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Case Study
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Motorcycle Chain Injuries: Case Series

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ABSTRACT

Motor cycle chain injury occurs when the fingers come between motorcycle chain and sprocket or gears of wheel. It leads to crushing or avulsion injury of the fingers. The force acting on the fingers are compression forces with pulling and rotational components. Initially finger is crushed between chain and the bone, which leads to fracture of the bone then finger is pulled in line of direction of chain leading to rotational injury to distal part of finger while proximal part also undergoes rotation in opposite direction. These two different directional forces act on the same finger produces pulling force which ultimately causes amputation of crushed finger at the site of fracture. In worst case patient himself can be pulled into the gear and chain system sustaining severe damage. This is a case series of fifteen young patients who underwent crush injury of fingers or hand due to motor cycle chain or gear system attached to a machine. We tried to Replant or revascularize all the patients but were successful only in nine patients. In rest six patient we lost the finger, few days after the surgery. We tried to find out the reasons for this failure in spite of successful anastomosis and blood supply of fingers at the time of surgery. We found the reason of failure was the type and force of trauma over fingers. Since these are never sharp cuts, the zone of trauma extends more proximally and distally. Chances of failures of anastomosis increases in zone of trauma. It is also associated with crushing components and fractures. Doing anastomosis away from zone of trauma, by using vein graft, or reducing the length so that end to end anastomosis is possible can lead to decrease in failure rate of Reimplantation. Giving anticoagulants for longer time, improving the micro vascular technique, smaller needle and the suture material, better microscopes and instruments can also make lots of difference in outcomes. To find out reasons for failures of Micro vascular surgery in Motor cycle machine chain injury. How to increase the chances of survival of reimplanted or revascularize traumatized/Amputated fingers.

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Key Words

Motor cycle chain injury, avulsion injury, micro vascular technique, rotational components, finger produces pulling force

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INTRODUCTION

Motor cycle chains have gears and upon which chain rolls. The injury happens as the fingers or the toes get caught between the gears and the roller of chain and it is pulled along with the movement of chain. There are different mechanisms of injury.

- Crush injury between gears and the chain, leading to fractures and damage to skin, tendons, neurovascular bundle and soft tissue.
- Rolling movements of fingers leads to rotational injury so the zone of trauma is much more than what it appears on first instant.
- Pulling forces causing avulsion of neurovascular bundle., this is a major determining factor in micro vascular surgery.
- Degloving of palmar skin of fingers and hand due to the dynamic forces which results in shearing off of blood vessels in the subcutaneous plane which may lead to secondary thrombosis of the blood vessels resulting in poor prognosis.

Oiling of chain, cleaning of chain, checking of chain tension when wheels are rotating and putting back the derailed chain all can cause motorcycle chain injuries. In this case series we are presenting 15 patients who sustained injuries to their digits/toes due to motor cycle chain injury and underwent revascularization, reimplantation or flap surgery for the same.

MATERIALS AND METHODS

All patients with crush injury to the digits presented to our emergency department are examined. If amputated part of digit was brought along with patient. Brief history was taken and examination of wound was done. All routine blood investigation, plain radiographs and if required vascular Doppler studies done in all patients. Before taking to surgery patient's relatives were explained about all the pros and cons of microvascular reconstruction surgery and chances of high failure due to crushing effect of motorcycle chain. First amputated parts were examined under microscope under effect of anesthesia. Debridement was done and neurovascular bundles were identified first in the distal amputated part. Then decision was taken whether to replant or not to replant. Then relatives are informed and replantation was attempted. Debridement of proximal part of amputated segment was done, neurovascular bundle and tendons were identified and separated and Amputated segment was fixed with the stump part by K wire or plating.

Then vessels were looked back again under microscope on both proximal and distal parts and then decision was taken for direct repair or repair with vein graft or arterial graft for both artery and veins. In four cases we did vein graft taken from dorsum of hand and in three cases from the distal crease at the wrist joint. In two cases we did arterial graft taken from posterior interosseous artery. In one case we were able cross the vessels across the midline to get end to end anastomosis. Arterial anastomosis was done with 10-0 ethilon. After arterial anastomosis clamps are released and checked for patency. Dorsal part was looked for veins. We tried to find two veins and they were anastomosed with or without vein graft using ethilon 9-0 or 10-0. Tendons were repaired using 4-0 prolene. Bleeding points were controlled and closure of wound done either primarily or with skin graft if needed. Loose dressing was applied.

Injection 2500 IU of heparin was given at the time of releasing of clamps. Next day onwards Inj. Clexane 0.4 ml SC given for five days.

In post operative phase fingers were looked for vascularity by inspection of blanching of pulp, temp, and by scratch test. If needed doppler ultrasound was also done.

For initial five days patients were kept in critical care unit then patients were shifted to ward and discharged after seven days. If the reimplanted finger did not survive then that part was amputated.

Fig. 1: Reimplantation of Four Toes of Right Foot. Final Result was Unsuccessful

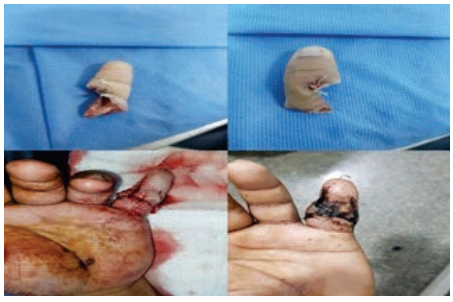

Fig. 2: Reimplantation of Little Finger of Left Hand

Fig. 3: Reimplantation of Right Hand Index Finger

Fig. 4: Right Hand Little Finger Reimplantation

Fig. 5: Left Hand Thumb Reimplantation

Fig. 6: Reimplantation of Four Digits of Right Hand. Final Result was Unsuccessful

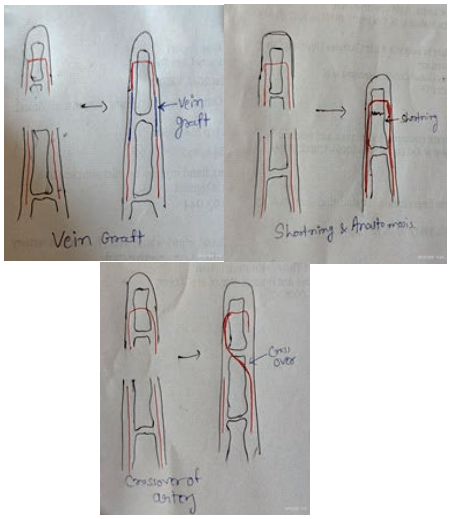

Fig. 7: Different Methods of Arterial and Venous Anastomosis

RESULTS AND DISCUSSIONS

Out of 15 patients there were 14 males and 1 female patient.

Table 1: Average Age of Patient

Age of Patients	Male	Female
20-40 years	10	1
40-60 years	4	0
60 years and above	0	

In 8 patient there was injury in the right upper limb. In 5 patients it was in left upper limb and in two patient injury was in left lower limb.

Table 2: Type of Surgeries Performed

Type of surgery	Male	Female
Replantation	9	1
Revascularisation	3	
V Y Plasty	2	

Table 3: Number of Digits/Toes Involved in Number of Patients.

Number of digits involved	Number of patients
All four fingers	2
Index finger	4
Little finger	3
Four toes of foot	1
Two toes of foot	1
Thumb	4

In our series of Motorcycle chain injury in fifteen patients, we found 60 % of survival of reconstruction by revascularization/replantation surgery. In spite of best of our efforts, we lost six of replanted/ revascularize fingers. Patients were followed for a years. Patients in whom the reimplant was successful has fairly good functional and aesthetic outcome. While few patients with failure has to change the work. Motor cycle chain injury is a grievous injury. Chances of survival of amputated fingers after micro vascular ananstomosis is less due to zone of trauma, type of injury and force imparted on the fingers.

The injuries are usually to fingers of hand and toes of the foot resulting in to the partial loss or amputation of the cushed digits. The mechanism of injury includes.

- Crushing components.
- Rotational components.
- Pressure effect and.
- Pulling down of soft tissue.

Chain pulls the bike forward by its default design so it also pulls the fingers between sprockets and the roller leading to avulsion and degloving injury due to traction. At the same time patient tries to resist this pull and thus finger gets amputated and patient is released from the grip of chain. During this patient may sustain other associated injury like fractures of limbs, chest injury, head injury or soft tissue of injury of face, Fractures of the clavicle and scapula bone, Brachial plexus injuries, Shoulder dislocations etc. In foot it may involve tire spoke leading injury to heel, tendoachillis,

Table 4 : Details of Patient and Surgeries Performed.

S. Nos	Age/Sex	Diagnosis	Surgery	Surgical technique	Result	Rehabilitation
1	M/30	Amputation Rt. Thumb at IP Jt.	Replantation	End to end Anast. After shortening	Successful	Return back
2	M/32	Amputation Rt. Thumb at IP joint	Replantation	Vein graft for artery and Vein	Successful	Return back
3	M/31	Amputation Rt. Index at PIP Jt.	Replantation	End to end Anast. After minimal shortening	Successful	Return back
4	M/28	Amputation of 4 finger through ppx	Replantation	End to end after shortening	Unsuccessful	Amputated
5	M/32	Amputation of little finger through DIP Jt.	Replantation	End to end anastomosis	successful	Return back to same work
6	M/35	Amputation Rt. Thumb at IP joint	Replantated Thumb become black after discharge	End to end for artery and vein graft for vein	Unsuccessful But pt was referred to higher centre fo toe to thumb transfer	Return back to function with good result
7	M/42	Amputation lt little finger at DIP jt.	Coverage by VY Plasty	Very distal so not tried	successful	Return back
8	M/44	Amputation of index finger dip joint avulsion injury	Replantation	End to end anastomosis	unsuccessful	Lost Index finger
9	M/22	Amputation of four toes at ppx level	Replantataion after shortening	End to end anastomosis	Unsuccessful	Turned black after four days amputation
10	M/35	Crush injury Rt index PPX level	Revascularization After shorteing	End to end anastomisis	successful	Return back
11	F//27	Crush injury two toes at ppx level	Replantation With vein graft	Vein graft for artery and vein.	unsuccessful	Lost toes
12	M/38	Amputation of index finger at DIP joint and crushed	Coverage by VY Plasty flap	Very distal and crushed replantation not tried	successful	Return back with minor deformity
13	M/37	Crush injury Thumb DIP jt.	Revascularisation of thumb	End to end anastomosis with shortening	successful	Return back
14	M/44	All four fingers crushed at pip joint	Revascularisation	End to end anastomosis after shortening	unsuccessful	Lost fingers
15	M/50	Little finger at MCP joint	Replantation	End to end anastomosis with cross over of vessels.	successful	Return back to work

or some time total or near total amputation of foot at ankle joint. In case of finger amputation injury amputated parts should be cleaned with saline, wrapped in a moist gauze and placed in a dry plastic bag. The bag should be placed in a container with ice. The container should be labelled clearly with patient's name and identification number. Condition of both proximal and distal parts of amputated digits were bad and ends covered with grease and oil. Looking at the first site these amputated parts not appearing to be replantable due to injury. Tendons, neurovascular bundle and bone were cut at different levels. It looks more difficult when there were multiple digits involved. Many times crushing element was more and patient's relative wants guarantee, so decision making was difficult. Doing micro vascular surgery is expensive and many a time negative results were not acceptable. Since motor cycle chain injury has few particular characteristics., there are some technical points in decision making

- Badly crushed it looks non reimplantable in first look.
- Force/pressure of injury is more so damage is more than what it looks.
- Trauma zone is large and anastomosing to the vessel proximal to the trauma zone.
- Vein graft should be used without hesitation to achieve utmost results.
- Crossing over of vessels are sometimes helpful.
- Instead of tight closure we preferred skin graft.
- Many time finger become black on third or fourth day. So we need to deal tactfully.
- Post operative cares as well as physiotherapy is important.
- Psychiatric reference is also important as there is always change is hand function even after successful replantation, so some time patient has to change the jobs.
- Need to manage other injuries as well as think about the rehabilitation of the patient.
- Fear of inability to earn make the patient more anxious or depressive.

In literature various machine cut injuries have been described. Yaffe[2] studied agricultural machine injuries. Hultman[3] studied hot press Hand Injury in 2010 and their reconstruction and rehabilitation. Zhi[1] gave soft tissue reconstruction of upper extremity. Dough Sheeter[4] gave severity grading on patterns of injury. BJ Gainor[5] analysed the mechanism of upper extremity trauma in three patients from round hay baler or roller injury. In 2007 Tuna Ozyurekoglu[6] analyzed the functional results of upper extremity repair. They found degree of initial tissue loss seemed to correlate with both the ability to replant and the functional outcome of reconstruction. Hassan[7] gave a case report of one and half year old baby with meat grinding Machine Hand Injury. Alexandra[8,9] gave strategy for reconstruction of mangled upper extremity. He stated that the minimum functional requirements of a hand can be defined using terms such as "basic hand" and "acceptable hand". It is generally accepted that for a hand to be usable, it needs to have an opposable thumb and one or more digits that have adequate motion, sensibility and length. Crush, degloving or avulsion-type injuries are encountered in cases of mutilating injuries. Jaiswal *et al.* has studied about àepidemiology and management of motorbike chain-related fingertip injuries[15]. Management of hand injury by JESS fixator[10] and flow through procedure for complex hand injury with amputated fingers was given by Alexandra[8]. Fu chen wei[11,12] and G Foucher[13,14] gave the way of

rehabilitation of amputated fingers by Toe transfers. All of them gave one conclusion that the Reconstruction depends upon the type of injury, amount of tissue loss, force of injury, apart from other components, While facility and expertise available in hospital. Rehabilitation depends upon sincere physiotherapy, Psychiatrist and patients desire to return back to original profession.

These type of motor cycle chain injuries can be easily prevented and avoided with a little caution when doing this sort of maintenance. While cleaning the chain, it is better to rotate the wheel with hand and not to keep engine in running stage so that we have more control on vehicle and if something goes wrong, vehicle could be stopped. When applying lubrication like dry Teflon, keep the hand above the chain ring and drip accordingly. There are complete chain covers are available. In some countries fitment of chain cover is mandatory requirement like Australia. In India regulation only says that left side of rear wheel should be covered so as to prevent Pillion rider's clothes entanglement.

CONCLUSION

Motor cycle chain injuries are dangerous hand injuries. This results in crushing, pulling, rotational, degloving and avulsion injury of fingers, toes or hand and leads to amputation of the digits as the patient tries to resist the pulling force of chain. The area of trauma is bigger leading to large degloved area. That is why replantation of the amputated finger after motorcycle chain injury is difficult and chances of survival is less.

With the advent of super microsurgery and higher magnification, it is now possible to anastomose 0.3mm to 0.8 mm sized vessels. However the condition of the donor and recipient vessels decides the fate of the reimplant surgery Various measures were taken like anastomosing away from the zone of trauma and using vein graft when necessary , shortening of bone length, crossing over of vessels have found to improve the results. As it states, prevention is better than cure, Cases of injury can be decreased if the general public is taught the way of cleaning of bike chain properly. Prevention of this injury is important for the public and society.

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