Injured limb – Amputation or salvage?

Bakota Bore

General Hospital Karlovac, Department of Traumatology, Zagreb, Croatia
University of Zagreb, School of Medicine, Zagreb, Croatia (2)

Treatment of a mangled extremity represents a major challenge. The decision whether to amputate or attempt reconstruction is currently based upon surgical evaluation.

The purpose of this article is to propose a new approach to surgical evaluation based on scoring systems and local clinical status of the patient, as well as comorbidities, mechanism of trauma, and hospital resources.

Based on current literature guidelines and evidence-based medicine, management for borderline cases is proposed to aid clinical decision making in these situations.

Despite a borderline Mangled Extremity Severity Score in some cases reconstruction can be attempted considering the overall health status of the patient and local clinical status, with preserved plantar sensitivity and satisfactory capillary perfusion.

In conclusion, management of mangled extremity treatment should refer to evidence-based literature in correlation with clinical evaluation of every individual patient. Scores are helpful but should not be taken as a sole indication for amputation.

Mangled extremity is a consequence of high energy trauma which result in combined bone and soft tissue injury associated with severe bone and soft tissue loss or destruction (1).Treatment of a mangled lower extremity represents a major challenge. The decision-whether to amputate or attempt reconstruction is currently based upon surgical evaluation (1).

Criteria

Until now, the absolute criteria for amputation have been non-reconstructablevascular injury, crush injury with warm ischemia over 6 hours, and severe bone and soft tissue loss with tibial nerve transsection (2,3). Relative criteria are elderly patients in shock with a mangled limb, massive soft tissue loss associated with bone loss, Mangled Extremity Severity Score (MESS) ≥ 7 (especially with absent plantar sensation), severe ipsilateral foot trauma, polytrauma, and patients who are not expected to tolerate reconstruction (4).

However, these criteria should not be considered strict rules, but rather guidelines, due to many patient and wound-related variables(5). A patient with a mangled extremity that matches criteria for amputation can successfully have a salvaged limb with restoration of full function due to an individualized approach to treatment and consideration of many other patient and wound variables (1).

Discussion

Decision making in a clinical situation of mangled extremity is complex (6). Due to the development of surgical techniques and technologies, comprehensive reconstructions are possible today in limb salvage procedures (7–12).

Figure 1a and 1b. Running train - Foot and ankle subamputation

Figure 2. Corn Machine separator injury

Figure 3a and 3b. Explosion Injury - Hand bomb fuse

However, uncritical limb salvage attempts expose patients to increased morbidity and mortality, prolonged and costly treatment and often result in dysfunctional extremity and disappointment (4). Although in many cases based solely on clinical examination the decision to amputate or attempt salvage is clear, in borderline cases the decision requires the utilization of different tools, such as scoring systems, that may help differentiate salvageable from non-salvageable extremities (1).

There is a variety of different scoring systems designed to aid clinical decision-making, such as the MESS, the Limb Salvage Index (LSI), the Predictive Salvage Index (PSI), the Nerve Injury, Ischemia, Soft-Tissue Injury, Skeletal Injury, Shock, and Age (NISSSA) Score, the Hannover Fracture Scale-97 (HFS-97) and many others(4,13–17). The purpose of these scores is to allow accurate prediction of either the need for amputation or the possibility of salvage. Ideally, a trauma limb-salvage score should have a perfect accuracy with a sensitivity of 100% (all amputated limbs with trauma limb-salvage scores at or above the threshold) and specificity of 100% (all salvaged limbs with scores below the threshold). Several clinical trials were conducted in order to determine the exact cut-off point for these scores that could be used in decision making (1). Johansen et al. reported that a MESS score greater or equal to 7 predicted amputation with 100% accuracy (4). Since delayed amputation in that study resulted in over 20% mortality from sepsis as compared to no mortality in primary amputation (4), the importance of accurate decision making is obviously of paramount importance. MESS, NISSSA, and HFS-97 scores are greatly influenced by the results of initial neurological examination, with the assumption that an acute sensory debilitation correlates with decreased limb-salvage potential and that the initial examination demonstrates the final deficiency (1).

Still, ischemia, contusion, stretch, or compression can cause transitory neurological deficit. When the LSI is used, the neurological impairment is scored on the basis of anatomical nerve findings. Howe et al. reported a sensitivity of 78% and a specificity of 100% for the PSI. On the other hand, Bosse et al. found the sensitivity and specificity of the PSI for patients with an ischemic limb injury were 56% and 79% when immediate amputations were included in the analysis and 40% and 79% when immediate amputations were excluded.

Performance was not improved when only open tibial fractures were considered. Given the large number of different scoring systems, a prospective, observational, multicenter evaluation of patients with Gustillo IIIB and IIIC open tibia fractures (Lower Extremity Assessment Project – LEAP study) was performed (16). However, the results of this study failed to validate clinical utility of any scoring system in predicting the need for amputation. On the other hand, it demonstrated the important role of psycho-social issues in long-term outcomes. Furthermore, an initial absence of plantar sensation was not a reliable indicator of the need for amputation as 55% of patients with no plantar sensation initially reported plantar sensation at 24 months. A repeat of the LEAP study confirmed these previous results, emphasizing the inability of scoring systems to accurately predict the need for amputation, although low scores may predict salvage potential (18,19).

Furthermore, there is also not enough evidence in the literature that supports the necessity of urgent temporary vascular shunting followed by orthopedic stabilization in combined orthopedic and vascular foot and ankle injuries with borderline MESS scores (20). The sequence of procedures and patient care should be adjusted to the specific needs of every patient in order to minimize the rate of amputation. Early soft tissue coverage of a mangled foot and ankle with Vacuum Asisted Closure (VAC) combined with silver hydrofiber dressings is very convenient and results in fewer complications, earlier mobilization and return to work. VAC is also an excellent bridging solution in situations where due to the absence of specialized surgical teams (late at night surgery, local community hospital, etc.) definite treatment (21,22) cannot be immediately performed. Delaying soft-tissue reconstruction beyond 7 days has been associated with increased flap complications and an increased risk of infection (23,24). Gopal et al. found a deep infection rate of 6% for fractures covered within 72 h, and an infection rate of 29% for fractures covered after 72 hours. The authors concluded that provided an adequate debridement has been performed, immediate internal fixation and healthy soft tissue cover with a muscle flap is safe (25). However, early aggressive fracture fixation and definitive soft-tissue reconstruction may be favorable for isolated extremity fractures but may not be the safest option for the majority of patients with complex extremity fractures, many of whom have severe additional injuries (26).

Bone and joint infections represent an important

problem which consists of three components: the extent of tissue involvement, the microorganism and the host. Management is based on radical debridement, skeletal stabilization, microbial-specific antibiotics, soft tissue coverage, and reconstruction of bone defects. Direct blunt trauma or open wounds of the distal tibia, the ankle joint and the foot often lead to tissue loss and subsequent bacterial colonization. Resistant microorganisms may further complicate the situation, meaning that systemically compromised patients are in a less favorable position (27–29).

Necrotizing fasciitis is a special problem which represents a rapidly progressive infection with necrosis of the fascia and surrounding tissues and has a mortality rate up to 76% (30). Important clinical findings are pain, hyperpyrexia, chills, cellulitis, edema, warmth, induration, fluctuance, crepitus, skin necrosis and bullae (31). Immediate aggressive surgical debridement (skin, subcutaneous tissue, muscle debridement, fasciotomy) and administration of high doses of antibiotics are the main steps of treatment.

The reconstruction of the resulting skeletal and soft tissue defects is usually demanding. Contrary to the more proximal parts of the leg, the availability of soft tissue for the coverage of full thickness defects with local or regional flaps in the foot and ankle is limited. However, large defects require complex reconstructive procedures, such as distraction osteogenesis, vascularized bone grafting or transfer of free flaps (32,33). Finally, amputations and more extensive amputative procedures in cases of diffuse osteomyelitis can fail as a limb and life saving procedure in resistless patients. In selecting the appropriate management plan, the surgeon should rely on the detailed evaluation of the patient, the extent of the bone and soft tissue involvement and the type and susceptibility of bacterial pathogens (34).

The importance of general and local conditions should be particularly evaluated in polytrauma for which there is still no clear guideline on whether to amputate or not (35).

In sepsis and/ or MOF occurrence, with the presence of a MESS score >7, the incidence of tibio-peroneal trunk injury and the occurrence of postoperative deep wound infection are significant independent factors for limb loss (36).

In the end, functional demands and expectations of the patients, in combination with the estimated time required for the reconstructive procedures, are also critical parameters for the final decision. Primary amputation should not be considered as a treatment failure, but rather as a means of meeting the goal of treatment (37). As Hansen pointed out, we should not let the heroism triumph over reason (38).

Conclusion

When treating mangled extremity, it is necessary to include all other patient and wound variables (1) in addition to scoring systems in order to allow improved treatment outcomes using an individualized approach to patients with mangled extremities. Consequently, there is an obvious need for comprehensive criteria proposal of mangled extremity treatment for borderline cases (1) that will take into account not only scoring systems, but also important patient and wound characteristics (39).

References

1. Bakota B, Kopljar M, Jurjevic Z, Staresinic M, Cvjetko I, Dobric I, et al. Mangled Extremity - Case Report, Literature Review and Borderline Cases Guidelines Proposal. Coll Antropol. 2012;36(4):1419–1426.

2. Hansen ST, Jr. The type-IIIC tibial fracture. Salvage or amputation. J Bone Joint Surg Am. 1987;69-A(6):799-800.

3. Lange RH, Bach AW, Hansen ST, Jr., Johansen KH. Open tibial fractures with associated vascular injuries: prognosis for limb salvage. J Trauma. 1985;25(3):203-208.

4. Johansen K, Daines M, Howey T, Helfet D, Hansen ST, Jr. Objective criteria accurately predict amputation following lower extremity trauma. J Trauma. 1990;30(5):568-572; discussion 72-73.

5. Wolinsky PR, Webb LX, Harvey EJ, Tejwani NC. The mangled limb: salvage versus amputation. Instr Course Lect. 2011;60:27-34.

6. Shawen SB, Keeling JJ, Branstetter J, Kirk KL, Ficke JR. The mangled foot and leg: salvage versus amputation. Foot Ankle Clin. 2010;15(1):63-75.

7. Guo QF, Xu ZH. Rescue and treatment of severely injured lower extremities. Chin J Traumatol. 2005;8(2):81-85.

8. Hallock GG. The utility of both muscle and fascia flaps in severe upper extremity trauma. J Trauma. 2002;53(1):61-65.

9. Melissinos EG, Parks DH. Post-trauma reconstruction with free tissue transfer--analysis of 442 consecutive cases. J Trauma.1989;29(8):1095-1102;discussion 102-103.

10. Mileto D, Cotrufo S, Cuccia G, Delia G, Risitano G, Colonna MR, et al. The distally based sural flap for lower leg reconstruction: versatility in patients with associated morbidity. Ann Ital Chir. 2007;78(4):323-327.

11. Ozkan O, Coskunfirat OK, Ozgentas HE. The use of free anterolateral thigh flap for reconstructing soft tissue defects of the lower extremities. Ann Plast Surg. 2004;53(5):455-461.

12. Tang J, Li K, Liu J. [Repairing widespread traumatic soft tissue defects in lower limb with free latissimus dorsi muscle-

skin flaps]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2006;20(11):1087-1089.

13. Howe HR, Jr., Poole GV, Jr., Hansen KJ, Clark T, Plonk GW, Koman LA, et al. Salvage of lower extremities following combined orthopedic and vascular trauma. A predictive salvage index. Am Surg. 1987;53(4):205-208.

14. Russell WL, Sailors DM, Whittle TB, Fisher DF, Jr., Burns RP. Limb salvage versus traumatic amputation. A decision based on a seven-part predictive index. Ann Surg. 1991;213(5):473-480; discussion 80-81.

15. Suedkamp NP, Barbey N, Veuskens A, Tempka A, Haas NP, Hoffmann R, et al. The incidence of osteitis in open fractures: an analysis of 948 open fractures (a review of the Hannover experience). J Orthop Trauma. 1993;7(5):473-482.

16. Bosse MJ, MacKenzie EJ, Kellam JF, Burgess AR, Webb LX, Swiontkowski MF, et al. A prospective evaluation of the clinical utility of the lower-extremity injury-severity scores. J Bone Joint Surg Am. 2001;83-A(1):3-14.

17. McNamara MG, Heckman JD, Corley FG. Severe open fractures of the lower extremity: a retrospective evaluation of the Mangled Extremity Severity Score (MESS). J Orthop Trauma. 1994;8(2):81-87.

18. Bosse MJ, McCarthy ML, Jones AL, Webb LX, Sims SH, Sanders RW, et al. The insensate foot following severe lower extremity trauma: an indication for amputation? J Bone Joint Surg Am. 2005;87-A(12):2601-2608.

19. Bosse MJ, MacKenzie EJ, Kellam JF, Burgess AR, Webb LX, Swiontkowski MF, et al. An analysis of outcomes of reconstruction or amputation after leg-threatening injuries. N Engl J Med. 2002;347(24):1924-1931.

20. Glass GE, Pearse MF, Nanchahal J. Improving lower limb salvage following fractures with vascular injury: a systematic review and new management algorithm. J Plast Reconstr Aesthet Surg. 2009 May;62(5):571-579.

21. Steiert AE, Partenheimer A, Schreiber T, Muehlberger T, Krettek C, Lahoda LU, et al. Das V.A.C.®-System (vacuum assisted closure) als bridging zwischen primärer Osteosynthese und Weichteilrekonstruktion in der Behandlung II°-III° offener Frakturen polytraumatisierter Patienten. Zentralbl Chir. 2004 May;129 Suppl 1:S98-100.

22. Steiert AE, Gohritz A, Schreiber TC, Krettek C, Vogt PM. Delayed flap coverage of open extremity fractures after previous vacuum-assisted closure (VAC) therapy - worse or worth? J Plast Reconstr Aesthet Surg. 2009 May;62(5):675-683. Epub 2008 Mar 25.

23. Cierny G 3rd, Byrd HS, Jones RE. Primary versus delayed soft tissue coverage for severe open tibial fractures. A comparison of results. Clin Orthop Relat Res. 1983 Sep;(178):54-63.

24. Fischer MD, Gustilo RB, Varecka TF. The timing of flap coverage, bone-grafting, and intramedullary nailing in patients who have a fracture of the tibial shaft with extensive soft-tissue injury. J Bone Joint Surg Am. 1991;73-A(9):1316-1322.

25. Gopal S, Majumder S, Batchelor AG, Knight SL, De Boer P, Smith RM. Fix and flap: the radical orthopaedic and plastic treatment of severe open fractures of the tibia. J Bone Joint Surg Br. 2000;82-B(7):959-966.

26. Steiert A, Gohritz A, Knobloch K, Krettek C, Vogt PM. Damage control flap reconstruction. Plast Reconstr Surg. 2009 Sep;124(3):1010-1011.

27. Levin LS. Soft tissue coverage options for ankle wounds. Foot Ankle Clin. 2001;6(4):853-866.

28. Baumeister S, Germann G. Soft tissue coverage of the extremely traumatized foot and ankle. Foot Ankle Clin. 2001;6(4):867-903.

29. Zalavras CG, Marcus RE, Levin LS, Patzakis MJ. Management of open fractures

and subsequent complications. J Bone Joint Surg Am. 2007;89-A:884–895.

30. Espandar R, Sibdari SY, Rafiee E, Yazdanian S. Necrotizing fasciitis of the extremities: a prospective study. Strategies Trauma Limb Reconstr. 2011 Nov;6(3):121-125.

31. Naqvi GA, Malik SA, Jan W. Necrotizing fasciitis of the lower extremity: a case report and current concept of diagnosis and management. Scand J Trauma Resusc Emerg Med. 2009;17:28.

32. Keating JF, Simpson AH, Robinson CM. The management of fractures with bone loss. J Bone Joint Surg Br. 2005;87-B(2):142-150.

33.Patzakis MJ, Zalavras CG. Chronic posttraumatic osteomyelitis and infected nonunion of the tibia: current management concepts. J Am Acad Orthop Surg. 2005;13(6):417–427.

34. Malizos KN, Gougoulias NE, Dailiana ZH, Varitimidis S, Bargiotas KA, Paridis D. Ankle and foot osteomyelitis: treatment protocol and clinical results. Injury. 2010;41(3):285-293.

35. Kobbe P, Lichte P, Pape HC. Complex extremity fractures following high energy injuries: the limited value of existing classifications and a proposal for a treatment-guide. Injury. 2009;40 Suppl 4:S69-74.

36. Zaraca F, Ponzoni A, Stringari C, Ebner JA, Giovannetti R, Ebner H. Lower extremity traumatic vascular injury at a level II trauma center: an analysis of limb loss risk factors and outcomes. Minerva Chir. 2011 Oct;66(5):397-407.

37. Cannada LK, Cooper C. The mangled extremity: limb salvage versus amputation. Curr Surg. 2005 Nov-Dec;62(6):563-576.

38. Hansen ST Jr. Overview of the severely traumatized lower limb. Reconstruction versus amputation. Clin Orthop Relat Res. 1989;243:17-19.

37. Scalea TM, Dubose J, Moore EE, West M, Moore FA, McIntyre R, et al. Western Trauma Association Critical Decisions in Trauma: Management of the mangled extremity. J Trauma. 2012;72(1):86-93.