



## LETTER TO EDITOR

# Factors affecting functional outcomes following mangled lower limb injury



Dear Editor,

Limb salvage for mangled lower limb injury has become possible in the past three decades, but surgeons nowadays realized that patients undergoing limb salvage did not necessarily acquire a better functional outcome than those having limb amputation.<sup>1–3</sup> Researchers have attempted to identify predictors for poor outcomes, thereby enabling surgeons to offer optimal treatment in personalized medicine.<sup>4</sup> In the current study, we found that higher Mangled Extremity Severity Score (MESS) is a significant predictor for amputation, and that older age is a significant predictor for poor functional outcomes.

We retrospectively enrolled patients treated for mangled lower limb injury between January 2013 and December 2015. Injury patterns ranged from traumatic amputation, femoral fracture combined with degloving injury, open tibiofibular fracture, foot fracture combined with degloving injury, major vessel injury with or without fracture, to severe degloving injury without fracture. Totally, 45 patients were enrolled in this study. Eleven patients (24.4%) underwent amputation within 14 days. 34 (75.6%) had their legs salvaged, but one of them (1/34, 2.9%) underwent delayed amputation 5 months away from injury (Table 1). Through multiple logistic regression analysis, MESS was identified as the only unfavorable predictive risk factor for limb salvage [odds ratio (OR): 0.438,  $p = 0.0056$ ]. The best cut-off threshold for MESS was 7 (When  $>7$ , sensitivity 63.6%, specificity 94.1% for amputation prediction). Next then, we seek for possible predictors for desirable functional outcome, defined as the ability of ambulation.

In spite of its significant role in limb salvage prediction, MESS does not exhibit meaningful correlation with functional outcomes (OR: 0.71 by simple logistic regression,  $p = 0.12$ ). We observed that the only significant predictor for functional outcome was age in the entire cohort (OR: 0.864, 95% CI: 0.77–0.97,  $p = 0.01$ ). It is reasonable that physical function declined throughout the aging process. The Lower Extremity Assessment Project (LEAP) reported similar findings<sup>5</sup>; they used the sickness impact profile (SIP) to indicate functional outcomes. It is believed that physical factors, including the age, are critical variables for health status. These along with other non-physical parameters, such as personal traits, economic resources, and environmental features, interactively contribute to the final performance outcome. Interestingly, age was not a significant predictor when patients were followed-up for just 2 years period.<sup>1</sup> However, in an extended follow-up of these patients, the SIP declined despite resolution of fracture nonunion or the proficient use of a prosthetic device. After seven years of follow-up, age became a significant risk factor for poor functional outcome.<sup>5</sup>

In summary, MESS is a significant predictor for amputation; however, it shows high specificity but modest sensitivity in predicting the need for amputation. Age is the only significant predictor for poor functional outcomes in this single institution study. Up to now, a clear guide for an optimal treatment in each clinical situation is still lacking. Decisions regarding amputation or salvage should be made individually, taking patients' own wishfulness into consideration.

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**Table 1** Base-line, injury characteristics, and outcomes of patients.

	Amputation (n = 11)	Salvage (n = 34)	p value
Age, y	53.4 ± 19.9	45.5 ± 20.4	0.27
Male Sex, n (%)	5 (45.5)	23 (67.7)	0.20
Smoking, n (%)	1 (9.1)	4 (11.8)	0.88
Alcohol, n (%)	1 (9.1)	1 (2.9)	0.19
Education			0.44
Before High School, n (%)	7 (63.6)	17 (50.0)	
After High School, n (%)	4 (36.4)	17 (50.0)	
Leg injury			
Multi level frx, n (%)	8 (72.7)	12 (35.3)	0.03
Contra leg inj, n (%)	4 (36.4)	1 (2.9)	0.003
Distal ischemia, n (%)	9 (81.8)	9 (26.5)	0.001
MESS	8.0 ± 2.1	5.4 ± 1.4	0.0008
Systemic injury			
ISS	18 ± 10.9	18.9 ± 11.8	0.88
Initial GCS	12.4 ± 4.3	13.6 ± 3.2	0.25
Initial SBP	121.6 ± 33.9	120.4 ± 38.8	0.80
Brain, <sup>a</sup> n (%)	3 (27.3)	7 (20.6)	0.66
Lung, <sup>b</sup> n (%)	1 (9.1)	7 (20.6)	0.40
Abdomen, <sup>c</sup> n (%)	1 (9.1)	3 (8.8)	1
Pelvis fracture, n (%)	0 (0)	4 (11.8)	0.25
Shock episode, n (%)	7 (63.6)	10 (29.4)	0.05
Functional Outcome <sup>d</sup>			0.16
Return-to-ambulation, n (%)	6 (54.5)	29 (85.3)	
Ambulation failure, n (%)	4 (36.4)	5 (14.7)	
Complication			
Fracture non-healing, n (%)		13 (38.2)	
Soft-tissue non-healing, n (%)	8 (72.7)	23 (67.7)	0.77
Infection/osteomyelitis, n (%)	2 (18.2)	7 (20.6)	0.88
Length of initial hospital stay, days	45.2 ± 24.8	33.7 ± 20.9	0.12
Total length of hospital stay, days	47.2 ± 24.1	45.2 ± 30.2	0.49
Re-hospitalization times	0.5 ± 1.2	0.9 ± 1.4	0.08
Total surgical times	3.9 ± 2.3	5.3 ± 2.8	0.11

Multi level frx: Multiple level fracture, Contra leg inj: Contralateral leg mangled injury, MESS: Mangled Extremity Severity Score, ISS: Injury Severity Score, SBP: systolic blood pressure.

<sup>a</sup> Include intracranial hemorrhage or diffuse axonal injury.

<sup>b</sup> Include lung contusion, hemothorax, pneumothorax.

<sup>c</sup> Include intra-abdominal hemorrhage, hollow organ perforation.

<sup>d</sup> The ambulation condition for one patient in the amputation group was not retrievable from the chart review.

## Conflicts of interest

Authors declare there is no conflict of interest.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.asjsur.2019.01.021>.

## Disclosure

None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this manuscript.

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