Musculoskeletal injuries represent one of the most common indications for operative intervention in patients admitted secondary to blunt trauma. High-energy mechanisms often result in multi-system injuries, including injuries to the pelvis and extremities, as well as the head, chest, and abdomen. Furthermore, patients with extensive injuries may often require multiple operative procedures and anesthetics. One of the more common questions for the perioperative physician is often “Is this patient ‘cleared’ for the operating room?” While few true orthopedic emergencies exist in present day trauma care, the coordination of fracture management is of significant relevance to the trauma anesthesiologist. Timely management of these injuries, as well as a thorough understanding of concomitant or competing injuries, may have a substantial impact on the resource utilization and ultimate outcome of these multi-system trauma patients.

Historically, long-bone fracture care in patients with multiple injuries consisted of skeletal traction until the patient’s physiology allowed for definitive operative fixation. This would necessitate prolonged periods of immobilization, exposing these critically injured patients to a significantly increased risk of pneumonia, fat embolism, deep venous thrombosis, and pressure ulcers. In addition, this lead to a heightened inflammatory response because of continued pain from motion at the fracture site that had yet to be adequately reduced. However, in the 1970s and early 1980s, retrospective series of multiply injured trauma patients began to suggest that this delayed approach to fracture care was harmful, and a more timely intervention to restore musculoskeletal anatomy is associated with improved clinical outcomes, including reduced pulmonary complications.\(^1\) In the seminal trial by Bone et al., patients were prospectively randomized to early definitive fixation of a femur fracture within 24-hours, or delayed internal fixation occurring more than 48-hours after admission.\(^2\) In patients with multi-system trauma, early definitive fixation resulted in fewer respiratory complications. This approach of early definitive fracture fixation became the standard of care throughout the 1990s, with numerous
critically injured trauma patients undergoing intramedullary nailing of long-bone fractures within the first day of hospital admission.

Throughout the latter part of the 20th century, as our understanding of the pathophysiology of critical illness and subsequent multiple organ failure matured, it became apparent that fracture care and musculoskeletal stabilization were an integral part of the initial resuscitation of the critically injured trauma patient. John Border’s lecture at the 1994 Annual Meeting of the American Association for the Surgery of Trauma, titled “Death from Severe Trauma: Open Fractures to Multiple Organ Failure,” highlighted the concept that “doing the fractures must be considered as completing the resuscitation.” However, further scientific evidence began to question the role of early definitive fracture care in all multiply injured trauma patients. Crowl et al. published a retrospective study of 47 trauma patients with an Injury Severity Score >18 and concluded that failure to normalize lactate was associated with increased complications in trauma patients with a femur fracture who underwent definitive fixation within 24-hours. Close inspection of the data revealed that only two patients with an elevated lactate achieved normalization prior to definitive fracture care. Further studies also began to question the routine practice of early fracture fixation and attributed the negative outcomes to inadequate resuscitation prior to operative intervention for orthopedic procedures. A large retrospective study from the National Trauma Databank concluded that “delayed repair of femoral shaft fractures beyond twelve hours in patients with multisystem trauma, which may allow time for appropriate resuscitation, reduces mortality.” However, resuscitation data, such as lactate and base deficit values, was not evaluated in this study. Furthermore, other large database investigations offered differing results regarding delayed internal fixation of femur fractures in multi-system trauma patients, such that the most recent 2014 Eastern Association for the Surgery of Trauma Practice Guidelines is a conditional recommendation for early (<24 hours) fixation, based on low strength of evidence.

How then are we to interpret and reconcile the available evidence and guidelines into clinical practice? Let us not forget the tenets proposed by Dr Border that prompt attention to cardiopulmonary care and resuscitation from traumatic shock also includes appropriate consideration of associated fractures. While there is no perfect marker of hemodynamic resuscitation, serum lactate remains one of the most valuable and easily attainable biomarkers to predict risk of death and multiple organ failure in critically injured patients. A recent retrospective study from three large academic trauma centers (Vanderbilt University Medical
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Center, Carolinas Medical Center, and R Adams Cowley Shock Trauma Center) suggested that while admission lactate was associated with increased pulmonary complications, there was no difference in outcome based on whether patients cleared their preoperative lactate to <2.5mmol/L prior to early definitive femur fracture fixation,\(^7\) as initially proposed by Crowl et al. Vallier et al. demonstrated that a protocol to definitively address fractures of the spine, acetabulum, pelvis, and/or femur within 24-hours was feasible and that statistical modeling identified admission acidemia, severity of chest injury, and delayed fracture fixation as risk factors for pulmonary complications.\(^8\) To this end, the authors have established and validated a grading system whereby critically injured trauma patients are stratified based on pH (≥7.25), base excess (≥5.5), and lactate (<4.0) to determine appropriateness of definitive fracture care.\(^9\)

Despite the abundance of emerging evidence on early definitive fracture care, there are undoubtedly limitations to this wealth of data, most notably that a large majority comes from retrospective databases, which contains inherent bias. Furthermore, there are certain patient populations that have been excluded from many of these studies but represent an important component of the multi-system, blunt trauma population (i.e. traumatic brain injury (TBI) patients). There has been considerable discussion in the literature on the optimal approach to orthopedic injuries in patients with TBI with no clear consensus or recommendation on timing of definitive fracture care.\(^10\)-\(^12\) Previous data has shown that intramedullary reaming reduces cerebral perfusion pressure,\(^13\) however, it is unknown whether certain anesthetic techniques will potentially optimize cerebral perfusion during the reaming process. Future scientific study will provide much needed data on this topic. Nonetheless, in trauma patients with severe TBI it seems reasonable and most safe, and is the practice at our institution, to provide temporary fracture fixation with external fixation and perform definitive care once intracranial pressure has normalized with minimal fluctuations, a period which is patient specific and dependent on injury severity.

As our knowledge of the critically injured patient has evolved over the last half-century, so have our approaches to the resuscitation and prioritization of their injuries. Further research will also provide better insight into the care and resource utilization of these multi-system trauma patients. Perioperative, intraoperative, and critical care trauma medicine are multi-disciplinary efforts that involve numerous specialists and subspecialists, of which the anesthesiologist is intimately involved and must be well-versed in the care of multi-system orthopedic trauma patients. Based upon available scientific evidence and considering astute clinical judgment, it
appears reasonable that multi-system trauma patients may safely proceed with definitive fixation of orthopedic injuries as long as their physiology demonstrates an improvement in acid-base status, lactate values that are approaching <4.0 mmol/L, and they lack a severe traumatic brain injury with intracranial hypertension. Those patients deemed too critically injured and metabolically deranged to undergo definitive fracture care should proceed with temporary external fixation, which is transitioned to definitive care at a time when is physiologically appropriate.¹⁴

References


