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Original Research Article

Validity of vetrivel trauma score in predicting salvage of limb in gustilo anderson grade III B and grade III C open fractures

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ABSTRACT

Introduction: There have been many classification systems developed for open fractures like Gustilo Anderson grading system, Mangled extremity severity score, Ganga hospital open injury severity score. But the gray zone still exists in many open fractures whether the limb has to be salvaged or amputated. The above-mentioned scores have poor sensitivity and specificity in evaluating open fractures. This led to the development of a novel scoring system known as Vetrivel trauma score.
Aim: This study aims to assess the validity of this novel scoring system in predicting the outcome of limbs in Gustilo Anderson Grade IIIB and Grade IIIC open fractures.
Materials and Methods: One hundred and forty-four open fracture cases were taken for this study. 82 patients sustained Grade III injuries according to the Gustilo Anderson classification. Of these, 35 patients were of Grade IIIB and above. These 35 patients were scored using Vetrivel Trauma score, Ganga hospital open injury severity score, and Mangled extremity severity score.
Results: Vetrivel trauma score was compared with Ganga hospital open injury severity score, and Mangled extremity severity score. Analysis indicated Vetrivel trauma scoring system is more accurate than others. The area under the curve of the receiver operating characteristic curve for Vetrivel Trauma score (0.983) is found to be significantly higher than other scoring systems compared.
Conclusion: Vetrivel trauma score is a better predictor of injury severity in Grade IIIB and Grade IIIC open fractures with the highest sensitivity and specificity in deciding amputation versus salvage. A score of 39 or more has the highest predictability for amputation.

1. Introduction

In today's world, road traffic accidents are rising at an alarming rate. Most of them being high-velocity injuries, a large number of them turn out to be open fractures. Open fractures require treatment by a team of doctors from many specialities and may impose major socio-economic problems on the patient and his family. Gustilo and Anderson classification remains the most widely used classification for open fractures.[1,2] It has three grades, of which, Grade III injuries are classified into Grade IIIA, IIIB, and IIIC according to the need for vascular reconstruction and the severity of the soft tissue injuries.[3]

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Table 1: Vetrivel trauma score[4]

	Preoperative non-laboratory parameters in Vetrivel trauma score	
S. No.	**Variable**	**Score**
1	**Mechanism /soft tissue injury kinetics/muscle injury :**	
	A. Type of injury	
	i) Injury not exposing the fracture site	1
	ii) Injury exposing the fracture site	3
	B. Extent of injury	
	i) Skin loss	
	a) Confined to one compartment	1
	b) Involving two or three compartment/ circumferential	2
	ii) Injury to musculotendinous units	
	a) Confined to one compartment	1
	b) Involving two or three compartment/ circumferential	3
2	**Circulation**	
	A. Colour*	
	i) Bright red	0
	ii) Dark(Non viable)	1
	B. Capillary bleeding– Response to pin prick at tip of great toe using lancet needle**	
	i) Yes	0
	ii) No	2
3	**Age**	
	A) 0-40 yrs	1
	B) 40-60 yrs	2
	C) >60 yrs	3
4	**Arterial injury - Palpating distal pulse**	
	A) Distal Pulses felt	0
	B) Distal pulses not felt	3
5	**Systolic BP<90mm Hg**	
	A) Yes	3
	B) No	0
6	**Bone loss**	
	A) No loss	0
	B) <4 cm	1
	C)>4 cm	2
7	**Warm ischemia time**	
	A) <6hrs	1
	B) 6-12 hours	2
	C)>12 hours	3
8	**Degree of contamination*** **	
	A) No contamination	0
	B) Less contaminated	1
	C) Grossly contaminated	2
9	**Systemic illness**	
	A) Preexisting systemic chronic illness	
	i) Smoking < 10 years	2
	ii) Smoking > 10 years	3
	iii) Hypertension	1
	iv) Diabetes	1
	B) History of vascular insult to affected limb- peripheral occlusive disease/ CKD/ IHD	2
10	**Associated injuries**	
	A) No(only bony injury)	1
	B) Visceral / chest injury	2

Continued on next page

Table 1 continued

	C) Visceral and Chest injury	3
11	**Muscle viability******	
	i) Consistency	
	Firm	0
	Soft and Friable	2
	ii) Contractility	
	Good	1
	Poor	2
12	**Skeletal stabilization*******	
	Possible	0
	Not Possible	4
	Pre-operative laboratory parameters in Vetrivel trauma score	
13	**LDH (Units/Litre)**	
	<500	0
	500-1200	1
	1200-2000	2
	>2000	3
14	**CPK (Units/Litre)**	
	<200	0
	200-800	1
	800-1800	2
	>1800	3
15	**SPO2(%)**	
	>95%	0
	80-95%	1
	Not recordable	4

*Color of exposed muscle tissue around fracture site, **Owing to peripheral vasoconstriction in cases of severe blood loss or polytrauma and due to grossly contaminated digits at the time of initial presentation, we preferred pin prick test over routine capillary refill test, ***Less contaminated- Surface contamination which can be easily removed not embedded in bone or deep soft tissues. Grossly contaminated embedded in bone or deep soft tissues/high risk environmental conditions (farnyard, fecal, dirty water etc.), ****Muscle viability was tested using a sterile artery forceps over the exposed muscle tissue around fracture site, *****X-rays were taken and routine pre-operative planning was done to determine the possibility and type of skeletal stabilization. BP: Blood pressure,
CKD: Chronic kidney disease, IHD: Ischemic heart disease, SPO2: Oxygen saturation,
LDH: Lactic acid dehydrogenase, CPK: Creatine phosphokinase

Grade IIIA injuries have adequate soft-tissue coverage of a fractured bone. Grade IIIB injuries have extensive soft tissue injury with exposure of bone and periosteal stripping with massive contamination. Grade IIIC injuries have an open fracture with arterial injury requiring repair for salvage of the limb.[5]

To assess the viability of the limb in open fractures, Mangled Extremity Severity Score, Ganga hospital open injury severity score, and Vetrivel trauma score systems are used.

The Mangled Extremity Severity Score (MESS) was developed 25 years ago.[6] It is based on four clinical criteria: limb ischemia, skeletal/soft tissue injury, shock, and age. A score of less than seven indicates that salvage is possible and a score of seven or more indicates the injured limb may land in amputation.[7,8]

Ganga hospital open injury severity score (GHOISS) is based on the severity of injury to the bone, the musculotendinous structures, and skin.[1,5,9] A score of 17 and above indicates the need for amputation of the injured limb, while a score of 14 and below can be salvaged.[5] A score of 15 and 16 are in the gray zone.

Vetrivel Trauma Score (Table 1) is based on preoperative clinical parameters and preoperative laboratory parameters.[4] The minimum score is six and the maximum score is 55. A limb with a score of 39 and above needs amputation. With a score of 28 and below, limb salvage is possible. A score between 29 to 38 is in the gray zone where the decision is made on patient-to-patient basis.[4]

With increasing severe open injuries of the limb, an ideal scoring system with good specificity and sensitivity is needed in predicting the salvage of the injured limb.[1]

2. Materials and Methods

A prospective study was conducted in Government Coimbatore Medical College hospital, Government Chengalpet Medical College Hospital, and Government Tirunelveli Medical College Hospital in the Department of Orthopaedics over a period of 12 months from February 2020 to January 2021 after ethical committee clearance.

One hundred and forty-four open fracture cases were analysed in our study. According to the Gustilo Anderson classification, 82 patients sustained Grade III open fractures. Of these 82 patients, 35 patients were of Grade IIIB and above. Those who come under Grade IIIB and IIIC were included in our study. Mangled extremity severity score, Ganga hospital open injury severity score, and Vetrivel trauma score were evaluated for patients with open fractures of Grade IIIB and IIIC patients in the emergency room. The mode of injury was road traffic accident in 33 patients, industrial accident in two patients.

Patients aged more than 18 years with open fractures of lower limb coming under Gustilo Anderson Grade IIIB and Grade IIIC were included in our study. Patients with Gustilo Anderson Grade I, Grade II, Grade IIIA injuries, and upper limb injuries were excluded from our study. Patients aged less than 18 years and irreparable vascular injury cases were also excluded from our study.

In the emergency room, Mangled extremity severity score, Ganga hospital open injury severity score, and Vetrivel Trauma score were evaluated by a team of qualified orthopaedic surgeon, Emergency room chief surgeon, and senior residents.

3. Results

Mangled extremity severity score, Ganga hospital open injury severity score, and Vetrivel trauma score were calculated and compared in patients with Gustilo Anderson classification Grade IIIB and Grade IIIC of open fractures. As per our results, there was a discrepancy in the Mangled extremity severity score and Ganga hospital open injury severity score. In a patient with a Mangled extremity severity score of seven, the limb was salvaged. Two patients with Ganga hospital open injury severity score of 13 and 14 went for primary amputation (Figure 1). All the patients with Vetrivel trauma score of 39 and above went for primary amputation (Figure 2). Twenty-three patients had a Vetrivel trauma score of less than 29 and their limbs were salvaged (Figure 3).

Fig. 1: Mangled extremity right lower limb. Below knee amputation done

A receiver operating characteristic (ROC) curve was constructed to assess the reliability of the Vetrivel trauma score to predict limb salvage when compared with Mangled extremity severity score and Ganga hospital open injury severity score and the area under the curve was calculated.

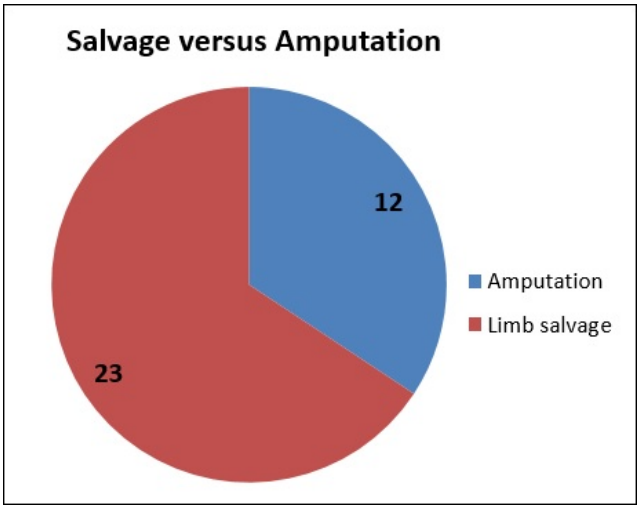

Fig. 2: Bar diagram showing limb salvage versus amputation in 35 patients

Fig. 3: Grade IIIB open fracture both bone left leg skeletally stabilized with external faxator

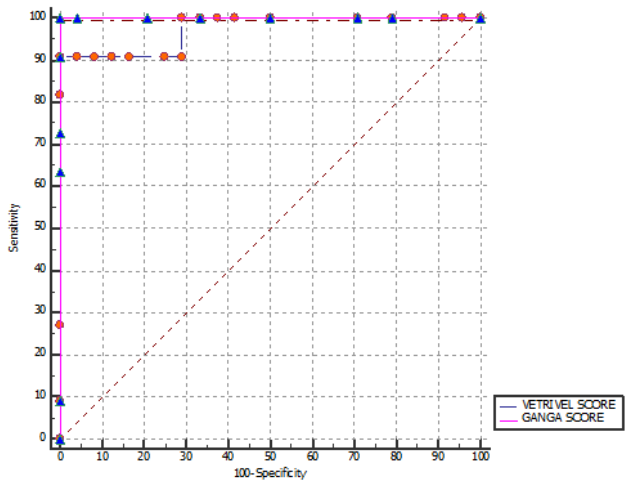

Fig. 4: Receiver operating characteristic curve with Ganga score as cut-off against Vetrivel trauma score as well as Ganga score

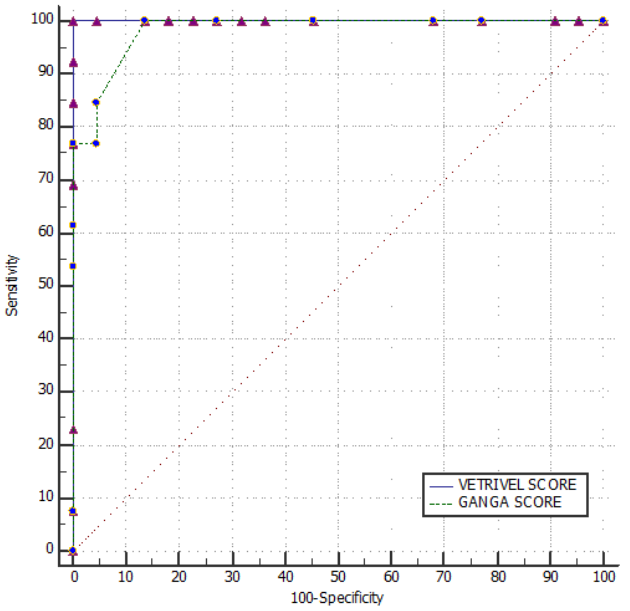

Fig. 5: Receiver operating characteristic curve with Vetrivel score as cut-off against Vetrivel trauma score as well as Ganga score

A receiver operating characteristic curve plots the sensitivity of an index by its false-positive fraction (1-specificity) over the entire range of possible scores. In the first receiver operating characteristic curve, Vetrivel trauma score and Ganga hospital open injury severity score were compared and Ganga hospital open injury severity was used as the cut-off score (Figure 4). Then another receiver operating characteristic curve was plotted with Vetrivel trauma score as cut-off against Ganga hospital open injury severity score and Vetrivel trauma score (Figure 5).

As per our study, using the receiver operating characteristic curve, the area under the curve for Vetrivel trauma score was 0.983 compared to 0.973 for the Ganga hospital open injury severity score. Hence, the Vetrivel trauma score was identified as a better predictor of limb salvage than the Ganga hospital open injury severity score system. If Mangled extremity severity score was used as the common cut-off for plotting against the Ganga hospital open injury severity score and Vetrivel trauma score, then it was observed that Vetrivel trauma score is a better predictor of limb salvage when compared to both Ganga hospital open

injury severity score and Mangled extremity severity score (Figure 6).

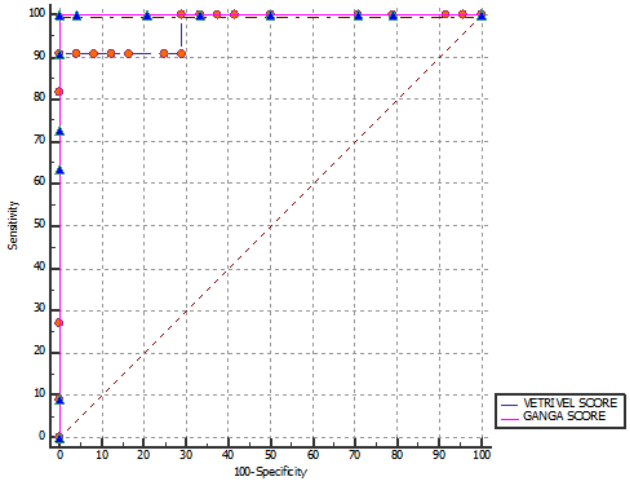

Fig. 6: Receiver operating characteristic curve with Mangled Extremity Severity score as the common cut-off against Vetrivel trauma score and Ganga score

The area under the curve for Vetrivel trauma score was 0.983 ± 0.015, the Ganga hospital open injury severity score was 0.973 ± 0.028, and the Mangled extremity severity score was 0.970 ± 0.028. Hence, the Vetrivel trauma score was more accurate in predicting limb salvage with less standard error mean.

All the 35 patients in the study group were categorized into four major groups based on Vetrivel trauma score. Group I: Vetrivel trauma score 6–16, Group II: Vetrivel trauma score 17–28, Group III: Vetrivel trauma score 29–38, and Group IV: Vetrivel trauma score 39 and above.

The outcomes were measured based on the occurrence of wound infection, need for secondary procedures, and the duration of hospital stay among the four groups. Two out of 14 patients in Group I, four out of nine patients in Group II, and the only patient in Group III had wound infection. Eleven patients underwent amputation in Group IV. Among these 11 patients, three had stump infection (Figure 7). Since group IV patients went for primary amputation, the incidence of wound infection was less.

The secondary procedures include split skin grafting, flap cover, and intramedullary interlocking nailing. Nine out of 14 patients in Group I, eight out of nine patients in Group II, and one patient in Group III had secondary procedures (Figure 8).

Regarding the hospital stay, the mean duration of hospital stay in Group I, II, III, and IV were 12.1 days, 22.1 days, 39 days, and 21.6 days, respectively (Figure 9). Group IV patients went for primary amputation, hence the length of hospital stay was less.

As per our study, the Vetrivel trauma score is useful as a reliable indicator regarding wound infection, the need

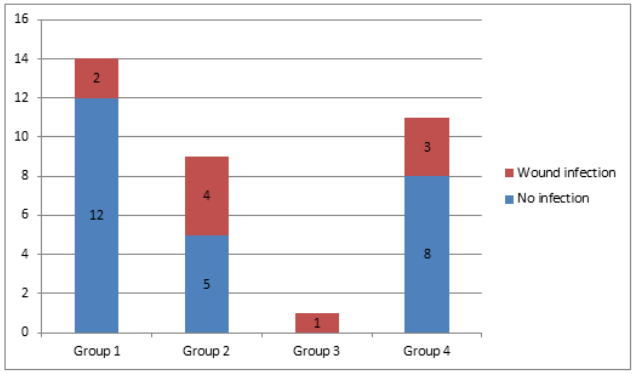

Fig. 7: Showing occurrence of wound infection

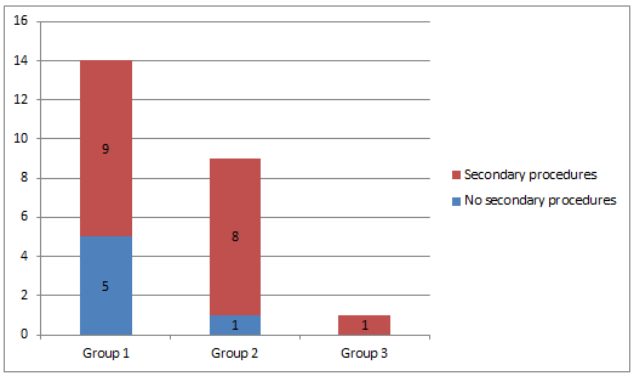

Fig. 8: Showing need for secondary procedures

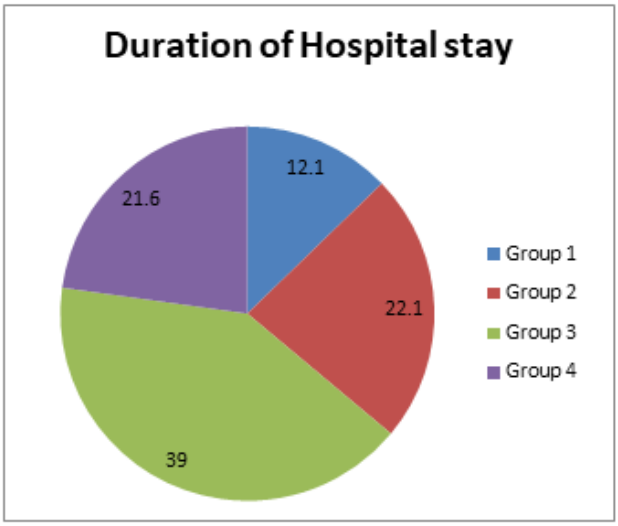

Fig. 9: Showing duration of hospital stay

for secondary procedures, and the length of hospital stay. Hence, Vetrivel trauma score will be helpful to the surgeons in explaining the prognosis even before surgery.

4. Discussion

In Tamilnadu, the trauma patients reach the hospital at the earliest because of the easy availability of National Trauma Ambulance Services. Gustilo Anderson classification Grade IIIB and Grade IIIC open injuries of limbs are a major challenge in management due to early and late infections [2], high incidence of non-unions [10], the need for secondary procedures [11], prolonged period of hospital stay, poor functional outcome and the possibility of secondary amputations. [5] Most attempts of limb salvage are successful, while many are not. Failed attempts at limb salvage result in pain, multiple surgical procedures, prolonged hospitalization, psychological trauma, as well as economic hardship to the patient [7]. It is important, in such cases, that the treatment protocol be tailor-made considering the patient as a whole, and not just the injured limb. Overenthusiastic attempts at limb salvage may result in pain, a functionally useless limb, and chronic disability. It may have to be later followed by delayed amputation [7]. Thus, the decision as to whether to use limb salvage techniques must be moderated by a realistic and practical assessment of the results, not just for the injured part but for the patient as an individual. [7] The burden of such an important decision, whether to amputate or salvage a limb in severely injured open fractures, lies on the surgeon. [1] Hence to properly guide this decision-making process and to predict the viability of a limb, an ideal scoring system needs to be sort after, which is more specific and sensitive, than the currently used scoring systems. [1]

At present, Mangled extremity severity score, Ganga hospital open injury severity score, and Vetrivel trauma score are used to predict the viability of limb in open injuries of Grade IIIB and IIIC of Gustilo Anderson classification of open fractures.

Mangled extremity severity score does not give any information about the prognostic outcomes of salvaged limbs. [1] The score doesn't consider a variety of factors that separately assess the limb in terms of survival, predicting the prognosis and need for further procedures. [12] It was found in many prospective studies that the sensitivity and positive predictive value of the score depend merely on the ischemic status of the limb. [13–16]

Ganga hospital open injury severity score does not consider laboratory factors, [4] which provide substantial evidence and is crucial in deciding amputations versus salvage of affected extremities. It helps to predict and to determine the ongoing tissue necrosis and rhabdomyolysis at the injured part of the limb. [4]

Vetrivel trauma score also considers laboratory parameters, which include serum lactate dehydrogenase (LDH), serum creatine kinase (CPK), and oxygen saturation. [4] Serum lactate dehydrogenase is a marker for rhabdomyolysis and is elevated in muscle ischemia and skeletal injury. [17] Serum creatine kinase is the most sensitive indicator of muscle injury and myoischemia. [18] Monitoring of oxygen saturation (SPo2) indicates tissue perfusion and vascular integrity. [4]

As per our multicentric study, Vetrivel Trauma Score has more sensitivity and specificity than other scoring systems. The scoring is done preoperatively which aids the surgeon in deciding the treatment plan. It also gives adequate information about the chances of infection, the need for secondary procedures, and the length of hospital stay. Vetrivel trauma score also gives significant weightage to laboratory parameters and hence, is superior to other scoring systems.

5. Conclusion

Validity of Vetrivel trauma score in predicting salvage of limb in Gustilo Anderson Grade IIIB and Grade IIIC open fractures over Mangled extremity severity score and Ganga hospital open injury severity score were analysed in our multicentric study. As per the results of our study, Vetrivel trauma score is better than the Mangled extremity severity score and Ganga hospital open injury severity score in predicting salvage of limb in Gustilo Anderson Grade IIIB and Grade IIIC open fractures, in terms of both sensitivity and specificity.

6. Source of Funding

None.

7. Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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