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REVIEW

Secondary healing of fingertip amputations: a review

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Abstract Most literature on fingertips reviews new surgical techniques of coverage while many surgeons prefer the results of secondary healing. This article reviews the current best evidence and concepts about secondary healing in fingertip injuries.

Keywords Fingertip amputation · Fingertip injury · Fingertip secondary healing · Conservative management of fingertip injury

Introduction

There is ongoing controversy among hand surgeons regarding the best treatment of fingertip amputations. The main camps are divided between flap closure and secondary healing. The method of treatment is influenced by strongly held beliefs, the history of the training program, and financial remuneration for surgery vs. conservative management. The purpose of this paper is to review conservative management with the best available evidence.

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Method of Literature Review

A PubMed search including keyword search "fingertip amputation" and "conservative management" limited to treatment was conducted. "Fingertip amputation" was defined as injury with soft tissue loss of the terminal phalanx, distal to the distal interphalangeal (DIP) joint. The definition is consistent in the literature compared to classification schemes by Allen [1]. All abstracts were screened for inclusion criteria: treatment of fingertip amputations distal to the DIP joint, treatment with dressings or conservative wound management, or comparing conservative management to operative treatment. Exclusion criteria included surgical treatment alone and single-case reports. Reference lists of selected papers were then screened for additional peer-reviewed papers.

Results

The search strategy yielded a heterogeneous body of literature including pediatric and adult patients and comparisons of a variety of conservative and surgical treatments. Evidence ranged between level II, III, and IV. Included studies totaled 1,592 fingertip injuries treated conservatively. Eleven studies directly compared the outcome of fingertip amputation between conservative management and surgical treatment. The 30 peer-reviewed articles included for review are discussed without attempting grouped comparison statistics due to the heterogeneous populations.

Typical Papers of Conservative Wound Management

In 1972, Douglas [8] investigated the functional and aesthetic outcomes of fingertip injuries treated with simple dressings in children. His series of 29 conservatively treated fingertips in

children age 4–15 found an average time to complete healing of 22 days with good aesthetic outcome and accompanying restoration of some of the length and thickness of pulp with contraction. He reported no adverse nail effects or sensory disturbances.

Allen's [1] classification of fingertip injuries into zones I–IV accompanied a prospective series of 57 patients with 60 fingertip amputations. Even the most proximal amputations, zone IV through the lunula, healed secondarily. The more proximal the amputated part, the higher is the likelihood of nail deformity. The incidence of cold intolerance, change in sensitivity, or change in skin quality was low but more common with proximal injuries. Only four patients in the series were unhappy with the overall results of the amputated digit at sixth-month follow-up. None of the patients had reduced range of motion, and one had a decrease in grip strength. Return to work after wound healing averaged 18 days for distal injuries and 26 days for proximal injuries. Like other authors, Allen questioned whether surgical intervention was warranted in fingertip injuries, with its hospital stay, immobilization, time off work, surgical complications, and donor site morbidity, considering the excellent functional results and high patient satisfaction using simple dressings.

Also in 1980, Louis et al. [21] followed 33 patients for an average of 8 months. Twenty five of them missed 1 day or less of work. The average 2-point discrimination was 3.5 mm. Four patients had cold intolerance. Two patients required revision because of inadequate bone padding.

Lee et al. [20] retrospectively studied the functional outcomes and time off work of 125 patients with 156 fingertip injuries. The injuries were <1 cm in diameter but included bone exposure in 63 % of the patients. The exposed bone was shortened to the level of the fat to allow the secondary healing of the pulp to pull fat and skin covering over the remaining bone. Only four minor infections were noted and there was no incidence of osteomyelitis. Average time to full healing was 32 days, and 85 % of the injured laborers returned to their normal work duties within 1 month. The authors noted good-quality durable skin after healing with no significant changes in sensation compared to uninjured fingertips.

Summary of Studies

Time to Healing

The most commonly reported mean time to complete healing using conservative wound care alone was 4 weeks [6, 23, 27, 29]. Small defects (<1 cm) with no bone involvement were frequently healed within 2 weeks [9, 22, 23, 31].

Time off Work

Patients treated conservatively can often return to work within the first week of injury. In studies that provided a protective fingertip splint or cap, many patients returned to work the day after injury [19, 21, 25]. Except for food service jobs [5] or when instructed by their physician to stay off work until fully healed [6], most patients returned to work at a mean of 1 month even in more severe proximal injuries.

Aesthetic Results of Secondary Healing

Most patients in the reviewed series tended to be satisfied with the appearance of the amputated fingertip, and most of our patients do not request treatment for the aesthetic deformity. Secondarily healed finger pulp contour was recently shown to increase in length from 6 to 7 mm, as well as thickness (4.2 vs. 4.5 mm) to near-normal levels even when bone is exposed [13]. This likely occurs because the thick fat of the fingertip is pulled over the end of the bone by the glabrous skin as it contracts with secondary healing. Residual nail deformity was the usual cause of aesthetic dissatisfaction. In the total population of 1,592 fingertip amputations of our review, there were 100 reported nail deformities, (6 % of the fingertip injuries) [1, 3, 5, 6, 13, 15, 23, 28, 31].

The main residual deformity with secondary healing is the hook nail or parrot beak deformity, which occurs mainly in the most proximal injuries [1, 31]. This can be a problem for some patients, but in our experience, most patients only have minor functional problems with this. Hook nails also occur after flap treatment of fingertip injuries [24]. A number of surgical treatments exist to treat the hook nail for those patients who request treatment [4, 14, 18, 30].

Sensation

Although Weichman et al. [32] (level III evidence) found 4/65 secondarily healed fingers to have decreased 2-point discrimination, other studies have found 2-point discrimination comparable to the uninjured hand in most patients [1, 11, 20] and ranging between 3 and 6 mm [5, 6, 10, 13, 15, 23, 25]. This makes sense when you think about how glabrous innervated fingertip skin heals, pulling the nerves attached to it over the stump as the wound contracts.

Cold Intolerance

The highest reported incidence of cold intolerance was 86 % at 2 months [31], but all reports showed a decreasing incidence with time. Cold intolerance frequently resolved by 1 year and caused disability in only a small minority of patients [24]. Cold intolerance is also not limited to secondary

Table 1 Results of studies describing conservative management of fingertip injuries

Author	Year	Dressing	Healing time (weeks), mean (range)	Return to work time (range or percentage of patients)
Halim, AS et al.	1998	Occlusive dressing, Hyphecan[a] left in place until it falls off (healed)	5 (3–12)	
Lee, LP et al.	1995	Occlusive dressing, Hyphecan[a] left in place until it falls off (healed)	4.6 (2–12)	<4 weeks (85 %)
Louis, DS et al.	1980	Weekly petroleum jelly gauze, gauze wrap, and padded aluminum splint. Soaked off weekly with peroxide and reapplied until healed	<10 weeks, dependent on wound size	1 day (64 %)
Chow, SP and Ho, E	1982	Framycetin-impregnated tulle gras; dressing change 3×/week soaking in chlorhexidine	3.9 (1.3–8.4)	Mean 5.9 weeks (3–10)[b]
Douglas, BS	1972	Tulle gras and dry dressing, changed at 10 days and 2 weeks	3.1 (1.3–5.7)	
Fox, J et al.	1977	Sterile aluminum foil dressing cut to conform to the defect. Secured with 1-in. gauze. Dressing changes at day 3,5, and 7 and then weekly	<4	<10 days
Damert, HG and Altmann, S	2012	Opsite semiocclusive dressing. Dressing change by soaking every 4–5 days	2–8	
Hoigne, D et al.	2013	Vaseline gauze initially then semiocclusive dressing applied at day 5. Weekly Opsite Flexifix. Cover with tube gauze or Band-Aid	6.5 (3–8)	Dependent on occupation, self-employment
Mennen, U and Wiese, A	1993	Opsite semiocclusive dressing. Weekly dressing changes	2.8–4.3	<7 days
Rosenthal, LJ et al.	1979	Xeroform (3 % bismuth tribromophenate) dressing, change at 1 week and then biweekly	12	
O'Donovan, DA et al.	1999	Mepitel semiocclusive dressing	4.1 (2.9–5.3)	
O'Donovan, DA et al.	1999	Paraffin gauze dressing	4.0 (2.8–5.2)	
Riyat, MS et al.	1997	Paraffin with Elastoplast dressing. Applied 2×/week	2.1 (1.4–3.1)	
Riyat, MS et al.	1977	Silver sulfadiazine with plastic occlusive dressing and gauze starting injury day 2	3.8 (2.5–4.9)	
van den Berg, WB et al.		Secondary intention		55.1 days (28–90)
Soderberg, T et al.	1983	Adhesive zinc tape or paraffin gauze dressing (Jelonet). Patient changed dressing 1–4×/week	4.5	1 day (50 %) mean 33 days
Ma, KK et al.	2006	Lipido-colloid dressing and daily gauze changes	1.7 (1–2.9)	
Buckley, SC and Das, SSK	2000	Thick Vaseline-impregnated gauze, silver sulfadiazine cream on wound, disposable glove covering. Dressing change every 2 days	5.6 (2.7–12.9)	3 days[c] (1–42)
Muhldorfer-Fodor, M et al.	2013	Semiocclusive dressing film (Opsite); weekly dressing change. Leather finger stalls for laborers to protect at work	2.9–4.3	
deBoer, P and Collinson, PO	1981	Fucidin gauze, glove finger over cream, Micropore tape	2.5 (1.9–3.1)	<1 day (30 %) 13.8 (7.9–19.7) days
deBoer, P and Collinson, PO	1981	Silver sulfadiazine cream, glove finger over cream, Micropore tape	1.7 (1.4–2.1)	<1 day (30 %) 5.8 days (2.7–8.9)
Ma, GFY et al.	1982	Daily simple dressing change, dip finger in Eusol	4 (2–8)	41
Lamon, RP et al.	1983	Covered bacitracin ointment, tubular gauze, plastic splint, hand soaks 10 min TID warm soap water	4.1	<1 day
Arbel, R et al.	1989	Fill tip glove silver sulfadiazine, finger of glove over finger as occlusion dressing; Micropore tape gauze; Change every 2 days for 10 days and then less frequently until healed		<3 weeks (96 %)

Table 1 (continued)

Author	Year	Dressing	Healing time (weeks), mean (range)	Return to work time (range or percentage of patients)
Ipsen, T et al.	1987	Dressing Vaseline gauze	3.6 (1.1–6)	22 days (0–60)
Farrell, RG et al.	1977	Xeroform, Telfa, and mesh Vaseline gauze; 2-in. gauze roll to wrist; soaks 15 min QID, dried and covered by Band-Aids; four-pronged splint for work protection	<2 weeks, exposed bone 4–6 weeks	4 days (2–11 days)
Allen, MJ	1980	Dressing Sofra-Tulle gauze and Tubigauze; change dressing 5 days		>6–17 days if infected

[a] Hyphecan=chitin, shrimp exoskeleton, 1-4,2-acetamide-deoxy-b-d-glucan

[b] Instructed to return to work 2 weeks after full healing

[c] −7 days $(1–90)^{+}$, one outlier (90 days food industry), mean 3 days (1–42) (outlier removed)

healing and was prevalent in studies using skin graft and flap coverage [23, 29].

Range of Motion and Grip Strength

Surgical management often requires a period of immobilization which can lead to stiffness. Chow and Ho reported 8 % incidence of stiffness after surgical treatment [6]. Increasingly complex surgical procedures were accompanied by a stepwise increased incidence of loss of total active motion of >10° [23].

In many fingertip injuries and amputations, primary closure requires significant bone shortening and mobilization of soft tissue in order to close the defect. Due to the shorter length, pinch grip strength and fine motor activities including picking up small objects is diminished [12, 29].

A benefit of minimally invasive simple dressings, conservative management protocols encourage patients to begin motion shortly after injury. Due to preservation of length, most studies reported no change in pinch grip strength except in the very proximal fingertip injuries [1, 23].

Infection

In all of the cases included in this review, only 13 cases of infection were described. All infections were superficial, and there were no reported incidence of osteomyelitis. Two studies performed routine wound swabs and found colonization with skin flora, staph species, and occasional *Escherichia coli* but no incidence of clinical infection [7, 13].

In contrast, Soderberg et al. [29] reported 11 cases of infection in a series of 36 fingertip amputations treated surgically. Chow and Ho [6] reported 17 % infection incidence in their retrospective comparison of surgically treated fingertips. In a study by Ma et al. [23], infection was associated with graft or flap failure, including a cross-finger flap.

Studies Comparing Surgery to Secondary Healing

Ma et al. [23] prospectively treated 200 patients with equal groups of secondary healing, split-thickness skin graft (STSG), full-thickness skin grafts (FTSG), V-Y advancement flap, Kutler flaps, revision amputation, and cross-finger flaps (level III evidence). They deemed the best surgical results to come from V-Y advancement flaps and the worst from cross-finger flaps. They rated secondary healing as having excellent results with the only drawbacks being the length of time to heal (average 28 days), scar tenderness, and hook nail deformity. Interestingly, the secondary healing group had the fastest average time to return to work (41 days). Scar tenderness at 3 months was slightly higher in the secondary healing group than in the flap groups but not as high as that in the skin grafting groups. Sensation and range of motion were clearly better in the secondary healing group. Surgical complications were much less in the secondary healing group. Satisfaction with cosmetic appearance was pretty equal in all groups, with the V-Y advancement flap being slightly ahead. Grip and pinch strength was similar in all groups except for that in cross-finger flaps which was clearly inferior.

In a systematic review, Wang et al. [16] reported an average of 7 weeks out of work for revision amputation for fingertip injuries and a cold intolerance rate of 24 % and a 2-point discrimination of 5.6 mm. Although neuroma-type problems can occur with secondary healing, they are rare [15, 31]. On the other hand Chow and Ho [6] reported a 7 % incidence of painful neuroma in 94 surgically treated patients (revision amputations, V-Y advancement flaps, and skin grafts).

Weichman et al. [32] followed 100 fingertips prospectively (level III evidence). Sixty-four percent of patients healed secondarily, 18 % underwent operative intervention, and 18 % were lost to follow-up. Patients requiring surgery were more likely to have a larger defect and exposed bone. They

Fig. 1 Materials required to treat fingertip injuries: (1) petrolatum jelly (Vaseline or antibiotic ointment) to prevent the wound from drying and dying, (2) cotton-tipped applicators or wooden stir sticks to apply the Vaseline to the Coban and remove excessive Vaseline from the fingertip with daily cleaning after the shower, and (3) Coban tape which is applied directly to the wound over a layer of Vaseline

also had a longer average return to work time (4.33 weeks) when compared with the secondary healing group (2.98 weeks).

Newmeyer and Kilgore [26] reported that STSG took 6–8 weeks for final healing including donor site. STSG also requires trimming of bone length for graft take [29]. Although they have improved skin quality compared to the STSG, FTSG can also lead to tenderness and unstable skin coverage. Graft take and healing are more difficult than with STSG [17]. STSG can become unstable and friable with less sensate skin coverage that can be annoying for patients. Our preferred solution to this problem is excision of the STSG and secondary healing.

Technique of Conservative Management in Most Studies

The results of 23 peer-reviewed studies describing conservative management of fingertip injuries are included in Table 1. In summary, conservative management of fingertip injuries consists of initial cleansing of the remaining part and application of a moist occlusive dressing. Frequently, patients would be instructed to elevate their hand for 24–48 h. After the period of elevation, a dressing change to another occlusive dressing would occur in the clinic. Many authors create protective caps or small splints to protect the sensitive distal end of the digit [9, 19, 21, 25]. The use of a protective cap or splint allowed the most patients to return to work quickly.

Fig. 2 Removing the excessive Vaseline or antibiotic ointment at the time of the daily shower

Our Management of Fingertips with Secondary Healing (See Movie 1)

In our center, we have had over 100 surgeons/year of experience treating amputated fingertips with secondary healing. When the bone is protruding beyond the fat, it is shortened to the level of the fat with a rongeur so that wound contracture will pull fat over the end of the bone for padding. The wound is showered daily and kept moist with Vaseline or antibiotic ointment emollient and Coban tape applied directly to the wound (Figs. 1, 2, 3, and 4). This provides an inexpensive dressing and gentle compression to control swelling. The Coban tape does not need to be sterile, as evidenced by previous work illustrating the low bacterial counts on clean, unsterile dressing materials [2]. After the shower, remaining Vaseline or antibiotic ointment is removed with a cotton-tipped applicator to avoid odor that can develop if excessive emollient remains on the wound.

Patients are encouraged to use their hand provided that they do not do what hurts and that they are not on pain medication if they are using the finger. Our hand therapists help them to get a full range of active motion and provide desensitization when required. Protective splints made from prefabricated aluminum finger splints or moldable plastic act as a protective cap which can be useful for early return to work and to maximize hand function during healing. We allow patients to return to the food industry provided they have reverse isolation with finger cots or gloves.

We also allow secondary healing for finger amputations proximal to the DIP joint to preserve length. For example, for mid-middle phalanx amputations, we do not remove the proximal part of the middle phalanx with its FDS-inserted tendon to get primary closure.

Fig. 3 Finger with Coban dressing illustrating range of motion

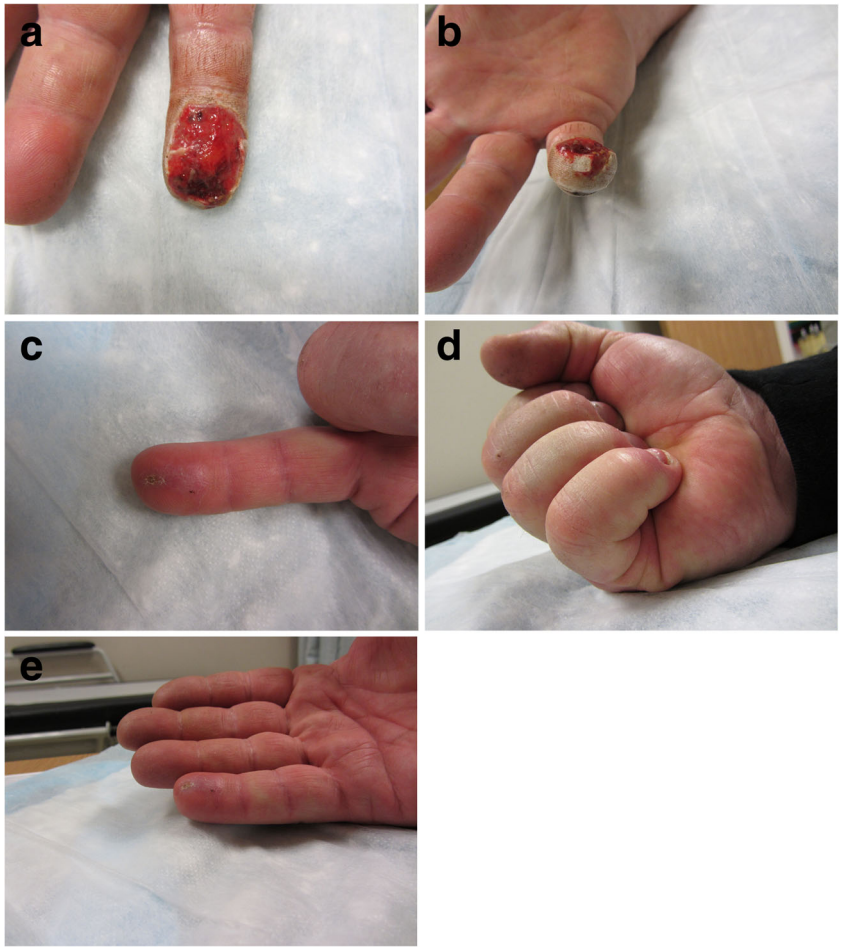

Fig. 4 **a**, **b** Typical fingertip injury with exposed bone. **c** Fingertip in **a** at 8 weeks after injury. **d**, **e** Range of motion of fingertip in Fig. 4a at 8 weeks

We do not feel that primary closure is more important than functional length.

We feel that every time a flap incision is made in a finger to reconstruct the tip, the incisions of that flap (1) cut blood vessels which can increase cold intolerance, (2) cut nerves which can increase numbness and dysesthesias, and (3) interrupt the fibrous septae which contain fat into "shock absorber" compartments. In addition, precious glabrous skin and fat can be lost with flap failure. None of the above occurs with secondary healing as there is no donor site.

Typical patients are illustrated in Figs. 1, 2, 3, and 4 and in movie 1.

Conclusion

Despite ongoing publication of new flaps for fingertip reconstruction, there is a paucity of evidence to support improved healing and function in a surgically reconstructed fingertip compared to conservative wound management. Controlled trials are sorely needed to distill the truth as to whether surgery is superior to secondary healing or not. After reviewing the literature and consideration of our own experience, we continue to believe the following: (1) Conservative wound management with dressings and protective splints allows patients to avoid immobilization and donor site morbidity; (2) good results with near-normal sensibility, minimal cold intolerance, and tip durability are usually achieved; and (3) early return to work is possible, lowering the overall healthcare costs and burden on society.

Conflict of Interest Emily M. Krauss declares that she has no conflict of interest.

Donald H. Lalonde declares that he has no conflict of interest.

Statement of Human and Animal Rights This article does not contain any studies with human or animal subjects.

Statement of Informed Consent Additional informed consent was obtained from all patients for which identifying information is included in this article.

References

1. Allen MJ. Conservative management of finger tip injuries in adults. Hand. 1980;12:257–65.
2. Alqahtani M, Lalonde DH. Sterile versus nonsterile clean dressings. Can J Plast Surg 2006;14:25–27.
3. Arbel R, Goodwin DRA, Otremski I. Treatment of finger-tip injuries with silver sulphadiazine occlusion dressing. Injury. 1989;20:161–3.
4. Bubak PJ, Richey MD, Engrav LH. Hook nail deformity repaired using a composite toe graft. Plast Reconstr Surg. 1992;90(6):1079–82.
5. Buckley SC, Das SSK. Late review of the use of silver sulphadiazine dressings for the treatment of fingertip injuries. Injury. 2000;31:301–4.
6. Chow SP, Ho E. Open treatment of fingertip injuries in adults. J Hand Surg. 1982;7:470–6.
7. Damert HG, Altmann S. Treatment of fingertip amputations using semioccluse dressing (German). Trauma Surgeon. 2012;115:798–801.
8. Douglas BS. Conservative management of guillotine amputation of the finger in children. Aust Paediatr J. 1972;8:86–9.
9. Farrell RG, Disher WA, Nesland RS, et al. Conservative management of fingertip amputations. JACEP. 1977;6:243–6.
10. Fox J, Golden F, Rodeheaver G, et al. Non-operative management of finger tip pulp amputation by occlusive dressings. Am J Surg. 1977;133:255–6.
11. Halim AS, Stone CA, Devvaraj VS. The Hyphecan cap: a biological fingertip dressing. Injury. 1998;29:261–3.
12. Hattori Y, Doi K, Ikeda K, et al. A retrospective study of functional outcomes after successful replantation versus amputation closure for single fingertip amputations. J Hand Surg. 2006;31A:811–8.
13. Hoigne D, Hug U, Schurch M, et al. Semi-occlusive dressing for the treatment of fingertip amputations with exposed bone: quantity and quality of soft-tissue regeneration. J Hand Surg (Eur) 2013; epub: 1–5.
14. Hook-nail deformity. Surgical treatment with a homodigital advancement flap. Dumontier C, Gilbert A, Tubiana R. J Hand Surg Br. 1995;20(6):830–5.
15. Ipsen T, Frandsen PA, Barfred T. Conservative treatment of fingertip injuries. Injury. 1987;18:203–5.
16. Keming W, Sears ED, Shauver MJ, Chung KC. A systematic review of outcomes of revision amputation treatment for fingertip amputations. Hand. 2013;8:139–45.
17. Krister S.J. Primary treatment of fingertip injuries by skin grafting. BMJ 1947:152.
18. Kumar VP, Satku K. Treatment and prevention of "hook nail" deformity with anatomic correlation. J Hand Surg Am. 1993;18(4):617–20.
19. Lamon RP, Cicero JJ, Frascone RJ, et al. Open treatment of fingertip amputations. Ann Emerg Med. 1983;12:358–60.
20. Lee LP, Lau PY, Chan CW. A simple and efficient treatment for fingertip injuries. J Hand Surg (Br). 1995;20B:63–71.
21. Louis DS, Palmer AK, Burney RE. Open treatment of digital tip injuries. JAMA. 1980;244:697–8.
22. Ma KK, Chan MF, Pang SM. The effectiveness of using a lipidocolloid dressing for patients with traumatic digital wounds. Clin Nurs Res. 2006;15:119–35.
23. Ma GFY, Cheng LCY, Chan KT, et al. Finger tip injuries—a prospective study on seven methods of treatment on 200 cases. Ann Acad Med. 1982;11:207–13.
24. Mennen U, Wiese A. Fingertip injuries management with semi-occlusive dressing. J Hand Surg (Br). 1993;18B:416–22.
25. Muhldorfer-Fodor M, Hohendorff AS, Vorderwindkler K-P, et al. Treatment of fingertip defect injuries with a semi-occlusive dressing according to Mennen and Wiese (German). Oper Orthop Traumatol. 2013;25:104–14.
26. Newmeyer WL, Kilgore ES. Fingertip injuries: a simple, effective method of treatment. J Trauma. 1974;14:58–64.
27. O'Donovan DA, Mehdi SY, Eadie PA. The role of Mepitel silicone net dressings in the management of fingertip injuries in children. J Hand Surg (Br). 1999;24B:727–30.
28. Riyat MS, O'Dwyer G, Quinton DN. Comparison of silver sulphadiazine and paraffin gauze dressings in the treatment of fingertip amputations. J Hand Surg (Br). 1997;22B:530–2.
29. Soderberg T, Nystrom A, Hallamns G, et al. Treatment of fingertip amputations with bone exposure. A comparative study between surgical and conservative treatment methods. Scand J Plast Reconstr Surg. 1983;17:147–52.
30. Strick MJ, Bremner-Smith AT, Tonkin MA. Antenna procedure for the correction of hook nail deformity. J Hand Surg Br. 2004;29(1):3–7.
31. van den Berg WB, Vergeer RA, van der Sluis CK, et al. Comparison of three types of treatment modalities on the outcome of fingertip injuries. J Trauma Acute Care Surg. 2012;72:1681–7.
32. Weichman KE, Wilson SC, Samra F, et al. Treatment and outcomes of fingertip injuries at a large metropolitan public hospital. Plast Reconstr Surg. 2013;131:107–12.