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Case Report

Fingertip Replantation without Venous Anastomoses

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Abstract

Background: In children complete and partial traumatic finger amputations are infrequent compare with adults. Significant differences exist in term of epidemiology, nature of injury, indication and contraindication for replantation, and surgical technique in children vs adults.

Clinical case: A 15-years old male child sustained traumatic fingertip amputation of 3rd and 4th fingers caused by axe. Replantation of both fingertips was performed. Digital arteries and nerves were repaired however veins were not. Both replanted fingertips survived well.

Discussion: Fingertip replantation in children is a real challenge. Vessels diameter less than 1 mm requires super microsurgical ability of the surgeon. Other than that post-operative venous congestion is frequent problem that requires tricky post-operative care in some patients.

Conclusion: Digital replantation attempt is 100 % indicated in children. In modern times most of professionals agree that fingertip replantation is a golden standard in pediatric population. The correct delivery and cold preservation of amputated part, the shortest possible ischemia time, perfect surgical technique and appropriate post-operative monitoring and care all play an important role in successful replanted fingertip survival.

Keywords: Fingertip; Replantation; Venous Anastomoses; Venous Congestion; Children

Introduction

Traumatic amputations in children are relatively uncommon and its incidence rate is from 1,32 to 18,8 cases per 100000 capita of pediatric population according several reports [1-3]. Despite similarities regarding principles and methods of replantation with those that have been used in adults there are certain differences. For instance, it is hard to see on radiographs, especially in young children, metaphyseal growing plates. It is recommended to preserve these plates during bone internal fixation to avoid late skeletal grow disturbances following replantation. Other than that children might be prone to post-operative vascular spasm [4-6]. This spasm if occurs needs to be diagnosed and addressed promptly. I adults the cause for traumatic amputation in vast majority cases is labor accident. In children especially young ones most cases happen due door trap, bicycle chain, and other moving parts of different machines accidents. Older children fall victims of insecure handling anything like knife, axe, power chain, etc. [7-12]. According prevalent agreement among specialists everywhere any

amputated part of upper extremity in a child worth replantation attempt [9]. That is why only 40% - 60% of attempted replantation end up successfully in children [10-12]. At the same time functional results of replantation in children are generally superior than those in adults due better and faster regeneration, shorter distance for nerve to regenerate, brain cortical plasticity, delicate scars, and sensory and motor re-education [13].

Clinical Case

15 years old male child sustained traumatic amputation of distal phalanges of Right hand middle and ring fingers due insecure handling with an axe. Amputated finger segments were simply sutured back by mean of interrupted sutures at local emergency department. It is important to point out at this stage that this was violation of amputated part cold transportation protocol. Thereby warm ischemia time at the admittance to our hospital was 4 hours. At the admittance to our hospital amputated parts of distal phalanges of Right hand middle and ring fingers sutured back at the midlevel of phalanges were pale without any sings of blood circulations. These sutures were taken off. Central segments of middle and ring fingers distal phalanges have been bleeding slightly. The level of amputation was estimated as Ishikawa 3, Tamai 2. Radiograph of Right hand was performed (Figure 1).

Figure 1: Right hand appearance at admittance to the hospital.

Before surgical operation was started a central artery and one digital nerve were tagged in both amputated parts of middle and ring fingers distal phalanges. An emergency replantation was started 4 hours and 30 minutes following accident. Since there were no any signs of tissues crush or any significant debris formal debridement has not been performed. During middle finger replantation ring finger amputated part was wrapped in sterile gauze and placed to the refrigerator at the temperature + 4 centigrade. Central digital artery and one digital nerve the same way were tagged in proximal part of distal phalanx in ring finger. Then skeletal internal fixation was performed by mean of longitudinal K-wire. Following this stage microvascular anastomosis of central digital artery an neurorraphy of one digital nerve were performed by monophilament suture material 11/0. Any reliable vein could not be identified at this level thus no venous microvascular anastomoses were ever performed. Same micro-neurovascular procedure was performed in ring finger. Both nail plates were removed to provide blood oozing from nail beds that were covered by gauze soaked in Heparin solution (Figure 2).

Figure 2: Replanted phalanges view on 1st post-operative day.

During post-operative period intravenous infusion was administered including Glucose and Saline solution, antibiotic (Ceftriaxon 50 mg/kg/daily) for 5 days. Additionally, systemic Heparin was administered starting at the operation room with the dose of 30 IU/kg/hour. Next post-operative day (1st one) Heparin dose was reduced to 20 IU/kg/hour due significant bleeding from nail beds (aPTT 89 sec).

Local temperature of replanted phalanges was monitored daily until 7th post-operative day by mean of portable thermal camera FLIR ONE. The local temperature within fingertip pulp of both replanted fingers reached 29 Centigrade during 1st ,2nd and 3rd postoperative days. Then local temperature raised up to 34 Centigrade. Mean local temperature in the areas next to nail beds reached 34 Centigrade (Figure 3). For comparison we present picture on 7th post-operative day (Figure 4, 5).

Both replanted phalanges have survived well.

Figure 3: Thermal camera image (FLIR ONE) on 1st post-operative day.

Figure 4: Replanted phalanges close view on 7th post-operative day.

Figure 5: Thermal camera image (FLIR ONE) on 7th post-operative day.

The patient was discharged from the hospital on 14th post-operative day. 5 weeks following replantation K-wires were removed. Despite two-point discrimination test showed only 6 mm at 5 weeks after surgery the patient could certainly feel touching.

Discussion

If we look at hands, fingers and especially fingertips we might think that these are small size wise compare with the rest of the body. However, if we consider functional value of these afore mentioned parts we by surprise can discover the ultimate value of these afore mentioned structures in term of attaining of sensory-motor functions and provide development for a child. Some specialists even call finger tips as "periphery eyes" [14]. Additionally, child interacts with other people, objects, and environment by their hands. Thereby the problem of fingertip reconstruction in children was underestimated for years and most popular option to care pediatric patients with digital traumatic amputations used to be just making a good stump [15]. However, thanks to clinical microsurgery coming and further development up to the current state of super microsurgery we gained new great opportunities enabling us to successfully anastomose neurovascular structures less than 1 mm in diameter. Thus we now can replant even fingertips even in very young children [16,17].

Correct transportation protocol of amputated part is an issue of critical importance. If this protocol not strictly followed the chance for replanted part to survive diminishes since either warm ischemia time rise or maceration develop [18].

Basically there are two methods of correct transportation. Three plastic bags protocol: an ice placed in outer plastic bag, then second plastic bag filled with the water placed in the outer one, then inner plastic bag with an amputated part wrapped in moist gauze placed in the second one. Two plastic bag protocol: first plastic bag with mix of the ice and the water, second plastic bag with an amputated part wrapped in moist gauze placed in first one (Figure 6). Important to avoid direct contact of the amputated part with either ice or water that will lead to either frost bite or maceration that both would decrease chance of success [18].

Figure 6: Triple bag and double bag transplantation protocols schematic.

Success rate of digital replantations in children vary from 30% to 40% according world literature mostly due absolute indication for replantation compare with adults. Throughout last 2 years we performed 12 digital replantations in children in our department and only 5 of replanted digits survived (50% success rate).

A microsurgeon who deals with digital replantation at the level of thumb distal to IP joint in case thumb or at the level of DIP in case of fingers faces several challenges. These are submillimeter diameter of digital artery and problem of venous insufficiency due lack of any suitable veins at this level [19,20]. A microsurgeon must be trained in digital vascular anatomy and super microsurgery since vessel diameter at this level is 0,5 - 0,7 mm. Only in some cases, is possible to find veins suitable for microvascular anastomoses. If just digital arterial micro anastomosis was established an artificial venous outflow should be made until neo veins regenerate and in grow into replanted digit. Several authors propose different ways to overcome this problem. Thus, Kamei proposed creation of venocutaneous fistula while Lin proposed making of skin pocket. However, these techniques are complicated and require several stages [21,22]. At the same time there were less complicated and efficient methods to establish artificial venous out flow. Chen described "chemical leech" protocol which consists in making a "fish mouth" incision in the very tip of replanted digit combined with repeated local subcutaneous injection of Heparin 5000 IU/ml 0,1 - 0,2 ml. Thus external venous out flow is maintained until neo veins regeneration and in grow into replanted phalanx [23] that happens usually on 7 - 9 post-operative day [24]. Han believes that this method does not require any high dose systemic heparin or even removal of nail plate to avoid late nail bed deformity. In our case we provided external venous out flow by mean of removal of both nail plates, repeated nail bed scarification, and topical application of gauze soaked in Heparin diluted 1:1 every 3 hours during 8 post-operative days until natural venous out flow re-established. Additionally, we used a "fish mouth "incisions combined with topical Heparin 2500 IU/ml similar way as in nail beds. Capillary refill in replanted phalanges was normal on 8th post-operative day. There is controversy regarding systemic Heparin in the literature. Some authors believe that there is no need for one [25]. Others advocate systemic Heparin [26]. We use systemic intravenous Heparin perfusion starting 30 IU/kg/hour during surgery with consecutive coagulogram control followed by Heparin titration until aPTT reaches 70 - 90 sec during 7 post-operative days. Then low molecular Heparin (Dalteparin sodium) 80 IU/kg/daily for 30 days was administered.

There is another issue to discuss. This is the fixation of replanted part of the digit. The most popular method is internal fixation by mean of longitudinal intraosseous K-wire that is reliable and safe technique [18]. However, Shim believes that interrupted sutures themselves are sufficient enough for keeping bone fragments reduced in good contact. Additionally, this author assumes that part of venous blood from replanted part may out flow through intramedullary canal and K-wire may obstruct this path. This might be essential in case when digital veins have not been anastomosed [27].

We prefer to use traditional internal fixation by mean of K-wire.

Figure 7: Arterial anatomy of fingertip.

Figure 8: Right hand close view 7 weeks following replantation.

Conclusion

Traumatic digital amputation is always sudden drama for a child and his parents. Other than visible physical defect this event brings with it psychological stress and some functional impairment. Digital replantation in children is "golden standard" of treatment. If successful it enables a child to grow and develop freely.

Important roles for success plays correct transportation of amputated part, as short as possible warm ischemia time, flawless microsurgical technique, and appropriate post-operative care.

Financial Source

Authors have no any financial interest.

Conflict of Interests

Authors declare lack of any apparent or potential conflicts of interests related to this article.

Ethical Criteria

Patient's (or their guardians) informed consent on using and publishing of their personal data.

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