Case Report

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Revascularisation of left hand after 33 hours of warm ischemia: a case report

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ABSTRACT

'Revascularisation' or 'replantation' is a limb saving procedure. In case of severe limb injury compromising its vascularity, before considering amputation, one should always consider these surgical procedures after thoroughly assessing the status of the patients injury and his hemodynamic status. Delayed revascularisation has proven successful in cases and there are substantial evidences based on some case studies published recently. There are very few reports and case studies documented on successful salvage of upper limb /forearm traumatic vascular injuries after considerable delay in revascularisation / replantation. Here we present a case of delayed revascularisation of left hand after 33 hours of warm ischemia which turned out to be a successful surgery without any dreadful complication and consequences in a year's follow-up. We believe and recommend that efforts must be made by every well-equipped health care system in salvaging the limb by revascularisation technique. We also want to mention that delayed revascularisation can be done successfully with constant monitoring of limb and patients hemodynamic status to rule out reperfusion injury and septicaemia. We recommend, one should always consider revascularisation/Replantation as an option before planning amputation which can be debilitating for the patient.

Keywords: Delayed, Ischemia, Revascularisation, Warm ischemia

INTRODUCTION

"Warm ischemia time" refers to the amount of time that an organ remains at body temperature after its blood supply has been stopped or reduced. Early detection and revascularization of traumatic vascular injuries is quintessential but delayed revascularization can also produce acceptable salvage outcomes. Constant improvement and innovations in surgical techniques has resulted in increased efficacy of medical professionals in salvaging the patient's limb which are affected by severe injuries and hence amputation can be prevented

ultimately. It is important to assess the level of injury and the exact type and an early and thorough assessment of the outcomes after performing surgery. This will enable us to decide our treatment which is in the best interest of patient's well-being. Indications and contra-indications must also be considered and also if available use of advanced radiological modalities like CT scans and CT angiograms can be used to assist the surgeons and ultimately increase the effectiveness of surgery. Success rates are usually low in case of crush/avulsion injuries as compared with a guillotine or sharp cut injury. ^{1,2} Nerve injuries and vascular injuries together could be difficult to

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deal with in terms of functional outcomes following replantation/revascularization which vary with level of injury. Replants and revascularization of the fingers distal to the flexor superficial is insertion, the hand at the wrist, and the upper extremity at the distal forearm can achieve good function.³⁻⁷ There are notable case reports and studies with successful salvage outcomes after prolonged ischemic time. We are presenting a successful revascularization case with a warm ischemia time of 33 hours.

CASE REPORT

A 45 years old male, was assaulted at a remote place in the outskirts of Thane district at around 6.30 pm by unknown people with multiple CLW's over the left hand dorsum and volar aspect of distal forearm and wrist. Patient had profuse bleeding from injured site and subsequently felled unconscious overnight. On the next day morning, trespassers took him to a primary health care center, where he received primary aid and was conscious and alert thereafter. Then patient was brought to our medical center at 9.00 AM by his relatives for further treatment and evaluation.

On admission, patient was conscious, alert and oriented in time place and person. His pulse was 118/min and BP was 90/56 mmHg, efforts were taken simultaneously to achieve hemodynamic stability. Patient seemed pale and had pallor as well. In the mean-while, an orthopedic surgeon was consulted as primary impression was that of a tendon injury. Considering the possibility for it to be a vascular injury as well, later plastic surgery reference was advised. Being a small hospital set up and unavailability of plastic surgeons in the nearby area there was a delay of 12 hours from 9 AM to 9 PM on that day and finally author received a call for the same and patient was looked after, since.

On local examination of left hand and fingers

- Horizontal contused lacerated wound over wrist from mid lateral to mid medial side with underlying tendons, nerves, vessels seems to be cut depth of which was bone deep
- Horizontal contused lacerated wound on ventral aspect of left forearm at the junction of middle 1/3rd and lower 1/3rd with underlying muscles cut
- Horizontal cut over left hand mid dorsum, depth of which was bone deep with underlying extensor tendons cut.

On pinprick there was no bleeding from pulp of all fingers. Hand and all fingers were cold and pale with loss of pulp pressure. There was no movement of index finger and thumb at IP joints. Also a very minimal flexion movement was found in middle, ring and little fingers, with hand cascade maintained suggesting intact FDP's. There is no range of motion at the level of wrist joint.

Extension of all fingers except thumb was lost. SpO₂ over all fingers was found to be 0% with no waveform.

During counseling, patient himself and his relatives were informed about the patient's nature and severity of injury along with remote chances of regaining his hand vascularity and functions after the revascularization operation and high possibility of a failure, leading to subsequent gangrene of hands in view of long delay and time since injury. Also a possibility that the patient could further need an amputation at appropriate level in near future was informed. Informed consent was taken for exploration of injury and repair of injured structures.



Figure 1: Intraoperative: repair of radial and ulnar artery.



Figure 2: Immediate post operation.

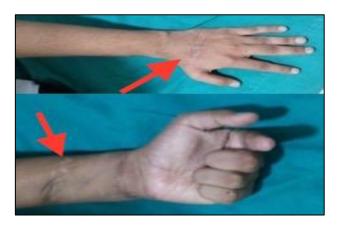


Figure 3: Follow up-18 months.

Intra operatively

After exploration of injuries ulnar artery, radial artery, median nerve, flexor digitorum superficialis (FDS) of middle, ring and little fingers were repaired along with extensor tendon repair of index, middle, ring and little fingers at dorsum of hand with tagging suturing of 'contused lacerated wounds' in supracondylar block and sedation under tourniquet control was performed.

Radial artery and ulnar artery were sutured under loop magnification (4.0) with 8/0 Ethilon round body microtip needle with standard method at around 4.00 am. Intraoperatively, distal blood flow through the vascular repair site was confirmed and found to be satisfactory and SpO₂ of 98% over fingers was achieved.

Median nerve 'epineural suturing' with 8/0 Ethilon with standard technique was done. Partial muscular cuts over common flexor digitorum superficialis muscle of middle, ring and little fingers were sutured with vicryl 3/0 round body needle.

Flexor carpi radialis (FCR), flexor pollicis longus (FPL) and both flexors (FDP and FDS) of index finger could not be repaired as there was a loss of a segment of tendon. Similarly, tendons at the cut end were shredded. Freshening of these cut ends was done and simultaneously they were tagged with 8/0 Ethilon for identification in subsequent surgeries.

Patient withstood surgery well. Splintage with cast was given upto finger tips in cock up position with thumb in abduction.

Postoperatively

Postoperative period was uneventful and patient recovered well.

On 18 months follow up patient demonstrated good full range of extensive movements of all fingers (middle, ring, little fingers) with flexion of middle, ring and little fingers power 5/5, normal sensations with palpable Radial and ulnar artery distal to repair site. Now Patient is awaiting second surgery for correction of his 'pointing index deformity' with absent flexor pollicis longus (FPL) movement.

DISCUSSION

Vascular and nerve injuries to the upper limb are very common in developing countries like India and usually in small cities and district level and so are amputations and near total amputations performed in majority of cases which, are the major surgeries. It has been observed in India that most of the patients present later, more than 6 hours of warm ischemia period due to multiple factors. It is important for us to understand the following terms,

The term "revascularization" is defined as condition in which most of the functional structures are separated but in which there is evidence of a residual circulation which can only be improved by a vessel anastomosis.

"Replantation" is defined as reattachment of the amputated limb using the neurovascular and musculoskeletal structures in order to obtain the recovery of limb.

"Cold ischemia", in surgery, the time between the chilling of a tissue, organ, or body part after its blood supply has been reduced or cut off and the time it is warmed by having its blood supply restored. This can occur while the organ is still in the body or after it is removed from the body if the organ is to be used for transplantation.

The time that an organ surgically removed for transplantation remains in a chilled perfusion solution before engraftment.

"Warm ischemia" is a term used to describe ischemia of cells and tissues under normo-thermic conditions. In surgery it is the time a tissue, organ, or body part remains at body temperature after its blood supply has been reduced or cut off but before it is cooled or reconnected to a blood supply. In the transplant setting, this term is used to describe two physiologically distinct periods of ischemia: (a) Ischemia during implantation, from removal of the organ from ice until reperfusion, and (b) Ischemia during organ retrieval, from the time of cross clamping (or of asystole in non-heart-beating donors), until cold perfusion is commenced.

Amputations of the upper limb if unsalvageable would cause severe disability. Delayed revascularization has proven to be life threatening at times. With a significant co-morbidity associated with it. 'Reperfusion syndrome' (which can progress to hyperkalemia, acidosis, multiple organ failure and death) is a very common complication occurring in patients on whom revascularization surgery has been performed. An impetus must be laid over the time consumed before the revascularization procedure starts.⁸ There are few notable literatures stating that delayed interventions for reperfusion of limb also produce successful outcomes.^{9,10}

Golder et al states that it is definitely unwise, to perform replantation or revascularization after a warm ischemia time more than 6 hours as the chances of restoring the circulation are markedly diminished. Conditions like Volkmans Ischemic Contracture may also arise even after restoring the circulation. However, in a case report published by A. M. Merican, he inferred that successful revascularization can be performed with at least 10 hours of warm ischemia.

In a study conducted by Krishnan J et al, the mean ischemic time was 23.51 hours (4-278 hours). 33 patients were treated more than 6 hours after the injury out of

which, 6 patients underwent revascularization after 24 hours; all the patients demonstrated good collateral circulation without distal pulses or evidence of any ischemic neurological deficit. In 39 patients who underwent revascularization within 24 hours, the mean ischemic time was 13.2 hours. Delayed amputation was performed in 5 patients. Of the 6 patients who underwent delayed revascularization (after 24 hours), 1 patient had early amputation, 1 had delayed amputation following infection and multiple flap procedures while the rest of the patients limb survived. 12 In a case series report published by Lutz, the number of patients who underwent successful hand and digit replantation and revascularization were as good as 64. Secondary procedures were found to be necessary in 45% of study population.¹³

However, results of revascularization have improved in the last four decades. With better understanding of the pathophysiology of the injury, early referral to a well-equipped and multi-speciality center with skilled team and better preservation to reduce warm ischemia times, advanced technology available for the surgeon, close monitoring in the post-operative period and a rigorous follow-up with appropriate secondary procedures are the factors responsible for successful outcomes. ¹⁴

The major limits of ischemia time for major injuries from the level of shoulder to wrist are six hours of warm and 12 hours of cold ischemia, although success have been reported after longer ischemia times. Reduction in ischemia time may be achieved by placing a shunt between the proximal and distal vessels while the patient is being prepared for surgery. Since wrist proximal procedures complete vascular washout with university of Wisconsin solution at 4°C into the artery has been shown to improve results. In such patients, fluid resuscitation and warming is an important part of preoperative preparation as it prevents vasoconstriction.

There are reports of successful finger replantation as late as 24 hours after the incidents, while a forearm requires revascularization, within first 6 hours of cold ischemia.² After this limit, an elementarisation is advocated which means removal of all but only the most essential muscles, leaving just basic flexors and extensors.²² Transection is found to be the most common type of arterial injury and is associated with highest risk of limb loss. Open surgery with primary repair, vein patch, interposition or bypass grafting are considered as the gold standards for the management of vascular injuries.²³ Arteries may be repaired earlier if the warm ischemia time is long. A vein graft can be harvested from the contralateral arm or leg and should be reversed for arterial interposition. If a vessel repair lies in hypo vascular muscles, it will thrombose within few days. If a vein graft lies between devascularised muscles, it may even rupture at the anastomosis. Hence after revascularization it is essential to observe vascularity of muscles and carry out further debridement of muscles, if necessary.²⁴

Post-operative care includes adequate fluids and warming the patients room to prevent hypotension and vasospasm. As Some reports have recommended use of Aspirin, Dextran, Heparin; however, none is backed by the randomized control trials. As Patient's hand should be monitored regularly for signs of arterial insufficiency. Systemic reperfusion problems in the form of myoglobulinuria, tachypnea, ARDS could be encountered in the post-operative period. Amputation thus becomes mandatory and can be life saving for the patient. Hence reperfusion syndrome should be carefully managed.

Huynh et al concluded that even though prolonged ischemia has been a well-recognized predictor of cell death, the tolerance periods varies from person to person. This depends on the severity of the ischemia and the presence of collateral flow. The fact that the patient's upper limb was salvaged can be attributed to the collateral flow and it was also a prima facie factor as both his ulnar and radial artery were injured due to the trauma he had. Development of good collateral flow is supposed to be the most important reason for salvage of limbs in cases of delayed revascularization.

Extremities vascular injury can be associated with several complications often leading to amputations if not treated in time. Chronic ischemia, chronic ulceration, development of arterio-venous fistulas, permanent neurological deficits are some of the notable complications.²⁷ It is associated with several other severe complications including nerve injuries, infections, malunions, non-unions (if limbs are fractured) and hence thorough assessment of the patient's injury is very essential.

The success of a replantation or a revascularization is no longer measured on the basis of survival of amputed or revascularised limb, but rather by function of that part. Various reports suggest that functional outcomes of the revascularised limb must be taken into account especially at the trans-metacarpal level. Most of the failures or poor results were attributed to multiple tendon adhesions, joint contractures, intrinsic tightness and poor return of sensibility. It had nothing to do with the surgery per say.

According to Chen et al's criteria, pinch strength, grasp strength, range of motion, intrinsic muscle function, return of sensibility and functional recovery are the most important factors in determining the success of the revascularization or replantation surgery post-operatively.

Our case is unique in the sense that the total ischemic time was 33 hours and which included both radial and ulnar artery injury along with a nerve injury which was successfully revascularised without any complication.

Many studies have claimed and mentioned the importance and effectiveness of CA and CTA in vascular injuries obtaining an angiogram prior and post the surgical procedure is highly recommended in most of the

studies. However, in our case we couldn't perform as the patient was not financially well equipped to go through it and also considering the time we had for the procedure to be done. ^{28,29}

The positive aspect of this case is the fact that a successful revascularization after 33 hours of warm ischemia of hand. As mentioned, very few cases have been reported till today's date with a prolonged ischemia time including the notable case of Nanda et al and A M Merican et al (warm ischemia time of 10 hours). Jagdish Krishnan et al in his study have mentioned successful revascularization cases with prolonged ischemia times. Hence our case is notable given to the warm ischemia time of 33 hours and no complications in the postoperative follow-up. Also this surgery was performed in a district level small city and a small hospital with limited resources available for microvascular surgery without a trained assistant and with relatively inexperienced staff to monitor revascularised or replantation patients in the post-operative period.

CONCLUSION

It is indeed important for us to understand that 'revascularization' and 'replantation' is an attempt in salvaging the limb in case of severe vascular injuries before performing an amputation. A time bound assessment and a skilled team with experienced professionals and surgeons can definitely help these patients to return to a better quality of life. Awareness regarding the same must be increased to a greater extent. It is always prudent on the part of health care personnel to take a decision which is in the interest of patient. Delayed revascularization must be attempted if possible as it has successful results as evident from various cases reports including ours. Functional outcomes can never be compared to the normal and healthy limb but however it helps in restoring some functional output and has cosmetic and psychological benefits as well. With recent advances in plastic surgery techniques and technological innovations it is definitely possible to salvage the severely devascularised limb and improve survival rate of patient's operated limb thereby avoiding dreadful complications. Through this case report, author and his team is trying to emphasize on the need and also making an effort and attempt to make every medical professional along with people in society around us aware of the fact that the severely injured limb can be also salvaged after a certain permeable time delay.

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