

AMPUTATION OR RECONSTRUCTION OF A SMASHED END: USE OF THE MANGLED EXTREMITY SYNDROME INDEX - MESI

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SUMMARY

Here we present the results of the use of the Mangled Extremity Syndrome Index – MESI in 64 open fractures of lower limbs. The ends regarded as smashed according to MESI criteria, in a total of twenty, have been scored and represent the basis for this study. According to the scale, the 20 points limit determines whether the end should or not be preserved. Only two limbs were submitted to primary amputation (scores 15 and 20) and, 19 months later, they were resigned with the decision made, and were not wearing orthosis, ambulating with the aid of crutches. The patients presenting the most

disappointing outcomes at reassessment achieved scores of 16 and 13, having their limbs spared. It was concluded that MESI criteria led to the determination of what is called as Mangled Extremity Syndrome. Injuries scoring was not easily made, and hardly reached the score of 20 points, which would determine primary amputation. In our case series, preservation of limbs scored below 20 did not mean that the decision has been the most appropriate one.

Keywords: Open fractures; Amputation; Classification.

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INTRODUCTION

A smashed end represents a deep challenge for surgeons⁽¹⁻⁵⁾. The more severe injuries are, the worse the functional results will be⁽²⁾ and, many times, complex plastic and vascular surgical procedures are required^(4,6). Thus, patients with tibial open fractures grade III of Gustillo and Anderson⁽⁷⁾ should be treated in hospitals where major reconstruction procedures can be performed⁽⁸⁾. Sparing smashed limbs with severe soft parts injuries in multiple trauma patients can result in severe metabolic disorders, secondary to changes on potassium and calcium serum levels, as well as lactic acid and myoglobin. There is also the risk of systemic infection spreading, leading to a sepsis picture⁽⁹⁾. Furthermore, unavoidable amputations are many times postponed, increasing financial, personal, and social expenses⁽²⁾.

In an attempt to make an objective critical decision of “amputation versus reconstruction”, different indexes have been proposed: the *MESI* (Mangled Extremity Syndrome Index), the *PSI* (Predictive Salvage Index), the *MESS* (Mangled Extremity Severity Score), the *LSI* (Limb Salvage Index), the *NISSSA* (Nerve Injury, Ischemia, Soft-tissue contamination, Skeletal injury, Shock and Age) and the *HFS* (Hannover Fracture Score)^(1,5,10-12). The objective of the present study is to analyze *MESI* applicability in patients with smashed lower limbs.

MATERIALS AND METHODS

In a period comprehending August to December 2003, we studied, prospectively, 64 lower limbs fractures (59 patients) treated in our service by different teams on duty. The authors

did not take part of the decisions made on emergency surgeries. A detailed study of surgery reports, X-ray images, photographs and surgeons' reports was conducted. The age group ranged from 11 to 91 years (average: 34 years). There was a prevalence of males (45 patients). The most frequent mechanism of trauma was car accident (52%), followed by trampling (29%), high falls (9%), gun shot injuries (8%), and blade-related injuries (2%). Patients with isolated digital injuries, or amputated limbs at baseline evaluation were excluded.

A similar protocol to that described by Gregory⁽⁸⁾ was employed, with the same number of cases. Fractures were classified according to *MESI* (Chart 1), which considers four major criteria (skin, nerve, artery, and bone), four minor criteria (related injuries, age, pre-existent diseases and shock), and the *Injury Severity Score – ISS*. *MESI* defines a smashed end as the one involving at least three major criteria.

Integumentary, nervous and arterial injuries were scored from 1 to 3. Each related venous injury was added by 1 score. Bone injuries received scores ranging from 1 to 7. Additional data (delayed treatment, pre-existent diseases and shock) were included on patients' overall evaluation. Two points were scored for patients in shock (systolic blood pressure below 90 mmHg).

The *ISS* provides a systemic scoring for patients with multiple injuries (Chart 2). Each injury is marked on an *Abbreviated Injury Scale – AIS*, an allocated to one of the six body regions (head, thorax, abdomen, ends, and skin). Only the highest *AIS* for each body region is included in the sum. The three most affected body regions had their scores

Study conducted at the Orthopaedics and Traumatology Service, Santa Casa de Misericórdia, Santos (SP), Brazil

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multiplied by square and then added for obtaining the ISS, which ranges from 0 to 75 *. A limit of 20 points determines whether the limb should or not be preserved. We compared the emergency surgeon's decision to the decision that should have been made according to MESI. The authors created a table for patients' reassessment under clinical, orthopaedic, psychological, and social perspectives (Chart 3). Lastly, our results were compared to those available in literature.

RESULTS

From the 59 patients studied, three presented with two fractured limbs (cases nr. 17, 27, and 44), and one presented with three fractured limbs (case nr. 56), totaling 64 open fractures. Twenty limbs were regarded as smashed because they fit into four major MESI criteria, or for being classified as Gustillo and Anderson's Grade III⁽⁷⁾.

Scores for this population were: 5, 6, and 7 (six cases), 8, 9, and 10 (five cases), 11, 12, and 13 (four cases), 14, 15, and 16 (three cases), 19 (one case), and 20 (only one case reached to score 20). (Table 1).

Two patients (cases nr. 45 and 61) were amputated at leg medial third (scores from 15 to 20). We were able to reassess 14 patients (16 limbs). Patients not available for reassessment continued treatment in other services (cases nr. 27 and 28) or moved to another city/ address/ telephone number (cases nr. 36 and 37). The minimum reassessment time was 19 months and the maximum, 23, with an average of 20.5 months (Table 2).

The mean hospitalization time was 63.8 days. Amputated patients (cases nr. 45 and 61) remained, respectively, 123 and 85 days in our hospital. The number of surgical procedures (including cleanings and débridement) ranged from two (cases nr. 8, 9, 10, 19, 25, 50, 55, and 59) to 21 (cases nr. 44 and 45). Amputated patients evolved with infection at amputation site and were submitted to 21 (case nr. 45) and five (case nr. 61) interventions in surgical environment. All patients agreed with the suggested approach, whether in the cases of salvage or amputation of the limb. Five patients (31%) did not

Chart 1 - Mangled Extremity Syndrome Index.

Injury Severity Score (ISS):	
0-25	1
25-50	2
>50	3
Tegmentum	
Guillotine	1
Smashing/burn	2
Avulsion/disleeving	3
Nerve	
Contusion	1
Transection	2
Avulsion	3
Vascular	
Artery	
Transection	1
Thrombosis	2
Avulsion	3
Vein	1
Bone	
Simple	1
Segmental	2
Segmental-Comminutive	3
Segmental-Comminutive with bone loss <6 cm	4
Segmental intra-extra joint	5
Segmental intra-extra joint with bone loss >6 cm	6
Bone loss > 6 cm, add 1	
Wait time (1 point for each hour exceeding 6h)	
Age	
40 - 50 years	1
50 - 60 years	2
60 - 70 years	3
Pre-existent disease	1
Shock	2

Source: Gregory⁽⁸⁾.

present changes (except for scars) when reassessing the smashed limb. The most frequent complication was ankle stiffness, evident in eight patients (cases nr. 8, 10, 19, 25, 50, 62, 63, and 64). Other complications included: chronic edema, limping, muscle atrophy, sores, infection, and pseudoarthrosis. Three patients (cases nr. 25, 61, and 63) presented with sensitive neurological changes on affected limb. The two amputated patients showed full healing of the amputation stump.

The patients presenting the most disappointing outcomes achieved a score of 16 and 13 points (cases nr. 62 and 63) and had their limbs preserved. They have been treated by Ilizarov method for 23 months, with bone exposure, infection and pseudoarthrosis. They both refused secondary amputation when questioned in their last reassessment visits.

DISCUSSION

Open fractures of lower limbs are among the most common kinds of care provided by traumatology. From these, 25% affect leg bones⁽¹³⁾. The classification by Gustillo and Anderson⁽⁷⁾ for open fractures enables

treatment standardization and is simple to for traumatologists discussions about approaches. However, fractures classified as IIIa- or IIIb-type often lead to a difficult decision concerning sparing or amputation of the limb^(1,2,3).

The current concept for absolute indication for lower limbs' primary amputation includes full avulsion of the limb, neurological deficit, hot ischemia higher than six hours, impossibility of re-establishing stream, and gaseous gangrene⁽¹¹⁾. Furthermore, in leg injuries, the consensus is towards tibial nerve rupture, with insensitive plantar surface or a severe smashing injury, with time of ischemia exceeding 6 hours, are indications for primary amputation⁽¹²⁾.

In the case series presented by the authors, within a period a little longer than 5 months, 64 leg bones' open fractures received care and have been treated - a similar sample to the original publication of the scale proposed by Gregory et al.⁽⁵⁾, the MESI. The so-called Mangled Extremity Syndrome, characterized by Gregory et al.⁽⁵⁾, determined the limbs having three or four injured tissues (skin, nerve, artery, and bone), being

Chart 2 - ISS Calculation Example.

Region	Injury Description	AIS	Three major injuries
Head & Neck	Brain contusion	3	9
Face	No injury	0	
Thorax	Unstable thorax	4	16
Abdomen	Minor hepatic contusion + complex spleen rupture	2 5	25
Extremities	Femoral fracture	3	
Skin	No injury	0	

Injury severity score (ISS): 50

Source: Association for the Advanced of Automotive Medicine AAAM, 1990 review.

*(Association for the Advanced of Automotive Medicine - AAAM), 1990 review, available at www.trauma.org; www.aaam.org.

easy for an orthopaedic surgeon to identify them in an emergency situation. Once we did not take part of the emergency care provided to patients, in our series, we had to assess medical reports on files, photographs and personal communications about

Chart 3 - Protocol for reassessing patients with mangled extremities.

Name:		Number of Order:			
Evolution time since accident:		<input type="checkbox"/> Excellent	<input type="checkbox"/> Good	<input type="checkbox"/> Fair	<input type="checkbox"/> Bad
Patient satisfaction:		<input type="checkbox"/> Yes	<input type="checkbox"/> No		
Return to job:		<input type="checkbox"/> Yes	<input type="checkbox"/> No		
Sports practice:		<input type="checkbox"/> No pain	<input type="checkbox"/> Pain at strong efforts		
Daily activities:		<input type="checkbox"/> Pain at light efforts	<input type="checkbox"/> Constant pain		
Use of crutches or other kind of support:		<input type="checkbox"/> Yes		<input type="checkbox"/> No Which:	
Drives cars/ motorcycles/ bikes, etc.		<input type="checkbox"/> Yes		<input type="checkbox"/> No	
Number of hospitalizations:		Total hospitalization time (days):			
Number of surgical procedures:		<input type="checkbox"/> Yes		<input type="checkbox"/> No	
Drugs use:		<input type="checkbox"/> Yes		<input type="checkbox"/> No	
Social/ family/ financial repercussion:		Which:			
Amputation x salvage:					
Physical Examination					
Verification:		Gait:		Skin status:	
Lower limb trophism:		Infection:		Palpation:	
Painful sites:		Active and passive motion:		Hip:	
Knee:		Ankle:		Neurological:	
Sensitiveness:		Motricity:			

It is also clear by the original article (5) that the scores for two mangled limbs must be summated. This approach raises the final score, and, as a result, the number of amputations. Thus, MESI calculation for cases 44 and 45 was a reason for controversies. The values for

the cases. Thus, we decided to include all type III open fractures for scoring purposes because they provide a higher probability of having mangled tissues.

The use of scales for assessing mangled limbs lead to targeting and standardizing approaches, either preserving it or not. Several methods have been created for that purpose. We decided to use the MESI because it's been largely commented in orthopaedic literature (12), despite of having no consensus about method sensitivity and specificity (6).

About the application of MESI scoring system, it is important to highlight that interpretation errors in clinical and X-ray data may raise or lower the score achieved. From the phases we considered as difficult, we highlight the calculation of the *Injury Severity Score - ISS* (which can raise scores up to 3 points). In emergency situations, we found this task not simple to accomplish, particularly because of the lack of familiarization with the method in our environment. Tables must be referred to and several indexes must be summated (remember that a decision for amputation is made at the emergency room and, many times, in critical situations). The determination and scoring for shock was also controversial. Is current shock concept the same as it was in 1985 (year in which the scale was published)? Should hypotension characterize shock? According to *ATLS (Advanced Trauma Life Support) protocol*(14) of the American College of Surgeons, used in our service, we should not wait for hypotension for characterizing shock, but any sign of tissue hypoperfusion.

each mangled end (6 and 15 points) did not indicate the need of primary amputation. Nevertheless, the sum of scores (21 points) suggests that at least one amputation should be performed. A study addressing the use of another scale, the MESS, describes that bilateral cases must not be summated, on the risk of unnecessary amputations (1). We also emphasize that the score for leg bones fractures, according to the original scale, is performed by means of summating tibial and fibular points, which lead to an increased final score (a comminuted fracture of the tibia conjunctively with a comminuted fibular fracture leads to a total of 6 points).

In contrast to the article by Gregory et al. (5), in which 10 of 17 smashing cases achieved the score 20 and were submitted to primary amputation. In this series, only two out of 20 patients regarded as mangled were amputated (cases 45 and 61). We can consider many causes for this approach discrepancy: traumas in our patients were less severe; antibiotic therapy strategies and reconstruction resources, particularly the Ilizarov method(15), progressed a lot in the last 20 years; in addition to less liberal amputations in our patients due to cultural factors.

Our cases amputated at emergency achieved 15 and 16 points, and, according to the scale, these would not require such resource. However, both presented irreparable vascular injuries along with smashing, which, according to some authors, would lead to amputation rates of 40% - 50%(6). In an opposite situation, cases 62 and 63 (scores 16 and 13,

Table 1 - Final scores of 20 patients with mangled lower limbs.

Nr.	8	9	10	17	18	19	25	27	28	33	37	44	45	50	55	59	61	62	63	64
ISS	1	1	1	1	1	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Age	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1
T	2	3	2	2	2	2	2	2	2	2	2	3	3	2	2	2	3	2	2	2
N	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	2	0	2	0
A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0
V	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	1	0
B	8	5	4	3	1	3	5	2	3	3	10	1	6	4	2	3	11	10	5	5
PD	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SH.	0	0	0	0	0	0	2	0	0	0	0	0	0	2	2	0	0	2	0	0
MESI	14	11	9	7	5	9	13	7	8	7	16	6	15	11	8	7	20	16	13	9

Nr. = case number; ISS = injury severity score; T = tegmentum; N = nerve; A = artery; V = vein; B = bone; PD = pre-existent diseases; SH = shock; MESI = final score.

Table 2 - Reassessment of 16 patients with mangled lower limbs.

Nr.	F-u	Op.	Job	Sp.	Pain	Sup.	Hos.	HI	Sur.	Drug	Reperc.	AxR	Verif.	Palp.	Hip	Knee	Ankle	Neur.
8	21	Exc.	Y	N	LE	N	3	15	2	N	Fam.	R	Ed.	D/P	OK	OK	STIF.	OK
9	21	Exc.	Y	N	NP	N	1	4	2	N	OK	R	OK	OK	OK	OK	OK	OK
10	20	G	Y	N	SE	N	1	7	2	N	Fin.	R	Limp.	OK	OK	OK	STIF.	OK
17	20	Exc.	N	N	SE	Y	1	34	4	Y	OK	R	Limp.	OK	OK	OK	FR/FL	OK
18	20	Exc.	N	N	SE	Y	1	34	4	Y	Fin.	R	Ed.	OK	OK	OK	OK	OK
19	21	G	Y	N	SE	N	1	5	2	N	Fin.	R	OK	OK	OK	OK	STIF.	OK
25	21	G	N	N	LE	Y	1	10	3	N	Fin./Soc.	R	Ed.	D/P	OK	OK	STIF.	Sensit.
44	20	Exc.	N	N	NP	Y	1	123	21	Y	Fam./Soc.	R	OK	OK	OK	OK	FR/FL	OK
45	20	Exc.	N	N	LE	Y	1	123	21	Y	Fam./Soc.	A	OK	D/P	OK	OK	(amput)	OK
50	19	Fair	N	N	LE	N	2	93	2	Y	Fin.	R	Ed.	D/P	FR/FL	FR/FL	STIF.	OK
55	19	G	N	N	LE	N	1	13	2	N	OK	R	Ed.	OK	OK	OK	OK	OK
59	22	Exc.	Y	S	NP	N	1	3	2	N	Fin.	R	OK	OK	OK	OK	OK	OK
61	23	Exc.	N	N	NP	Y	3	85	5	N	Fam.	A	Atr./Limp.	OK	OK	OK	(amput)	Sensit.
62	23	Fair	N	N	LE	Y	2	135	12	Y	Fam./Fin.	R	S / Atr./ Inf./ Pseu.	D/P	OK	FR/FL	STIF.	OK
63	23	Fair	N	N	LE	Y	2	62	17	Y	Fam.	R	S / Inf./ Pseu.	D/P	OK	FR/FL	STIF.	Sensit.
64	19	Exc.	N	N	SE	Y	1	160	20	Y	Fam.	R	Atr.	OK	OK	OK	STIF.	OK

Nr. = case number; F-u. = follow-up (months); Op. = opinion about case evolution; Exc. = excellent; G = good; Job = return to job; N = no; Y = yes; Sp. = sport activities; Pain; SE = pain at strong efforts; LE = pain at light efforts; NP = no pain; Sup. = need support for ambulation; Hos. = number of hospitalizations; HT = hospitalization time (days); Sur. = number of surgeries; Drug = regular use of analgesic drugs; Reperc. = social/family/financial repercussion; Fam. = family repercussion; Soc. = social repercussion; Fin. = financial repercussion; A x R = patient's opinion regarding amputation or reconstruction; Verif. = verification; Limp. = limping; Ed. = edema; Atr. = atrophy; S = sore; Inf. = infection; Pseu. = pseudoarthrosis; Palp. = palpation; FR = flexion restraint; (amput) = amputation; STIF. = stiffness; Neur. = neurological; Sensit. = sensitive changes.

respectively) are mentioned as having their limbs preserved. They both evolved with a severe soft parts injury, pseudoarthrosis and infection. Until the last evaluation, they had been submitted to 12 and 17 surgical procedures, and 135 and 62 days of hospitalization, respectively. They are currently being treated in an outpatient basis, and presenting with sores, severe local atrophies, ankle stiffness and infected pseudoarthrosis. After all those procedures, the emotional distress of patients and their families along with the high hospital bills charged, amputation is being discussed.

Regarding time of hospitalization, Georgiadis et al.⁽³⁾ and Gregory⁽⁵⁾ describe that amputation leads to a shorter hospitalization time and a lower number of surgical procedures. We report a large number of surgeries performed after emergency care, both for reconstructed injuries and amputated ones, particularly due to the need of frequent surgical débridements. We created a reassessment protocol for the 20 patients with lower limbs regarded as mangled. We studied the impact of

reconstruction *versus* amputation under clinical, emotional, labor-related, and economical scopes. According to patients' opinions, only three of them did not regard their outcomes as good or excellent at reassessment time. From these, two had their limbs preserved despite of being severely mangled (cases 62 and 63). Two patients who had their limbs amputated at emergency room were satisfied with the condition in which they were at reassessment visit. Those reassessments evidence how reconstruction did not necessarily lead to patients' satisfaction with the method.

CONCLUSIONS

MESI criteria led to the determination of what is referred to as Mangled Extremity Syndrome.

Injuries scoring was not easily provided, and barely reached the score 20, which determines amputation.

In our case series, preserving limbs with scores below 20 did not mean that this decision was the best one.

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