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REVIEW ARTICLES OF TOPICS

A systematic review of outcomes of revision amputation treatment for fingertip amputations

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Abstract
Purpose The purpose of this study was to conduct a systematic review of outcomes of fingertip revision amputation for fingertip amputation injuries in the English-language literature to provide best evidence of functional outcomes.
Methods A MEDLINE literature search was performed to identify studies that met the following criteria: (1) reported primary data; (2) included at least five cases of primary revision amputation treatment following digit amputation injury; (3) reported finger or thumb amputation at or distal to the distal interphalangeal (DIP) joint or interphalangeal (IP) joint, respectively; (4) presented at least one of the following outcomes: static two-point discrimination (2PD), cold intolerance, arc of motion (AOM) of metacarpophalangeal (MCP) joints, proximal interphalangeal joints (PIP), DIP joints, or return-to-work time.
Results Thirty-eight studies met the inclusion criteria. Twenty-seven studies reported 2PD, 20 studies reported cold intolerance, eight studies reported AOM, and 18 studies reported return-to-work time after revision amputation of fingertip injuries. The mean 2PD was 5.6 mm. On average, 24 % of patients experienced cold intolerance. AOM at the PIP joint was reported in four studies and averaged 94°. DIP joint AOM was presented in four studies and averaged 66°. Thumb MCP and IP joint AOM was presented in three and four studies, respectively. Mean thumb MCP joint AOM was 54° and that of the IP joint was 71°. The mean return-to-work time was 47 days.
Conclusions On average, fingertip revision amputation can achieve almost normal sensibility and satisfactory motion and patients can expect to return to work on average approximately 7 weeks after surgery.

Keywords Fingertip amputation · Hand surgery outcomes · Systematic review · Treatment

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Fingertip amputation, involving the distal interphalangeal joint (DIP) for fingers and the interphalangeal (IP) joint for the thumb [23], is the most common amputation injury treated by hand surgeons. Sixty-three percent of patients do not undergo replantation [38]. Revision amputation of the fingertip may result in the loss of skin, fingernail, or digit length, which may lead to functional deficits. Some previous studies have reported normal sensibility [51] whereas other studies have reported inadequate outcomes [22]. Outcomes of fingertip injuries have not been examined critically in an evidence-based manner by applying systematic review principles. Although fingertip replantation results in acceptable outcomes if successful [42], the outcomes of revision amputation are not well-known. Amputation should be critically examined to determine if its outcomes are sufficiently poor to support an increased effort in replanting these distal amputated parts.

Most studies, including a recent systematic review [42], focused on outcomes of fingertip amputation treated with replantation, but little attention has been given to outcomes after revision amputation. Furthermore, the current literature on revision amputation lacks the rigorous evidence necessary to evaluate outcomes compared to replantation. Current studies that report outcomes after revision amputation suffer from small sample size and present varied outcomes. In order to inform clinical decision-making between the two treatment options, outcomes after revision amputation treatments need to be arduously evaluated. Systematic review is a rigorous tool for evidence-based medical practice and can be used in the clinical setting to synthesize available data to determine the best evidence [10] for outcomes of revision amputation treatment for fingertip amputations. However, no such review of the evidence has been performed. The purpose of this study is to conduct a systematic review of the English language literature on revision amputation treatment of fingertip amputation injuries to provide the best available evidence of functional outcomes, including sensibility, arc of motion (AOM), and return-to-work time. We hypothesize that revision amputation treatment will have acceptable functional outcomes.

Materials and Methods

Literature Search

We performed a literature search using MEDLINE in March 2012 to summarize outcomes after primary revision amputation treatment of fingertip injuries. We defined the fingertip as the portion of the digit at or distal to the DIP joint of the fingers or the IP joint of the thumb. We used the key words "fingers", "thumb", or "finger injuries" combined with "amputation, traumatic" or "replantation" to identify studies. Studies were limited to those of humans and those published in English.

Included studies met the following criteria:

1. Study reported primary data
2. Study included at least five cases of primary revision amputation following digit amputation injury of any mechanism, where treatment included open treatment, primary closure, split-thickness skin grafting, full-thickness skin grafting, local, or regional flap closure
3. Study reported outcomes of finger or thumb amputation at or distal to the DIP joint or IP joint, respectively
4. The study presented at least one of the following outcomes: static two-point discrimination (2PD), cold intolerance, AOM of metacarpophalangeal (MCP) joints, IP joints, proximal interphalangeal (PIP) joints, DIP joints, or return-to-work time

The following manuscripts were excluded:

1. Cases of secondary revision amputation performed after failure of replantation
2. Amputation injuries treated using microsurgery, such as toe-to-thumb transfer
3. Amputation injuries treated with composite graft

We first screened the titles and abstracts of the identified studies. Next, we performed full-article reviews of studies in which no abstract was published or if the content was unclear based on abstract review. If several articles presented data from the same author, we determined the techniques they performed as well as the time period patients were treated to verify that data from the same patient sample was not duplicated in this systematic review.

Data Analysis

For each study meeting our inclusion criteria, we recorded study characteristics, patient demographic information, mean follow-up time, and functional outcomes. Functional outcomes included one or more of the following: (1) static 2PD, (2) cold intolerance, (3) AOM, and (4) return-to-work

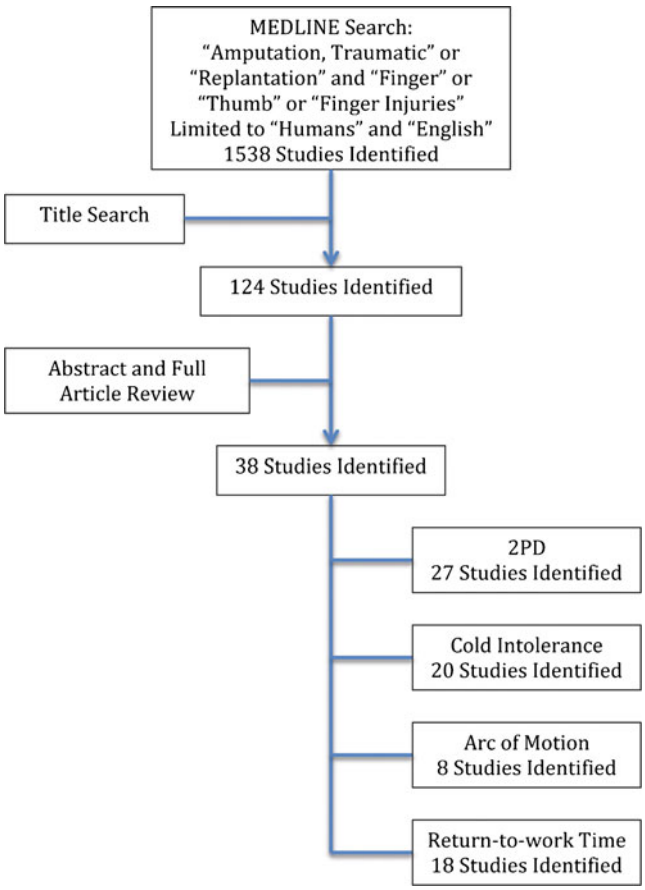

Fig. 1 Flow chart of database search, including number of citations identified at each level of search

time. The weighted mean of each functional outcome was calculated based on sample sizes of each included study using the following method: (1) multiply the mean outcome of each study by the study sample size, (2) sum the products to get the total value, (3) sum the sample sizes to get the total weight, and (4) divide the total value by the total weight to provide a weighted mean for each outcome. We defined presence of cold intolerance as having at least moderate cold intolerance. Thus, we did not include patients with mild or slight cold intolerance in our summary statistics

Table 1 Demographic characteristics of patients undergoing fingertip amputation

Year[a]	First author	Study location	No. of patients	Male	Female	Mean age or range (years)	Mean follow-up, months (range)	No. of digits
1972	Freiberg	Canada	10	–	–	4–79	–	10
1977	Farrell	USA	17	–	–	–	–	21
1977	Fox	USA	18	–	–	–	6	22
1978	Frandsen	Denmark	24	24	1A 3C	34	32 (6–57)	24
1980	Louis	USA	33	29	4	16–70	8	38
1982	Ma	Hong Kong	140	130	10	35	6	140
1985	Kappel	USA	23	19	5	–	6	23
1985	Tupper	USA	16	15	1	34	71 (12–132)	20
1989	De Smet	Belgium	108	90	18	33	6	112
1989	Foucher	France	64	53	11	34	15–72	64
1994	Foucher	France	41	37	4	34	36 (12–72)	43
1995	Adani	Italy	11	9	2	37	26 (7–43)	11
1995	Lanzetta	Canada	25	21	4	38	30 (6–48)	25
1996	Tsai	USA	16	12	4	43	62	16
1997	Adani	Italy	25	25	7	37	27 (8–52)	25
2000	Borman	Turkey	19	10	7	25	4 (0.8–17)	25
2000	Buckley	UK	19	19	0	44	76 (40–96)	21
2001	Karamursel	Turkey	6	5	1C	19–66	10	11
2001	Kim	Korea	14	16	7	33	6	15
2001	Özdemir	Turkey	9	6	3	–	9 (3–18)	9
2001	Pelissier	France	14	12	2	42	13 (6–20)	15
2002	Baumeister	Germany	25	34	2	42	27	25
2002	Cao	China	5	8	3	29	29–33	5
2003	Laoulakos	Greece	9	8	1	41	6–30	9
2005	Adani	Italy	22	14	8	34	–	22
2005	Varitimidis	Greece	50	36	14	35	46 (14–94)	63
2006	Hattori	Japan	23	18	5	45	21	23
2006	Tuncali	Turkey	9	8	1	33	12	9
2007	Ozyigit	Turkey	7	6	1	33	18 (12–24)	7
2008	Sano	Japan	11	8	3	44	12–21	14
2008	Woon	Singapore	9	8	1	50	4 (1–15)	9
2009	Bakhach	France	13	12	1	40	–	15
2009	Omokawa	Japan	15	11	4	41	48	15
2009	Shao	China	11	8	3	36	27 (25–34)	11
2010	Chen	China	11	–	–	30	32 (26–47)	11
2010	Yazar	Turkey	66	56	10	32	18	70
2011	Hammouda	Qatar	6	6	0	29	9–12	6
2011	Wang	China	5	9	2	4	15 (10–32)	5

– not reported, *A* adult, *C* child

[a] Studies listed in chronological order

[b] Did not include patients lost to follow-up

due to the high prevalence of slight or mild cold intolerance in this patient population [44].

Results

We identified 1,538 studies through our MEDLINE search (Fig. 1). The abstract and title review narrowed the field to 124 studies that underwent full text review. Upon further review, 38 studies met the inclusion/exclusion criteria [1–9, 12–18, 21, 22, 25–30, 32, 35, 37, 39–41, 43–47, 49, 50, 52] (Table 1). The included studies were published between 1972 and 2011, and a total of 1,009 fingertip amputations were treated. Twenty-seven studies reported 2PD outcomes [2, 3, 6, 8, 9, 14, 16, 18, 21, 25–27, 29, 30, 32, 35, 37, 39–41, 43, 45–47, 49, 50, 52], 20 studies reported cold intolerance outcomes [1–3, 6, 7, 9, 14, 17, 22, 28–30, 39, 41, 43–45, 47, 49, 50, 52], eight studies reported AOM outcomes [5, 9, 21, 22, 40, 43, 44, 50], and 18 studies reported return-to-work time [4, 7, 12–17, 21, 22, 25, 28, 29, 32, 39, 44, 47, 49]. The mean 2PD was 5.6 mm (Table 2). On average, 24 % of patients experienced cold intolerance (Table 3). AOM at the PIP joint was reported in four studies and averaged 94° (Table 4). DIP joint AOM outcomes were presented in four studies and averaged 66° (Table 4). Thumb MCP and IP joint AOM outcomes were presented in three and four studies, respectively (Table 5). Mean thumb MCP joint AOM was 54° and mean thumb IP joint AOM was 71°. The mean return-to-work time was 47 days (Table 6).

Table 2 Sensibility outcomes after fingertip amputation

Year[a]	Author	No. of digits	2PD (mm)
1972	Freiberg	10	6.0
1977	Fox	22	4.0
1980	Louis	29	3.5
1982	Ma	140	5.4
1985	Kappel	23	8.3
1985	Tupper	20	5.7
1994	Foucher	43	7.0
1995	Adani	11	12.0
2000	Borman	25	4.3
2001	Karamursel	11	6.0
2001	Kim	15	4.2
2001	Ozdemir	9	4.5
2001	Pelissier	15	8.0
2002	Cao	5	4.2
2003	Laoulakos	9	8.0
2005	Adani	22	9.0
2005	Varitimidis	63	4.0
2006	Tuncali	9	6.3
2007	Ozyigit	7	4.7
2008	Sano	14	4.3
2008	Woon	9	3.3
2009	Omokawa	15	8.4
2009	Shao	11	4.6
2010	Chen	11	5.0
2010	Yazar	70	5.7
2011	Hammouda	6	4.0
2011	Wang	5	3.4
Mean 2PD after fingertip amputation[b]		624	5.6

2PD two-point discrimination

[a] Studies listed in chronological order

[b] Weighted averages based on sample size of each study

Discussion

The aim of fingertip amputation treatment is to maintain as much function as possible in the form of sensibility and AOM. In addition, patients and physicians aim to have patients return to the previous level of employment as soon as possible. According to the American Society for Surgery of the Hand, 2PD is considered normal if it is less than 6 mm [31]. Our review found that mean 2PD following revision amputation was 5.6 mm, which was within normal range. Additionally, the normative AOM reference value of the DIP joint is reported to be 70–90° and that of the PIP joint 100° [33]. We found that after revision amputation, the average AOM of the DIP joint and the PIP joint was 66° and 94°, respectively, which approach the normative value. This systematic review of fingertip amputation injuries treated with revision amputation showed acceptable outcomes. On average, patients have good sensibility, adequate AOM of the IP joints and MCP joints, and return to work approximately 7 weeks after injury.

In general, outcomes after revision amputation of fingertip amputation injuries appear to be similar to functional outcomes reported after fingertip replantation. In a systematic review of outcomes of replantation of fingertip injuries, Sebastin et al. found that of 220 digits reported among 12 studies, the mean 2PD was 7 mm [42]. Based on our review, patients undergoing fingertip revision amputation had slightly better sensibility outcomes.

We found that the mean incidence of cold intolerance was 24 %. After fingertip replantation, cold intolerance was reported in 0–35 % of patients reported in the literature [22, 36, 48]. Hattori et al. compared 23 patients who had undergone fingertip replantation and 23 patients with fingertip revision amputation, and found no statistically significant difference ($P>0.05$) between the two groups in cold intolerance: 35 % in fingertip replantation and 40 % in fingertip revision amputation [22]. In another study, Ozcelik et al. evaluated thumb tip replantation in 14 patients and reported that the rate of cold intolerance was 21.4 % [36].

Table 3 The prevalence of cold intolerance outcome after fingertip amputation

Year[a]	Author	No. of digits	Cold intolerance (%)
1978	Frandsen	24	50
1980	Louis	38	11
1994	Foucher	41	51
1995	Adani	11	0
1995	Lanzetta	25	80
1996	Tsai	16	38
1997	Adani	25	0
2000	Buckley	21	38
2000	Borman	25	0
2003	Laoulakos	9	0
2005	Adani	22	0
2005	Varitimidis	63	44
2006	Hattori	23	22
2006	Tuncali	9	29
2007	Ozyigit	7	0
2008	Sano	14	0
2008	Woon	9	33
2010	Chen	11	0
2010	Yazar	66	0
2011	Wang	5	0
Mean cold intolerance after fingertip amputations[b]		464	24

[a] Studies listed in chronological order

[b] Weighted averages based on sample size of each study

However, in a more recent study, cold intolerance was not reported by any of 24 patients with fingertip replantation [48]. It is important to note, though, that cold intolerance is assumed to be the result of vascular insufficiency and peripheral nerve injury suffered during the original trauma, rather than as a result of treatment [19, 20, 24, 34].

Table 4 Finger DIP and PIP Joint arc of motion after fingertip amputation

Year[a]	Author	No. of digits	DIP (degrees)	PIP (degrees)
1996	Tsai	16	54	96
2001	Pelissier	15	64	–
2006	Hattori	23	–	86
2009	Shao	11	86	98
2011	Hammouda	6	69	108
Mean arc of motion after fingertip amputation[b]			66 (n=48)	94 (n=56)

DIP distal interphalangeal, *PIP* proximal interphalangeal, – not reported in the study

[a] Studies listed in chronological order

[b] Weighted averages based on sample of fingers in study

Table 5 Thumb MCP and IP joint arc of motion after thumb tip amputation

Year[a]	Author	No. of thumbs	MCP (degrees)	IP (degrees)
1996	Tsai	2	–	54
2002	Baumeister	25	50	77
2010	Woon	9	64	59
2010	Chen	11	56	70
Mean arc of motion after thumb tip amputation[b]			54 (n=45)	71 (n=47)

MCP metacarpophalangeal, *IP* interphalangeal, – not reported in the study

[a] Studies listed in chronological order

[b] Weighted averages based on sample of thumbs in study

Similar to our experience reviewing outcomes after revision amputation, few studies described joint AOM after fingertip replantation. Sebastin et al. described only three studies reporting AOM after fingertip replantation [42]. Two of the studies reported the percent of normal AOM achieved by the replanted finger. One study [22]

Table 6 Return-to-work time after fingertip revision amputation

Year[a]	Author	No. of patients	Return-to-work time (days)
1977	Farrell	17	4
1977	Fox	18	10
1978	Frandsen	24	51
1982	Ma	140	53
1985	Kappel	23	67
1989	De Smet	108	50
1989	Foucher	64	61
1994	Foucher	41	43
1995	Lanzetta	25	56
1996	Tsai	16	30
2000	Buckley	19	7
2003	Laoulakos	9	28
2005	Varitimidis	50	36
2006	Hattori	23	30
2007	Ozyigit	7	21
2009	Bakhach	13	106
2011	Hammouda	6	56
2011	Wang	5	35
Mean return-to-work time after fingertip amputation[b]		608	47

[a] Study listed in chronological order

[b] Weighted averages based on sample size of each study

reported DIP joint AOM was 49° and PIP joint AOM was 94° in fingertip replantation group, which was similar to the outcomes in our review of revision amputation treatment. In addition, this systematic review showed that DIP and PIP joint AOM were relatively close to the normative values [33].

The return-to-work time after fingertip replantation ranged from 3.2 to 4.0 months in previous published studies [22, 36]. Our systematic review found the return-to-work time following fingertip revision amputation to be 47 days, approximately 1.5 months. Therefore, revision amputation allows patients to return to work in half the time on average than replantation patients.

This systematic review has several limitations. One limitation of our study is that analysis of data in systematic reviews is limited by the manner in which data is presented in the original studies. Studies did not reliably stratify outcomes according to mechanism of injury or demographic characteristics, thus our review was not able to stratify outcomes according to these variables. In addition, there is considerable variability in techniques used for fingertip revision amputation. Eighteen studies used the homodigital island flap [1–3, 6, 14, 15, 21, 26–29, 37, 40, 43, 44, 47, 49, 52], whereas seven studies reported V-Y advancement flap [4, 5, 17, 18, 39, 41, 46] and another two studies reported cross-finger flap treatment [9, 46]. Three studies treated fingertip amputations with dressings and allowed wounds to heal by secondary intention [13, 16, 30]. The remaining studies reported outcomes from more than one method of revision amputation. Only one study reported all of the outcomes of interest for this systematic review [22]. Many studies focused more on techniques rather than presenting functional outcomes. There was limited AOM data given for individual joints. Additional considerations were the variability of outcomes measures. Cold intolerance is a subjective experience that is not easily or reliably measured and return-to-work time can be influenced by many factors not related to injury or treatment.

This systematic review synthesizes the evidence on revision amputation for fingertip amputation injury. The results can aid surgeons and patients when making decisions regarding fingertip replantation and fingertip revision amputation. After fingertip revision amputation, sensation can be similar or better than following fingertip replantation. Cold intolerance, as well as DIP and PIP joint motion is similar to outcomes reported in the literature for replantation treatment. The return-to-work time is shorter than what is reported after fingertip replantation. Thus, for patients who need to return to work sooner, fingertip revision amputation is recommended. Fingertip revision amputation can achieve good sensibility and AOM, in addition to allowing an earlier return-to-work compared to fingertip replantation treatment. Given similar objective functional outcomes, future studies should evaluate health-related quality of life of both treatments. Given the greater cost of performing replantation treatment [11, 38], improved patient-reported quality of life should be demonstrated to justify performing replantation following fingertip amputation injuries.

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References

1. Adani R, Busa R, Castagnetti C, Bathia A, Caroli A. Homodigital neurovascular island flaps with “direct flow” vascularization. Annals of Plastic Surgery. 1997;38:36–40.
2. Adani R, Busa R, Pancaldi G, Caroli A. Reverse neurovascular homodigital island flap. Annals of Plastic Surgery. 1995;35:77–82.
3. Adani R, Marcoccio I, Tarallo L, Fregni U. The reverse heterodigital neurovascular island flap for digital pulp reconstruction. Techniques in Hand & Upper Extremity Surgery. 2005;9:91–5.
4. Bakhach J, Guimberteau JC, Panconi B. The Gigogne flap: an original technique for an optimal pulp reconstruction. Journal of Hand Surgery: European Volume. 2009;34:227–34.
5. Baumeister S, Menke H, Wittemann M, Germann G. Functional outcome after the Moberg advancement flap in the thumb. Journal of Hand Surgery—American Volume. 2002;27:105–14.
6. Borman H, Maral T, Tancer M. Fingertip reconstruction using two variations of direct-flow homodigital neurovascular island flaps. Annals of Plastic Surgery. 2000;45:24–30.
7. Buckley SC, Scott S, Das K. Late review of the use of silver sulphadiazine dressings for the treatment of fingertip injuries. Injury. 2000;31:301–4.
8. Cao X, Cai J. Double mini-flaps from fingers for reconstruction of distal portion of thumb. Hand Surgery. 2002;7:15–9.
9. Chen C, Zhang X, Shao X, Gao S, Wang B, Liu D. Treatment of thumb tip degloving injury using the modified first dorsal metacarpal artery flap. The Journal of Hand Surgery. 2010;35:1663–70.
10. Chung KC. JHS guidelines on systematic review and meta-analysis submissions. The Journal of Hand Surgery. 2012;37:1121–4.
11. Chung KC, Kowalski CP, Walters MR. Finger replantation in the United States: rates and resource use from the 1996 Healthcare Cost and Utilization project. The Journal of Hand Surgery. 2000;25:1038–42.
12. De Smet L, Kinnen L, Moermans JP, Ceuterick P, Van Wetter P. Fingertip amputations: distal or advancement flaps. Acta Orthopaedica Belgica. 1989;55:177–82.
13. Farrell RG, Disher WA, Nesland RS, Palmatier TH, Truhler TD. Conservative management of fingertip amputations. JACEP. 1977;6:243–6.
14. Foucher G, Dallaserra M, Tilquin B, Lenoble E, Sammut D. The Hueston flap in reconstruction of fingertip skin loss: results in a series of 41 patients. Journal of Hand Surgery—American Volume. 1994;19:508–15.
15. Foucher G, Smith D, Pempinello C, Braun FM, Citron N. Homodigital neurovascular island flaps for digital pulp loss. Journal of Hand Surgery—British Volume. 1989;14:204–8.
16. Fox JW, Golden GT, Rodeheaver G, Edgerton MT, Edlich RF. Nonoperative management of fingertip pulp amputation by occlusive dressings. American Journal of Surgery. 1977;133:255–6.

17. Frandsen PA. V-Y plasty as treatment of finger tip amputations. Acta Orthopaedica Scandinavica. 1978;49:255–9.
18. Freiberg A, Manktelow R. The Kutler repair for fingertip amputations. Plastic & Reconstructive Surgery. 1972;50:371–5.
19. Gelberman RH, Urbaniak JR, Bright DS, Levin LS. Digital sensibility following replantation. The Journal of Hand Surgery. 1978;3:313–9.
20. Graham B, Schofield M. Self-reported symptoms of cold intolerance in workers with injuries of the hand. Hand (N Y). 2008;3:203–9.
21. Hammouda AA, El-Khatib HA, Al-Hetmi T. Extended step-advancement flap for avulsed amputated fingertip—a new technique to preserve finger length: case series. Journal of Hand Surgery—American Volume. 2011;36:129–34.
22. Hattori Y, Doi K, Ikeda K, Estrella EP. A retrospective study of functional outcomes after successful replantation versus amputation closure for single fingertip amputations. Journal of Hand Surgery—American Volume. 2006;31:811–8.
23. Heistein JB, Cook PA. Factors affecting composite graft survival in digital tip amputations. Ann Plast Surg. 2003;50:299–303.
24. Irwin MS, Gilbert SE, Terenghi G, Smith RW, Green CJ. Cold intolerance following peripheral nerve injury. Natural history and factors predicting severity of symptoms. J Hand Surg Br. 1997;22:308–16.
25. Kappel DA, Burech JG. The cross-finger flap. An established reconstructive procedure. Hand Clinics. 1985;1:677–83.
26. Karamursel S, Kayikcioglu A, Aksoy HM, Dayican A, Safak T, Kecik A. Dorsal visor flap in fingertip reconstruction. Plastic & Reconstructive Surgery. 2001;108:1014–8.
27. Kim KS, Yoo SI, Kim DY, Lee SY, Cho BH. Fingertip reconstruction using a volar flap based on the transverse palmar branch of the digital artery. Annals of Plastic Surgery. 2001;47:263–8.
28. Lanzetta M, Mastropasqua B, Chollet A, Brisebois N. Versatility of the homodigital triangular neurovascular island flap in fingertip reconstruction. Journal of Hand Surgery—British Volume. 1995;20:824–9.
29. Laoulakos DH, Tsetsonis CH, Michail AA, Kaxira OS, Papatheodorakis PH. The dorsal reverse adipofascial flap for fingertip reconstruction. Plastic & Reconstructive Surgery. 2003;112:121–5. discussion 6–8.
30. Louis DS, Palmer AK, Burney RE. Open treatment of digital tip injuries. JAMA. 1980;244:697–8.
31. Lundborg G, Rosen B. The two-point discrimination test—time for a re-appraisal? J Hand Surg Br. 2004;29:418–22.
32. Ma GF, Cheng JC, Chan KT, Chan KM, Leung PC. Finger tip injuries—a prospective study on seven methods of treatment on 200 cases. Annals of the Academy of Medicine, Singapore. 1982;11:207–13.
33. Mallon WJ, Brown HR, Nunley JA. Digital ranges of motion: normal values in young adults. The Journal of hand surgery. 1991;16:882–7.
34. Nystrom A, Backman C, Backman C, Bertheim U, Karlsson L, Carlsson A. Digital amputation, replantation, and cold intolerance. J Reconstr Microsurg. 1991;7:175–8.
35. Omokawa S, Fujitani R, Dohi Y, Tanaka Y, Yajima H. Reverse midpalmar island flap transfer for fingertip reconstruction. Journal of Reconstructive Microsurgery. 2009;25:171–9.
36. Ozcelik IB, Purisa H, Mersa B, Sezer I, Erturer E, Ergun O. Late results of replantations in tip amputations of the thumb. Acta Orthop Traumatol Turc. 2008;42:252–7.
37. Ozdemir R, Kilinc H, Sensoz O, Unlu RE, Baran CN. Innervated dorsal adipofascial turnover flap for fingertip amputations. Annals of Plastic Surgery. 2001;46:9–14.
38. Ozer K, Kramer W, Gillani S, Williams A, Smith W. Replantation versus revision of amputated fingers in patients air-transported to a level 1 trauma center. The Journal of hand surgery. 2010;35:936–40.
39. Ozyigit MT, Turkaslan T, Ozsoy Z. Dorsal V-Y advancement flap for amputations of the fingertips. Scandinavian Journal of Plastic & Reconstructive Surgery & Hand Surgery. 2007;41:315–9.
40. Pelissier P, Genin-Etcheberry T, Casoli V, Pistre V, Martin D, Baudet J. Limits and indications of the dorsal transposition flap: critical evaluation of 15 cases. The Journal of Hand Surgery. 2001;26:277–82.
41. Sano K, Ozeki S, Kimura K, Hyakusoku H. Relationship between sensory recovery and advancement distance of oblique triangular flap for fingertip reconstruction. Journal of Hand Surgery—American Volume. 2008;33:1088–92.
42. Sebastin SJ, Chung KC. A systematic review of the outcomes of replantation of distal digital amputation. Plastic and Reconstructive Surgery. 2011;128:723–37.
43. Shao X, Chen C, Zhang X, Yu Y, Ren D, Lu L. Coverage of fingertip defect using a dorsal island pedicle flap including both dorsal digital nerves. Journal of Hand Surgery—American Volume. 2009;34:1474–81.
44. Tsai TM, Yuen JC. A neurovascular island flap for volar-oblique fingertip amputations. Analysis of long-term results. Journal of Hand Surgery—British Volume. 1996;21:94–8.
45. Tuncali D, Barutcu AY, Gokrem S, Terzioglu A, Aslan G. The hatchet flap for reconstruction of fingertip amputations. Plastic & Reconstructive Surgery. 2006;117:1933–9.
46. Tupper J, Miller G. Sensitivity following volar V-Y plasty for fingertip amputations. Journal of Hand Surgery—British Volume. 1985;10:183–4.
47. Varitimidis SE, Dailiana ZH, Zibis AH, Hantes M, Bargiotas K, Malizos KN. Restoration of function and sensitivity utilizing a homodigital neurovascular island flap after amputation injuries of the fingertip. Journal of Hand Surgery—British Volume. 2005;30:338–42.
48. Venkatramani H, Sabapathy SR. Fingertip replantation: technical considerations and outcome analysis of 24 consecutive fingertip replantations. Indian Journal of Plastic Surgery: Official Publication of the Association of Plastic Surgeons of India. 2011;44:237–45.
49. Wang B, Chen L, Lu L, Liu Z, Zhang Z, Song L. The homodigital neurovascular antegrade island flap for fingertip reconstruction in children. Acta Orthopaedica Belgica. 2011;77:598–602.
50. Woon CY-L, Lee JY-L, Teoh L-C. Resurfacing hemipulp losses of the thumb: the cross finger flap revisited: indications, technical refinements, outcomes, and long-term neurosensory recovery. Annals of Plastic Surgery. 2008;61:385–91.
51. Yazar M, Aydin A, Kurt Yazar S, Basaran K, Guven E. Sensory recovery of the reverse homodigital island flap in fingertip reconstruction: a review of 66 cases. Acta Orthop Traumatol Turc. 2010;44:345–51.
52. Yazar M, Aydin A, Kurt Yazar S, Basaran K, Guven E. Sensory recovery of the reverse homodigital island flap in fingertip reconstruction: a review of 66 cases. Acta Orthopaedica et Traumatologica Turcica. 2010;44:345–51.