

APPROACH TO ASSESSMENT AND MANAGEMENT OF BLEEDING RISK IN LONG BONE TRAUMA: A COMPREHENSIVE BIBLIOGRAPHICAL REVIEW

Luisa Miranda Zafalão

Universidade Federal de Jataí (UFJ)

Jataí - GO

<https://orcid.org/0000-0003-3284-9490>

Marina Luiza Veloso Ferreira

Faculdade de Medicina de Barbacena

(FAME)

Barbacena - MG

<https://orcid.org/0009-0001-6511-7379>

Heloisa Brazil Ephigenio de Souza

Universidade Cidade de São Paulo (UNICID)

São Paulo - SP

<https://orcid.org/0009-0004-6513-4285>

Isabella dos Santos

Universidade de Mogi das Cruzes (UMC)

Mogi das Cruzes - SP

<https://orcid.org/0009-0006-7093-437X>

Leonardo Davi Crespo Santana

Centro Universitário Redentor

(UniRedentor)

Itaperuna - RJ

<https://orcid.org/0000-0003-0644-1600>

All content in this magazine is licensed under a Creative Commons Attribution License. Attribution-Non-Commercial-Non-Derivatives 4.0 International (CC BY-NC-ND 4.0).



Rodrigo Macena Rossi

Pontifícia Universidade Católica de
Campinas (PUCC)
Campinas - SP
<https://orcid.org/0009-0001-8541-4071>

Ludmilla Vieira Magalhães

Universidade Federal de Juiz de Fora
(UFJFGV)
Governador Valadares - MG
<https://orcid.org/0009-0002-4715-101X>

Ana Laura Lacerda Santana Gomes

Centro Universitário Redentor
(UniRedentor)
Campos dos Goytacazes - RJ
<https://orcid.org/0009-0001-7239-3304>

Samantha Costa de Sousa

Faculdade de Ciências Médicas do Pará
(FACIMPA)
Marabá - PA
<https://orcid.org/0000-0002-4354-3203>

Gabriela Domingues Gama

Faculdade de Medicina de Barbacena
(FAME)
Barbacena - MG
<https://orcid.org/0009-0008-0676-0576>

Neidejany de Assunção do Sacramento

Universidad Nacional de Rosario (UNR)
Rosario - Argentina
<https://orcid.org/0000-0001-7050-6697>

Abstract: Objective: To carry out an analysis of the clinical profile of patients prone to bleeding complications after long bone fractures, focusing on early identification. Furthermore, evaluate therapeutic approaches aimed at preventing, controlling and minimizing damage. **Methodology:** An integrative review was conducted using the PubMed database and the descriptors “Long Bone Fractures” and “Hemorrhage”, combined with the Boolean operator “AND”, resulting in 60 initial articles. After applying inclusion and exclusion criteria, 10 articles were selected to compose the study. **Discussion:** Post-trauma hemorrhagic complications represent risk factors for the lethal triad composed of hypothermia, metabolic acidosis and coagulopathy. In the context of pelvic fractures, a mortality rate above 30% is observed. Antifibrinolytic therapy, particularly tranexamic acid, demonstrates benefit in selected cases by blocking post-traumatic hyperfibrinolysis. Damage control surgery, in turn, contributes to reducing hospitalization time and complications. Fixation in the first 24 hours has a positive impact on the prognosis, although it can be harmful if the intervention lasts for more than 90 minutes. **Conclusion:** Given these considerations, the diversity of therapeutic options available is understood, highlighting the importance of a personalized approach. Furthermore, the need for more robust data for the development of protocols to improve clinical practices is highlighted.

Keywords: Long bone fractures, Bleeding complications, Early identification, Therapeutic approaches.

INTRODUCTION

Approximately two decades ago, it became apparent that early fixation of femoral shaft fractures resulted in improvements in mortality and morbidity rates in patients suffering from multiple traumatic injuries. However, recently, the effectiveness of early stabilization in patients with multiple injuries who present with femoral shaft fractures has been questioned. Some limited studies have reported an increase in morbidity as well as hemodynamic or metabolic instability. Additionally, the external fixation method, used for damage control, has demonstrated significant advantages over previous methods. This method is applied in conjunction with acute resuscitation, ensures hemodynamic stability and allows stabilization of the fracture with reduced blood loss and anesthetic time, minimizing, at the same time, the potential risk of increased morbidity and mortality due to prolonged surgical exposure (Tuttle et al., 2009).

To compare treatment approaches, two cohorts of patients with multiple injuries who also had femoral shaft fractures were identified. One cohort received early total care, while the other underwent orthopedic surgery for damage control. Patients treated with external fixation for damage control had significantly less surgical time and blood loss. Furthermore, no substantial differences were observed between the groups regarding pulmonary complications, multiple organ failure, length of stay in the intensive care unit, or length of hospital stay (Tuttle et al., 2009).

Assessing the hemodynamic status in patients with pelvic ring injuries is crucial to determining the immediate risk of mortality. These patients must be classified as stable, unstable, or “in extremis” as early as possible in primary emergency care. Patients “in extremis” are at high risk of death, as they are in a state of shock, with systolic blood pressure \leq

70 mmHg, requiring mechanical resuscitation and administration of catecholamines (Gänsslen, Hildebrand, & Pohlemann, 2012).

Regarding the origin of pelvic bleeding, around 80-90% are of venous origin, while arterial bleeding accounts for 10-20%. An essential part of initial treatment involves mechanical stabilization of the pelvic ring, combined with control of hemorrhage. Mechanical stabilization can be performed non-invasively, through the application of pelvic ligatures, or invasively, through techniques such as classic anterior pelvic fixation or the use of posterior pelvic C-clamps, depending on locally available resources. In patients in an “in extremis” state, the use of the concept of direct extraperitoneal pelvic packing is recommended. In cases of moderately unstable patients or patients who continue to experience hemodynamic instability despite previous interventions, arterial injury must be ruled out through angiography, followed by selective embolization of the pelvic vessels (Gänsslen, Hildebrand, & Pohlemann, 2012).

Therefore, the main objective of this literature review article is to examine the assessment of bleeding risk in cases of trauma involving long bones and analyze the management strategies used to prevent and control bleeding complications associated with these injuries, providing fundamental information for clinical practice.

METHODOLOGY

This literature review is based on the PVO strategy (population or research problem, variables and outcome) and aims to analyze the assessment of bleeding risk in cases of trauma to long bones, as well as the management strategies used to prevent and control complications. hemorrhagic in this context. The population or research problem involves patients who have suffered long bone trauma, potentially resulting in hemorrhage.

The searches were conducted in PubMed Central (PMC), combining the descriptors “Long Bone Fractures” and “Hemorrhage” with the Boolean operator “AND”. This initial search identified 60 articles, which were subsequently subjected to careful selection criteria. The inclusion criteria covered articles in English, published from 2011 to 2023, that were related to the research themes, including review and meta-analysis studies, as long as they were available in full. Duplicate articles, abstracts that were not directly related to the study proposal and those that did not meet the other inclusion criteria were excluded. As a result, we selected a total of 10 articles to compose this study. This approach aims to provide a comprehensive analysis of the risk assessment of bleeding in long bone trauma, as well as the management strategies employed. This will contribute to the understanding and improvement of clinical practices related to these conditions.

DISCUSSION

ASSESSMENT AND MANAGEMENT OF BLEEDING RISK IN LONG BONE TRAUMA AND PELVIC FRACTURES

Severe trauma and subsequent hemorrhagic shock are recognized as determining factors for the Lethal Triad, composed of hypothermia, metabolic acidosis and coagulopathy. Kalinterakis et al. (2019) highlight the importance of recognizing, preventing and treating these components, emphasizing the critical role of medical professionals in this context.

The management of orthopedic patients with multiple injuries presents significant challenges, especially in the context of long bone trauma. Damage Control, a therapeutic strategy initially developed for femoral fractures, stands out as an effective approach for long bone and pelvic fractures.

Prioritizing physiological restoration over definitive anatomical repair minimizes the impact of primary surgery, being especially relevant in cases of hemodynamic instability and uncontrolled bleeding (Cimbanassi et al., 2017).

Specific intraoperative clinical parameters indicate the application of Damage Control, including hypothermia, acidosis, massive transfusions, and clinical evidence of coagulopathy. The strategy is recommended for patients with hypotension, acidosis and coagulopathy, being an adaptive response to the severity of the hemodynamic and coagulation state (Kalinterakis et al., 2019; Cimbanassi et al., 2017).

The decision to perform early definitive treatment in stable patients is considered safe after successful resuscitation, with criteria such as hemodynamic stability, controlled lactate, adequate body temperature and absence of coagulation disorders. Furthermore, reassessment through radiographs after hemodynamic stabilization is essential, although more advanced examinations, such as ultrasound and magnetic resonance imaging, are reserved for future therapeutic planning (Kalinterakis et al., 2019; Cimbanassi et al., 2017).

Despite being less common, pelvic fractures are frequently associated with high-energy trauma, representing a significant challenge in the trauma context. Adequate hemorrhage control emerges as a crucial modifiable factor for favorable outcomes. Trauma-induced coagulopathy, present in many patients with pelvic fractures, highlights the importance of controlled resuscitation until bleeding is contained (Dubose et al., 2021; Cimbanassi et al., 2017).

Additional studies are needed to develop effective algorithms and intervention sequences that optimize the management of pelvic fractures, providing more satisfactory

results. The definition of conduct and the order of interventions must be the subject of further investigation, aiming to improve clinical practices and the outcome of these patients (Dubose et al., 2021).

The comparative review of studies highlights the need for personalized approaches for patients with long bone trauma and pelvic fractures. While Damage Control stands out as an effective strategy in some cases, the continuous search for algorithms and specific interventions highlights the complexity of these clinical scenarios. Future development of clearer guidelines and more comprehensive studies will help improve the assessment and management of bleeding risk in these situations.

INTERVENTIONS

As highlighted by Von Lübken et al, (2023), early stabilization of fractures within the first 24 hours emerges as a crucial element to improve the prognosis of critically ill patients. However, definitive fracture fixation in patients with intervention longer than 90 minutes and hemodynamic instability is associated with negative outcomes. In these cases, late definitive stabilization is preferred, indicating the performance of an initial temporary fixation, followed by stabilization and definitive fixation in a second surgical stage, minimizing the immunological response and the risk of "Second Trauma".

In line with these conclusions, Cullinane et al. (2011) highlights the effectiveness of using external fixators, such as T-POD, in reducing blood loss, reducing fracture volume and improving biomechanical stability, especially in unstable patients. Comparison between commercial and non-commercial belts reveals that both have similar effects on the need for transfusion, angiographic embolization and patient mortality. Although this intervention may cause unwanted effects,

such as bone breakage and tissue trauma, the study highlights a favorable cost-benefit ratio.

In the study by Constantini et al. (2016), who analyzed 178 patients in shock, computed tomography and angiography with contrast extravasation were the main diagnostic methods. Treatment of critically ill patients involved the application of arterial embolization and the placement of an external fixator for venous bleeding. In addition to these methods, preperitoneal packing was used in some cases. Aortic balloon occlusion was the least frequent method, generally associated with other forms of tamponade. These results highlight the diversity of therapeutic approaches, highlighting the importance of individualizing treatment according to the patient's clinical condition.

As discussed previously, Damage Control Surgery presents significant benefits in the treatment of patients with severe trauma and hemodynamic instability, aiming to restore the body's physiological function. The adoption of this technical approach results in a reduction in hospitalization time, the need for blood transfusions, the period of ventilatory support and the occurrence of complications. When the patient's hemodynamic condition allows it, the recommendation is to perform definitive fixation of the fracture during the first surgical intervention. The literature supports that this intervention in the first 24 hours has a positive impact on patient survival. In cases of Damage Control Surgery, a temporary surgical fixation is chosen, followed by a second procedure for definitive fixation, generally carried out between 5 and 10 days after the initial intervention. Regarding patients with a borderline situation, the lack of consensus in the literature regarding the choice between definitive fixation and Damage Control Surgery stands out. Therefore, care must always be personalized, taking into account the balance between risks and benefits for the

patient, as well as the availability of specific technical tools. This individualized approach plays a crucial role in optimizing clinical outcomes, emphasizing the importance of detailed assessment of each case (Rondanelli et al., 2021).

Performing surgery on intertrochanteric fractures is crucial in many cases, mainly aiming to avoid complications associated with immobility, restricted mobility and deterioration in quality of life (Luo et al., 2023). Studies highlight that anemia resulting from hip fractures and subsequent surgical procedures represents a significant risk factor for mortality, highlighting the importance of controlling occult blood loss in the perioperative period. It is widely recognized that trauma, including fractures, triggers the activation of the body's fibrinolytic system, leading to post-traumatic hyperfibrinolysis, worsening bleeding resulting from the initial injury. Tranexamic acid (TXA), as a hemostatic agent, demonstrates efficacy by blocking fibrinolytic activity, preventing fibrin degradation and inhibiting plasminogen binding sites to lysine. This action effectively results in reducing post-traumatic blood loss by inhibiting hyperfibrinolysis (Luo et al., 2023). Therefore, according to Luo et al. (2023), antifibrinolytic therapy, based on the regular administration of tranexamic acid (1.5 g of TXA every 12 hours, from the day of admission until the third postoperative day), is an effective intervention to significantly reduce

blood loss occult in the perioperative period in elderly patients with intertrochanteric fractures, when initiated within the first 72 hours after the injury. This approach aims to improve outcomes for patients undergoing surgery.

FINAL CONSIDERATIONS

Hemodynamic instability and the risk of hemorrhagic shock are critical factors after trauma to long bones and pelvic fractures. The prevention and treatment of these complications are essential, but the choice of therapeutic approach faces complex challenges. Damage Control stands out as an effective strategy, especially in cases of hypotension, acidosis and coagulopathy. Early definitive surgical intervention is recommended in stable conditions, while temporary stabilization is preferable in unstable situations. Studies investigate other therapies, highlighting the need for a personalized approach. The complexity of therapeutic options reinforces the importance of adapting treatment to the patient's clinical condition. Additional research is crucial to creating specific guidelines, especially in areas such as aortic balloon use, bleeding management in the elderly, and interventions to control hemorrhage in pelvic fractures. These in-depth studies are essential for developing effective protocols and improving clinical practices.

REFERENCES

CULLINANE, D. C. et al. Eastern Association for the Surgery of Trauma Practice Management Guidelines for Hemorrhage in Pelvic Fracture—Update and Systematic Review. *The Journal of Trauma: Injury, Infection, and Critical Care*, v. 71, n. 6, p. 1850–1868, 2011.

COSTANTINI, T. W. et al. Current management of hemorrhage from severe pelvic fractures. *Journal of Trauma and Acute Care Surgery*, v. 80, n. 5, p. 717–725, 2016.

CIMBANASSI, S. et al. Orthopedic injuries in patients with multiple injuries: Results of the 11th trauma update international consensus conference Milan. *Journal of trauma and acute care surgery*, v. 88, n. 2, p. e53-e76, 2020.

DUBOSE, J.J. et al. Pelvic fracture-related hypotension: A review of contemporary adjuncts for hemorrhage control. *Journal of Trauma and Acute Care Surgery*, v. 91, n. 4, p. e93-e103, 2021.

GÄNSSLEN, A.; HILDEBRAND, F.; POHLEMANN, T. Management of hemodynamic unstable patients “in extremis” with pelvic ring fractures. *Acta Chir Orthop Traumatol Cech*, v. 79, n. 3, p. 193-202, 2012.

KALINTERAKIS, G. et al. The evolution and impact of the “damage control orthopedics” paradigm in combat surgery: a review. *European Journal of Orthopaedic Surgery & Traumatology*, v. 29, p. 501-508, 2019.

LUO, G. et al. Early Posttraumatic Antifibrinolysis Reduces Perioperative Hidden Blood Loss in Elderly Patients with an Intertrochanteric Fracture: A Randomized Controlled Trial. *Journal of Clinical Medicine*, v. 12, n. 15, p. 5018, 2023.

RONDANELLI, A.M. et al. Damage control in orthopaedical and traumatology. *Colombia Médica*, v. 52, n. 2, 2021.

TUTTLE, M.S. et al. Safety and efficacy of damage control external fixation versus early definitive stabilization for femoral shaft fractures in the multiple-injured patient. *Journal of Trauma and Acute Care Surgery*, v. 67, n. 3, p. 602-605, 2009.

VON LÜBKEN, F. et al. Early total care or damage control orthopaedics for major fractures? Results of propensity score matching for early definitive versus early temporary fixation based on data from the trauma registry of the German Trauma Society (TraumaRegister DGU®). *European Journal of Trauma and Emergency Surgery*, p. 1-14, 2023.