JOURNAL PRESENTATION

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- TOPIC -Care of the Severely Injured Orthopedic Trauma Patient Considerations for Initial Management, OperativeTiming, and Ongoing Resuscitation

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INTRODUCTION

- In the setting of major Trauma, Musculoskeletal injuries are the most common indication for surgery in the severely injured polytrauma patient .
- The current consensus statement for polytrauma defines it as an Abbreviated injury score (AIS) 3 points in at least 2 body regions with a least 1 pathologic value (systolic blood pressure 90 mm Hg,Glasgow Coma scale 8, base deficit 6, partial thromboplastin time 40 s, or age 70) with the presence of concomitant limb and pelvic fractures counting as a single body region.
- More than 95% of polytrauma cases occur due to blunt trauma,with thoracic and traumatic brain injuries being the most commonly associated injuries.
- Although Traumatic brain injury (TBI) and Exsanguination due to hemorrhage continue to be the leading causes of death in the polytrauma patient
- The presence of significant extremity injury is associated with worse outcomes, including an increased hospital length of stay, transfusions, and operative procedures.
- Recent advances in management of the severely injured orthopedic trauma patient can affect perioperative management.

Injury Severity Score; ISS

Region	Injury Description	AIS	Square Top Three
Head & Neck	Cerebral Contusion	3	9
Face	No Injury	0	
Chest	Flail Chest	4	16
Abdomen	Minor Contusion of Liver Complex Rupture Spleen	2 5	 25
Extremity	Fractured femur	3	
External	No Injury	0	
		Injury Severity Score:	50

AIS Score	Injury
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Survivable

ISS	
1-8	Minor
9-15	Moderate
16-24	Serious
25-49	Severe
50-74	Critical
75	Maximum

- PREHOSPITAL AND INITIAL MANAGEMENT

- Prehospital management of the polytrauma patient with orthopedic injuries will focus on the early and aggressive management of any immediate, lifethreatening injuries, including airway management and hemorrhage control, followed by triage and transport to an appropriate treatment facility.

- Specific to the management of orthopedic injuries, prehospital care focuses on reduction and splinting of extremity fractures and control of hemorrhage using direct pressure,topical agents, and tourniquet application.

- In the setting of obvious or likely unstable pelvic injury based on examination and/or mechanism, placement of a pelvic binder, either commercial or improvised, also can be considered.

- On arrival to the hospital, ongoing resuscitation, evaluation, and treatment will continue to focus on the likely sources of life-threatening conditions, including active hemorrhage.

- Aspects of the prehospital and initial emergency department (ED) management may have an impact on operative planning and can affect the anesthetic management of those patients presenting to the operating room (OR) for orthopedic procedures.

- Use of tourniquets in extremity trauma

- Tourniquets, limb constrictive devices either commercially manufactured or improvised, have been used to stop extremity hemorrhage since at least the Middle Ages.

- They are applied proximal to the injury, never over a joint, and are effective when they eliminate distal arterial flow to the injured extremity.

- Although application time can be prolonged due to extended transport times, it should be minimized where possible to limit tourniquet-related complications.

- Although no human trials have been conducted to determine the maximum safe duration, most recommendations advise 2 hours as the maximum tourniquet time, with deflation intervals if required beyond that limit.

- Bleeding from extremity wounds, with and without concomitant bony injury,is a major cause of potentially preventable death .
- Tourniquets to be effective in achieving temporary hemostasis and reducing mortality from extremity hemorrhage .
- Earlier application (point of injury) for blunt and penetrating trauma.
- The American College of Surgeons Committee on Trauma has published evidence-based guidelines including a recommendation for the civilian use of tourniquets when direct pressure is inadequate to control hemorrhage .
- More recently, a multicenter retrospective study by Teixeira and colleagues compared mortality and other outcomes in 1026 patients with peripheral vascular injuries with and without prehospital tourniquet application.

- They also noted that tourniquet use was independently associated with a significant survival benefit without increasing the risk of delayed amputation, although the application rate remains low even when potentially beneficial.
- In the perioperative setting, tourniquet application in the prehospital or ED setting may necessitate more urgent access to the OR due to concern for limb ischemia or damage with prolonged inflation time.
- Typically, however, many field-applied tourniquets can be removed in the ED.
- A pneumatic tourniquet is applied proximal to the existing tourniquet that is then removed .
- If active hemorrhage is noted, the pneumatic tourniquet is inflated with a plan for immediate operative intervention.
- If no active hemorrhage is noted, the pneumatic tourniquet is left uninflated and in place while further workup is completed before any required operative intervention.

- Initial management of severe pelvic trauma

- High-energy injuries,can produce significant pelvic injury and associated hemorrhage leading to hemodynamic instability.

- Torso and pelvic fractures are not as amenable to tourniquet use or direct pressure requiring other measures to control active hemorrhage.

- A recent review of treatment options for life-threatening truncal and junctional hemorrhage provides an overview of devices available for controlling or limiting ongoing bleeding in the prehospital or ED setting .
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- This review included a discussion of junctional tourniquet systems; however, they found no documented clinical use of these devices in the setting of hemorrhage due to pelvic fracture.

- The most common initial management of severe pelvic trauma includes pelvic stabilization with a pelvic binder (prehospital, ED, or OR) or anterior external fixation (ED or OR).

- Pelvic stabilization serves multiple purposes, including the following:
- -Prevention of additional injury from pathologic pelvic motion
- -Reduction in pelvic volume limiting further blood loss
- -Tamponade and limitation of pelvic hemorrhage
- -Management of pain

- With significant hemodynamic instability and rapid, ongoing exsanguination due to arterial injury below the diaphragm, arterial inflow arrest with open cross clamping or via percutaneous or open balloon occlusion techniques is another option for controlling or limiting bleeding.

- In some patients, this may serve as a temporary measure to allow for surgical or angio embolization attempts at control of ongoing hemorrhage,This includes a recent surge of interest in the use of Resuscitative endovascular balloon occlusion of the aorta (REBOA).

- Patients with pelvic fractures can initially be divided into 2 groups:
- (1) stable pelvic fracture, or
- (2) displaced pelvic ring fractures with hemodynamic instability or high risk for deterioration.

- This second group has the highest risk for complications and mortality related to their injuries.

- The presence of associated injuries to the head, chest, and abdomen can lead to conflicting priorities in management of these patients.

- For example, a computed tomography (CT) finding of a high-grade splenic injury in the setting of a severe pelvic injury and hemodynamic instability may require an exploratory laparotomy before addressing the pelvic injury.
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- These patients may present for operative procedures with or without early interventions, such as placement of a pelvic binder or REBOA.

- As the unstable trauma patient is moved to the angiography suite or hybrid OR, resuscitation should continue to maintain an acceptable perfusion pressure; and survival is higher if this transition occurs within 3 hours of presentation.

- Management of these interventions in the OR requires an understanding of the anatomy, physiology, and surgical considerations involved in their use in the operative setting.

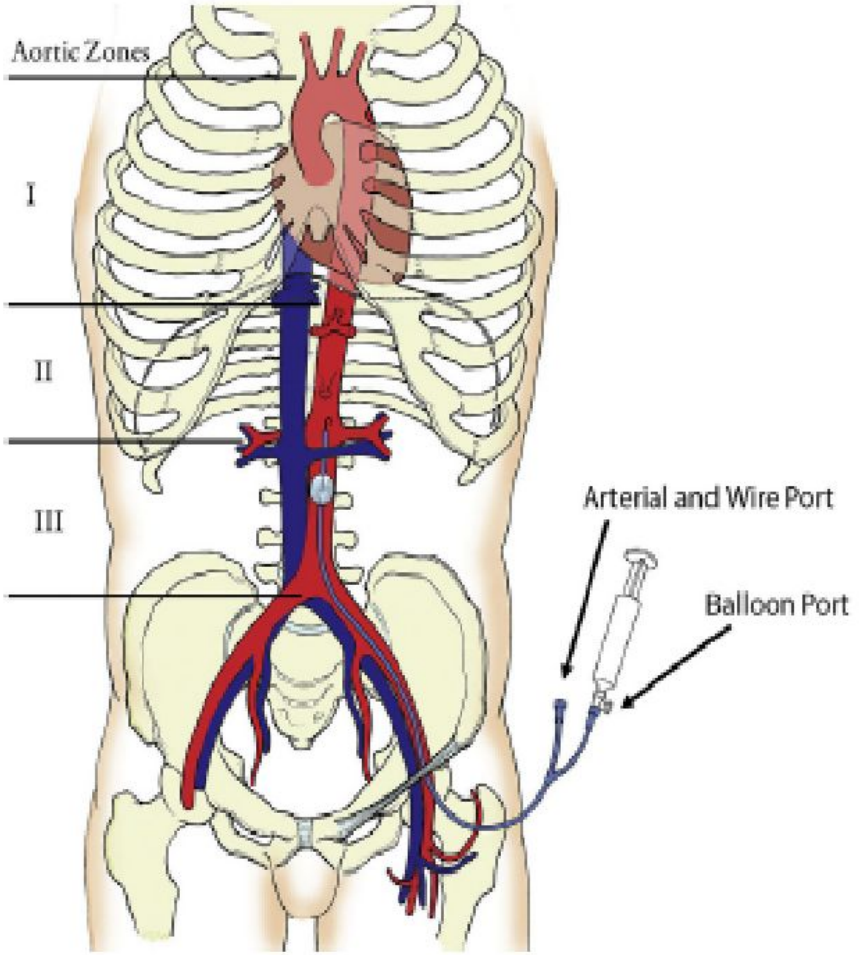

Fig. 2. Anatomy and inflation zones for REBOA. Zone 1, origin of the left subclavian artery to celiac artery; zone 2, from celiac artery to the most caudal renal artery; zone 3, from the most caudal renal artery to the aortic bifurcation. (*From* Conti BM, Richards JE, Kundi R, et al. Resuscitative endovascular balloon occlusion of the aorta and the anesthesiologist: a case report and literature review. A A Case Rep 2017;9:155; with permission.)

- In trauma, REBOA has evolved as an alternative to a resuscitative thoracotomy with cross clamping of the aorta to reduce ongoing bleeding, increase central perfusion pressure, and allow time for operative control of hemorrhage.
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- In addition, it allows for a more localized approach to intra-aortic occlusion compared with cross clamping, because the balloon can be inflated in different zones to preferentially preserve more proximal perfusion with know nor suspected hemorrhage sites.

- Zone 1, used for intra-abdominal hemorrhage,is occlusion in the thoracic aorta above the diaphragm;

- zone 2 is a nonocclusion zone in the paravisceral aorta;

- zone 3, used for pelvic and lower extremity hemorrhage, is occlusion in the infrarenal aorta .

- Although the use ofzone 3 may appear beneficial in terms of limiting visceral ischemic burden and instability on reperfusion.

- Multiple investigators have recommended use of zone 3 occlusion in the hemodynamically unstable patient with pelvic fractures.

- In-hospital placement of REBOA has also been shown to temporize venous hemorrhage and change the treatment algorithm for hemorrhage due to pelvic injury.

- Where pelvic packing was once the mainstay when angioembolization was unavailable, REBOA deployment in zone 3 can reduce arterial inflow decreasing blood loss and allowing for resuscitation and definitive treatment with either surgery, angioembolization, or both .

- In the setting of coagulopathy, REBOA results in better hemorrhage control, lower rate of bleeding, higher mean arterial pressure, and lower mortality compared with direct pressure with a hemostatic dressing.

- When effective at stabilizing blood pressure,the usual next step involves embolization or control of hemorrhage within the abdomen via a laparotomy and pelvic packing with or without external pelvic fixation.

- Embolization is 85% to 97% effective in controlling arterial bleeding associated with pelvic fractures; however, these interventions require significant ongoing support and patients may not be stable for transfer to an angiography suite without extensive resources for ongoing resuscitation and management, particularly after balloon deflation .

- In those cases, use of a hybrid OR with angiography and operative/anesthesia support may be the best option.

- To date, there are no reports specifically looking at REBOA deployment solely for the control of hemorrhage related to severe pelvic trauma.

- Several recent reports document the effectiveness of REBOA for noncompressible truncal hemorrhage, including a subset of patients with pelvic hemorrhage and associated pelvic fractures.

- The first report from the American Association for Surgical Trauma Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) registry was published in 2016 comparing prospective observational outcomes and procedural information for both REBOA and open aortic occlusion (thoracotomy with cross clamping).

- There were no significant differences in mortality, resuscitation requirements, or organ system complications in survivors.

- After occlusion, REBOA patients were noted to have a higher mean systolic blood pressure , but were less likely to have an identified source of bleeding above the level of occlusion (intrathoracic injury).

- The general conclusions from this report support the continued use of REBOA over open aortic occlusion in a subset of severely injured trauma patients.
- Pelvic bleeding accounted for 21% of the zone 1 and 53% of the zone 3 REBOA cases.
- The highest survival rate (54%) was seen in patients undergoing zone 3 deployment with vital signs present during REBOA placement.
- Taken together, the use of REBOA appears to be on the rise as another method for resuscitation of the patient with severe hemodynamic compromise or potential deterioration from ongoing hemorrhage below the diaphragm,including those with severe pelvic fractures.
- Concerns remain about more broad usage since methods for controlling hemorrhage (access to angiography, availability of a trauma surgeon, and/or OR capability) must be immediately available.

- To that end, the American College of Surgeons Committee on Trauma and the American College of Emergency Physicians have published a joint statement regarding the clinical use of REBOA
- Recommended indications for REBOA use include the following:

- -traumatic life-threatening hemorrhage below the diaphragm in patients in hemorrhagic shock who are unresponsive or transiently responsive to resuscitation
- -patients arriving in arrest from injury due to presumed life-threatening hemorrhage below the diaphragm; no evidence exists for the recommended duration of arrest and use of REBOA but should be used within the same time as would resuscitative thoracotomy
- - patients with severe intra-abdominal or retroperitoneal hemorrhage, or those with traumatic arrest with inflation at the distal thoracic aorta (zone 1)
- -patients with severe pelvic, junctional, or proximal lower extremity hemorrhage with inflation at the distal abdominal aorta (zone 3)

- Additionally, they emphasized that REBOA should be performed by an individual with training and experience.

- When performed by a nonsurgeon, the individual must be able to have immediate availability of an acute care or vascular surgeon trained in REBOA to address hemorrhage control and removal of the device.
- For patients presenting to the OR with severe pelvic trauma and hemorrhage with a REBOA catheter in place, there should be advanced planning for deflation of the balloon.
- Current recommendation is for slow deflation once surgical or embolization has controlled most of the associated pelvic hemorrhage.
- Communication is key to ensure the surgical and anesthesia teams are prepared for reperfusion because the patient may deteriorate after balloon deflation and preplanning with volume loading and pressor management may be necessary.
- Slow deflation should occur over several minutes with small volumes being removed to allow for more gradual equilibration and reperfusion.
- In the event of prolonged balloon occlusion in the setting of poorly controlled hemorrhage or a delay in getting to more definitive treatment, early partial REBOA may be used [36].

- If the patient responded well to resuscitation in combination with full occlusion, the balloon may be partially deflated after 10 minutes.
- In theory, this allows for a more normotensive resuscitation above the level of balloon inflation while allowing some distal perfusion.
- This can best be accomplished by monitoring the distal arterial pressure waveform from the femoral sheath introducer and withdrawing small volumes from the REBOA cuff (<1 mL of saline at a time) until a pulsatile arterial waveform is just seen.
- If this is tolerated, deflation can continue slowly to complete or further partial deflation while monitoring other markers of perfusion.
- Several recent reviews of REBOA deployment and anesthetic considerations have been published describing the physiologic changes associated with balloon deflation and will not be covered in detail in this review .

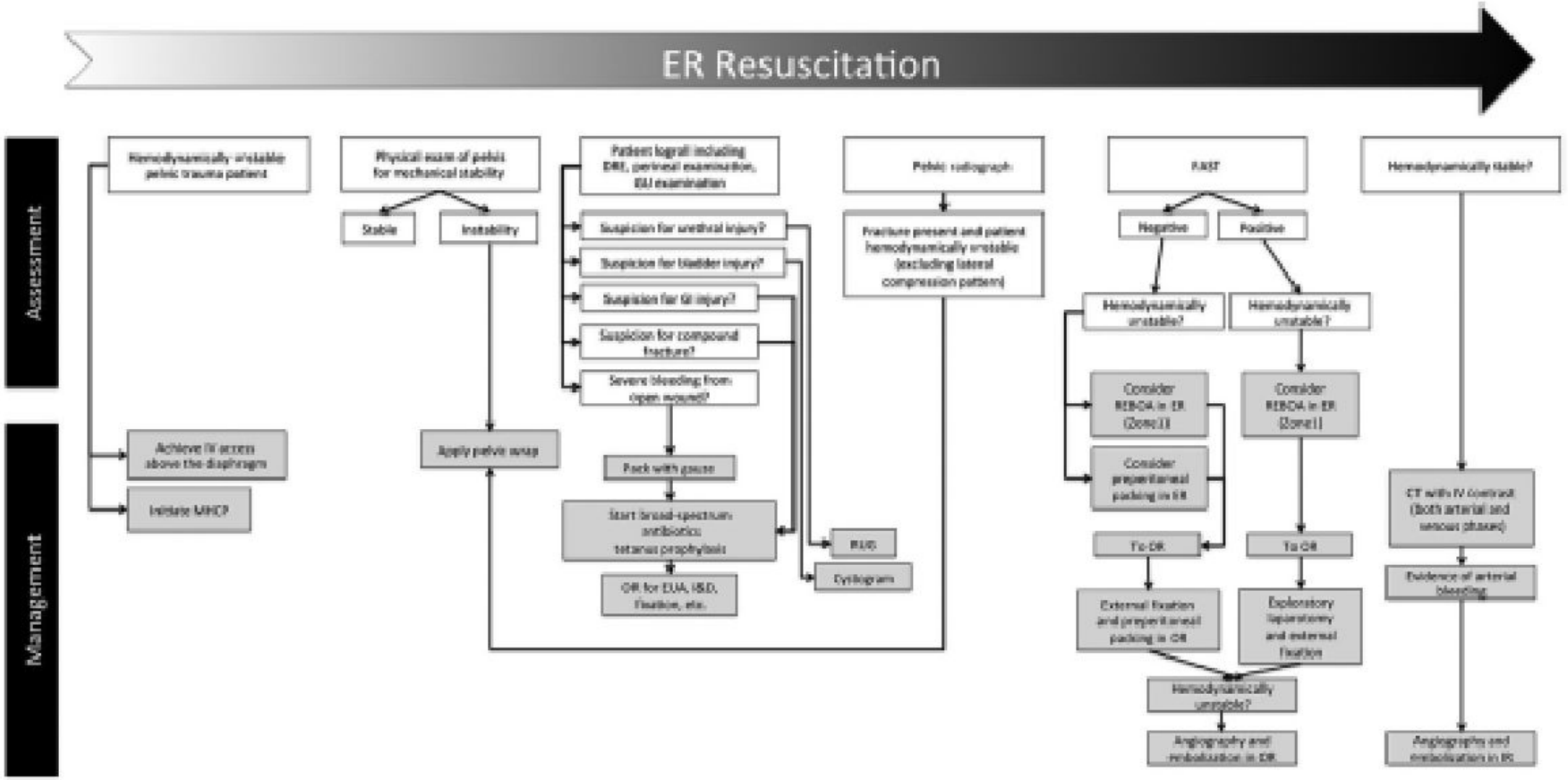

Fig. 4. Pelvic trauma assessment and management algorithm showing integration of REBOA into operative planning. DRE, digital rectal examination; ER, emergency room; EUA, examination under anesthesia; FAST, focused assessment with sonography for trauma; GI, gastrointestinal; GU, genitourinary; I&D, incision and drainage; IR, interventional radiology; IV, intravenous; MHCP, massive hemorrhage control protocol (also known as massive transfusion protocol); RUG, retrograde urethrogram. (*From* Skitch S, Engels PT. Acute management of the traumatically injured pelvis. Emerg Med Clin N Am 2018;36:163; with permission.)

- OPERATIVE TIMING: NOW OR LATER ?
- General considerations

- Timing of operative intervention in polytrauma patients with orthopedic injuries has been a topic of considerable academic and clinical discussion.

- Musculoskeletal injuries represent common injury patterns seen in patients with highenergy mechanisms of injury and are one of the more common reasons for operative intervention in the trauma population .

- Historically, injuries to the extremities in multisystem trauma patients who were too critically injured for definitive operative intervention were managed with traction and prolonged immobilization.

- These patients experienced high rates of pulmonary failure and prolonged mechanical ventilation, developed sepsis frequently, and had high mortality rates .

- Specifically, pulmonary complications have been a common occurrence in this population of trauma patients with nearly 30% of patients with multiple extremity injuries experiencing pulmonary morbidity .

- Therefore, the goal of fracture management in the multisystem trauma patient is restoring musculoskeletal anatomy that allows for mobilization, pulmonary toilet, and adequate pain control.

- In the patient with isolated extremity or hip fracture without polytrauma, the evidence remains clear that early definitive fracture care improves outcomes.

- In patients with hip fracture, current US and Canadian guidelines recommend surgery within 48 hours.

- Within the United Kingdom, surgery within 36 hours is a quality of care indicator, although adherence to these guidelines is incomplete.

- These recommendations may require revision, as more recentwork has consistently demonstrated an increasing complication rate for surgery >24 hours after injury .

- Among adults requiring hip fracture surgery, a wait time of 24 hours appears to be a threshold defining higher risk.

- Similarly, fixation of femur fractures in patients with a lower ISS within 48 hours of injury is also associated with improved outcomes .

- Pathophysiologic considerations
- Decision about timing of operative interventions in the polytrauma is more complex.
- The inflammatory response to disruption of soft tissue structures, including muscle and bone, may produce marked changes in the pulmonary vascular system .
- Furthermore, the operative intervention required to treat severe musculoskeletal injuries may further exacerbate the inflammatory reaction .
- Fat particles released into the systemic circulation after injury resulting in a fractured bone may embolize into the pulmonary vasculature leading to activation of neutrophils and complement resulting in endothelial damage and alterations in pulmonary capillary permeability.

- The end result of this inflammatory reaction is the potential for increased pulmonary vascular resistance with an abnormal and increasing alveolar-arterial oxygen (PAO_2-PaO_2) gradient .
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- The method by which traumatic orthopedic injuries are operatively managed is a topic of importance.

- The technical process of inserting an intramedullary nail involves opening of the intramedullary canal, mechanical reaming to increase the diameter of the intramedullary space, and insertion of the intramedullary device itself, which allows for rigid fracture fixation.

- Fat emboli were generated with pressurization of the intramedullary canal,

- There was no difference in the occurrence of acute respiratory distress syndrome, pulmonary emboli, pneumonia, multiple organ failure, or death when fixation of the fracture was with an intramedullary nail compared with open reduction and internal fixation with a plate.

- Considering the large amount of evidence suggesting no difference in pulmonary outcomes in patients with multisystem trauma treated with reamed intramedullary nailing, and the considerable success of the intramedullary device at achieving fracture healing, this is the preferred method of operative treatment for these trauma patients with a femur fracture at most centers.

- Invariably, many trauma patients with musculoskeletal injuries will require an operative intervention, and although the method of that intervention has been discussed, there remains an inherent risk of a "second hit" related to that intervention .

- The 2-hit theory describes the initial traumatic injury as the "first hit" in a cascade of pathophysiologic events that are affected by the degree of soft tissue destruction and systemic inflammation.

- the pathophysiologic response to the "first hit" may resolve with minimal long-term adverse sequelae.
- However, when the magnitude of this initial insult is severe, causing hematologic and microvascular derangements, trauma patients are at an increased risk of multiple organ failure.
- The "second hit" of this phenomenon is manifested when a second insult, often times an operative intervention but also any potential changes in patient physiologic status, such as hypoxia or hypotension, occurs before resolution of the initial "first hit."
- In the case of patients with multisystem orthopedic trauma, the 2-hit theory focuses on the definitive operative intervention, which aims to address the primary musculoskeletal injuries.
- Therefore, this "second hit," when performed at an inappropriate time, may further exacerbate the inflammatory response and place the patient at greater risk of systemic complications, such as multiple organ failure or acute respiratory distress syndrome.

- Timing
- Early definitive fixation of lower extremity fractures in multiply injured trauma patients has become a standard treatment approach in most patients.

- The idea that definitive fracture care may represent a "second hit" in severely injured patients with multisystem orthopedic trauma tempered enthusiasm for early definitive care.

- Following the examples in the general trauma literature and the practice of damage control resuscitation (DCR),whereby life-threatening hemorrhage is controlled in conjunction with hemodynamic resuscitation and correction of coagulopathy followed by later definitive repair of injuries,

- the concept of damage control orthopedics has evolved to minimize the "second hit" of long-bone fracture care in patients deemed at significant risk for pulmonary complications and multisystem organ failure.

- Therefore, it is hypothesized by the 2-hit theory that initial serious metabolic disturbances in the form of hemorrhagic shock and endothelial dysfunction may prime an inflammatory response that is further exacerbated by definitive fracture care if the "second hit" occurs during a period of underresuscitation and systemic hypoperfusion.

- The grading scheme and subsequent algorithm incorporates various measurements of depth of clinical shock and resuscitation requirements, such as blood pressure, units of blood transfused, serum lactate, base deficit, platelet count, and fibrinogen level.

- All of these measurements have demonstrated a significant association with the subsequent development of multiple organ failure [65,66].
- Serum lactate represents an easily obtainable and readily available marker of hemodynamic resuscitation in trauma patients.

- The idea that under resuscitation before early definitive fracture fixation posed a greater risk of multiple organ failure was further clinically supported by the two-hit theory.

- More recent advances in the assessment of clinical shock and resuscitation of the patient with multisystem orthopedic trauma have potentially offered greater insight into determining the optimal time of definitive operative fixation.

- In the context of the two-hit theory, an improvement toward normalization of basic markers of resuscitation and anaerobic metabolism appears to allow sufficient recovery from the initial first hit of traumatic injury.

- Patients with multisystem trauma with TBI may often have significant extremity injuries.

- However, the impact of a prolonged operation in patients with intracranial hypertension may predispose this population to lower cerebral perfusion pressure and worse neurologic outcomes .

- Furthermore, evidence from patients with a femur fracture and a TBI demonstrates that intramedullary reaming is associated with a significant decline in cerebral perfusion pressure.

- In addition to intracranial pathology, trauma patients who sustain a blunt mechanism of injury may have various degrees of thoracic injuries.

- Numerous studies have evaluated the impact of timing of operative intervention in patients with multisystem orthopedic trauma with long-bone fractures who have also sustained severe chest trauma.

- The degree of chest injury is most predictive of pulmonary outcome and early definitive fixation is associated with reduced pulmonary complications even in patients with thoracic trauma .

- Unfortunately,the optimal ventilator strategy for these patients is unknown; however, in clinical practice the most reasonable approach is likely reflective of the patients' pulmonary compliance, with attention toward maintaining functional residual capacity, an open lung strategy, and optimal oxygenation.

- Last, there has been much discussion regarding definitive fracture fixation once all intraabdominal injuries have been addressed and resuscitation completed.

- ONGOING RESUSCITATION

- General considerations

- The ideal resuscitation strategy in the polytrauma orthopedic patient has not been completely elucidated.

- Whether or not a massive transfusion strategy based on a resuscitation ratio (ie, 1:1:1 of blood:plasma:platelets) is appropriate during the intraoperative period for definitive fracture care is unknown; however, it is clinically prudent to maintain a balanced resuscitation that corrects underlying metabolic disturbances and adjust the serum pH toward more normal parameters .

- Severe trauma and soft tissue injury degrades the microvascular endothelial glycocalyx and is represented by elevations in inflammatory markers, such as serum lactate.

- This predisposes patients to alterations in coagulation function and ultimately multiple organ failure.

- Evaluate the role of plasma resuscitation and restoration of the endothelial glycocalyx in the intraoperative and perioperative management.
- Commonly such patients are at risk for coagulation disturbances and may present for definitive fracture fixation demonstrating hypocoagulability , there is likely also an under appreciation for patients who are hypercoagulable.
- The emergence of viscoelastic testing allows for real-time evaluation of coagulation and identification of specific components of the clotting pathway that are deficient or in excess.
- Trauma patients are known to be at greater risk of thromboembolic complications during hospitalization in patients with severe extremity injuries.
- In addition, intramedullary reaming may generate a prothrombotic state via activation of platelets and inhibition of fibrinolytic activity .
- Ultimately,continuous assessment of coagulation and a balanced, goal-based resuscitation is of significant value in the severely injured orthopedic trauma population.

Role of Antifibrinolytic Therapy

- The Clinical Randomization of an Antifibrinolytic in Significant Hemorrhage-2 (CRASH-2) trial in 2010 showing a reduction in death due to bleeding in trauma for patients allocated to receive the antifibrinolytic TXA compared with individuals receiving placebo has resulted in the inclusion of TXA in multiple guidelines and resuscitation strategies for the trauma patient population.

- Early TXA administration appears to decrease mortality in both civilian and military populations, but a later analysis of the CRASH-2 trial suggested that late administration, after 3 hours, may be less effective and potentially harmful.

- The need for early administration was confirmed in a mixed population study of TXA used in the setting of ongoing or potential hemorrhage.

- Using results from the CRASH-2 and World Maternal Antifibrinolytic (WOMAN) trials , the investigators concluded that even a short delay in treatment reduces the benefit of TXA administration with no impact on vascular occlusive events.

- Overall, survival benefit decreased by 10% for every 15 minutes of treatment delay up to 3 hours after injury at which point no benefit could be identified.

- Concern remains, however, for the potential to increase thromboembolic complications with the use of TXA.
- As noted previously, there are multiple factors in the orthopedic trauma patient that already create a prothrombotic state.
- In addition, Moore and colleagues have identified a subset of trauma patients who appear to have fibrinolytic shutdown manifested by increased circulating plasminogen activator activity and decreased evidence of fibrinolysis on viscoelastic monitoring.
- The addition of TXA to this subgroup of trauma patients with fibrinolytic shutdown and a heightened prothrombotic state has been theorized to increase the incidence of vascular occlusive events.
- To date, the only study examining the effect of TXA on different patterns of fibrinolysis (shutdown, physiologic, systemic) found that TXA administered to patients in fibrinolytic shutdown did not increase mortality; however, TXA use was associated with increased mortality in patients showing a physiologic (normal) level of fibrinolysis on admission .

- The questions of TXA with respect to timing and VTE are particularly pertinent to the patient with severe orthopedic trauma.
- Based on the extensive work done on the use of TXA in an elective orthopedic surgical population looking at blood loss and transfusion requirements, there has been a natural extension of this literature to the orthopedic trauma population requiring surgical interventions.
- In the elective orthopedic surgical population, TXA administration either intravenously or topically, is associated with fewer transfusions, decreased blood loss, and no increase in VTE complications.
- Overall,TXA appears to have an acceptable safety profile in the elective surgical population.
- As noted previously, the general resuscitative approach in the orthopedic polytrauma patient with ongoing hemorrhage and/or hemodynamic instability would be early administration of TXA at time of initial assessment to optimize benefit.
- It is unclear if this would have an impact on blood loss and intraoperative transfusion requirements.

- Additionally, it is not known if multiple administration of TXA (at admission and in the OR) is beneficial or more likely to result in thromboembolic complications.

- Additionally, the CRASH-2 trial secondary analysis did find that late administration, such as would typically occur with an orthopedic surgical procedure, may be potentially harmful.

- In summary, current data suggest that intraoperative administration of TXA in orthopedic trauma patients presenting with single-system injury from a low-energy mechanism is safe and can reduce blood loss and transfusion requirements.

- In the setting of polytrauma with physiologic disturbance, TXA is most likely beneficial if administered early as part of a DCR strategy

- The impact of later administration of TXA in the orthopedic polytrauma patient presenting to the OR is unknown, although clear evidence of fibrinolysis on laboratory or viscoelastic monitoring would support its use.

SUMMARY

- Perioperative management of the orthopedic polytrauma patient requiring operative intervention can be extremely challenging.
- An understanding of prehospital and initial management of hemorrhage control, including the increasing use of tourniquets and REBOA, will affect operative planning.
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- Decisions regarding operative timing for non–life-saving orthopedic surgical intervention requires consultation among anesthesiologists, surgeons, and other specialists to determine whether a definitive repair is appropriate given the overall patient condition.
- Most patients, however, will be appropriate for early definitive care and likely to benefit from this approach.
- Intraoperative resuscitation of these patients starts at the point of initial contact and will frequently continue into the operative setting.
- Use of antifibrinolytic therapy has a role in the management of orthopedic trauma, although additional study is required to assess the impact on the subpopulation with fibrinolytic shutdown on arrival to the hospital.