



Original Article

Prospective Evaluation of Mangled Extremity Severity Scoring (MESS) with Ganga Hospital Scoring for Modified Gustilo Anderson Type 3 Open Lower Limb Fractures

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Received: 15-03-2026

Accepted: 20-04-2026

Available online: 30-04-2025

ABSTRACT

Background: Severe open lower limb injuries, particularly Gustilo–Anderson Grade IIIB and IIIC fractures, pose a major challenge in trauma surgery due to the critical decision between limb salvage and amputation. The Mangled Extremity Severity Score (MESS) is widely used, while the Ganga Hospital Open Injury Severity Score (GHOISS) was developed to better address complex open fractures, especially in settings with advanced reconstructive capabilities.

Aim and Objectives: To compare the effectiveness of the Mangled Extremity Severity Score (MESS) and the Ganga Hospital Open Injury Severity Score (GHOISS) in predicting limb salvage and guiding management decisions in modified Gustilo–Anderson Grade III open lower limb fractures.

Materials and Methods: This prospective comparative study was conducted in the Department of Orthopaedics, Narayan Medical College and Hospital, Sasaram, over a period of 1 year and 8 months. A total of 30 patients aged 18 years and above with Gustilo–Anderson Grade IIIB and IIIC open lower limb fractures were included. Each patient was evaluated using both MESS and GHOISS at presentation. Clinical details, mechanism of injury, limb involvement, management strategies, and outcomes were recorded. Statistical analysis was performed using SPSS software, with appropriate descriptive and inferential tests.

Results: The study population predominantly consisted of middle-aged males, with road traffic accidents being the most common mechanism of injury. Most fractures were classified as Gustilo–Anderson Grade IIIB. According to MESS, 90% of limbs were predicted to be salvageable, while GHOISS categorized 73.3% as salvageable, 13.3% as requiring amputation, and 13.3% falling into a grey zone. Overall limb salvage was achieved in 76.7% of patients. Both scoring systems correlated with clinical outcomes; however, GHOISS provided more detailed stratification by incorporating soft tissue, skeletal, functional, and systemic factors, particularly in borderline cases.

Conclusion: Both MESS and GHOISS are useful tools in the assessment of severe open lower limb injuries. However, GHOISS offers a more comprehensive and practical framework for decision-making in Gustilo–Anderson Grade III fractures, especially in complex injuries requiring reconstructive procedures. Its ability to identify grey-zone cases allows for individualized clinical judgment, potentially reducing failed salvage attempts and improving overall outcomes.

Keywords: Mangled Extremity Severity Score (MESS), Ganga Hospital Open Injury Severity Score (GHOISS), Open Lower Limb Fractures, Limb Salvage, Gustilo–Anderson Grade III Fractures.

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INTRODUCTION

Early efforts at categorizing injured extremities date back to the late 19th and early 20th centuries, making this a significant difficulty in trauma surgery.

The Ganga Hospital Open Injury Severity Score (GHOISS) was created in India in response to the need for a scoring system that is better suited to complicated open fractures, especially in environments with specialist reconstructive competence.

More than 350 patients were prospectively monitored by Gustilo and Anderson. Three criteria were used to classify the injuries.

Grade	Description
Grade I	Open fracture with wound less than 1 cm long and clean.
Grade II	Open fracture with wound >1 cm wound but <10 cm.
Grade IIIa	Open fractures with adequate soft tissue coverage (laceration >10 cm).
Grade IIIb	Open fractures with extensive soft tissue injury, periosteal stripping, and bone exposure.
Grade IIIc	Open fractures with arterial injury.

Ganga Hospital Open Injury Severity Score (GHOISS).^[4]

Description	Score
Covering structures: Skin and Fascia	
Wounds without skin loss	
Not over the fracture	1
Exposing the fracture	2
Wounds with skin loss	
Not over the fracture	3
Over the fracture	4
Circumferential wound with skin loss	5
Skeletal Structures: bone and joints	
Transverse/oblique fracture/Butterfly fragment < 50% circumference	1
Large butterfly fragment > 50% circumference	2
Comminution/segmental fractures without bone loss	3
Bone loss < 4 cm	4
Bone loss > 4 cm	
Functional tissues: musculotendinous (MT) and nerve units	
Partial injury to MT unit	1
Complete but repairable injury to MT units	2
Irreparable injury to MT units/partial loss of a compartment/complete injury to posterior tibial nerve	3
Loss of one compartment of MT units	4
Loss of two or more compartments/subtotal amputation	5
Co-morbid conditions: add 2 points for each condition present	
Injury - debridement interval > 12 hours	
Sewage or organic contamination/farmyard injuries	
Age > 65 years	
Drug-dependent diabetes mellitus/cardiorespiratory diseases leading to increased anaesthetic risk	
Polytrauma involving chest or abdomen with injury severity score > 25/fat embolism	
Hypotension with systolic blood pressure < 90 mmHg at presentation	
Another major injury to the same limb/compartment syndrome\	

AIM AND OBJECTIVES

AIM:

- The present study is aimed to evaluate Mangled Extremity Severity Scoring (MESS) with Ganga Hospital Scoring for modified Gustilo Anderson type 3 open lower limb fractures.

OBJECTIVE:

- To Evaluate wound status and assess the management options by using Mangled Extremity Severity Scoring (MESS) for modified Gustilo Anderson type 3 open lower limb fractures.

- To Evaluate wound status and assess the management options by using Ganga Hospital Scoring for modified Gustilo Anderson type 3 open lower limb fractures.

MATERIALS AND METHODS

Site of study: The study was conducted in the Department of Orthopaedics, at Narayan Medical College and Hospitals, Sasaram

Type of study: Prospective comparative study design

Place of study: NMCH, Sasaram

SAMPLE SIZE: 30 sites

Duration of study: 1 year and 8 months

Source of data: ORTHO OPD AND EMERGENCY

SAMPLE SIZE ESTIMATION

Sample size was estimated for Independent t test.

A minimum total sample size of 28 was found to be sufficient for an alpha of 0.05, power of 95 %, 1.3 as effect size (assessed from a similar study).

t tests - Means: Difference between two independent means (two groups)

Analysis: A priori: Compute required sample size

Input: Tail(s) = One Effect size d = 1.3 α err prob = 0.05 Power (1- β err prob) = 0.95

Allocation ratio N2/N1 = 1

Output: Noncentrality parameter δ = 3.4394767 Critical t = 1.7056179

Df = 26

Sample size group 1 = 14

Sample size group 2 = 14

Total sample size = 28

Actual power = 0.9557238

Formula

$$n = \frac{2s_p^2 [Z_{1-\alpha/2} + Z_{1-\beta}]^2}{\mu_d^2}$$

$$s_p^2 = \frac{s_1^2 + s_2^2}{2}$$

Where,

s_1^2 : Standard deviation in the first group

s_2^2 : Standard deviation in the second group

μ_d^2 : Mean difference between the samples

α : Significance level

1- β : Power

Inclusion criteria:

- Age group- 18 years and above
- Patients with open fractures of lower limb coming under Gustilo Anderson Grade IIIB and Grade IIIC.

Exclusion criteria:

- Anderson Grade I, Grade II, Grade IIIA injuries, and upper limb injuries
- Patients aged less than 18 years and
- Irreparable vascular injury cases

OBSERVATION & RESULTS

Table 1: Age Distribution of Subjects

	No.	%	P value
18-31	5	16.7%	<0.001
32-45	14	46.7%	
46-59	9	30%	
>59	2	6.7%	
Total	30	100%	

Mean ± SD	42.10±11.24
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This table shows the age distribution of the study subjects.

Table 2: Sex Distribution of Subjects

	No.	%
Male	19	63.3%
Female	11	36.7%
Total	30	100%

This table presents the sex distribution among the study participants.

Table 3: Distribution of Limb Involvement Among Study Participants

	No.	%
Leg	14	46.7%
Foot	9	30%
Thigh	7	23.3%
Total	30	100%

This table illustrates the distribution of limb involvement among the 30 study participants.

Table 4: Laterality of Limb Involvement (Left vs. Right Side)

	No.	%
Left	15	50%
Right	15	50%
Total	30	100%

This table presents the distribution of limb involvement based on laterality.

Table 5: Mechanism of Injury Among Study Participants

	No.	%
RTA	22	73.3%
Crush injury	6	20%
Fall From height	2	6.7%
Total	30	100%

This table summarizes the mechanisms of injury among the 30 study participants

Table 6: Distribution of Gustilo-Anderson Fracture Types

	No.	%
III B	27	90%
III C	3	10%
Total	30	100%

This table shows the classification of open fractures according to the Gustilo-Anderson system among the 30 participants.

Table 7: Distribution of Mangled Extremity Severity Score (MESS) Among Participants

	No.	%
4-5	6	20%
6-7	9	30%
8-9	12	40%
>9	3	10%
Total	30	100%

This table presents the Mangled Extremity Severity Score (MESS) distribution among the 30 study participants.

Table 8: Distribution of Ganga Hospital Open Injury Severity Score (GHOISS)

	No.	%
10-12	10	33.3%
13-15	6	20%
16-18	8	26.7%
>18	6	20%
Total	30	100%

This table outlines the distribution of GHOISS among the 30 study participants.

Table 9: Limb Salvage Outcomes Among Study Participants

	No.	%
Salvaged	23	76.7%
Amputated	4	13.3%
Unknown	3	10.0%
Total	30	100%

Table 9 outlines the limb salvage outcomes among the study participants

Table 10 presents limb outcomes based on MESS (Mangled Extremity Severity Score)

	No.	%
Salvaged	27	90.0%
Amputated	3	10.0%
Total	30	100%

Table 10 presents limb outcomes based on MESS (Mangled Extremity Severity Score) interpretation among the study participants.

Table 11: Limb Outcome Based on GHOISS Interpretation

	No.	%
Salvaged	22	73.3%
Amputation	4	13.3%
Grey Zone	4	13.3%
Total	30	100%

Table 11 shows limb outcomes based on GHOISS (Ganga Hospital Open Injury Severity Score) interpretation among the study participants.

Table 12: Time of Presentation After Injury (in Hours)

	No.	%
1-3	8	26.7%
4-6	7	23.3%
7-9	9	30%
10-12	6	20%
Total	30	100%

This table shows the distribution of the time elapsed between injury and medical presentation among the 30 participants.

Table 13: Presence of Vascular Injury Among Study Participants

	No.	%
Yes	3	10%
No	27	90%
Total	30	100%

Table 14: Distribution of Skeletal Injury Score Among Study Participants

	No.	%
1-2	9	30%
3-4	10	33.3%
5-6	11	36.7%
Total	30	100%

This table presents the distribution of skeletal injury scores among the 30 participants.

Table 15: Distribution of Soft Tissue Injury Score Among Study Participants

	No.	%
1-2	13	43.3%
3-4	9	30%

5-6	8	26.7%
Total	30	100%

This table shows the distribution of soft tissue injury scores among the 30 participants.

Table 16: Distribution of Muscle Injury Score Among Study Participants

	No.	%
1-2	9	30%
3-4	12	40%
5-6	9	26.7%
Total	30	100%

This table presents the distribution of muscle injury scores among the 30 participants

Table 17: Management Approaches Used in Study Participants

	No.	%
Amputation	4	13.3%
Debridement + Fixation	9	30%
External Fixator	6	20%
Flap + Fixation	8	26.7%
Unknown	3	10%
Total	30	100%

This table summarizes the different management approaches applied to the 30 participants.

Table 18: Final Outcome of Limb Treatment Among Study Participants

	No.	%
Healed	7	23.3%
Infection	7	23.3%
Non-union	7	23.3%
Re-amputation	6	20%
Unknown	3	10%
Total	30	100%

This table shows the final outcomes of treatment for the 30 participants.

Table 19: Follow-up Duration Among Study Participants (in Weeks)

	No.	%
6-11	3	10%
12-17	11	36.7%
18-23	14	46.7%
>23	2	6.7%
Total	30	100%

This table shows the follow-up duration for the 30 study participants.

Table 20: Mechanism of Injury by Limb Involved

	Leg	Foot	Thigh	Total
RTA	10 (33.3%)	5 (16.7%)	7 (23%)	22 (73%)
Crush injury	2 (6.7%)	4 (13.3%)	0	6 (20%)
Fall From height	2 (6.7%)	0	0	2 (6.7%)
Total	14 (46.7%)	9 (30%)	7 (23%)	30 (100%)

This table presents the distribution of mechanisms of injury across different limbs.

Table 21: Mechanism of Injury by Side (Left vs. Right)

	Left	Right	Total
RTA	13 (43.3%)	9 (30%)	22 (73%)
Crush injury	1 (3.3%)	5 (16.7%)	6 (20%)

Fall From height	1 (3.3%)	1 (3.3%)	2 (6.7%)
Total	15 (50%)	15 (50%)	30 (100%)

This table shows the distribution of injury mechanisms based on laterality (left vs. right side).

Table 22: Mechanism of Injury by MESS Score

	4-5	6-7	8-9	>9	Total
RTA	5 (16.7%)	6 (20%)	9 (30%)	2 (6.7%)	22 (73%)
Crush injury	1 (3.3%)	3 (10%)	1 (3.3%)	1 (3.3%)	6 (20%)
Fall From height	0	0	2 (6.7%)	0	2 (6.7%)
Total	6 (20%)	9 (30%)	12 (40%)	3 (10%)	30 (100%)

This table shows the distribution of injury mechanisms based on the Mangled Extremity Severity Score (MESS) categories.

Table 23: Mechanism of Injury by GHOISS Score

	10-12	13-15	16-18	>18	Total
RTA	7 (23%)	4 (13.3%)	6 (20%)	5 (16.7%)	22 (73%)
Crush injury	3 (10%)	1 (3.3%)	1 (3.3%)	1 (3.3%)	6 (20%)
Fall From height	0	1 (3.3%)	1 (3.3%)	0	2 (6.7%)
Total	10 (33.3%)	6 (20%)	8 (26.7%)	6 (20%)	30 (100%)

This table displays the distribution of injury mechanisms across different Ganga Hospital Open Injury Severity Score (GHOISS) categories.

Table 24: Mechanism of Injury and Final Outcome

	Healed	Infection	Non- union	Re- amputation	Unknown	Total
RTA	6 (20%)	5 (16.7%)	3 (10%)	5 (16.7%)	3 (10%)	22 (73%)
Crush injury	1 (3.3%)	1 (3.3%)	3 (10%)	1 (3.3%)	0	6 (20%)
Fall From height	0	1 (3.3%)	1 (3.3%)	0	0	2 (6.7%)
Total	7 (23%)	7 (23%)	7 (23%)	6 (20%)	3 (10%)	30 (100%)

This table presents the final outcomes of treatment based on the mechanism of injury.

Table 25: Side (Left/Right) Distribution with MESS Score

	Left	Right	Total
4-5	2 (6.7%)	4 (13.3%)	6 (20%)
6-7	4 (13.3%)	5 (16.7%)	9 (30%)
8-9	7 (23%)	5 (16.7%)	12 (40%)
>9	2 (6.7%)	1 (3.3%)	3 (10%)
Total	15 (50%)	15 (50%)	30 (100%)

This table shows the distribution of the Mangled Extremity Severity Score (MESS) by side (left vs. right).

Table 26: Side (Left/Right) Distribution with GHOISS Score

	Left	Right	Total
10-12	4 (13.3%)	6 (20%)	10 (33.3%)
13-15	4 (13.3%)	2 (6.7%)	6 (20%)
16-18	6 (20%)	6 (20%)	12 (40%)
>18	1 (3.3%)	1 (3.3%)	2 (6.7%)
Total	15 (50%)	15 (50%)	30 (100%)

This table presents the distribution of the Ganga Hospital Open Injury Severity Score (GHOISS) by side (left vs. right).

SUMMARY

Final outcomes were mixed, reflecting the challenges inherent in treating severe limb trauma. Equal proportions of participants experienced healing, infection, and non-union, while re-amputation was required in 20% of cases. Follow-up duration was generally adequate to assess these outcomes, with most patients followed for 12 to 23 weeks.

The balanced distribution of injury severity scores by limb side and the spectrum of management approaches highlight the tailored clinical decisions necessary for optimizing limb salvage and functional recovery.

RESULTS:

The study population predominantly consisted of middle-aged males, with road traffic accidents being the most common mechanism of injury. Most fractures were classified as Gustilo–Anderson Grade IIIB. According to MESS, 90% of limbs were predicted to be salvageable, while GHOISS categorized 73.3% as salvageable, 13.3% as requiring amputation, and 13.3% falling into a grey zone. Overall limb salvage was achieved in 76.7% of patients. Both scoring systems correlated with clinical outcomes; however, GHOISS provided more detailed stratification by incorporating soft tissue, skeletal, functional, and systemic factors, particularly in borderline cases.

CONCLUSION:

Both MESS and GHOISS are useful tools in the assessment of severe open lower limb injuries. However, GHOISS offers a more comprehensive and practical framework for decision-making in Gustilo–Anderson Grade III fractures, especially in complex injuries requiring reconstructive procedures. Its ability to identify grey-zone cases allows for individualized clinical judgment, potentially reducing failed salvage attempts and improving overall outcomes.

BIBLIOGRAPHY

1. Madhuchandra P, Rafi M, Devadoss AS, Devadoss. Predictability of salvage and outcome of Gustilo and Anderson type-IIIA and type-IIIB open tibial fractures using Ganga Hospital Scoring system. *Injury. Int J Care Injured.* 2015;46:282–7.
2. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg Am.* 1976;58(4):453–8.
3. Gustilo RB, Mendoza RM, Williams DN. Problems in the management of type III (severe) open fractures: a new classification of type III open fractures. *J Trauma.* 1984;24:742–6.
4. Gustilo RB, Mendoza RM, Williams DN. Problems in management of type III (severe) open fractures: a new classification of type III open fractures. *J Trauma.* 1984;24:742–746.
5. Howe HR Jr, Poole GV Jr, Hansen KJ, et al. Salvage of lower extremities following combined orthopedic and vascular trauma: a predictive salvage index. *Am Surg* 1987;53:205-8.
6. Swets JA. Measuring the accuracy of diagnostics systems. *Science* 1988;240:1285-93.
7. DeLong ER, DeLong DM, Clarke-Pearson DL. Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. *Biometrics* 1988;44:837-45.
8. Bondurant FJ, Cotler HB, Buckle R, Miller-Crotchet P, Browner BD. The medical and economical impact of severely injured lower extremities. *J Trauma* 1988;28: 1270-3.
9. Lange RH. Limb reconstruction versus amputation decision making in massive lower extremity trauma. *Clin Orthop* 1989;243:92-9.
10. Morris R, Jones NC, Pallister I. The use of personalised patient information leaflets to improve patients' perceived understanding following open fractures. *Eur J Orthop Surg Traumatol.* 2019 Apr;29(3):537-543.