

## ORIGINAL RESEARCH

# Indicators of limb amputation cases with long ischemia time

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### ABSTRACT

**Background** - Ischemia time is a single major factor, determining outcome of a traumatic limb. It affects the degree of soft tissue injury. In India, due to lack of availability of vascular surgeons in periphery, patient often reach hospital after the golden hour of revascularization post traumatic injury i.e., 6 hours. We prospectively assessed such patients treated at our tertiary care institute in central India with ischemia time more than 10 hours and indicators affecting the outcome. **Material and Methods**- Our objective was to assess the outcome of the cases with ischemia time more than 10 hours with intervention done after the golden hour of revascularization with concomitant bony and vascular injuries. We have studied the indicators affecting the outcomes of these cases. 47 out of 58 patients who attended emergency medicine with concomitant bony and vascular injury were included in the study and were operated. We have assessed various parameter i.e., type of orthopedic and vascular intervention, presence of passive stretch pain or compartment syndrome and need for fasciotomy, type of bony injury and vessel injury, timing of surgery in both limb salvage and limb amputated group. **Results** - Total 47 out of 58 patients with concomitant bony and vascular injury had ischemia time more than 10 hours. About 10 patients underwent amputation (21.2%). Absence of passive stretch pain and presence of compartment syndrome was found to be significant and is said to be the major indicator determining limb salvage. **Conclusion**- Patients with vascular injury presenting after golden hour of revascularization should be promptly treated as per protocol targeting limb salvage. Early diagnosis and prompt treatment can prevent amputation and improve quality of life of the patients and decrease burden on society.

**Keywords**- limb salvage, amputation, compartment syndrome, bony injury.

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### INTRODUCTION

Ischemia time is a single major factor, determining outcome of a traumatic limb. It affects the degree of soft tissue injury. With increasing ischemia time, the muscles develop non-reversible changes and neural damage which results in loss of sensory and motor function. When a total blood supply to a limb is obstructed, gross changes in skin appear after 8-12 hours, in muscles after 4-6 hours and irreversible changes in nerves start even before 4 hours. Moreover, light microscopic changes appear from half an hour of complete obstruction of blood supply. As such, early intervention has always been a key factor in determining outcome of a traumatic limb with vascular injury. In India, due to lack of availability of vascular surgeons in periphery, patient often reach hospital

after the golden hour of revascularization i.e., 6 hours [1,2].

Due to improvement in technology, better medical facilities, damage control protocols and better intensive care, the recent studies showed mortality rates of around 1.5%-5.5% and amputation rate over 14-25% [3-5].

Often patients with borderline pre gangrenous changes had to be operated even when they arrive hours and even days after traumatic vascular obstruction. We prospectively assessed such patients treated at our tertiary care institute in central India.

### AIMS AND OBJECTIVES

#### Primary

To assess the outcome of the cases in concomitant bony and vascular injury with ischemia time more than

10 hours and intervention done after the golden hour of revascularization.

### Secondary

To assess the epidemiological features and the indicators affecting the outcomes of these cases.

### METHODOLOGY

The study was conducted in the Department of Cardiothoracic and Vascular Surgery, in a tertiary care institute in central India after getting approval from the Institute Ethics Committee and proper consent from the patients.

#### Study group

A single group with subjects who have concomitant vascular injury and bone injuries of the limbs and intervention done after 10 hours of vascular trauma.

#### Study participants

##### 1. Inclusion criteria:

Subjects with concomitant vascular (femoral, popliteal, brachial, radial, ulnar vessels) injury and bone (femur, tibia, fibula, humerus, radius, ulna bone) injuries (fractures, dislocation) of the limbs

##### 2. Exclusion criteria:

- Crush injury of the limbs (direct injury to soft tissue of limbs resulting in extensive skin damage, muscle laceration and nerve injury)
- Life threatening trauma to abdomen/ chest / head

**Source of subjects:** Patients attending emergency medicine department from December 2020 to October 2022 fulfilling the study criteria.

**Study design:** Prospective descriptive study

Intervention/ exposure: Not applicable

### Procedure of the study

Patients attending the Emergency medicine department fulfilling the foresaid criteria were included in our study. Factors like age, sex, mode of injury, co-morbidities ( hypertension, coronary artery disease, peripheral vascular disease, diabetes mellitus), site and side of injury, clinical parameters (pulses, capillary refill time, sensory and motor function), bone and vessel injured, type of bone and vessel injury, presence of compartment syndrome, Mangled extremity severity score (MESS), Limb salvage index (LSI), ischemia time were assessed to find the cause leading to amputation of limb.

In our institute, the protocol of performing orthopedic intervention before the vascular procedure was followed for all the patients without use of shunts for temporary restoration of blood flow distal to injury.

The patients were followed till the time of discharge or death.

Confounding/interacting factors: Logistic factors , the availability of emergency theatre facilities on the day of arrival of the patient

### STATISTICAL ANALYSIS

The association of outcome with the other categorical variables was carried out using the t-test and Chi-square test. All statistical analysis was performed in IBM PASW statistics 16.0 (SPSS version 16.0) and graph in Microsoft word.

Table 1-

Variable	Sub-group	Ischemia time more than 10 hours-limb salvaged (N=37)	Ischemia time more than 10 hours-limb amputated (N=10)	p value
Mode of injury	Road traffic accident	32	6	0.059
	Fall from height	5	4	
Co-morbidities	PVD	0		0.32
	DM	1	0	
	HTN	2	2	
	None	34	8	
Distal pulses at presentation	Present	1	0	0.3
	Feeble	2	0	
	Absent	34	10	
Sensory function	Present	28	6	0.3
	Absent	9	4	

Capillary refill time	3 secs or less	15	01	0.07
	more than 3 secs	22	9	
Passive stretch pain	Present	7	4	<b>0.01</b>
	Absent	30	6	
Type of bone injury	Fracture	23	9	0.3
	Dislocation	14	1	
Type of fracture	Closed	17	5	0.1
	Open	6	5	
Bone/joint involved	Humerus	10	2	0.06
	Elbow	6	0	
	Radius	1	0	
	Femur	3	1	
	Knee	8	1	
	Tibia	9	6	
Vessel injured	Brachial artery	16	2	0.5
	Radial artery	1	0	
	Femoral artery	3	1	
	Popliteal artery	17	7	
Type of vessel injury	Contused	25	5	<b>0.3</b>
	Transected	12	5	
Compartment syndrome	Absent	31	4	<b>0.005</b>
	Present	6	6	
Systolic Blood pressure during surgery	More than 90 mm Hg	31	8	<b>0.06</b>
	Below 90 mm Hg	6	2	
Cause of delayed presentation	Late referral from other hospital	34	9	0.8
	Late diagnosis of vascular injury	3	1	
Cause of delay to take in OT	Late availability of OT table	36	10	0.5

	Late diagnosis of vascular injury	1	0	
Type of orthopaedic intervention done	External fixation	31	10	0.6
	Internal fixation	2	0	
	Closed reduction	3	0	
	K wiring	1	0	
Vascular intervention done	Embolectomy	14	2	0.6
	Primary repair	17	4	
	Vein graft	6	4	
MESS	3-6	29	0	0.0001
	7-12	8	10	
LSI	Less than 6	33	1	0.0001
	More than 6	4	9	

**Table 2**

Outcome		N	Mean	Std. Deviation
Ischemia time(min)	Limb salvage	37	1005.405	411.1947
	Limb amputated	10	1092.000	220.5448
Time between time injury and presentation to hospital (min)	Limb salvage	37	555.405	400.1013
	Limb amputated	10	558.000	207.9423
Time between presentation and surgery (min)	Limb salvage	37	222.703	157.1208
	Limb amputated	10	273.000	231.7110
Duration of surgery (min)	Limb salvage	37	327.568	132.3591
	Limb amputated	10	327.000	94.2868

**RESULTS**

This study was a single-center, prospective descriptive study carried out in the Department of Cardiothoracic and Vascular Surgery, in a tertiary care institute after being approved by the Institute Ethics Committee and consent from the patients. Data was collected from December 2020 to October 2022 and analyzed.

A total number 58 patients were found to have concomitant vascular and skeletal injury. Out of 58 patients, 47 patients were taken into consideration with ischemia time more than 10 hours. (n=47) out of which 45 (95.7%) patients were males and 2 (4.3%) were females. The mean age in the study was 30.1 +/- 1. Out of 47 patients, 10 patients land up into amputation of limb (21.2%) while in 37 patients limb salvage was possible.

**LIMB SALVAGE GROUP**

As per table 1, among the limb salvage group (N=37) , 32 patients had road traffic accident and 5 had fall from height. On presentation 34 had no distal pulses ,

while 2 had feeble pulses. Sensory function present in 28 patients.

Capillary refill time was more than 3 seconds in 22 patients. 30 patients had absent passive stretch pain. 23 patients had fracture in long bone and 14 suffered dislocation with most commonly involving humerus followed by tibia. Brachial artery is most common among vessel injured followed by popliteal artery. At presentation compartment syndrome present in 6 patients and 6 patients were hypotensive while rest were normotensive.

MESS score was more than 7 in 8 patients while it was less than 6 in 29 patients.

Mean ischemia time among limn salvage group was 1005 min as shown in table 2.

**LIMB AMPUTATED GROUP**

As per table 1, among the limb amputated group (N=10), 6 patients suffered road traffic accident and 4 had fall from height. On presentation 10 had no distal pulses. Sensory function was present in 6 patients.

Capillary refill time was more than 3 seconds in 9 patients and 6 patients with absent passive stretch pain which was found to be statistically significant ( $p < 0.05$ ). 9 patients had fracture in long bone. Most commonly involving tibia. Popliteal artery is most common among vessel injured followed by brachial artery. At presentation compartment syndrome present in 6 patients and 2 patients were hypotensive while rest were normotensive. MESS score was more than 7 in 10 patients. Mean ischemia time among limb amputated group was 1092 min as per table 2.

## DISCUSSION

Often patients with borderline pre gangrenous changes had to be operated even when they arrive hours and even days after traumatic vascular obstruction. We prospectively assessed such patients treated at our tertiary care institute in central India.

Management of concomitant vascular and orthopedic injury is a challenge requiring early diagnosis and intervention for better outcome with the goal to have a functional limb. The rate of amputation found in our study was 21.2% (10 patients) like the previous studies [3,6].

The factors associated with increased rate of amputation found in this study were passive stretch pain, presence of compartment syndrome, high scores of MESS and LSI.

Whenever there is doubt about the salvageability of the limb, revascularization is done provided the ischemic time is within the acceptable limits. It should be kept in mind that a non-functional limb is an obstacle for the quality of life with respect to the day-to-day activities and hence it is suggested to go for primary amputation than to save a non-functional limb.

External fixation was done for most of the patients (41, 85.1% patients) to provide adequate bone stabilization in a shorter period. Studies show no difference or added advantage of external fixation over internal fixation though some other studies recommend external fixation of fracture or joint dislocation in vascular trauma [1].

Modrall et al recommend that vascular repair can be done later if only external fixation and closed reduction of fracture is anticipated. If internal fixation and open reduction of a fracture are planned then arterial repair should be done first [7].

In our study around 47 out of 58 patients had delayed revascularization i.e. after 10 hours of ischemia time. In 37 patient's limb salvage was possible which is consistent with the similar finding in other study. The repair should be done beyond the golden hour of revascularization as shown in the study done on traumatic brachial artery injury in 124 patients [8]. This is proven in our study that among the 47 patients only 10 underwent amputation. The risk factors causing the amputation were presence of compartment syndrome and absence of passive stretch pain.

Open fractures and traumatic sub-total amputations are associated with higher rates of amputation and functional impairment of the involved limbs; associated irreversible necrosis and extensive damage to soft tissue in this subset account for the high amputation rate. 5 out of eleven patients (45%) who had open fractures eventually required amputation. This is consistent with the previous studies which document a higher rate of amputation with blunt injuries than with penetrating injuries [6].

High rate of amputation was found in patients who develop compartment syndrome at some point after injury [19]. In this study, 10 patients developed compartment syndrome, and finally, 5 out of them underwent amputation. A significant association between limb loss and compartment syndrome was found ( $p = 0.03$ ) – as evident in table 1. Also, compartment syndrome did not develop in 35 (74.5%) patients and 4 of them ended up with amputation.

Out of 47 patients, 36 patients had no passive stretch pain and 6 undergo amputation and 4 patients among the 10 with passive stretch pain underwent amputation ( $p = 0.01$ ). Therefore, absence of passive stretch pain is found to be significant (as evident in table 1).

No significant difference was found in amputation rates between those underwent fasciotomy and those who did not undergo fasciotomy. Prophylactic fasciotomy is recommended as it restores collateral circulation rather than waiting for the signs of compartment syndrome to develop to perform fasciotomy [9]. If fasciotomy is not done pre-operatively or intraoperatively, regular monitoring of limb for development of compartment syndrome is done so that fasciotomy could be done as soon as needed.

Various scoring systems like MESS, LSI, Predictive Salvage Index, have been used globally in decision-making process for the management of mangled lower extremities. We used MESS and LSI in this study. Sharma S et al found a 100% positive predictive value of MESS in the Indian population [10]. We found similar findings in this study with all the 10 patients (100%) who underwent amputation in this study had MESS of more than 7 and LSI of more than 6.

The use of interposition graft for vascular repair or primary repair doesn't affect rate of amputation as shown by various literatures [11,12] similar results are comparable in our study also.

No significant difference was found in a delayed presentation to the hospital and delay to take-up for surgery after the presentation. Duration of surgery was also not significantly different between the two groups (0.341). In our study, out of 37 patients in the limb salvage group, 10 patients with limb amputated group, there was no significant difference in time the intervals between the time of injury and presentation, the time between presentation and surgery and the duration of surgery in both the groups.

**CONCLUSION**

The present study targeted the patients with ischemia time more than 10 hours with concomitant bony and vascular injury. Presence of compartment syndrome and absence of passive stretch pain were found significant. Further multicenter study with long term follow up of the salvaged limb patients needed to be done to find the other parameters affecting limb amputation and guiding the surgeons for decision making.

**ETHICAL STATEMENT**

The study Was approved by institutional ethical committee of NSCB Medical College, Jabalpur, M.P. Written informed consent was taken from patients.

**CONFLICT OF INTEREST**

None

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None

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