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Full Length Research Paper

Mechanisms and management of fingertip amputations in a teaching hospital, South-South, Nigeria

Mba O. Ozinko, Otei O. Otei, Rijami G. Ekpo and Grace I. Bassey

Department of Surgery, University of Calabar and University of Calabar Teaching Hospital, Calabar, Nigeria.

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ABSTRACT

Injuries to the fingertip are common in our Accident and Emergency Department. The goal of treatment is restoration of a painless, functional digit with protective sensation. In other words, it involves the provision of sensate and durable fingertip and bone support for nail growth. When selecting a treatment option the amount of soft-tissue loss, the integrity of the nail bed, the age and physical demands of the patient should be considered. The study seeks to evaluate the mechanisms and management of fingertip amputations including the treatment modalities used and its impact on patient outcomes. This is a prospective study of 37 patients with 43 cases of fingertip amputations. Patient ages ranged from 5 to 56 years. Data was collected from January, 2016 to December, 2017. Various reconstructive options were considered for the fingertip amputations such as skin grafting, cross finger flap, thenar flap, hypothenar flap, louvers flap and groin flap in multiple digital injuries. The total duration of treatment varied from two to seven weeks with follow-up of two to eight months. The results showed preservation of finger length and contour, retention of sensation and healing minimal complication. About 40% of the patients had well formed fingertip pulps which were aesthetically acceptable. In conclusion, fingertip amputation is a common injury. Treatment depends on how much skin, soft tissue, bone and nail were damaged and how much of the finger or thumb was cut off. A good knowledge of the mechanism of injury, type of injury, occupation of patient and hand dominance would help in deciding the surgical technique to use. A satisfactory reconstruction is ascertained if the patient has durable, sensate, fingertip length preservation and a fairly formed pulp.

Keywords: Fingertip amputation, fingertip injury, mechanism of fingertip amputation, management of fingertip amputation.

*Corresponding author. E-mail: ozinkomba@yahoo.com. Tel: +2348063406514.

INTRODUCTION

Injuries to the fingertip were common in the Accident and Emergency Department. Fingertip amputation was a very common type of fingertip injuries frequently managed. The goal of treatment was restoration of a painless, functional digit with protective sensation (Gellman, 2009). In other words, it involved the provision of sensate and durable fingertip and bone support for nail growth. When selecting a treatment option the amount of soft-tissue loss, the integrity of the nail bed, the age, the hand dominance and physical demands of the patient should be considered (Yam et al., 2008).

Injury to the fingertip (that is, injury distal to the insertion of the flexor and extensor tendons), was common, especially in young men who performed manual labor (Ozyigit et al., 2007). The paucity of local soft tissue available for coverage of these injuries and the presence of the nail bed complicate management. The nail itself played an important role in the normal function of the hand by protecting the fingertip, providing counterforce to assist in picking up small objects, and contributing to the tactile sensation of the fingertip (Ashbell et al., 1967; Zook, 1981).

After history taking, attention was then focused on the injury itself. All the structures of the fingertip must be examined. Circulation, sensation, and extent of soft tissue injury, especially loss of skin and soft tissues, were carefully assessed. Radiographs were almost always needed to evaluate the distal phalanx and to identify the presence of any foreign body. Integrity of the nail bed and flexor and extensor tendon functions were assessed. Because the fingertip can be divided into the thin and mobile dorsal skin, the tough and tethered pulp, and the exquisitely sensate tip, reconstruction could best be performed by replacing like with like tissues.

Fingertip amputation occurred when the injury was distal to the insertion of the extensor and flexor tendons of the distal phalanx (karadsheh, nd). Proper assessment of the digit was of essence to determine appropriate soft-tissue coverage of fingertip wounds by the nature of the injury and the physical demands and co-morbidities of the patient. Management of the fingertip amputation varied from local wound care to complex reconstruction and replantation (Dumontier et al., 1995). For injuries with pulp loss and no distal bone exposure, management options included primary closure, healing by secondary intention, full-thickness skin grafting and split-thickness skin grafting. This is non operative management of fingertip amputation in which the loss of skin or pulp is less than 1 cm^2, which can heal by secondary intention (Palaniappan, 2017).

Primary closure or healing by secondary intention was preferable to partial fingertip amputations where no bone was exposed and when adequate soft tissue coverage was available to fingertip (Hattori et al., 2006). Different flaps were used from loco-regional to distant flaps. Some complications noticed were insensate digit, nail deformity and painful stump (Fox et al., 1977). The study seeks to evaluate the mechanisms and management of fingertip amputation including the treatment modalities used and its impact on patient outcomes

MATERIALS AND METHODS

This was a prospective study of 37 patients having 43 amputations ranging from one to three fingers. The socio-demographic data such as the age, sex, hand dominance, occupation and vocation of the patients were obtained through oral interview. History of immunization, alcohol intake and co-morbidity were taken and 19 and 24 cases were admitted in 2016 and 2017 respectively. The exclusion criteria were nail injury alone, crushed injury and fingertip gangrene. The mechanisms of injuries were industrial accident, domestic accident, road traffic accident, blast injury, assault and trapdoor injury (Table 2). In assessing the nature of injury, they were classified in terms of the Allen type and the orientation of the injury.

The choice of wound cover was based on the Allen type, orientation of the amputation and the number of fingertip injuries involved in a hand. The surgical options ranged from healing by secondary intention to distant flaps. The complications were documented and treated. Duration of hospital stay and follow-up period were also noted. The study was carried after hospital ethical approval was obtained. SPSS version 7 was used to analyze the data.

RESULTS

A two-year prospective study with convenience sampling that involved 37 patients who presented to the hospital with 43 fingertip injuries. A total of 19 and 24 cases were admitted per year. They were 26 males and 11 females with male to female ratio of 2.4:1. The age ranged from 5 to 56 years, with mean value of 28 ± 2 years. Right hand dominance was 35 (94.6%) while left hand dominance was 2 (5.4%). The exclusion criteria were nail injury alone, crushed injury and fingertip gangrene. The mechanisms of injuries were industrial injuries 12 (27.9%), domestic injuries 6 (14.0%), Road traffic accidents 10 (23.3%), blast injuries 9 (20.8%), assault 6 (9.3%) and trapdoor injury 2 (4.7%) (Table 1). Using Allen Classification, there were type I (n=5) 9.3%, type II (n=8) 18.6%, type III (n=19) 44.2% and type IV (n =12) 27.9%. The orientation of the wounds were transverse 12 (27.9%), volar oblique 16 (37.2%) and dorsal oblique was 15 (34.9%) (Table 2). The wound cover was achieved by healing by secondary intension, split thickness skin graft, local flaps, regional flaps and distant flaps. Partial amputations were closed primarily and healed by first intention. The complications observed were nail deformities 4 (9.3%), painful neuromas 2 (4.7%) and insensate digits 3 (7%). The rate of admission was 72.1%. Duration of hospitalization varied between three and seven weeks, with a mean period of 4 weeks. Follow-up period ranged from 2 to 8 months.

Table 1. Demographic characteristics.

Sex	Age [n = 37]	Occupation	Duration before presentation	Handedness
Male = 26 (70.3%)	4-6 yrs = 5.4%	Industrial workers = 32.5%	>8 h = 16.2%	Right hand = 94.6%
Female = 11 (29.7%)	20-30 yrs = 56.8%	House wife = 16.2%	8-12 h = 21.6%	Left hand = 5.4%
	31-40 yrs = 29.7%	Unemployed youths = 21.6%	12-24 h = 24.3%	
	41-50 yrs = 8.1%	Children = 5.4%	After 24 h = 37.8%	
		Passengers = 21.6%		
		Paramilitary [police] = 2.7%		

Table 2. Accident description.

Mechanism of injury	Allen type	Wound orientation
Industrial=27.9%	Type I = 9.3%	Transverse = 25.6%
RTA = 23.3%	Type II = 18.6%	Dorsal oblique = 30.2%
Blast injury = 14%	Type III = 44.2%	Ventral oblique = 23.3%
Domestic injury = 20.8%	Type IV = 27.9%	Ulnar oblique = 11.6%
Assault = 9.3%		Radial oblique = 9.3%
Trapdoor injury		

DISCUSSION

Fingertip injuries are common traumatic presentations in our hospital. Out of 113 traumatic injuries to the fingertip, 43 of them were fingertip amputations which represented 38.1% of the fingertip injuries. There was male preponderance which was due to the nature of their work. Most of the industrial workers and those involved in assaults and road transport accidents were males while the domestic injury was predominated by the females. The children were involved in trapdoor injury as they play by jamming the doors. The age ranged from 5 to 56 years, with mean age of 28 years. The youths and middle age patients were more involved in the injuries as they were the active groups which were more vulnerable to the injury. Right handed people were more, accounting for 94.6% of the patient population while the left handed patients were 5.4%. Occupation such as manual labour could greatly predispose them as well as social deviants who were involved in assault.

The hand is second only to the face in its representation in the somatic sensory cortex of the brain. It is one of our most powerful sensory organs, allowing us to perceive and interpret our environment. For the deaf and mute, it supplants their ears and voices, and for the blind, it becomes their eyes. At the same time, our hands are our ultimate tools, extremely mobile and powerful, yet precise and resilient. To imagine life without functional hands is difficult, and to live without functional hands is even more so. The fingertip is defined as the structures distal to the creases at the distal interphalangeal joint; injuries to the fingertip are generally regarded as those distal to the insertions of the flexor and extensor tendons at the base of the distal phalanx (Gellman, 2009; Seaberg et al., 1991). This region represents an intricate aggregate of structural and functional entities and is responsible for some of the most complex functions of the hand. Its exposed position gives the fingertip a significant cosmetic value but also places it at high risk for injury. The upper extremity is affected in one third of all traumatic injuries; hand injuries account for 5 to 10% of all Emergency Department visits in the United States (Seaberg et al., 1991; Strauch and de Moura, 1990). Injuries to the fingertip are among the most common hand injuries. They occur in all age groups and could result from recreational or occupational activities. The potential for disability in this population as a result of loss of mobility, sensation, or strength is significant. The hand is second only to the trunk as a source of work-related disability, accounting for 10 to 30% of all occupational injuries and 5 to 10% of workers' compensation paid (Simon and Wolgin, 1987; O'Shaughnessy et al., 1990). The annual cost of these injuries was estimated at more than $10 billion. Because fingertip injuries have the potential for significant morbidity, their efficient management requires the sound judgment and technical proficiency of a knowledgeable hand surgeon. Although the management of specific injuries is controversial, certain guidelines remain. In general, the goal is to replace like with like in restoration of the normal anatomy. A stable, durable cover is a must, and intact sensation can make the difference between a functional finger and one that is bypassed. Conversely, a painful fingertip with unstable coverage is not only bypassed but may lead to an entirely dysfunctional hand. Length should be preserved as much as possible, especially in the thumb. Treatment should be expeditious, simple, reliable, and cost-effective. It should take into consideration the age, sex, occupation, hobbies, hand dominance, health, and needs of the patient. A thorough understanding of the limitations, possible complications, and likely outcomes of the management modality, all tempered by sound judgment, can transform a potentially debilitating injury into a temporary nuisance.

The mechanisms of injuries were industrial injuries 12 (27.9%), domestic injuries 6 (14.0%), road traffic accidents 10 (23.3%), blast injuries 9 (20.8%), assault 6 (9.3.0%) and trapdoor 2 (4.9%). Manual labour and blast injuries were common among the young adults who were prone to violence and physical labour. Using Allen Classification, there were type I = 3(9.3%), type II = 8(18.6%), type III = 19 (44.2%) and type IV = 12 (27.9%). Therefore the bulk of the injuries comprised of wounds of types II-IV. The orientation of the wounds were transverse 12 (27.9%), volar oblique 16 (37.2%) (Figure 1) and dorsal oblique was 15 (34.9%). There was no significant difference in their orientation. The Allen type, occupation and the orientation of the injuries were considered in the surgical options of reconstruction.

In planning fingertip reconstruction, several factors would determine the approach. In general, the ulnar digits are used for power grip, and the radial digits are used for

Figure 1. A ventral oblique injury.

Figure 2. 3rd day post moberg flap surgery.

precision pinch. Thus, sensory feedback is critical for the thumb and index fingers to accomplish prehensile activities. In particular, the radial pulp of the index and middle fingers and the ulnar pulp of the thumb require a sensate reconstruction whenever possible (Wei et al., 1988). For a distal amputation, the level and size of the defect along with the angle of the injury should be considered. A proximal oblique volar injury is treated differently from a transverse distal injury (Figure 1 to 3). If coverage is to be obtained with skin grafting, or the injury is allowed to heal spontaneously with sequential dressing changes alone, a well vascularised surface could survive a skin graft (Sebastin and Chung, 2011). If the remaining distal phalanx is deemed insufficient to support the nail, either the remaining nail should be ablated or the missing bone reconstructed as part of the initial treatment or planned as a secondary procedure. Digital tissues suffering crush and avulsion injuries with more extensive zones of injury, unlike sharp injuries, are less likely to support the raising of local flaps or successful microsurgical anastomoses. Time is often necessary for the full zone of injury to demarcate itself. Similarly, contaminated wounds should initially be debrided by dressing changes or surgical debridement before closure. In children, many of the rules can be pushed to their limits (Ito et al., 2010). Composite grafts are more likely to survive in children. Functional recovery is often better in children because they are more likely to adapt to and use their newly reconstructed fingertip.

The following surgical options were considered based on the Allen classification, wound orientation, hand dominance and the type of occupation. For instance, the fingertip wound of a musician would require more soft tissue cover with sensate durable tissue than that of a labourer. The type of flaps ranges from local, regional and distant flaps. Skin graft could be used or healing by secondary intention in small lesion less than 10mm without bone exposure.

In Allen type I injury, surgical options used were healing by secondary intention or skin grafting. As the wound healed, the scar contracted and became smaller and less

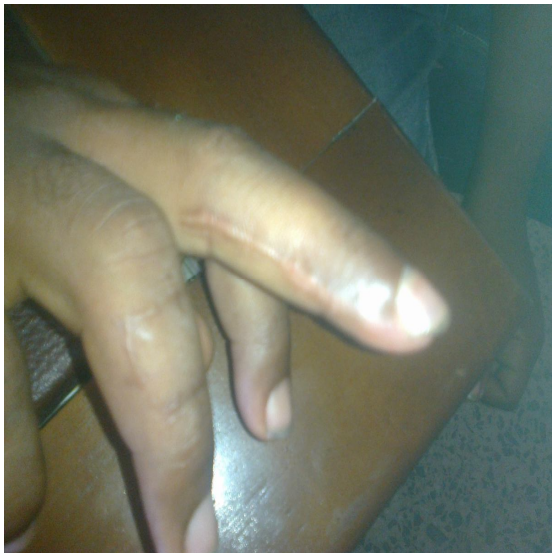

Figure 3. 4th month post Moberg flap surgery.

conspicuous. In Allen type II and its various orientations, local flaps could suffice. These include kutler lateral V-Y flap, Atasoy flap and Morbeg flaps. The advantage of these homodigital flaps is that they were raised on the same fingers and therefore requires a single stage surgery.

In 1976, Segmuller described a variant of the Kutler flap that was elevated on the neurovascular bundle. This flap has greater potential for advancement, but later Segmuller used small flaps limited to the distal finger with resultant limited mobility. Venkataswami and Subramanian (1980) then described an oblique triangular flap based on the contralateral neurovascular bundle for oblique dorsolateral tip amputations. This extension of the Segmuller flap required dissection of the neurovascular bundle to the level of the proximal interphalangeal joint for extended mobility. Smith and Elliot (2000) have further extended the Segmuller flap to the middle and proximal finger, making the flap

significantly longer and significantly more mobile. The entire flap can be dissected to the proximal finger, or the pedicle alone can be dissected proximally while limiting the skin and subcutaneous dissection to the more distal finger. Unlike the original Kutler flap, these extended flaps are effective not only for small transverse and dorsal oblique injury. In Allen type III fingertip amputations where a single digit was involved, regional flaps were used such as neurovascular flag flap, thenar flap, hypothenar flap and cross finger flap. It has the advantage of limiting the surgery to one hand but has disadvantage of two staged surgeries.

In Allen type IV fingertip injuries, regional flaps could also be used as in type III. In few cases where there was laceration of the flexor or extensor tendon, the repair or fixation of the tendons was done. The flap options were groin flap, lower abdominal flap and louvers flap. In the event of fracture of the distal phalanx, it was stabilized and allowed to heal in 6 to 8 weeks. Physiotherapy was commenced passively from the third week and actively by the sixth week.

The complications observed were hook nail deformities 4 (9.3%), painful neuromas 2 (4.7%) and insensate digits 3 (7%).The management of painful neuroma involves neuroma excision, neurectomy, neurolysis, bone and muscle reimplantation or steroid injection (Allen, 1980).

Hook nail deformity is a complication of digital amputation at the level of nail bed. The digital bone cannot support the growing nail, thus result in palmar curvature of the nail. Hook nail deformity is cosmetically unappealing and can be painful. Management includes ablation of the nail with removal of the nail plate and complete excision of the underlying matrix.

In Allen's (1980) prospective study, he classified fingertip amputation into zones I–IV of 57 patients with 60 fingertip amputations. He conservatively managed his patients. Even the most proximal amputations, zone IV through the lunula, healed secondarily. He noticed that the more proximal the amputated part was, the higher 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. The study was similar to our research because the more proximal the injuries were the more the nail deformity and other complications. There was nail deformity in 4 patients, representing 9.3%. There was no deformity in type I injuries.

Skin insensitivity has been a challenge in managing fingertip amputations, especially the proximal types. In 1980, Louis et al. followed 33 patients for an average of 8 months. The average 2-point discrimination was 3.5 mm. In our study, we had 3.8 mm two point discrimination with insensate tip which improve with time in 3 patients, representing (7%), with a follow-up period of 8-months.

Although neuroma-type problems can occur with secondary healing, they are rare. On the other hand, Chow and Ho (1982) reported a 7% incidence of painful neuroma in 94 surgically treated patients (revision amputations, V-Y advancement flaps, and skin grafts).

In this study the duration of hospitalization varied between 21 and 35 days, with a mean period of 28 days. In similar studies, Douglas (1972) – had 22 days, Lee et al. (1995) – had 32 days while Allen (1980) had 18 to 26 days hospital stay. Follow-up period ranged from 2 to 8 months in the study.

Prevention is very important, especially in the homes and industrial settings. The aim of prevention is to reduce the risk of finger injuries by protecting the hands in any physical activity. Common strategies such as use of gears to reduce exposure of fingers when using machines/tools, construction of machines with safeguard technology and implementation of occupational health and safety regulations in the work place should be enforced (Shawver et al., 2016).

Conclusion

Fingertip amputation is a common occurrence in our Emergency Department. There is a gradual rise in the incidence of the trauma. It requires a good hand surgeon in the evaluation and treatment of the condition to prevent some complications. The goal of treatment includes provision of sensate, durable and functional fingertip with minimal complication. Prevention is important and all efforts must be put in place to prevent its occurrence.

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