Preperitoneal Pelvic Packing/External Fixation with Secondary Angioembolization: Optimal Care for Life-Threatening Hemorrhage from Unstable Pelvic Fractures

Clay Cothren Burlew, MD, FACS, Ernest E Moore, MD, FACS, Wade R Smith, MD, FACS, Jeffrey L Johnson, MD, FACS, Walter L Biffl, MD, FACS, Carlton C Barnett, MD, FACS, Philip F Stahel, MD, FACS

BACKGROUND: Preperitoneal pelvic packing/external fixation (PPP/EF) for controlling life-threatening hemorrhage from pelvic fractures is used widely in Europe but has not been adopted in North America. We hypothesized that PPP/EF arrests hemorrhage rapidly, facilitates emergent operative procedures, and ensures efficient use of angioembolization (AE).

STUDY DESIGN: In 2004 we initiated a PPP/EF guideline for pelvic fracture patients with refractory shock requiring ongoing blood transfusion at our regional trauma center.

RESULTS: Among 1,245 patients admitted with pelvic fractures, 75 consecutive patients underwent PPP/EF (age 42 ± 2 years and injury severity score 52 ± 1.5). Emergency department systolic blood pressure was 76 ± 2 mmHg and heart rate 119 ± 2 beats/min. Time to operation was 66 ± 7 minutes, and 65 patients (87%) underwent 3 ± 0.3 additional procedures. Blood transfusion before PPP/EF compared with the first postoperative 24 hours was 10 ± 0.8 units versus 4 ± 0.5 units ($p < 0.05$). The fresh frozen plasma–red blood cell ratio was 1:2. After PPP/EF, 10 patients (13%) underwent angioembolization with a documented blush; time to angioembolization was 10.6 ± 2.4 hours (range 1 to 38 hours). Mortality for all pelvic fractures was 8%, with 21% mortality in this high-risk group. There were no deaths due to acute hemorrhage.

CONCLUSIONS: PPP/EF was effective in controlling hemorrhage from unstable pelvic fractures. None of these high-risk patients died due to pelvic bleeding. Secondary angioembolization was needed in a minority, permitting selective use of this resource-demanding intervention. Additionally, PPP/EF temporizes arterial hemorrhage, providing valuable transfer time for facilities without angiography. With other urgent operative interventions required in >85% of patients, combining these procedures with PPP/EF for operative pelvic hemorrhage control appears to optimize patient care. (J Am Coll Surg 2011;212:628–637. © 2011 by the American College of Surgeons)

Despite the implementation of early multidisciplinary management for patients with hemodynamic instability due to pelvic fractures, mortality remains >40%,[1-11] with one-third of patients dying secondary to uncontrolled hemorrhage.[12-15] Current management algorithms in the majority of trauma centers in the United States emphasize angioembolization (AE) for hemorrhage control.[16,17] Advocates of emergency angiography have shown the technique to be efficacious in controlling pelvic hemorrhage.[18-23] However, transporting an unstable patient from the emergency department (ED) to the interventional radiology (IR) suite may be a fatal error if the patient requires a laparotomy or thoracotomy to arrest ongoing torso hemorrhage. Additionally, AE only addresses arterial hemorrhage, not the more

Disclosure Information: Nothing to disclose.

Presented at Southern Surgical Association 122nd Annual Meeting, Palm Beach, FL, December 2010.

Received December 10, 2010; Accepted December 15, 2010.

From the Department of Surgery, Denver Health Medical Center and the University of Colorado Denver, Denver, CO (Burlew, Moore, Johnson, Biffl, Barnett), Department of Orthopedics, Denver Health Medical Center, Denver, CO (Stahel); and Department of Orthopedics, Geisinger Health System, Danville, PA (Smith).

Correspondence address: Clay Cothren Burlew, MD, FACS, Director, Surgical Intensive Care Unit, Program Director, Trauma and Acute Care Surgery Fellowship, Department of Surgery, Denver Health Medical Center, 777 Bannock Street, Denver, CO 80204. email: clay.cothren@dhha.org

ISSN 1072-7515/11/$36.00
doi:10.1016/j.jamcollsurg.2010.12.020

Abbreviations and Acronyms

AE = angioembolization
ED = emergency department
EF = external fixation
FFP = fresh-frozen plasma
IR = interventional radiology
ISS = injury severity score
OR = operating room
PPP = preperitoneal pelvic packing
RBC = red blood cell
SBP = systolic blood pressure
SICU = surgery intensive care unit

prevalent venous or bony hemorrhage within the pelvis.[24]

Another option for emergency control of pelvic hemorrhage in patients with unstable pelvic fractures is preperitoneal pelvic packing (PPP). PPP can eliminate the often difficult decision of whether to take the patient to the operating room (OR) or the IR suite. Originally described in Europe by Pohlmann et al in Hannover[25] and Ertel et al in Zurich[26] as packing of the retroperitoneum for hemorrhage control, we have modified the technique[27,28] to ensure direct packing of the pelvic space through a preperitoneal approach. Because 85% of bleeding due to pelvic fractures is venous or bony in origin,[24] hemorrhage is often arrested only by increasing tamponade within the retroperitoneal space. The combination of external fixation (EF) and PPP address the major sources of hemorrhage by reapproximating bony edges and tamponading the venous bleeding. Additionally, by surgically packing the pelvic space, the overall potential space required to tamponade bleeding from the pelvis is markedly reduced. Moreover, in facilities where AE is not available, PPP/EF can be life saving. We hypothesized that PPP/EF arrests hemorrhage rapidly, facilitates emergency operative procedures, and ensures efficient use of AE.

METHODS

All patients since September 2004 at our American College of Surgeons–verified and state-certified level I urban trauma center (Rocky Mountain Regional Trauma Center at Denver Health) with hemodynamic instability and a pelvic fracture underwent PPP/EF according to our protocol (Fig. 1). Indication for PPP is persistent systolic blood pressure (SBP) <90 mm Hg in the initial resuscitation period despite the transfusion of 2 units of packed red blood cells (RBCs). Those patients with thoracic or abdominal sources of blood loss are taken to the operating room to address these sources in addition to PPP. Skeletal fixation of the pelvis with an external fixator or pelvic C-clamp is done concurrent with PPP. Realignment of the pubic rami is facilitated with digital assessment of their location.

Our technique of PPP has been described previously.[27,28] Briefly, a 6- to 8-cm lower midline incision is made from the pubic symphysis cephalad. The midline fascia is divided leaving the peritoneum intact. The pelvic hematoma is typically encountered on transection of the posterior fascial layer, or on blunt dissection toward the symphysis pubis. The hematoma often dissects the preperitoneal and paravesical space down to the presacral region, and minimal blunt dissection is required. PPP is performed by placing 3 standard surgical laparotomy pads on each side of the bladder, into the true pelvis below the pelvic brim (Fig. 2). The first laparotomy pad is placed deep posteriorly, with the aid of a ringed forceps, onto the sacrum after retracting the bladder to the opposite side; the deep position is confirmed manually. Then 2 additional laparotomy pads are placed anterior to this, lateral to the bladder. Occasionally the hematoma-dissected space is large enough to accommodate an additional seventh pad in the midline anteriorly. In the pediatric population, fewer laparotomy pads are required for tamponade. Suprapubic urinary catheters are placed for urethral or bladder injuries after packing but before closure of the fascia. The fascia is closed with a running O-PDS suture and the skin with staples. Patients undergoing midline laparotomy for abdominal hemorrhage should have separation of the 2 incisions, if technically feasible, to optimize PPP tamponade. Angiography is performed for ongoing pelvic bleeding after admission to the surgery intensive care unit (SICU). Patients undergo standard post-trauma resuscitative care, including restoration of coagulation guided by thromboelastography.[29] Pelvic pack removal is performed within 48 hours. The pelvis is repacked if there is persistent bleeding at the time of reoperation.

All patients undergoing PPP/EF have been prospectively followed since initiation of the technique at our institution. In addition, patient demographics, admission hemodynamics, physiologic indices, transfusion requirements, angiography results, length of SICU stay, and hospital course were reviewed. The Young and Burgess classification was used to categorize fracture patterns.[30] The Colorado Multi-Institutional Review Board exempted this study.

RESULTS

During the 5½ year study period, 75 consecutive patients underwent PPP/EF among 1,245 patients admitted with pelvic fracture. The majority (75%) of patients undergoing PPP were men, with a mean age of 42 ± 2 years. Patients were multiply injured, with a mean injury severity score (ISS) of 52 ± 1.5; in addition to their pelvic fractures, 49% of patients had associated head injuries, 67% thoracic in-