

Original Research Article

SCORING THE STAKES: EVALUATING MANGLED EXTREMITY SEVERITY SCORE (MESS) FOR SALVAGE VERSUS AMPUTATION IN MANGLED EXTREMITIES

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ABSTRACT

Background: Severe lower limb trauma often necessitates urgent decisions between limb salvage and amputation. The Mangled Extremity Severity Score (MESS) offers an objective framework for guiding these decisions. This study aimed to assess the predictive accuracy of MESS in a tertiary care setting.

Materials and Methods: A prospective observational study was conducted at the Department of Orthopaedics, Government Medical College & General Hospital, Ongole, from October 2025 to April 2026, involving 72 patients with mangled lower limb injuries. Demographics, mechanism of injury, time to presentation, and MESS were recorded. Outcomes included limb salvage or amputation. Diagnostic performance at a cut-off ≥ 7 was analyzed.

Results: Mean age was 36.7 ± 11.5 years; 76.4% were male. Amputation occurred in 27 patients (37.5%). MESS ≥ 7 predicted amputation with 92.6% sensitivity, 88.9% specificity, 86.2% PPV, and 93.9% NPV, with overall accuracy of 90.3%. Mean MESS was significantly higher in the amputation group (8.3 ± 1.4) versus salvage (5.6 ± 1.1 , $p < 0.001$). Early presentation within six hours was associated with higher salvage rates ($p < 0.001$). ROC analysis yielded an AUC of 0.94 (95% CI 0.88–0.99).

Conclusion: MESS remains a robust predictor of amputation in severe lower limb trauma, particularly in resource-variable settings. Early intervention significantly improves salvage outcomes. The score should complement multidisciplinary clinical judgment.

Keywords: Mangled Extremity Severity Score, limb salvage, amputation, lower limb trauma, predictive accuracy.

INTRODUCTION

Severe limb trauma remains a significant challenge in trauma surgery, often involving complex decisions between attempts at limb salvage and primary amputation. Such injuries, frequently resulting from high-energy mechanisms such as road traffic accidents, industrial incidents, or blast injuries, are associated with extensive soft tissue disruption, vascular compromise, skeletal instability, and neural injury.^[1] Early and accurate decision-making is critical, as inappropriate delays in amputation may increase morbidity, prolong hospitalization, and worsen functional outcomes, whereas unnecessary amputations can have devastating physical, psychological, and socioeconomic consequences.^[2]

The Mangled Extremity Severity Score (MESS) was developed as a clinical tool to aid in this decision-making process, integrating four key domains: skeletal and soft tissue injury, limb ischemia, shock, and patient age.^[3] The scoring system is simple to apply, with higher values reflecting more severe injury. Previous research has suggested that a MESS threshold of ≥ 7 is strongly predictive of amputation, with reported sensitivities and specificities exceeding 90% in some cohorts.^[4] However, other studies have questioned its universal applicability, citing variations in outcomes based on advances in vascular reconstruction, microsurgical techniques, and multidisciplinary trauma care.^[5]

Despite widespread use, controversy persists regarding the accuracy of MESS as a sole predictor

in contemporary practice. Factors such as time to revascularization, infection control measures, and patient comorbidities may influence outcomes independently of the score.^[6] Additionally, most validation studies were conducted in Western trauma systems, raising questions about its reliability in resource-variable settings where delays in presentation and limited microsurgical facilities may alter predictive performance.^[7,8]

Given these uncertainties, there is a need for context-specific evaluation of MESS in guiding clinical decision-making for mangled lower limb injuries. This study was undertaken to assess the predictive value of MESS in determining limb salvage versus amputation outcomes in a tertiary care setting.

MATERIALS AND METHODS

Study Design and Setting: This was a prospective observational study conducted at the Department of Orthopaedics, Government Medical College & General Hospital, Ongole, from October 2025 to April 2026. The study aimed to evaluate the predictive value of the Mangled Extremity Severity Score (MESS) in determining limb salvage versus amputation outcomes in patients with severe lower limb trauma.

Study Population: A total of 72 consecutive patients aged ≥ 18 years who presented with high-energy lower extremity trauma were included. All patients had injuries classified as “mangled extremities” based on combined skeletal, soft tissue, vascular, and/or neural involvement.

Inclusion Criteria

- Traumatic lower limb injury with features suggestive of significant skeletal and soft tissue disruption.
- Presentation within 12 hours of injury.
- Complete clinical and radiological assessment feasible on admission.

Exclusion Criteria

- Patients with isolated soft tissue injury without skeletal or vascular damage.

- Presentation >12 hours after injury.
- Polytrauma patients with unsurvivable head or thoracoabdominal injuries.
- Patients declining consent.

Data Collection: On admission, demographic data, mechanism of injury, injury laterality, hemodynamic status, and time from injury to presentation were recorded. Each patient underwent MESS calculation based on four parameters: skeletal/soft tissue injury severity, limb ischemia, shock, and age. Scores were assigned according to the original MESS criteria. All patients were managed following Advanced Trauma Life Support (ATLS) principles, and limb salvage or amputation decisions were made by the attending orthopaedic team in consultation with vascular and plastic surgery specialists.

Outcome Measures: The primary outcome was the need for primary or delayed amputation. Limb salvage was defined as preservation of the extremity with restoration of vascular continuity and functional viability at discharge. Secondary outcomes included hospital stay duration, complication rates, and mortality.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean \pm standard deviation (SD) and compared using Student’s t-test. Categorical variables were presented as frequencies and percentages, with comparisons performed using the Chi-square or Fisher’s exact test as appropriate. The diagnostic accuracy of MESS was assessed by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), with a receiver operating characteristic (ROC) constructed to determine the optimal cut-off. A p-value < 0.05 was considered statistically significant.

Ethical Considerations: The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants.

RESULTS

Table 1: Baseline demographic and injury characteristics (n = 72)

Variable	Limb Salvage (n=45)	Amputation (n=27)	Total (n=72)	p-value
Mean age (years)	34.6 \pm 10.8	39.8 \pm 12.1	36.7 \pm 11.5	0.048*
Male sex	34 (75.6%)	21 (77.8%)	55 (76.4%)	0.829
Right limb involved	26 (57.8%)	14 (51.9%)	40 (55.6%)	0.625
Mechanism of injury				
Road traffic accident	31 (68.9%)	21 (77.8%)	52 (72.2%)	
Industrial accident	8 (17.8%)	4 (14.8%)	12 (16.7%)	
Other	6 (13.3%)	2 (7.4%)	8 (11.1%)	0.667
Time to presentation ≤ 6 h	37 (82.2%)	9 (33.3%)	46 (63.9%)	<0.001**

Table 2: MESS distribution in limb salvage vs. amputation groups

MESS score category	Limb Salvage (n=45)	Amputation (n=27)	Total (n=72)
≤ 6	39 (86.7%)	2 (7.4%)	41 (56.9%)
7-8	5 (11.1%)	15 (55.6%)	20 (27.8%)
≥ 9	1 (2.2%)	10 (37.0%)	11 (15.3%)

Table 3: Diagnostic accuracy of MESS cut-off ≥ 7 for predicting amputation

Parameter	Value (%)	95% CI
Sensitivity	92.6	75.7–98.9
Specificity	88.9	75.9–96.3
Positive Predictive Value (PPV)	86.2	68.3–96.1
Negative Predictive Value (NPV)	93.9	82.8–98.7
Accuracy	90.3	–

Table 4: Secondary outcomes

Outcome	Limb Salvage (n=45)	Amputation (n=27)	p-value
Mean hospital stay (days)	14.3 \pm 4.2	18.6 \pm 5.5	<0.001**
Wound infection	9 (20.0%)	11 (40.7%)	0.048*
Mortality	1 (2.2%)	2 (7.4%)	0.305

In this cohort of 72 patients with mangled lower limb injuries, the mean age was significantly higher in the amputation group (39.8 \pm 12.1 years) compared to the limb salvage group (34.6 \pm 10.8 years, $p = 0.048$). Time to presentation was a critical factor: 82.2% of limb salvage cases presented within 6 hours, whereas only 33.3% of amputation cases did so ($p < 0.001$). MESS distribution revealed a strong association between higher scores and amputation. Among patients with MESS ≤ 6 , 95.1% achieved limb salvage, while MESS ≥ 9 resulted in amputation in 90.9% of cases. Using a cut-off of ≥ 7 , MESS demonstrated a sensitivity of 92.6%, specificity of 88.9%, PPV of 86.2%, and NPV of 93.9%, with an overall accuracy of 90.3%.

Secondary outcomes indicated that amputation patients had a longer mean hospital stay (18.6 \pm 5.5 vs. 14.3 \pm 4.2 days, $p < 0.001$) and higher rates of wound infection (40.7% vs. 20.0%, $p = 0.048$), though mortality did not differ significantly between groups ($p = 0.305$).

MESS as a continuous variable differed markedly between groups (8.3 \pm 1.4 in amputation vs. 5.6 \pm 1.1 in salvage, mean difference 2.7, $p < 0.001$). The ROC curve analysis yielded an AUC of 0.94 (95% CI 0.88–0.99), confirming excellent predictive capability, with an optimal cut-off of 7 aligning with traditional thresholds.

These findings support the high diagnostic performance of MESS in predicting amputation risk in severe lower limb trauma, while highlighting the influence of early presentation and infection control on outcomes.

DISCUSSION

The Mangled Extremity Severity Score (MESS) has long been advocated as a rapid, objective adjunct to guide the decision between limb salvage and amputation in severe lower limb trauma. In the present study, a MESS cut-off of ≥ 7 predicted amputation with a sensitivity of 92.6%, specificity of 88.9%, PPV of 86.2%, and NPV of 93.9%, with an AUC of 0.94 (95% CI 0.88–0.99). These findings confirm the strong discriminatory capacity of the score and closely align with several earlier reports. Johansen et al.^[3] in their original prospective and retrospective cohorts, reported 100% sensitivity and specificity for predicting amputation at a threshold of

≥ 7 , with mean MESS scores of 4.88 in salvaged limbs and 9.11 in amputated limbs. While our sensitivity was comparable (92.6%), specificity was slightly lower (88.9%), potentially reflecting improved salvage rates in certain high-MESS cases due to advances in microsurgical techniques. Similarly, Korompilias et al.^[10] found sensitivity of 91% and specificity of 98% in 62 patients, again comparable to our sensitivity but with marginally higher specificity.

Lin et al.^[11] in a series of 54 patients, observed sensitivity of 83% and specificity of 92% for MESS ≥ 7 , values slightly lower than ours for sensitivity but similar for specificity. The difference may be attributed to the proportion of delayed presentations in our amputation group, where the mean MESS was 8.3 compared to 5.6 in salvage cases. Sharma et al.^[6] in a cohort of 50 Indian patients, reported sensitivity of 91% and specificity of 88%, closely matching our results. Both studies highlighted delayed revascularization as a critical factor, a finding we corroborated—82.2% of salvage patients presented within six hours compared to only 33.3% in the amputation group ($p < 0.001$).

Fodor et al.^[7] reported that MESS performance varies between centers, with pooled sensitivity around 78% and specificity near 70% in some series, particularly when reconstruction expertise is readily available. Our higher accuracy (90.3%) may be explained by the inclusion of patients from a setting where such advanced reconstructive resources are less universally accessible, making MESS a stronger predictor. Ly et al.^[8] from the LEAP study, noted that although MESS showed high specificity, its sensitivity was insufficient to be used as the sole determinant for amputation, and it did not predict functional outcomes after salvage—emphasizing the importance of clinical judgment.

We also found higher infection rates in the amputation group (40.7% vs 20.0%, $p = 0.048$), which mirrors the results of Akula et al.^[5] who reported infection rates of 38% in amputated cases compared to 19% in salvaged limbs. This reinforces the link between extensive tissue damage, higher MESS scores, and increased susceptibility to infection.

Overall, our findings are consistent with most of the comparative literature in supporting MESS as a robust predictor for amputation at the traditional cut-

off of ≥ 7 . However, as several authors have noted,^[6-8,10] it should be integrated into a broader clinical assessment, considering ischemia duration, contamination, patient comorbidities, and institutional capabilities.

CONCLUSION

The present study reaffirms the Mangled Extremity Severity Score (MESS) as a reliable predictor for amputation in severe lower limb trauma, with a cut-off of ≥ 7 demonstrating high sensitivity (92.6%) and specificity (88.9%). Early presentation within six hours significantly improved salvage rates, underscoring the importance of rapid prehospital referral systems. Higher MESS values were associated with prolonged hospital stay and increased infection rates, indicating the score's utility beyond predicting amputation alone. While MESS is an effective decision-making adjunct, it should be interpreted alongside comprehensive clinical assessment and multidisciplinary input, particularly in centers with advanced reconstructive capabilities. Adoption of MESS within trauma protocols, in combination with timely vascular intervention and infection control, can optimize patient outcomes. Future multicenter studies should explore refining cut-offs to suit diverse healthcare settings.

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