al	5	5	0	0	0/0	2/2	2/2	0/0	3/3	3/3

*Survival based on venous repair is provided only for digits having venous compromise. Figure in brackets shows overall survival for zone I and zone II replantations

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Table 7

Early outcome (survival) of patients based on type of injury

No.	Authors	No. of replantations	Overall survival			Survival based on type of Injury		
			Complete	Partial	Failure	Clean-cut	Crush-cut	Crush-avulsion
1	Gordon et al.	13	9	0	4	3/3	4/7	2/3
2	Cheng et al.	64	62	0	2	-	-	-
3	Suzuki et al.	25	16	0	9	4/4	4/6	8/15
4	Goldner et al.	38	34	0	4	0/0	23/25	11/13
5	DeSmet L	10	9	0	1	-	-	-
6	Koshima et al.	23	20	0	3	9/10	7/7	4/6
7	Foucher et al.	39	26	0	13	-	-	-
8	Yamano Y*	131	100	0	31	26/26	19/20	55/85
9	Ikeda et al.	10	9	0	1	4/4	3/3	2/3
10	Malizos et al.	12	9	2	1	5/5	0/0	6/7
11	Chen et al.	23	18	0	5	7/9	8/8	3/6
12	Kim et al.	135	106	4	25	42/48	42/54	26/33
13	Hirase Y	38	35	0	3	-	-	-
14	Dubert et al.	13	10	0	3	-	-	-
15	Patradul et al.	181	162	0	19	-	-	-
16	Akyurek et al.	21	15	1	5	-	-	-
17	Hattori et al	64	54	1	9	16/16	22/26	17/22
18	Lin et al.	6	6	0	0	6/6	0/0	0/0
19	Matsuzaki et al.	15	13	0	2	7/7	0/0	6/8
20	Koshima et al.	16	13	0	3	-	-	-
21	Hahn et al.	510	469	0	41	-	-	-
22	Ozcelik et al.	112	76	7	29	-	-	-
23	Li et al.	211	172	0	39	57/65	32/54	83/92
24	Zhang et al.	120	115	0	5	-	-	-
25	Hasuo et al.	143	111	0	32	8/9	83/101	20/33
26	Yan et al.	121	107	0	14	-	-	-

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No.	Authors	No. of replantations	Overall survival			Survival based on type of Injury		
			Complete	Partial	Failure	Clean-cut	Crush-cut	Crush-avulsion
27	Ito et al	67	58	0	9	-	-	-
28	Buntic et al	19	19	0	0	2/2	6/6	11/11
29	Shi et al	12	11	0	1	5/5	5/5	1/2
30	Hsu et al	5	5	0	0	0/0	5/5	0/0

* Data available only for zone 1 replantations

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Table 8

Subgroup analysis of survival rate in distal digital replantation

No.	Comparison Criteria	Comparison Groups	Total (%)	Survival (%)	Failure (%)	p-value*
1.	Level of amputation	Zone I	1107 (64)	962 (87)	145 (13)	0.920
		Zone II	617 (36)	535 (87)	82 (13)	
2.	Venous anastomosis	Zone I with vein repair	574 (56)	529 (92)	45 (8)	<0.001
		Zone I without vein repair	446 (44)	370 (83)	76 (17)	
		Zone II with vein repair	421 (79)	371 (88)	50 (12)	0.004
		Zone II without vein repair	112 (21)	87 (78)	25 (22)	
3.	Type of injury	Clean-cut	219 (40)	201 (92)	18 (8)	<0.001
		Crush-cut	327 (60)	263 (80)	64 (20)	
		Clean-cut	219 (39)	201 (92)	18 (8)	<0.001
		Crush-avulsion	339 (61)	255 (75)	84 (25)	
		Crush-cut	327 (49)	263 (80)	64 (20)	0.106
		Crush-avulsion	339 (51)	255 (75)	84 (25)	

*Chi-square

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Table 9

Long term outcomes of patients undergoing distal digital replantation

No.	Authors	No. of replantations	No. of replant survivals	No. of digits followed up long term	Average hospital stay	Average TAM	2 PD			Pulp Atrophy	Nail Deformity	Return to Work
							≥10mm	<10mm	Average (mm)			
1	Gordon et al.	13	9	8	10	137	6	2	12	-	4	7
2	Cheng et al.	64	62	34	-	-	-	-	4.2	-	-	-
3	Suzuki et al.	25	16	12	-	84.3%	-	-	-	-	-	-
4	Goldner et al.	38	34	34	-	-	-	-	-	-	-	34
5	DeSmet L	10	9	8	-	-	5	3	12	-	-	8
6	Koshima et al.	23	20	-	-	-	-	-	-	-	-	-
7	Foucher et al.	39	26	-	-	-	-	-	-	-	-	-
8	Yamano Y	207	166	166	-	-	129	37	-	-	-	-
9	Ikeda et al.	10	9	9	-	-	-	-	7.3	2	2	-
10	Malizos et al.	12	11	-	-	-	-	-	-	-	-	-
11	Chen et al.	23	18	17	-	-	-	17	7	8		14[#]
12	Kim et al.	135	110	52	-	-	-	-	8	7	9	-
13	Hirase Y	38	35	35	-	-	-	-	-	-	5	-
14	Dubert et al.	13	10	10	8	-	-	-	6.5	-	-	-
15	Patradul et al.	181	162	150	-	-	142	8	-	-	-	-
16	Akyurek et al.	21	16	16	-	-	-	-	6.1	-	-	-
17	Hattori et al	64	55	32	-	-	-	-	-	7	10	-
18	Lin et al.	6	6	6	-	-	-	-	5.3	-	-	-
19	Matsuzaki et al.	15	13	12	-	92%	-	-	5.9	1	-	-
20	Koshima et al.	16	13	-	-	-	-	-	-		-	-
21	Hahn et al.	510	469	469	-	-	-	-	-	47	117	
22	Ozcelik et al.	112	83	38	-	-	-	-	7.2	14	9	33[*]
23	Li et al.	211	172	-	-	-	-	-	-	-	-	-
24	Zhang et al.	120	115	-	-	-	6 (>6)	85 (<6)	-	-	-	-
25	Hasuo et al.	143	111	-	-	-	-	-	-	-	-	-

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							≥10mm	<10mm	Average (mm)			
26	Yan et al.	121	107	-	-	-	-	-	-	-	-	
27	Ito et al	67	58	-	-	-	-	-	-	-	-	-
28	Buntic et al	19	19	-	9	-	-	-	-	-	-	-
29	Shi et al	12	11	10	-	-	0	10	4.2	1	0	-
30	Hsu et al	5	5	1	-	-	-	-	-	-	-	-

[#]One adult patient out of 15 adults did not return to work

[*]All 33 adult patients returned to work