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Successful Distal Finger Replantation in a 9-Year-Old Child with Double Level Injury: A Case Report & Literature Review

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ABSTRACT

This study discusses a completely amputated right middle finger in a 9-year-old boy. The study employed a case report relating to a successful distal finger replantation in a 9-year-old child with a double-level injury. A bicycle chain accident caused traumatic amputation at the distal interphalangeal joint level, requiring surgery for replantation. The fingertip's properties are crucial for tracing, gripping, and protection, hence surgery was attempted. Post-debridement, severely crushed radial and ulnar neurovascular bundles were found. The proximal ulnar digital artery and nerve stumps were affected. The radial neurovascular bundle was crushed with segmental loss evident after exploring post-debridement. Radial distal structures were found to be the least damaged. One proximal digital artery was repaired, and single digital nerve was approximated. The artery was repaired cross-sectionally with the proximal ulnar digital artery anastomosed to the distal radial artery stump. As the damage was complex and a double-level cut, surgery was mainly performed to restore the cosmetic and functional characteristics of the finger and to eliminate the requirement of a donor site using another reconstructive option. This case is important in highlighting the developments and advancements in digital replantation procedures. This is also valid in pediatric cases if complex injuries occur. Besides, all these, essential insights are put into the current literature in the domain of pediatric digital replantation, and this is done by a detailed surgical approach, potential challenges experienced, and the discussion of outcomes.

INTRODUCTION

Finger amputations, especially in pediatric patients are not easy to manage as they present a noticeable clinical challenge (Loewenstein & Adkinson, 2021). Replantation requires great attention to detail in microvascular techniques to recover both the form and function of the injured fingers (Tang *et al.*, 2020). Distal finger injuries, particularly those that involve not only one level but multiple levels, are significantly complicated (Cannon *et al.*, 2016). This complication comes into play from the requirement to carefully reconnect small blood vessels and nerves, which are important for the sensation and function of the finger.

This case pertains to a 9-year-old child who had a complete middle finger amputation of the right hand at the distal interphalangeal joint (Tamai zone II) after experiencing a bicycle chain accident. The injury was not just an ordinary one, as it was further complicated by crushing and an additional distal volar laceration with gross contamination with grease. Such injuries are not common and present specific threats and challenges, especially in those children having smaller anatomical structures in which attention must be paid to the smallest details during surgery (Hill & Remick, 2020). Moreover, successful replantation of pediatric cases has immense importance due to multiple factors (Leiskau *et al.*, 2021). In the first place, the fingertips are important for fine motor skills and they are essential for a child to develop and perform daily activities such as writing, playing, and

self-care (Soden, 2020). Secondly, preserving the aesthetic appearance of the hand is essential, it should be cared for the psychological betterment of the child. Hence, getting both functional and cosmetic reestablishment is vital in such cases.

This report is intended to showcase the advancements and developments in surgical procedures that provide desired results in complex digital replantations (Thibedeau *et al.*, 2023). We add precious information to the existing literature on pediatric digital replantation after presenting the comprehensive approach of surgery, the potential challenges faced, and the outcomes obtained. This case ensures the importance of an approach that is not just limited to one area but it is a multidisciplinary approach and the requirement for sustained improvement of microvascular surgical techniques to improve the prognosis for young patients with severe finger injuries (Stefanou *et al.*, 2022).

Case Presentation

A case of a male child aged nine was presented. The child experienced an injury to his right middle finger that happened when his finger became caught in a bicycle chain, causing complete amputation through the distal interphalangeal joint (Tamai zone II) (Billig *et al.*, 2021).

Injury Description

The part where amputation occurred showed crushed wound edges with contamination by grease. An additional

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distal volar laceration was also there. The injury is depicted in Figures 1, 2, and 3. The Ischemia time was around 3 hours from the time of injury when the patient arrived at the emergency department.

Preoperative Considerations

Before taking the patient to surgery, the minimal chances of success to the family were explained, providing the nature of the injury, the distal amputation, and the presence of another deep wound over the pulp that makes it a double-level cut to the neurovascular bundles.

Surgical Technique

Surgery was executed with general anaesthesia and having an arm tourniquet and standard microvascular procedures. Following proper debridement and cleaning, exploration showed a crushed neurovascular bundles proximally with a segmental loss on the radial side. Distally, the digital artery and nerve stumps of the ulnar side were greatly damaged, whereas the radial digital distal structures were in acceptable condition. A decision regarding repairing the ulnar proximal digital artery to the distal radial artery by 9-0 Ethilon in a cross-fashion was made. After the arterial anastomosis the vascularity was regained in the amputated part including in the distal crushed portion and thus distal laceration was sutured without arterial repair at the distal crush end. The radial digital nerve was repaired with 8-0 Ethilon, though it was impossible to repair the ulnar digital nerve. Both of flexor and extensor tendons were repaired with 3-0 PDS by modified Kessler's technique before performing the digital structures anastomosis. Osteosynthesis was executed using 1mm double axial K wires, shown in Figure



Figure 1: Injured fingers with crushed wound edges



Figure 2: The amputated part as a result of injury

Two Dorsal Veins Were Repaired Using 9-0 Ethilon Postoperative Care

The hand was immobilized in a splint after restoring finger perfusion on the table. The patient was kept for 2 days in the ICU postoperatively for monitoring. An anticoagulant, low molecular weight heparin infusion was initiated for five days as per the protocol in our institution. The colour of the finger was pink during all this duration. Eventually, the patient was discharged.

Follow-Up and Outcomes

After six weeks of the postoperative period, the K wires were cut and removed, and mobilization was started. It is illustrated in Figure 5. More follow-up showed a good range of motion & complete healing as shown in Figure 6. At six months follow-up, the patient exhibited satisfactory functional outcomes. Motion range was also found to be acceptable with sensory recovery. There was a favourable aesthetic result, having the least scarring, in addition, nail growth was also acceptable. An extended follow-up period will be required to know how disturbances and more functional developments are progressing.



Figure 3: X rays scan of the injured hand

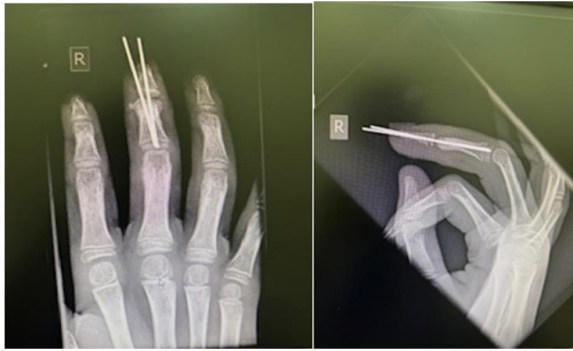


Figure 4: X ray scan of the specific sections of hand



Figure 5: Injured Finger after removing K wires (6 weeks)



Figure 6: Healed up and recovered hand with its fingers moving freely (10 weeks)

Findings

History and Use of Digital Replantation

Digital replantation has generally been used since the first successful procedure of Komatsu and Tamai. This is important because if such injuries occur, this will be an effective approach to treat them (Duah-Asante *et al.*, 2023).

Factors Influencing Practicality, Cost, and Suitability

Practicality, cost, and suitability rely on the details of the injury, involved digits, the patient's demographics, and the experience the surgeon possesses. Such factors must be considered (Kwon *et al.*, 2020).

Common Indications for Digital Replantation

It is usually executed for thumbs, multiple digits, and whatever digit in a child. Sometimes, it is performed for

isolated digits in young individuals or those who play music (Fan *et al.*, 2022). This is important to consider in such individuals to ensure effective utilization of the hand.

Drawbacks of Various other reconstructive Methods

Methods including secondary intention healing, finger shortening, skin grafts, and flaps usually result in morbidity like pain & stiffness (Kawaiiah *et al.*, 2020). Such pain or tenderness can further complicate the case and long-term disability can result.

Disability Rates for Different Closure Techniques

Disability rates for primary closure are 15%, Split-thickness grafts 25%, Full-thickness grafts 26%, and Palmar flaps 19%.

Benefits of Distal Phalanx Replantation

Replantation maintains function, provides better soft tissue coverage, preserves length and appearance, and generally requires one surgery (Winge & Røkkum, 2023). After surgery, complete and quick recovery is expected with a functional hand and fingers.

Discussion

This case report presents a 9-year-old boy's right middle finger distal amputation requiring replantation. Standard microvascular methods, along with general anaesthesia and an arm tourniquet, were used during the surgery. Double axial K wires were used to accomplish osteosynthesis before vascular repair was performed. The patient exhibited appropriate mobility range and sensory recovery after six weeks, along with satisfactory functional outcomes. Komatsu and Tamai's initial effective replantation through microvascular anastomosis report states that digital replantation has recently emerged as a widely accepted method (Noh & Hacquebord, 2020). Regardless of the practical, economical, and feasible nature of the replantation, the outcome of surgery relies on the extent and injury, the area damaged, level of education, financial condition and avocation. Additionally, some other factors, include the surgeon's training and their experience. The outcome is also related to the indications for replantation. Replantation attempts are absolutely indicated in an amputated thumb, amputation of multiple digits or in a child with an amputated digit (Goel *et al.*, 2020). Sometimes, isolated digit amputation is recommended for patients due to professional or social reasons, like for young adults or musicians. But still, there remains debate over whether single amputated digit replantation is warranted or not. In Eastern states, maintaining Physical well-being is often favored over function leading patients to request replantation despite being informed that it is not mandatory for preserving adequate function of the hand.

Despite various challenges, our spirit to execute replantation has not declined. Several centres have achieved the desired outcomes, even though the small size of the vessels presented a problem (Liao & De, 2021). A

significant amount of controversy is still associated with the distal digital replantation. A few surgeons consider single finger replantation imprudent. Most patients utilize an unaffected finger instead of the one replanted which may lead to more harm caused by the replanted finger potentially affecting overall hand function.

The findings of our study relate to (Wang *et al.*, 2022) which discuss various alternative procedures such as secondary intention healing, finger shortening, wound closure using skin grafts, and free flaps. With these procedures, several patients experience unwanted symptoms including continued pain, excessive tenderness, cold intolerance, hyperesthesia, atrophic soft tissue, damaged nails, and reduced grip power.

Sturman and Duran's study on 235 fingertip injury patients found that 15% received basic dressing, 25% had partial thickness skin grafts, 26% had full thickness skin grafts, and 19% had significant disability. Following replantation, tissue quality is superior to traditional skin coverage methods. Sensation after repairing the digital nerve in the fingertip which is planted is maintained, and even superior to other closure methods including tissue transfer from the base of the thumb (de Berker *et al.*, 2022). The finger's length is preserved by distal replantation and provides the best appearance. It maintains movement in the metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints, as these joints are not inactivated post-replantation. This decent and efficient movement at the proximal joints compensate for no movement at the far end joint. Creation of a neuroma and high sensitivity stump is avoided in the proximal end of an amputated limb (Shaterian *et al.*, 2019). which is a frequent post-amputation complication needing multiple revisions. Replantation surgery is generally secure and typically requires only one procedure.

According to most authors, all amputated thumbs and multiple digital amputations must undergo trial of replantation, but there is little consensus on the consideration of distally amputated parts or single digital replantations (Bahm, 2023). Only a few of them highlighted the advantages of distal digital replantation. Also, there is a minor focus on the functional distinctions existing between digital replants proximal and distal to the PIP joint (Stone *et al.*, 2021). The study of surgical techniques and rehabilitation protocols for distal digital replantation could offer unique advantages compared to proximal replants (Persitz *et al.*, 2023).

CONCLUSION

This case highlights the importance of digital replantation in restoring function and quality for patients having finger injuries. As the initial successful procedure was performed by Komatsu and Tamai, digital replantation has proven to be a crucial development in the clinical and surgical practice. The practicality, cost, and suitability of the technique rely on different factors, such as the characteristics of the injury, number of digits involved, the demographics of the patient, and the experience

of the surgeon. Replantation is most generally used for thumbs, multiple digits, and any digit in children, and is seldom performed for isolated digits in young individuals or musicians. Alternative procedures like secondary intention healing, finger shortening, skin grafts, and flaps can cause unwanted symptoms such as pain and tenderness. The rates of disability for different wound closure techniques also change with primary closure being the lowest at a rate of 15%. Distal phalanx replantation is a cost-effective, efficient, and long-lasting procedure that can restore essential functions and improve the quality of life for patients with finger injuries, demonstrating its effectiveness in a single surgery. In the future, experience from such cases can be utilized to treat finger injuries, especially those with more complications and severity. All the literature and the findings are evident that this procedure is effective, hence, it can be implemented for treatment with a good success rate. Fingers are important components of our body, and preserving them is crucial. More research is required to modify and enhance the existing procedures and techniques to treat a wide variety of injuries.

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