

Preliminary Results of a Prospective Study on Severe Lower Limb Trauma: Analysis of Laboratory Tests as Predictors of Amputation

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ABSTRACT

The decision of either preserving a member or primary amputation (PA) in severe extremity trauma, especially in the presence of fractures, vascular injuries or serious injuries of soft tissues has always been a challenge for the trauma surgeon. The initial assessment with objective criteria like indexes, such as the Mangled Extremity Severity Score (MESS) or the PSI, can aid in the differentiation of members that can be saved or should be amputated primarily. We report on the design and preliminary results of our ongoing prospective study analyzing laboratory test as predictors of amputation in severe lower limb trauma.

Materials and methods: All patients treated in our emergency department with severe lower limb trauma and open fractures (classified as Gustilo III) were included in this study. We collected blood for laboratory test of all patients at admission. All injured limb were photographed for posterior analysis and MESS classification.

Results: From March 15, 2012, to June 10, 2012, n = 20 patients were included in our study. PA was performed in eight (40%) and preserving procedures (PP) in 12 (60%). Mean age was 30 in PP group and 40.5 in PA. Mean systolic pressure at the emergency room was 130 mm Hg in PP and 107 mm Hg in PA. MESS index was calculated for all patients and the means were 5 for the PP group and 8 for the PA group. Laboratory test of the two groups were compared and statistically analyzed. Acidosis, arterial lactate levels and hemoglobin levels at admission had a statistical difference between the two groups: pH = 7.36 PP vs 7.18 PA (p = 0.001); lactate: PP = 25 vs PA = 63 (p < 0.001); hemoglobin: PP = 13.6 vs PA = 7.85 (p = 0.03).

Conclusion: Laboratory results of tests collected during initial assessment of patients with severe lower limb trauma are different between those submitted to PA or a PP.

Keywords: Lower limb, Extremity trauma, Amputation, MESS, Laboratory, Predictors.

How to cite this article: Garcia DFV, de Sá RRC, Bernini CO, Rasslan S. Preliminary Results of a Prospective Study on Severe Lower Limb Trauma: Analysis of Laboratory Tests as Predictors of Amputation. *Panam J Trauma Critical Care Emerg Surg* 2013;2(1):58-61.

Source of support: Nil

Conflict of interest: None declared

RESUMO

A decisão de preservar ou amputar primariamente um membro no trauma grave de extremidades, especialmente na presença de fraturas, lesões vasculares ou lesões graves dos tecidos moles sempre foi um desafio para o cirurgião de trauma. A avaliação inicial com critérios objetivos, como índices, como o

Mangled Extremity Severity Score (MESS), podem auxiliar na diferenciação de membros que podem ser salvos ou deveriam ser amputados primariamente. Relatamos o desenho e os resultados preliminares do nosso estudo prospectivo em curso analisando exames laboratoriais como preditores de amputação de membros nos casos de trauma grave de membros inferiores.

Métodos: Todos os pacientes tratados em nosso departamento de emergência com trauma de membros inferiores grave e fraturas expostas (classificadas como Gustilo III) foram incluídos neste estudo. Foram coletados exames laboratoriais de todos os pacientes no momento da internação. Todos membros traumatizados foram fotografados para posterior análise e classificação.

Resultados: De 15 de março de 2012, a 10 de junho de 2012, n = 20 pacientes foram incluídos em nosso estudo. Amputação primária (PA) foi realizada em 8 (40%). e procedimentos de preservação (PP) em 12 (60%). A média de idade foi de 30 no grupo PP e 40,5 no PA. A média da pressão sistólica na sala de emergência foi 130 mm Hg no PP e 107 mm Hg no PA. O índice MESS foi calculado para todos os pacientes e as médias eram 5 para o grupo PP e 8 para PA de grupo. Teste de laboratório dos dois grupos foram comparados e analisados estatisticamente. Acidose, níveis de lactato arterial e níveis de hemoglobina na admissão tiveram uma diferença estatística entre os dois grupos: pH = 7,36 vs 7,18 PP PA p = 0.001; Lactato PP = 25 vs PA = 63 p < 0,001; hemoglobina PP = 13,6 vs PA = 7,85 p = 0,03.

Conclusão: Os resultados de testes de laboratório coletados durante a avaliação inicial dos pacientes com trauma grave de membros inferiores são diferentes entre aqueles submetidos à amputação primária ou um procedimento de preservação.

Palavras-chaves: Membros inferiores, Trauma de extremidades, Amputação, MESS, Laboratório, Preditores.

INTRODUCTION

The decision of either preserving or not a limb in severe extremity trauma, especially in the presence of fractures, vascular injuries or severe injuries to soft tissues has always been a challenge to the trauma surgeon. The early amputation of a nonviable limb allows a rapid functional recovery.¹ Moreover, attempted limb preservation involves multiple surgical procedures, prolonged hospital stay and increased rehabilitation time and can be devastating both physically, psychologically and financially for the patient and his family.^{2,3} Some factors that influence the decision to amputate or preserve a limb include: The extent and severity of the injury, presence and severity of associated injuries, patient's physiological reserve, functional prognosis of the limb and, in some cases, the social condition of the patient.³

There are some objective criteria that could help the trauma surgeon to make the decision of either amputate or preserve the mangled limb. The severity of the fracture can be assessed using various scales of fractures, and the scale of Gustilo-Anderson is the most used. This classification divides fractures into type I, II and III. Fractures with minimal bone exposure are classified as type I fractures; the ones with exposure greater than 1 cm and smaller than 10 cm are classified as type II; and fractures with exposure greater than 10 cm are subdivided into: IIIA—exposure greater than 10 cm that can be corrected with primary suture; IIIB—exposure greater than 10 cm that can not be corrected with primary suture and IIIC—fractures requiring vascular corrective procedures.^{3,4} Other tools that may be useful in the decision to preserve or amputate the limb are the scores of lower limb trauma. Many scores have been described and the Mangled Extremity Severity Score (MESS) index, that was described by Johansen et al in 1990,⁵ is one of the most studied and used indexes. The criteria considered include the degree of damaged bone and soft tissues, the degree of limb ischemia, presence of hypotension and age of the patient.

Associated injuries can be assessed by various trauma scores being one of the most used Injury Severity Score (ISS) which is an index based on anatomical classification of injuries divided into six body regions [head, face, chest, abdomen, extremities (including the pelvis) and external]. Each region receives a score according to a table—Abbreviated Injury Scale (AIS). Only the highest score from each region is considered. The three highest scores are squared and the sum of these results is the value of the ISS. Trauma patients can be divided by severity according to the ISS: Mild ISS <9; moderate trauma ISS: 10 to 15; severe trauma ISS: 16 to 25; very severe trauma ISS >25. This classification is especially important in complex cases, such as patients with multiple associated injuries, in which in the attempt to preserve the patient's limb one can lose his life. However, it is very difficult to have all information needed to calculate the ISS in an emergency setting. There should be a better way to access the severity of associated injuries in the patient with severe lower limb trauma.

The improvement of revascularization techniques, executions of cutaneous microsurgical flaps, and especially new antibiotics have enabled reconstruction and preservation of members that until a decade ago were submitted to amputation.⁶⁻⁸ However, some authors have shown that patients undergoing limb preservation compared to patients undergoing primary amputation (PA) had longer rehabilitation, greater rates of rehospitalization and complications, and a greater number of procedures performed with similar functional outcomes.⁷⁻⁹ In addition, the unsuccessful attempt of preserving a limb can result

in organ dysfunction and higher mortality rates even after delayed amputation, indicating that the attempt to preserve may not be the best choice for all patients.⁸⁻¹⁰ Therefore, the initial decision about preserving or not the member should be taken safely and definitively. The initial assessment with objective criteria with limb trauma scores (MESS) can help to differentiate between limbs that could be preserved or should be amputated in emergency. However, the use of these scores has been questioned by several authors regarding the difficulty of clinical applicability and for have been developed from retrospective studies with small numbers of patients involved.^{6,7,9,10} In addition, the physiological criteria of those scores is either very poor or absent.¹¹⁻¹³

OBJECTIVE

The aim of this study is to make an initial evaluation of an ongoing prospective study and compare laboratory test results at the emergency department (ED) of trauma patients with severe lower limb submitted to either preservation or primary amputation.

MATERIALS AND METHODS

Trauma patients brought to our ED with severe lower limb trauma and open fractures (classified as Gustilo II and III) and/or presenting: extensive soft tissue injuries, vascular injuries associated or peripheral nerves, or degloving injuries were asked for informed consent.

Inclusion Criteria

- Age between 18 and 70 years.
- Patients with lower limb trauma with fractures classified as Gustilo III.
- Extensive injuries of the lower limbs (as degloving or crush).
- Signing the informed consent form (ICF) by the patient or his legal representative at the time of arrival at hospital.

Exclusion Criteria

- Patients with ASA classification IV or V
- Patients on oral anticoagulants
- Patients transferred from other services.

All information on the patient initial assessment, prescribed drugs and procedures were prospectively collected. We performed blood tests for all patients at admission. These included: CBC, coagulation, electrolytes, creatine phosphokinase, arterial blood gas analysis and lactate. All injured limbs were photographed for posterior analysis and MESS classification.

Data was collected by the attending physician with an iPod touch 4th generation device (Apple Inc, 1 Infinite Loop, Cupertino, California, USA) with FormEntry software (FormEntry for Mac Version 2.2-Widget Press Inc, 537 St. Charles Ave, NE, Atlanta, GA) and then sent by e-mail to main researcher.

The analysis of qualitative variables was done through measures of association (chi-square or Fisher exact test) between the independent variables and the outcome (amputation or preservation). The analysis of the quantitative variables was performed by testing for differences in means (parametric or nonparametric) depending on the result of the normality test applied in the independent variables.

RESULTS

From March 15, 2012, to June 10, 2012; n = 20 patients were included in our study. There were four (20%) women and 16 (80%) men. PA was performed in eight (40%) and preserving procedures (PP) in 12 (60%). Mean age was 30 in PP group and 40.5 in PA. Mean systolic pressure at the emergency room was 130 mmHg in PP and 107 mmHg in PA. MESS index was calculated for all patients and the means were five for the PP group and eight for the PA group. Laboratory tests of the two groups were compared and statistically analyzed. Acidosis, arterial lactate levels and hemoglobin levels at admission had a statistical difference between the two groups: pH = 7.36 PP vs 7.18 PA ($p = 0.001$); lactate: PP = 25 vs PA = 63 ($p < 0.001$); hemoglobin: PP = 13.6 vs PA = 7.85 ($p = 0.03$).

DISCUSSION

Complex lower limb injuries are associated to amputation rates of 30% or more.¹⁰ In our study, we have had a 40% amputation rate so far. As our center is a tertiary hospital, in our trauma system that would be the equivalent to a level 1 trauma center, we receive very severely injured patients and

our amputation rate may be equal or even a little higher than the literature. We have had a seven patients/month incidence. That would mean 84 patients/year and 16 amputations/year.

Many authors have shown that the age of the patient influences in decision making.¹⁴⁻¹⁶ In our sample, we had a higher median age in the amputation group (40.5 years \times 30 years) but it was not statistically significant. That may be due to the small number of cases. As the number of patients increase we will have to re-evaluate it.

The presence of hemorrhagic shock is another variable that has been present in many studies on severe lower limb trauma.^{10,15,16} It is an important marker of associated injuries and has been included in different limb trauma scores. In our study the systolic pressure at the emergency department, which is a variable of the MESS score, was lower in the amputation group (107 mmHg PA \times 130 mmHg PP) but it did not have statistical difference. Once again it may be due to the small number of cases. Also, the systolic pressure is not the best way to evaluate the presence of hemorrhagic shock.

The MESS score (Table 1) was applied in all 20 patients. A score higher than 7 would indicate amputation. In the PP group all cases had a MESS score lower than 7 and in the PA two patients had a MESS score lower than 7 that would not predict amputation. The age of PP group ranged from 20 to 48 years, so no patient received 2 points in the age criteria. In addition, all cases in the PP group had a systolic pressure over 90 mmHg at the ED and scored 0 points in this variable. The two cases with a score that would not predict amputation (MESS final score 6/5) had Gustilo IIIc fractures (fracture and soft tissue 4/3), were young patients (age 0/0), had mild hemorrhagic shock at the ED (1/1) and had absent pulse with good distal perfusion (1/1). The probable cause of the amputation in these cases was the association of severe head and abdominal trauma. As the MESS score only accounts for hemodynamic status, polytraumatized patients who had not yet developed hypotension may be underestimated. In

Table 1: Mangled extremity severity score (MESS) (5)

#Category	#Characteristics	Score
Skeletal and soft tissue injury	Low energy injury	1
	Medium energy injury	2
	High energy injury	3
	Very high energy injury	4
Limb ischemia (double the score for ischemia >6 hours)	Pulse reduced or absent, perfusion normal	1
	Pulseless, paraesthetic with diminished capillary refill	2
	Cool, paralysed, insensate or numb	3
Presence of shock	Systolic blood pressure always >90 mm Hg	1
	Transient hypotension	2
	Persistent hypotension	3
Age of the patient	<30	1
	30-50	2
	>50	3

Source: Mangled Extremity Severity Score (MESS) (4)

these cases, the systolic pressure may not be the best way to evaluate the patient and his associated injuries. Physiological criteria, such as acidosis or arterial lactate levels, may be better predictors of amputation. Some authors have shown that these markers can predict multiple organ failure in patients with severe trauma.^{11-13,17,18} In our study acidosis, arterial lactate levels and hemoglobin levels at admission were different between the two groups: pH = 7.36 PP vs 7.18 PA (p = 0.001); lactate: PP = 25 vs PA = 63 (p < 0.001); hemoglobin: PP = 13.6 vs PA = 7.85 (p = 0.03). Those laboratory tests represent the patient's general condition and its physiologic status and could serve as predictors of amputation in trauma patients with severe associated injuries.

CONCLUSION

Acidosis and blood levels of arterial lactate and low hemoglobin may serve as predictors of amputation. The results of those tests during initial assessment in patients with severe lower limb trauma are different between those submitted to PA or PP.

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