E-ISSN: 2707-8353
P-ISSN: 2707-8345
IJCRO 2022; 4(2): 04-08
Received: 06-04-2022
Accepted: 10-05-2022

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The treatment of an Allen type III fingertip injury with a composite graft: A case report and review of the literature

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DOI: https://doi.org/10.22271/27078345.2022.v4.i2a.114

Abstract
Fingertip injuries are frequently seen and there are many treatment options. Small defects with limited exposure of the bone can be treated conservatively with healing by secondary nature. Good results can be achieved with standard dressings or a semi-occlusive dressing. With larger defects, surgical treatment is needed. Local advancement flaps can be used when there is sufficient local tissue. If this is not present, a pedicle flap or tissue transfer is needed. The non-microsurgical refixation of the amputated part as a composite graft yields excellent results in children. It is, however, not frequently used in adults, due to the less favourable results.
In this case report, an Allen type III fingertip amputation was successfully treated by non-microsurgical re-fixation of the amputated fingertip. At final follow up, 18 months after injury, there was a satisfactory aesthetic and functional result. Although smaller in size, the fingertip resembled the other fingers with normal nail growth. Sensibility had recovered moderately and cold intolerance was present. However, the patient was very satisfied with the result and did not experience any limitations during daily activities.
In conclusion, the use of a composite graft in Allen type III fingertip injuries is a viable option in selected cases.

Keywords: Fingertip injury, fingertip amputation, composite graft

Introduction
The finger is the most injured part of the upper extremity, accounting for more than a third of the injuries [1]. Although amputations of the finger only constitute a small portion of these injuries (2%), the burden of disability is highest, when compared to other injuries such as fractures [2]. The estimated incidence has been steady for the last decades with an average of 7, 5 injuries per 100.000 persons per year [1, 3]. The incidence rises with age in adults [3, 4]. Most non-occupational injuries occur at home due to a crushing or cutting trauma, such as a door or power tool [4]. Although the overall need for hospitalization is low, it is increasing [3, 4].
Distal amputations of the finger can be described using various classification systems. Most classification systems describe a transverse amputation level [5-8]. The Allen classification[5] is based on the level of amputation with regard to the nail. In type I injuries there is only loss of the pulp. When there is loss of pulp and nail, it is classified as a type II. Type III injuries include partial loss of the terminal phalanx. And in type IV injuries the lunula of the nail is involved.
In the classification by Evans [9] a more extensive approach is used, classifying the injury to each individual component of the fingertip: pulp, nail and bone. This leads to a 3-digit code which provides detailed information about the injury. Using this classification system 648 combination can be made. Which reflects the great variation in injury patterns of fingertip amputations. As a result, there are great differences in the preferred treatment of fingertip amputations among international hand- and microsurgeons [10-12].
When primary closure is not possible, treatment options include: healing by secondary nature, revision amputation and local or regional flap coverage. The use of a composite graft has been proven to give good results in children [13, 14]. However, it is not frequently used in adults, due to the possible high failure rate [15].
I believe that composite grafting is a good alternative for treatment of Allen type III fingertips injuries in adults. Which is illustrated by the following case report and review of the literature.

Case Report

Our patient is a healthy 55-year-old man. He is a right-handed auto mechanic and a non-smoker. He injured the 5th finger of his left hand at home. He was chopping wood with the use of an automatic wood cleaver machine. This injury resulted in a fingertip amputation. Both his wife and daughter were trained nurses, they immediately put the amputated fingertip on ice (no direct contact). He presented to our emergency department within 1 hour of the injury.

Inspection of the finger showed a volar oblique amputation, starting just distal to the level of the lunula dorsally and ending distal to the DIP crease on the volar side. The distal phalanx was almost completely intact and protruded beyond the level of the wound. The amputated part consisted of the pulp, the majority of the nail bed and the complete nail (Figure 1). Due to the intact germinal matrix on the dorsal side, the injury was classified as an Allen type III.

Intravenous antibiotics were administered in the emergency department and sterile dressings were applied. Within 2 hours of presentation, the patient was prepared for surgery. After discussing the various treatment options, a non-microsurgical re-fixation was chosen.

Surgery was performed under loco-regional anaesthesia (supraclavicular plexus) and tourniquet control. The amputated part was cleaned and debrided with removal of the nail. Inspection showed a limited part of the tuft, which was removed. Then the proximal stump was first cleaned and debrided. Inspection showed a distal remnant of the ulnar digital nerve. It was resected deep to the level of the wound to prevent the formation of a neuroma. At this level no digital artery was seen. Due to the oblique nature of the wound, on the radial side no digital nerve or artery was found. Small incisions were made on the ulnar and radial corner of the nail fold to expose the proximal nail bed and germinal matrix. The amputated part was positioned on the exposed distal phalanx and the nail bed was sutured with absorbable 4/0 sutures (Vicryl Rapide, Ethicon Inc.). The skin on the radial, volar and ulnar side was sutured with a non-absorbable nylon 4/0 suture (Ethilon, Ethicon Inc.). A fake nail was made out of a 10cc syringe and held in place with a dorsal "figure of 8" nylon 2/0 suture (Figure 2). A sterile dressing was applied.

Postoperatively the patient was treated with intravenous antibiotics for 24 hours. After which he was discharged home with oral antibiotics for 1 week. Two days after discharge he was seen in our outpatient clinic and the dressings were removed. Some discoloration of the tip had appeared, without signs of infection. Daily wound care was started by his wife and daughter.

He was seen repeatedly in the outpatient clinic in the days and weeks after. 24 days after surgery the sutures and fake nail were removed (Figure 3). At this time the discoloration had progressed and the first signs of necrosis were visible at the volar and ulnar aspect. Due to stiffness of both the PIP and DIP joint, he was advised to start physiotherapy. During the next weeks the necrotic graft regressed in size, with proximal regeneration of the tissue (Figure 4). The graft was left in place to function as a biological dressing. After 4 months nail growth was observed and a two weeks later the remaining necrotic tip had fallen off. Functionally he did not experience any limitations with a good flexion and contact pulp-palm.

The patient was last seen at 18 months postoperatively (Figure 5). He was very satisfied with both the appearance and functional result. The length and mobility made it possible for him to perform his normal activities with excellent grip strength. He reported some loss of sensibility and mild cold intolerance of the fingertip. On clinical examination there was a 2-point discrimination of 12mm. Range of motion of the MP and PIP joint equalled the contralateral side. There was only a slight decrease in flexion of the DIP joint, 52° compared to 60°. The length of the distal phalanx on the affected side was 1 cm shorter; 16mm versus 26mm (measured on the volar surface from the DIP crease).

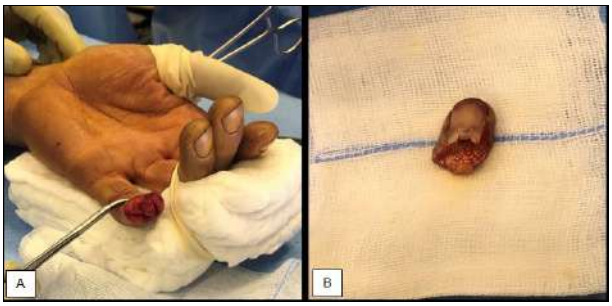

Fig 1: (A) Intra-operative view of the injured finger. Notice the protruding bone. (B) Intra-operative view of the amputated fingertip with nail in situ

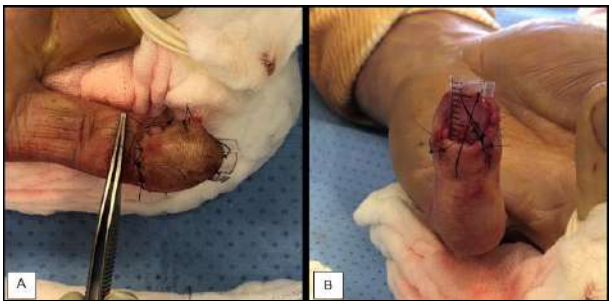

Fig 2: (A) Volar aspect after re-fixation of the fingertip. (B) Dorsal view with "fake" nail in situ

Fig 3: Volar view after suture removal at 3 weeks

Fig 4: Progression of healing / necrosis. (A) Volar view at 6 weeks. (B) Volar view at 8 weeks. (C) Volar view at 12 weeks. (D) Volar view at 18 weeks

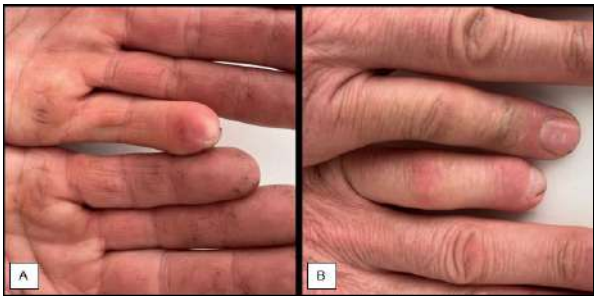

Fig 5: Appearance of the injured finger compared to contralateral at 18 months. (A) Volar view; (B) Dorsal view

Types of treatment

Conservative

Conservative treatment of fingertip injuries provides good results with almost no difference in sensibility, range of motion or grip strength. Donor site morbidity and long immobilization are avoided. Which leads to an overall quick recovery, with an average healing time of 4 weeks and subsequent early return to work [5, 16, 17]. Treatment can easily be done at home, with for example the use of Vaseline and Coban tape. It is important to keep the wound bed moist [18].

Another form of healing by secondary nature is with the use of semi-occlusive dressings. Excellent results have been reported without complications or the need for secondary surgery [19]. Time to healing seems a little longer, averaging 6.5 weeks. However, it provides a high percentage of soft tissue regeneration of almost 90% [20]. Secondary healing seems to be the treatment option of choice in fingertip amputations, even with bone exposure up to the wound level. However, when the bone protrudes beyond the level of the wound, a surgical treatment seems necessary [19].

Surgical

When performing a revision amputation, the bone is shortened to the level where primary closure is possible. It provides good results when tension free closure is achieved with an average time to work of 7 weeks [21]. Sensibility is near to normal and range of motion is acceptable. However, cold intolerance is frequently seen with an average of 24%.[21] Care must be taken if excessive shortening of the bone is required. A shorter phalanx increases the risk of nail deformity and can lead to serious functional deficits [22].

Therefore, numerous reconstruction methods with flap surgery have been described with the purpose of maintaining length and sensation. Various algorithms to achieve this goal have been described [23, 24]. They are based on the involved finger and geometry of the defect.

In small defects various types of VY advancement flaps can be performed. Volarly with the Atasoy flap, and laterally with the Kutler flap [25]. These flaps are not technically demanding and yield good results with limited complications. In medium sized defects other local advancement flaps can be used, depending on the geometry of the defect and affected finger. The Moberg flap, the Venkataswami flap and the Hueston flap are some examples [23, 26]. In a larger defect a pedicle flap is frequently needed. The homodigital island flap, antegrade or retrograde, is frequently used in this situation [23]. The survival rate of these pedicle flaps is high, with normal sensibility and absence of cold intolerance [27, 28]. The first dorsal metacarpal artery (DMCA) or kite flap is another example of a versatile pedicle flap [26]. Various other options include the cross-finger flap and the nar flap [23, 29]. Both are reliable and easy techniques.

Free tissue transfer with the use of a full thickness skin graft from the hypothenar region has also been described [30, 31]. However, it is commonly seen as a last resort, due to superior results of other techniques. Alternatively, a free pulp toe transfer can be performed. The transferred tissue resembles that of the fingertip, yielding good functional and esthetical results. With minimal donor site morbidity [29, 32].

Composite graft

Non-microsurgical refixation of the amputated fingertip is a common practice in children, although the clinical failure rate reported is high (up to 32% and 41%) [13, 14]. The patient reported survival, however, is much higher; 78.4% versus 59% [13]. And revision surgery is seldom needed because almost all of the failures heal by secondary nature [14]. Kiuchi *et al*. [33] reported similar results for the survival rate of the composite grafts in adults. They concluded that clean-cut injuries distal to the base of the nail (meaning Allen type I-III) are good candidates for composite grafting.

Discussion

In this case of an Allen type III fingertip amputation, the non-microsurgical re-fixation resulted in an excellent patient reported outcome. It is important to understand that the circumstances were optimal. It was a healthy, non-smoking patient. His relatives were trained nurses, who aided in the primary care of the amputated part and the precise aftercare. The surgery was also performed within several hours of the injury. If any of these factors had been different, the result might not have been as good. Clinical evaluation at 18 months revealed only moderate recovery of the sensibility, with the presence of cold intolerance. However, this was well tolerated by the patient, probably because it was the 5th finger. The regaining of his grip strength was more important to him than the loss of sensibility. A major drawback of the treatment was the long leave of absence from work (4.5 months). This was mainly a result of his job as an auto mechanic. The patient was very concerned that contamination with grease would have a negative impact on the healing.

From a clinical point of view, the graft survival can be classified as a failure. After 3 weeks the first signs of necrosis were visible and after 6 weeks almost the whole amputated portion had gone black. Although in the end more than 50% of the fingertip had regenerated with the presence of a nail. This result is probably achieved by a combination of graft take and secondary healing.

Various techniques have been described to enhance the outcome of the composite graft. These techniques include the use of cooling, hypobaric oxygen, and intravenous lipo-prostaglandin E1 [34-37]. These techniques however, require a long hospital stay of up to 15 days. Microsurgical repair of an artery and vein also increases the survival rate [38, 39]. However, distal from the lunula (Allen type I-III) this reconstruction is described as very difficult to impossible [39].

Few other treatment options would have resulted in a better patient reported outcome in this case. With revision amputation the finger would have been significantly shortened, probably to the level of the DIP joint. Which would have probably resulted in loss of function [22]. A local

advancement flap was not possible due to the size and geometry of the defect. And although the sensibility might have been better with the use of a homo-digital island flap. The volar scar would have probably caused complaints with loss of mobility and grip strength [23]. An important advantage of the chosen treatment was the preservation of the nail. Which would not have been possible with the other mentioned treatment options.

In conclusion, a non-microsurgical re-fixation of the amputated fingertip as a composite graft in Allen type III injuries can be a viable treatment option in certain cases.

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