Submitted: 09 September, 2020 Accepted: 19 October, 2020 Published: 08 January, 2021 DOI:10.22514/sv.2020.16.0103

Open Access
Signa Vitae

ORIGINAL RESEARCH

Association of clinical characteristics with decision making in patients with severe lower extremity trauma

Vahide Aslıhan Durak[1,*], Cenk Ermutlu[2], Teoman Atıcı[2]

[1]Department of Emergency Medicine, Bursa Uludag University Medical Faculty, Bursa, Turkey
[2]Department of Orthopaedics and Traumatology, Bursa Uludag University Medical Faculty Bursa, Turkey

***Correspondence**
aslidurakis@hotmail.com
(Vahide Aslıhan Durak)

Abstract

Severe lower limb trauma represents a challenge for both the emergency department physicians and the surgeons. These injuries are associated with significant incidence of limb loss and it is not uncommon for the treating physician to make the hard decision between limb salvage, amputation or stump closure for a patient in critical condition. Our aim was to evaluate the epidemiology of traumatic lower extremity amputations and to analyze the factors which may have effect on patient resuscitation, limb salvage and efficient patient management. Patients who were admitted to our institution's emergency department for traumatic lower extremity amputation over an 8 years' period (2012 to 2020) were retrospectively analyzed. Patient files with the possibility of severe lower limb trauma and mangled extremity were retrieved and analyzed using ICD codes recorded/registered during the emergency department admission. Mean time from emergency admission to transfer to operating theater was 184,5 minutes. Replantation of the amputate was performed in 4 patients (19%). 25% of the amputations at the ankle level (1 out of 4) and 37.5% of the transtibial amputates (3 out of 8) were replanted. A multidisciplinary approach is necessary in every aspect of patient management; however, this does not justify a delay in treatment. Time spent during conclusion of necessary consultations does not have negative effects on patient outcome as long as patient is closely monitored and resuscitated in the emergency department.

Keywords

Amputation; Emergency department; Trauma

1. Introduction

Severe lower limb trauma represents a challenge for both emergency department physicians and surgeons [1]. These injuries are associated with a significant incidence of limb loss [2]. The patients may present with a Gustilo-Type 3C open fracture with vascular compromise, or an amputated limb. It is not uncommon for the treating physician to make the hard decision between limb salvage, amputation or stump closure for a patient in critical condition. The critical condition of a hemodynamically unstable patient may preclude attempting to perform a long reimplantation procedure. Limb salvage should be considered for non-life-threatening mangled extremities, only if this lengthy procedure does not decrease patient survival [3].

Distinguishing between a Type IIIC open fracture and subtotal amputation may be challenging. The widely accepted classification by Biemer [4] defines subtotal amputation as a severe injury where the soft tissue connection of the distal part of the limb is less than one-quarter of the circumference and there is no evidence of perfusion. In total amputations, the entire connection with the proximal limb is lost. In all cases, a multidisciplinary approach is required to assess the salvagability of a mangled extremity and manage patient resuscitation.

Fortunately, the incidence of traumatic amputations is relatively rare, compared to ischemic or diabetic amputations [5]. Still, it has a significant burden on an individuals' life and society. All patients who sustain traumatic amputations, reimplanted or not, will have permanent impairment. These patients are generally younger, with longer life expectancy and a higher activity level prior to injury. Because of their longer survival, traumatic amputees comprise nearly 50% of amputees [6]. Recent advances in surgical techniques made the replantation or reconstruction of mangled extremities possible which were once considered designated for amputation [1, 7, 8]. The studies on limb salvage versus primary amputation have revealed conflicting results [2, 7]. A successful replantation is generally defined as a viable salvaged limb. Patients who undergo replantation or limb salvage are prone to complications and more likely to require additional surgeries or re-hospitalization, compared to primary amputations [8, 9].

Several scoring and grading systems are described to assist the surgeon to decide whether to attempt limb salvage or proceed with a primary amputation [10]. The results of studies on the validation of these scoring systems are far from uniform, and the clinical judgment of the surgeon still has an important

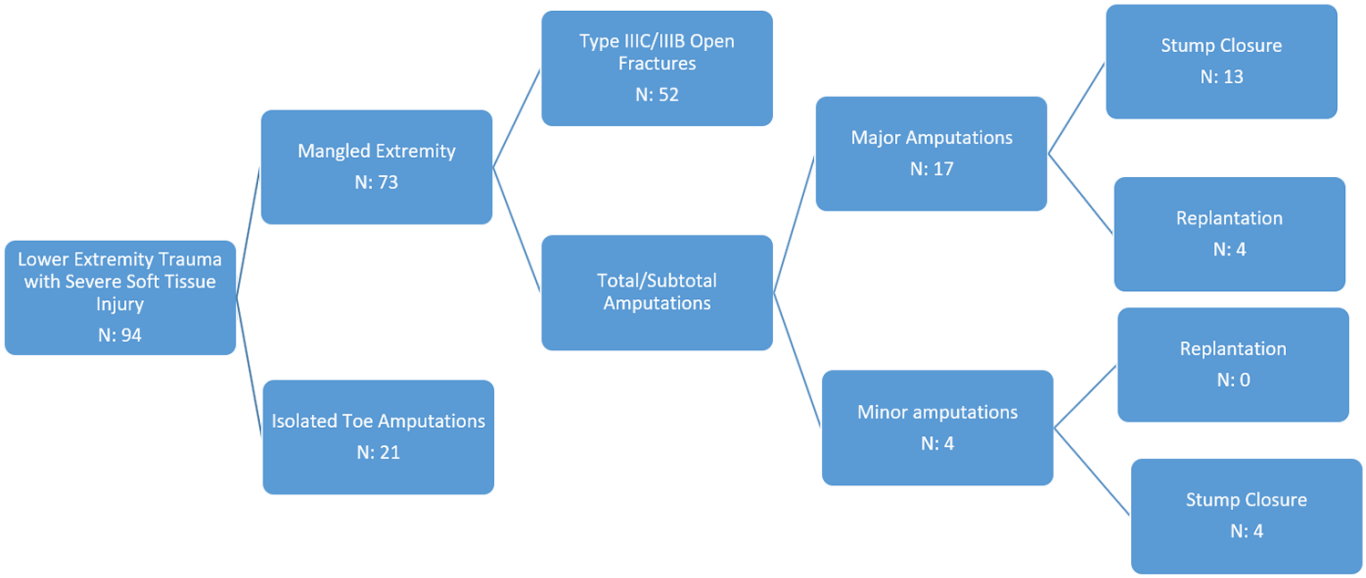

FIGURE 1. Flow chart for patient inclusion and performed treatment.

role [2, 11, 12]. A Mangled Extremity Severity Score was proposed as a guide to predict the success and adequacy of limb salvage, taking into account both the systemic and extremity-related factors [13]. Generally, a score less than 7 means that the extremity has a higher chance of salvage and the patient's overall condition is good enough to permit a relatively long reconstructive surgery.

In our clinical practice, we realized that patients with traumatic amputations, even those with clear indications for amputation, are almost always referred to higher-tier centers. This is generally because of the fear of litigation and the patient's or patient relatives' desire for a limb salvage procedure. The effect of delays caused by referrals and consultations on patient resuscitation and outcomes are not reported in the literature. The only study evaluating the delays to treatment of orthopedic injuries was performed by Pouramin *et al.*, on behalf of the INORMUS investigators. This multinational, multicenter study involves a large cohort of patients, and focuses on delays to hospital admission, caused mainly by geographic or socioeconomic factors [14]. Even in comprehensive studies such as the Lower Extremity Assessment Project (LEAP) [8] or the study by de Mestral *et al.* [15], data on the process from admission to definitive treatment is missing. We performed this retrospective study to evaluate the epidemiology of traumatic lower extremity amputations and to analyze those factors and parameters prior to surgery, which affect patient resuscitation, limb salvage and expedite patient management.

2. Materials and methods

Following approval from the institutional review board (Decision number 2020-13/6), patients who were admitted to our institution's emergency department for traumatic lower extremity amputation over an 8 years' period (2012 to 2020) were retrospectively analyzed. The hospital records of patients with severe lower limb trauma and a mangled extremity were retrieved and analyzed using ICD codes registered during the emergency department admission. Records of 114 patients were available for the initial evaluation. 20 cases had inaccurate or missing records and were removed from the study group. Of the remaining 94 patients, 42 patients with type IIIC open fractures, 10 cases with type IIIB open fractures and 21 patients with isolated toe amputations were excluded. 21 cases with total/subtotal amputations were available for final analysis and included in the study (Fig. 1). Patient demographics, the mechanism of trauma, the initial status of the patient, severity of the injury, details of resuscitation and patient monitoring, the number of consulted departments and the time it took to complete the consultations were recorded. Factors that might influence the decision to proceed with reimplantation, the number of consulted departments, the time till operation and the patients' vital signs were evaluated.

In our institution, the standard of care in traumatic amputation cases is to initiate aggressive fluid resuscitation upon admission to the emergency department. The patients' general condition and ABC is closely monitored. The patient is examined for visceral injuries and appropriate consultations are obtained. The bleeding from the mangled extremity is managed with compressive bandages. A temporary thigh tourniquet is applied if compression is not enough to provide hemostasis and major vessels are ligated with suture to prevent unexpected bleeding during wound irrigation. All the traumatic amputations of the lower extremity are approached as contaminated wounds and wide-spectrum antibiotic therapy (1st generation cephalosporin, aminoglycoside and metronidazole) is initiated as soon as possible. All patients receive antitetanus prophylaxis and an immunoglobulin is administered when necessary. The wound is meticulously irrigated with 10 L of saline and foreign debris is removed. The stump is cleansed further with an povidine-iodide solution and a sterile compressive bandage is applied.

2.1 Statistical analysis

The Shapiro-Wilk test was used to test variable normality. Normally distributed variables are presented as the mean (standard deviation). Variables that were not normally distributed are presented as median (minimum-maximum) values. An independent *T*-test was used to compare the measurements between the groups. The Chi-square test was used to determine the relationship between categorical variables. Pearson correlation coefficients were calculated to determine the relationships between measurements. Categorical variables are presented as n (%) values. The level required for statistical significance was $P = 0.05$ and statistical analyses were performed with IBM SPSS Statistics 25 software.

TABLE 1. Amputation types.

Major	17 (81%)
Minor	4 (19%)
Total	5 (23.8%)
Subtotal	16 (76.2%)
Guillotine	3 (14.3%)
Crush	18 (85.7%)

3. Results

3.1 Demographics and etiology

The mean age of patients was 45.1 years. Five patients were female and 16 patients were male. 17 patients had major lower extremity amputations and 4 cases had minor amputations (Table 1). No amputation occurred with low energy trauma. Two cases (10%) were the result of moderate energy trauma, 7 (33%) high energy, and 12 (57%) cases were result of very high energy trauma (Table 2). Forty-eight percent (10), 5% (1), and 48% (10) of amputations were the result of motor vehicle accidents, shotgun/blast injury and industrial/agricultural machinery, respectively (Table 3).

3.2 Presentation

Fourteen cases (67%) presented directly to our institution, whereas 7 (33%) cases were referred from other institutions. The mean time from injury to the emergency department of patients who were referred from other institutions (141.4 minutes) was significantly longer ($P = 0.001$) than patients who presented directly to our emergency department (59.6 minutes) (Table 3). Seventy-nine percent [11] of the direct presentations were major amputations, 21% [3] were minor amputations. Eighty-six percent [6] of the direct presentations were major amputations, whereas 14% [1] were minor amputations. The percentage of amputation types were similar among referred cases and direct presentations ($P = 0.69$). Four patients had concomitant potentially life-threatening visceral injuries or fractures.

3.3 Extremity injury severity

Seventeen patients had major lower extremity amputations, 4 cases had minor amputations, 23.8% of the patients presented with total amputations, and 76.2% of the patients had subtotal amputations. Three cases (14.3%) were Guillotine type amputations and 18 cases (85.7%) were crush injuries (Table 1). 19.1% [4] of the amputations occurred at the foot level, 23.8% [5] at the ankle, 42.9% (9) at the transtibial level and 14.2% [3] were above-knee amputations. Fourteen patients (66.6%) had a MESS score < 7, 7 cases (33.3%) had a MESS score > 7 (Table 3). The mean time from injury till admission was 90 minutes for patients with a MESS < 7 and 81 minutes for patients with a MESS > 7. Both groups had similar mean time from injury till admission.

The mean age of patients with major amputations was 44.9 years. 11.8% [2] of these cases were the result of moderate energy trauma, 29.4% [5] were high energy and 58.8% [10] were the result of very high energy trauma. 3 of these patients had concomitant potentially life-threatening visceral injuries or fractures. 64.7% [11] of the cases presented directly to our institution, whereas 35.3% [6] of the cases were referred from other institutions.

The mean age of patients with minor amputations was 46 years. Fifty percent [2] of these cases were the result of high energy and 50% [2] were result of very high energy trauma. One of these patients had concomitant potentially life-threatening visceral injuries or fractures. Seventy-five percent [3] of the cases presented directly to our institution, whereas 25% [1] of the cases were referred from other institutions.

3.4 Resuscitation

Mean arterial blood pressure (MAP), heart rate and Hemoglobin (Hgb) at the time of admission were 81.1 mmHg, 101 heartbeats/min and 11.14 mg/dL, respectively. Mean blood Hgb at the time of presentation was similar between referred patients and direct admissions (11.14 vs. 11.15, $P = 0.999$) There was no significant correlation between the time from injury till admission and hemoglobin levels at presentation ($P > 0.05$ c = -0.43). Six patients were hypotensive, 12 patients were normotensive and 3 cases were hypertensive during admission. All the hypotensive patients (6 cases) had major amputations. Higher MESS scores and longer admission time did not result in a significant decrease in MAP. Seven patients required inotropic medication at some time from admission till surgery. Two patients were intubated in the emergency department. Following resuscitation and emergency patient care, 40% of hypotensive patients became normotensive before surgery. Two patients (17%) who were initially normotensive became hypotensive prior to surgery. One patient required 12 units of erythrocyte suspension (ES), 1 patient required 3 units of ES, 1 patient required 2 units of ES and 3 patients needed 1 unit of ES replacement.

3.5 Consultations

85.7% (81) of the cases were consulted by 3 or more departments. The most frequently consulted departments were Orthopedics and Traumatology (100%, 21), Plastic and Recon-

TABLE 2. Severity of injury mechanism.

	Major Amputation	Minor Amputation
Low Energy Trauma	0	0
Moderate Energy Trauma	2 (11.8%)	0
High Energy Trauma	5 (29.4%)	2 (50%)
Very High Energy Trauma	10 (58.8%)	2 (50%)

TABLE 3. Descriptive statistics of patients with traumatic amputations.

Amputation Mechanism	
Motor Vehicle Accident	10 (48%)
Shotgun/blast Injury	1 (5%)
Industrial/agricultural Machinery	10 (48%)
Time Till ER Admission	
Direct presentation	59.6 minutes
Referred patients	141.4 minutes
Amputation Level	
Foot	4 (23.8%)
Ankle	5 (23.8%)
Trans-tibial	9 (42.9%)
Above-knee	3 (14.2%)
MESS Score	
MESS Score Lower than 7	14 (66.6%)
MESS Score Higher than 7	7 (33.3%)

structive Surgery (100%, 21), Cardiovascular Surgery (85.7%, 18), Neurosurgery (33.3%, 7) and Intensive Care (25.3%, 5). The mean time from the consultation request to consultation completion was 60.8 minutes for Plastic and Reconstructive Surgery, 57.7 minutes for Intensive Care, 56.2 minutes for Orthopedics, 43.6 minutes for Cardiovascular Surgery and 43.3 minutes for Neurosurgery (Table 4). In 6 cases, it took between 2 and 3 hours for the laboratory tests and imaging studies in the emergency department to be concluded.

There was no correlation between higher MESS scores and the number of consultations ($P > 0.05$, c = 0.08). There was no significant difference in number of consulted departments between patients with MESS scores greater or less than 7 ($P = 0.792$).

3.6 Transfer to the operating theater

The mean time from emergency admission to transfer to operating theater was 184.5 minutes and was 183.8 and 187.5 minutes for patients with major amputations and cases with minor amputations, respectively. When evaluated according to the number of consultations, mean time to surgery was 120, 195, 171, and 220 minutes for patients consulted to 5, 4, 3 and 2 departments, respectively. There was no correlation between the number of consulted departments and time from admission till surgery ($P > 0.05$, c = -0.304). There was no significant correlation between MESS score and time from injury till surgery ($P > 0.05$, -0.25). Mean time from admission to surgery was 176 minutes for patients with MESS score > 7 and 189 minutes for patients with MESS score < 7. There was no significant difference in time from admission to surgery between patients with MESS scores greater or less than 7 ($P = 0.774$).

3.7 Surgery

Reimplantation of the limb was performed in 4 patients (19%). 25% of the amputations at the ankle level (1 out of 4) and 37.5% of the transtibial amputations (3 out of 8) were reimplanted. In the remaining patients, the stump was closed or the limb was amputated at a higher level (Table 5). All the reimplanted patients had crush injuries. None of the Guillotine type amputations and no patients with foot or above-knee amputations were deemed suitable for replantation. All the patients who underwent replantation had a MESS score < 7.

3.8 Post-operative period

All patients with reimplanted extremities survived and were discharged from the hospital with a viable limb. Three patients with traumatic amputations died in the early postoperative period. One of these patients died on postoperative day 1, from uncal herniation following intracranial bleeding. Another patient had concomitant cranial fractures and an inferior vena cava laceration, and died on postoperative day 1 due to hypotensive shock. One patient developed septicemia and died on day 12 after multi-organ failure.

3.9 Wound complications

Of the four patients who had undergone reimplantation, 1 case required local debridement, 2 cases needed wide debridement and split-thickness skin grafting. Eight patients with amputated limbs developed wound complications and were managed with local debridement (3 cases) alone or debridement and skin grafting (4 cases). One patient with an above knee amputation required hip disarticulation.

4. Discussion

The rate of re-hospitalization and additional surgeries is higher in patients with a salvaged limb, and the functional results at 2 years are not superior to amputation [8]. Nevertheless, the idea of losing a limb is not easy to accept, and many patients are willing to undergo a lengthy reconstruction and rehabilitation period no matter how small the chance of success. Patients undergoing amputation following an injury are usually younger, with higher functional demands and a longer life expectancy. This creates a fear of future litigation before

TABLE 4. Consulted departments.

Consulted departments	Percentage	Time till closure (min)
Orthopaedics and Traumatology	21 (100%)	56.2
Plastic and Reconstructive Surgery	21 (100%)	60.8
Cardiovascular Surgery	18 (85.7%)	43.6
Neurosurgery	7 (33.3%)	43.3
Intensive Care	5 (25.3%)	57.7

TABLE 5. Surgeries performed according to amputation level.

Level of traumatic amputation	Replantation	Amputation
Foot	0	4 (100%)
Ankle	1 (25%)	4 (75%)
Transtibial	3 (33.3%)	6 (66.6%)
Above-knee	0	3 (100%)

performing an irreversible procedure such as an amputation or stump closure. Therefore, even patients with a clear indication for amputation are referred to 3^{rd} tier trauma centers for consultation regarding reconstructive procedures. Time spent during patient transport and repeated medical examination and consultations increase the time till definite treatment can occur. Even though this delay in treatment may have detrimental effects on patient resuscitation and outcomes, our study did not support these concerns [16].

Higher MESS scores and longer admission time did not cause a significant decrease in initial MAP during admission. We had expected that patients with higher MESS scores would have lower MAP, since a higher MESS score indicates a more severe trauma that might cause increased blood loss, and lower blood pressure which is an integrated component of the scoring system. A possible explanation is that blood loss from the severed extremity is prevented during patient transportation and the patients' fluid resuscitation is managed properly.

In 6 cases, it took between 2 and 3 hours for the laboratory tests and imaging studies in the emergency department to be concluded. Similarly, the mean time from emergency admission to transfer to the operating theater was 184.5 minutes. Although it may seem long and inappropriate for a patient with an amputated limb to wait that long in the ER, it is vital to exclude visceral injuries. Blood loss from an amputation can be managed with a simple tourniquet, whereas missed visceral bleeding may result in a mortality. In our clinical practice, we encountered cases where patients who were initially deemed stable by general surgeons and admitted to the orthopedics ward; subsequently required an emergency laparotomy. Nevertheless, unnecessary delays that prolong the warm ischemia time and reduce the chance of a successful repimlantation should be avoided.

There was no correlation between higher MESS scores and the number of consultations. The increased number of consultations did not cause an increase in time spent until definitive surgery. This was in contrast to our expectation that a patient with a more serious injury would have more concomitant injuries and would require a higher number of consultations, resulting in a significant delay. A possible explanation is that, no matter the condition of the patient, a minimum of two consultations are made; orthopedics for stump closure and plastic surgery for a possible reimplantation. Furthermore, the results of final laboratory tests and studies ordered by emergency department doctors tend to come back after the consultation is completed.

All patients whose lower extremities were reimplanted had an initial MESS score < 7. The typical clinical decision making algorithms proposed by different authors have two crucial considerations in the early treatment stages [17, 18]. Is the warm ischemia time less than 6-8 hours, and does the patient's general status allow a long and extensive reconstruction procedure? By default, a traumatic amputation patient who is in critical condition or who has a long ischemia time will have a MESS score > 7, since these two criteria are taken into consideration during the calculation. Clinical judgement is still the cornerstone of decision making, and scores cannot be used as the sole criteria for an amputation [3].

In our series, survival of the reimplanted limb (100%) was higher and the need for a major secondary procedure (50%) was lower than that reported by Battiston *et al.* [19]. In their study, 35% of the reimplanted lower extremities required amputation, and 78% of the remaining cases underwent complex soft tissue surgeries such as free flaps or ostetomies. In the literature, the success rate of lower extremity reimplantation differs between 37-89% [17]. Although all patients in our study who had undergone reimplantation were dishcarged with a viable limb, a relatively low number of cases makes a direct comparison impossible.

This study has several limitations. Consultation times were analyzed based on inputs in the electronic patient records. It is likely that many of the consultations were performed orally or discussed among consulting and treating physicians in the emergency ward prior to closing their electronic notes. The time spent during each consultation may be shorter than that appearing in the official documents. However, any future medico-legal liability will be evaluated based on electronic patient records, not on conversations. There are several procedures such as "verbal order" defined to speed-up the patient management during an emergency. However, there is no

defined "verbal consultation" in the institution where this study was conducted. The importance of an accurate medical record in an irreversible procedure cannot be over-emphasized. The surgeon should state in the electronic medical record that they proceeding with an amputation after consulting with the appropriate colleagues and taking into account their verbal recommendations.

5. Conclusions

The final decision for performing a traumatic amputation should be based on sound clinical knowledge and patient consent. Reimplantation should be avoided to prevent increased morbidity and mortality in those cases where reimplantation is unlikely to be successful. A multidisciplinary approach is necessary to determine if the limb can be reimplanted; however, this does not justify a delay in treatment. The time spent obtaining the necessary consultations does not have negative effects on patient outcomes as long as the patient is closely monitored and properly resuscitated in the emergency department.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was taken from the Clinical Researches Ethical Commitee of the University (2020-13/6).

ACKNOWLEDGEMENTS

The authors thank Adnan Çakar for his help in preparation of this manuscript.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

HUMAN RIGHTS

Human rights permissions are taken for our study.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and/or analysed during the current study are available from corresponding author.

REFERENCES

[1] Fochtmann A, Binder H, Rettl G, Starlinger J, Aszmann O, Sarahrudi K, *et al*. Third degree open fractures and traumatic sub-/total amputations of the upper extremity: Outcome and relevance of the Mangled Extremity Severity Score. Orthopaedics & Traumatology: Surgery & Research. 2016; 102: 785-790.

[2] Dagum AB, Best AK, Schemitsch EH, Mahoney JL, Mahomed MN, Blight KR. Salvage after severe lower-extremity trauma: Are the outcomes worth the means? Plastic & Reconstructive Surgery. 1999; 103: 1212-1220.

[3] Cimbanassi S, O'Toole R, Maegele M, Henry S, Scalea TM, Bove F, *et al*. Orthopedic injuries in patients with multiple injuries: Results of the 11th trauma update international consensus conference Milan, December 11, 2017. Journal of Trauma and Acute Care Surgery. 2020; 88: e53-e76.

[4] Biemer E. Definitions and classifications in replantation surgery. British Journal of Plastic Surgery. 1980; 33: 164-168.

[5] Gabel J, Jabo B, Patel S, Kiang S, Bianchi C, Chiriano J, *et al.* Analysis of patients undergoing major lower extremity amputation in the vascular quality initiative. Annals of Vascular Surgery. 2018; 46: 75-82.

[6] Tintle LSM, Keeling CJJ, Shawen LSB, Forsberg LJA, Potter MBK. Traumatic and trauma-related amputations. The Journal of Bone and Joint Surgery-American Volume. 2010; 92: 2852-2868.

[7] Busse JW, Jacobs CL, Swiontkowski MF, Bosse MJ, Bhandari M. Complex limb salvage or early amputation for severe lower-limb injury: A meta-analysis of observational studies. Journal of Orthopaedic Trauma. 2007; 21: 70-76.

[8] Bosse MJ, MacKenzie EJ, Kellam JF, Burgess AR, Webb LX, Swiontkowski MF, *et al*. An analysis of outcomes of reconstruction or amputation of leg-threatening injuries. The New England Journal of Medicine. 2002; 347: 1924-1931.

[9] Georgiadis GM, Behrens FF, Joyce MJ, Earle AS, Simmons AL. Open tibial fractures with severe soft-tissue loss. Limb salvage compared with below-the-knee amputation. The Journal of Bone & Joint Surgery. 1993; 75: 1431-1441.

[10] Rajasekaran S, Sabapathy SR, Dheenadhayalan J, Sundararajan SR, Venkatramani H, Devendra A, *et al*. Ganga hospital open injury score in management of open injuries. European Journal of Trauma and Emergency Surgery. 2016; 41: 3-15.

[11] Loja MN, Sammann A, DuBose J, Li CS, Liu Y, Savage S, *et al.* The mangled extremity score and amputation: Time for a revision. The Journal of Trauma and Acute Care Surgery. 2017; 82: 518-523.

[12] Schechtman DW, Walters TJ, Kauvar DS. Utility of the mangled extremity severity score in predicting amputation in military lower extremity arterial injury. Annals of Vascular Surgery. 2020; S0890-5096(20)30775-5.

[13] Johansen K, Daines M, Howey T, Helfet D, Hansen ST. Objective criteria accurately predict amputation following lower extremity trauma. *The Journal of Trauma: Injury, Infection, and Critical Care*. 1990; 30: 568-573.

[14] Pouramin P, Li CS, Busse JW, Sprague S, Devereaux PJ, Jagnoor J, *et al.* Delays in hospital admissions in patients with fractures across 18 low-income and middle-income countries (INORMUS): a prospective observational study. The Lancet Global Health. 2020; 8: e711-e720.

[15] de Mestral C, Sharma S, Haas B, Gomez D, Nathens AB. A contemporary analysis of the management of the mangled lower extremity. Journal of Trauma and Acute Care Surgery. 2013; 74: 597-603.

[16] Pollak AN, Jones AL, Castillo RC, Bosse MJ, MacKenzie EJ, LEAP Study Group. The relationship between time to surgical debridement and incidence of infection after open high-energy lower extremity trauma. The Journal of Bone and Joint Surgery. 2010; 92: 7-15.

[17] Hierner R, Berger AK, Frederix PR. Lower leg replantation-decision-making, treatment, and long-term results. Microsurgery. 2007; 27: 398-410.

[18] Märdian S, Schaser KD, Wichlas F, Jakobs C, Kraphol B, Schwabe P. Lower limb salvage: indication and decision making for replantation, revascularisation and amputation. Acta Chirurgiae Orthopaedicae Et Traumatologiae Cechoslovaca. 2015; 81: 9-21.

[19] Battiston B, Tos P, Pontini I, Ferrero S. Lower limb replantations: indications and a new scoring system. Microsurgery. 2002; 22: 187-192.

How to cite this article: Vahide Aslıhan Durak, Cenk Ermutlu, Teoman Atıcı. Association of clinical characteristics with decision making in patients with severe lower extremity trauma. Signa Vitae. 2021;17(1):89-94. doi:10.22514/sv.2020.16.0103.