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Control of pelvic fracture–related hemorrhage

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ABSTRACT

This is a paper about pelvic fracture–related bleeding control.

The management of patients with unstable pelvic fractures is extremely challenging. There is potential for massive hemorrhage emanating from the extensive pelvic arterial and venous networks, bony fragments, and disrupted soft tissues. Along with major hemorrhage, there is typically coagulopathy; moreover, significant associated injuries are common because these injuries result from significant transmission of force. Consequently, these patients suffer high morbidity and mortality. A recent series from level 1 trauma centers in the US reported 32% mortality in patients presenting with pelvic fractures and shock [1]. A multispecialty approach is mandatory, and interventions must be timely and effective to optimize survival and functional outcome of the patient. The focus here is on the control of bleeding in these patients.

INITIAL APPROACH

The Advanced Trauma Life Support (ATLS) course of the American College of Surgeons Committee on Trauma [2] promotes a systematic approach to every trauma patient, prioritizing airway–breathing–circulation, ie, the ABCs. Recently, it has been suggested that "C"—definitive control of hemorrhage and restoration of adequate circulating volume—should be prioritized first in patients with hemorrhagic shock [3]. Hemorrhage control and resuscitation can and should begin in the prehospital arena. It all begins with recognition of a major pelvic fracture. Patients at highest risk include pedestrians struck by motor vehicles, those who fall from a significant height (eg, >10 m), and those who are ejected from a motor vehicle or motorcycle at a high rate of speed.

HEMORRHAGE CONTROL

Hemorrhage control in these complex scenarios should be broken down into 3 fundamental steps: (1a) stabilization of the bony pelvis; (1b) resuscitation; (2) identification of associated hemorrhagic injuries; and (3) control of the pelvic arterial, venous, and soft tissue bleeding.

Step 1a: Stabilization of the Bony Pelvis. It is estimated that 85% of pelvic fracture–related bleeding is due to venous and soft tissue bleeding. It is a low-pressure bleeding and will fill the space it is given. Thus, stabilization of the bony pelvis will help limit the space and facilitate early tamponade of the bleeding. Stabilization also helps minimize further movement and soft tissue injury. If it has not been done by prehospital providers, it should be done at the time of arrival in high-risk patients in shock. Historically, external fixation devices have been utilized for this purpose, but they generally require the expertise of a trained orthopedic surgeon [4]. More recently, pelvic binding devices have been devised for this purpose. They are relatively easy to use and effective in approximating and stabilizing the bony architecture. If one does not have a pelvic binder available, a bed sheet can be used for the same purpose (Fig 1).

The binding device should be positioned at the level of the greater trochanter of the femurs for optimal anatomic alignment. It should not be overtightened because this can distort the anatomy and potentially worsen bleeding, especially in lateral compression fractures. Once the binder is applied, it should be left undisturbed, but to avoid pressure necrosis, it should not be left on for more than 48 hours. By that time, either definitive stabilization or external fixation should be performed.

Step 1b: Hemostatic Resuscitation. Resuscitation should be initiated immediately, simultaneously with bony stabilization. The principles of "damage control resuscitation"—particularly avoidance of crystalloid and aggressive hemostatic resuscitation—are applicable [5]. Some prehospital providers carry plasma or blood, and there appears to be a survival advantage to plasma transfusion in the setting of transport times 20 minutes or longer [6]. Excessive crystalloid resuscitation is associated with adverse outcomes, but in the absence of blood products, it may be

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Fig 1. A sheet wrapped around the pelvis at the level of the greater trochanters is effective in reducing and stabilizing the fractures. Taping the knees and ankles together may add additional support to close the pelvic volume.

necessary. The strategy of permissive hypotension may have a beneficial role in penetrating trauma, but it should be undertaken cautiously in the setting of blunt injury and avoided in traumatic brain injury [7]. Systolic blood pressures below 90—and possibly 110—are associated with hypoperfusion and oxygen debt, as well as acute renal failure.

Hemostatic resuscitation is targeted at correcting trauma-induced coagulopathy, and abundant literature supports improved survival with this strategy. An aggressive balanced resuscitation strategy (1:1:1 ratio of packed red blood cells, fresh frozen plasma, and platelet concentrates) was incorporated into our algorithm for severe pelvic fracture–related hemorrhage in 1999 and was associated with a reduction in mortality from 30% to 15% [8]. Whole blood appears to be a safe alternative with theoretical advantages compared with 1:1:1 component therapy, but whole blood is less abundant and data do not show clear superiority [9]. The use of viscoelastic assays to guide blood product administration appears to be superior to "standard" coagulation tests, with an improvement in survival as well as lower blood product usage overall [10]. Further research is necessary in this area.

Step 2: Determine What Else Is Bleeding. There are five potential sources of blood loss in a trauma patient: external, extremities, thorax, abdomen, and pelvis/retroperitoneum. The last one is presumed in a patient with unstable pelvic fracture. External bleeding and major extremity fractures with soft tissue injury can be detected on physical examination. Major bleeding in the chest is generally apparent on chest radiograph and can also be detected with the extended focused abdominal sonographic examination for trauma (E-FAST). The abdomen presents the greatest diagnostic challenge. Although computed tomographic (CT) scanning is currently the gold standard and widely used in trauma, unstable patients with unstable pelvic fractures are not safe to go to the CT scanner in many cases. Early studies recommended diagnostic peritoneal lavage or aspiration, but this has fallen out of favor for a number of reasons, not the least of which is diminishing clinician experience with the technique. The E-FAST examination has proven reliable in identifying significant hemoperitoneum, and consequently, it is a pivotal point in algorithms for the management of major pelvic trauma [11]. It is important to recognize that exsanguinating hemorrhage in the abdomen can be lethal and will progress despite pelvic-focused interventions. Thus, the demonstration of significant hemoperitoneum mandates immediate laparotomy in the pelvic fracture patient. Similarly, emergency thoracotomy or control of major extremity hemorrhage should not be delayed for nonsurgical pelvic interventions (ie, angioembolization).

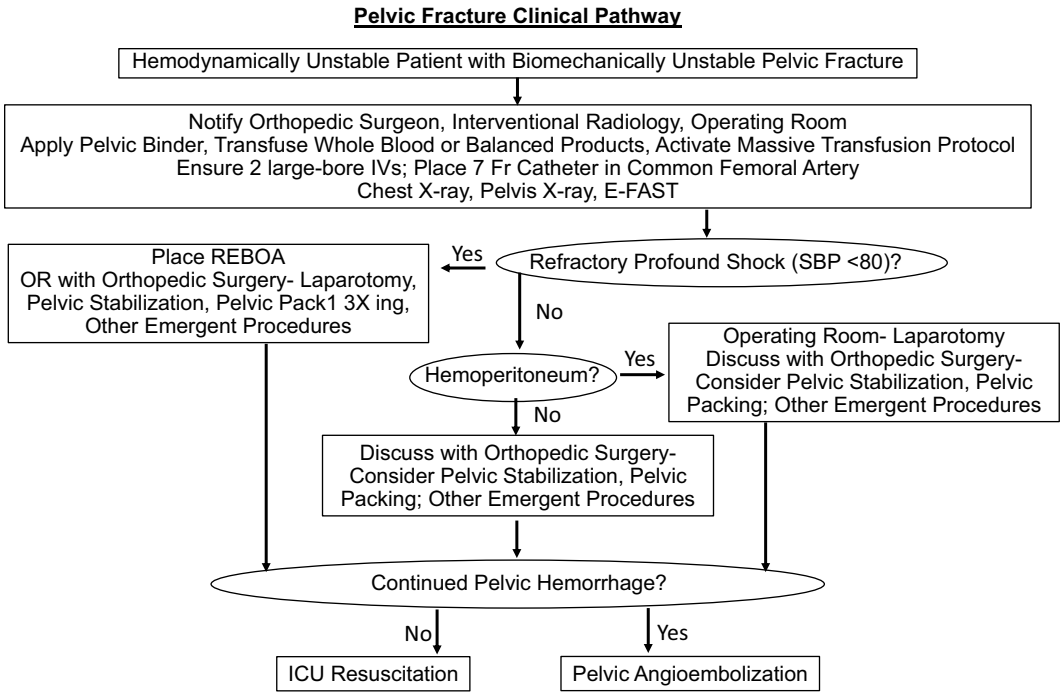

Fig 2. Pelvic fracture management algorithm.

Step 3: Control of Pelvic Bleeding. Once the pelvic bones have been stabilized, hemostatic resuscitation has been initiated, and other life-threatening bleeding has been addressed, control of pelvic bleeding must take place. There are currently 3 tools that can be used to augment the bony stabilization and hemostatic resuscitation. They include angioembolization, preperitoneal pelvic packing, and resuscitative endovascular balloon occlusion of the aorta (REBOA).

Angioembolization

This technique was first reported for pelvic fracture bleeding in 1972 and has been employed widely in the management of pelvic fractures for more than 20 years. Indications include ongoing bleeding without an apparent other source, pelvic bleeding that is uncontrolled after laparotomy, or the presence of contrast extravasation on CT scan. Practice management guidelines and algorithms from the Eastern Association for the Surgery of Trauma [12], Western Trauma Association [13], and World Society of Emergency Surgery [14] recommend angioembolization after the other key interventions that have been described. It is important to recognize that angioembolization is not a panacea for all pelvic bleedings and that the other steps cannot be skipped. Recent studies have demonstrated that angiography is used in only 4% to 7% of patients with pelvic fractures, and only half of them have active bleeding. A concerning finding reported in many studies is that the time to angiographic embolization is quite long, exceeding 3 hours in many cases. The patient cannot be left without hemorrhage control for this long.

Preperitoneal Pelvic Packing

This approach provides direct tamponade of bleeding with laparotomy sponges. In 2004, the group from Denver incorporated it into their algorithm for patients who remained unstable after 2 U of blood in the emergency department. Of note, and one of the more compelling arguments for the procedure, is that 87% of patients underwent another procedure in the operating room (OR); in fact, an average of 3 additional operative procedures was performed during the initial surgery [15]. Only 13% required angioembolization after packing. This reinforces the concept that these patients are more likely to need something done in the OR rather than the angiography suite.

Aside from the lack of training/technical expertise with this procedure, there are concerns related to infection, particularly among those who require a second packing procedure.

REBOA

Balloon occlusion of the aorta was first reported decades ago but only resurrected in the civilian trauma world in the last decade after a small case series from Baltimore and Houston [16]. It was rapidly incorporated into practice in the military and a number of civilian centers, as well as internationally. Current data suggest better outcomes when compared with resuscitative thoracotomy, although patient populations are not directly comparable. A recent systematic review and meta-analysis suggests worse outcomes when compared with a non-REBOA group, but no prospective randomized studies have been performed [17]. Given the complexity of pelvic hemorrhage, this appears to be the optimal patient population for REBOA to augment blood pressure and mitigate the pelvic bleeding while comprehensive interventions are planned [18].

PUTTING IT ALL TOGETHER/TAKE-HOME POINTS

1. Patients with unstable pelvic fractures and shock face a very high mortality.
2. There is no single intervention that is applicable in every case or effective in isolation. The steps outlined above can organize the approach.
3. Pelvic binding and aggressive hemostatic resuscitation must be initiated rapidly and can be very effective: the group from Oslo demonstrated that implementation of a more aggressive hemostatic resuscitation strategy decreased the need for both pelvic packing and angioembolization [19].
4. Associated injuries are common and must be managed in a timely manner; the OR is a safe place to be for these patients, and a hybrid OR can be advantageous.
5. The trauma surgeon should be prepared to perform preperitoneal pelvic packing in select circumstances, and REBOA may help salvage patients who are in extremis.
6. The key is to prepare an algorithm for one's institution that takes into account the available resources and local expertise (Fig 2). Moreover, the approach should be tailored to the individual patient and not rely on previous traditions.

Author Contribution

WLB performed all of the work.

Conflict of Interest

There are no financial or other conflicts of interest.

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Ethics Approval

This review article did not involve human subjects or animals and was exempt from ethics committee approval.

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