Case Report

The Circumferential Antishock Sheet

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Hemorrhage control in patients with pelvic ring disruptions remains problematic. To decrease bleeding, efforts have been made to acutely reduce and stabilize the pelvis. The goals of rapid pelvic reduction and stabilization are restoration of normal pelvic volume, protection of the early clot, and improved patient comfort. The use of military antishock trousers, hip spica casts, external fixators, antishock pelvic clamps, early open reduction/internal fixation, and open packing have been reported in the literature. A simple temporary technique of reduction is reported using a circumferential bed sheet. The sheet is placed between the iliac crests and the greater trochanters, encircling the pelvis. The circumferential sheet provides stabilization for transportation and allows transfemoral angiographic embolization or exploratory laparotomy at the receiving hospital. Definitive fixation can then be accomplished.

Case Report

A 31-year-old male helmeted motorcyclist struck a parked car at unknown speed. He was alert and oriented but complained of abdominal and pelvic pain. Emergency medical teams transported him to a level I trauma center with military antishock trousers (MAST) inflated to "stabilize" the pelvis. No signs of hemodynamic instability were noted. On admission, the primary survey revealed stable vital signs and a mechanically unstable pelvis with a 2-cm right perineal laceration. The patient had blood at the urethral meatus and a large scrotal hematoma. His peripheral neurologic examination was normal. Tetanus toxoid and intravenous antibiotics were given. Radiographic examination of his pelvis revealed a complete right sacroiliac joint dislocation with cephalad migration of the right hemipelvis. The left sacroiliac joint was disrupted anteriorly, and bilateral superior and inferior pubic rami fractures were noted with associated air densities in the soft tissues (Fig. 1). After MAST deflation and removal, a circumferential sheet was applied as traction was applied to the right leg with good results (Fig. 2).

Serial hematocrit values changed from 40 to 27% despite a negative diagnostic peritoneal lavage. The patient was taken to the angiography suite, where his left internal pudendal artery was noted to be lacerated. The anterior division of the left internal iliac artery was embolized with Gelfoam (Pharmacia Corp., Peapack, New Jersey) and a Gianturco coil (Cook, Inc., Bloomington, Indiana), which arrested the arterial bleeding (Fig. 3). A strategic approach was coordinated by the trauma surgeon with input from the urology and orthopedic teams. Exploratory laparotomy was otherwise negative, so loop colostomy and feeding catheter jejunostomy were performed. The urologists were able to stent the total bulbar urethral disruption using a slippery wire technique. A simple two-pin anterior frame was applied, the sheet was removed, and bilateral percutaneous sacroiliac screws were inserted (Fig. 4).

The patient did well postoperatively and was discharged 10 days after the accident. His perineal wound was allowed to heal by secondary intention. He was mobilized from bed to chair for 6 weeks, and his anterior pelvic external fixator was removed 5 weeks after discharge from the hospital. Radiographs at 5 months (Fig. 5) showed consolidated fractures except for a fibrous union of the right inferior pubic ramus. He was subsequently lost to follow-up.

Discussion

Significant disruption of the pelvic ring from blunt trauma manifests a high-energy injury. Concomitant life-threatening injuries are commonplace. Mortality rates for patients with pelvic fractures range from 5 to 50%.[1-14] Open pelvic fractures are associated with higher mortality rates of 40 to 60%.[15] These rates probably reflect the overall severity of the injuries sustained, because the cause of death is associated with the pelvic fracture less than 50% of the time.[1,16] Hemorrhage is a frequent complication of major pelvic fractures. Head injury, nonpelvic hemorrhage, and multiple system organ failure are also causes of death.[5,9,13] Survival rates have increased steadily during the past 20 years with the advent of modern trauma protocols.[3] Mortality rates of 6 to 8% are currently reported.[1,9,10]

Several authors have implicated exsanguination as a major cause of death after severe pelvic trauma.[7,8,17-22] Although many patients with pelvic fractures do not bleed excessively,[3] significant pelvic hemorrhage frequently affects the resultant outcome of multiple trauma patients.[13,23] The pelvis, with its major vessels, extensive arterial and venous arborizations, and the richly vascular cancellous bone, has been called a "vascular sink"[18] (Fig. 6). The exact contributions of high- vs. low-pressure systems to the blood loss encountered with pelvic fractures remain unclear.[16,18] Arterial lacerations reportedly occur in 6 to 18% of patients with major pelvic disruptions.[3,9,21,24,25] Pelvic fractures most susceptible to arterial injury include anterior posterior compression III and lateral compression III types.[1,13] The superior gluteal and internal pudendal arteries are the high-pressure vessels most commonly compromised, followed by the obturator and lateral sacral arteries.[25] Percutaneous transcatheter embolization is considered the procedure of choice to control artery-associated retroperitoneal hemorrhage.[13,17,19]

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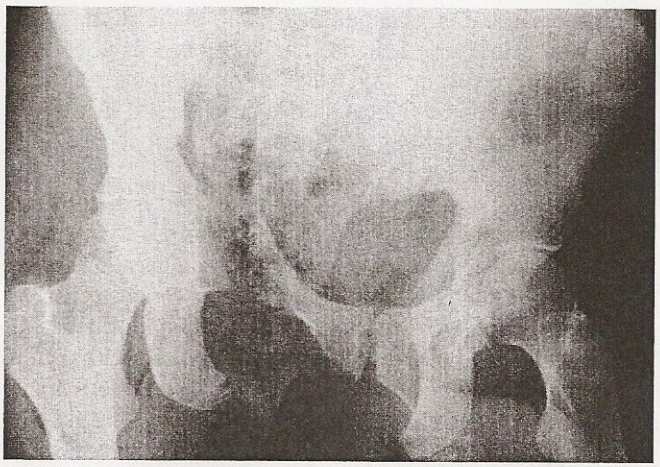

Fig. 1. Initial anteroposterior pelvis radiograph showing a complete right sacroiliac joint dislocation with cephalad migration of the right hemipelvis. The left sacroiliac joint is disrupted anteriorly, and bilateral superior and inferior pubic rami fractures were noted with associated air densities in the soft tissues.

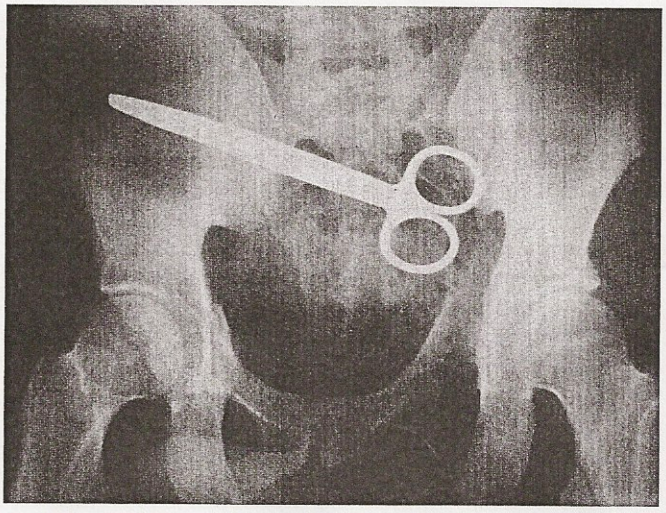

Fig. 2. Subsequent anteroposterior radiograph demonstrating satisfactory reduction after circumferential antishock sheet application (while traction was applied to the right leg).

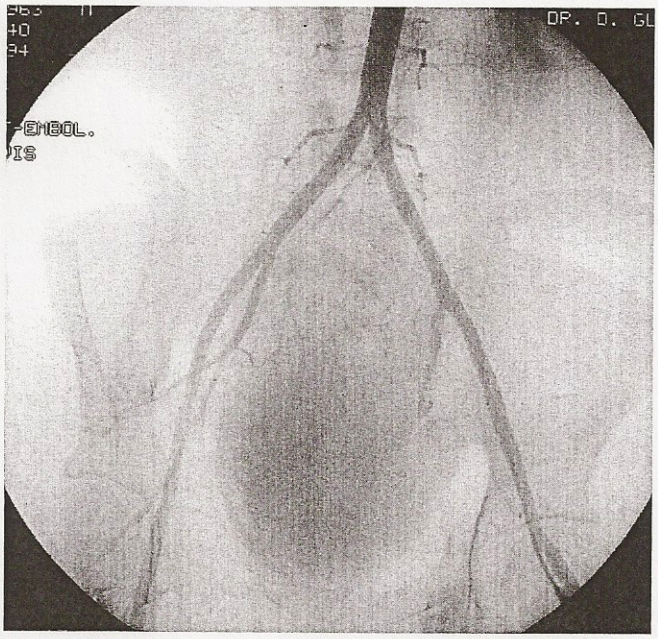

Fig. 3. Angiography with the sheet in place demonstrating a left internal pudendal artery laceration. The anterior division of the left internal iliac artery was embolized, which arrested the arterial bleeding.

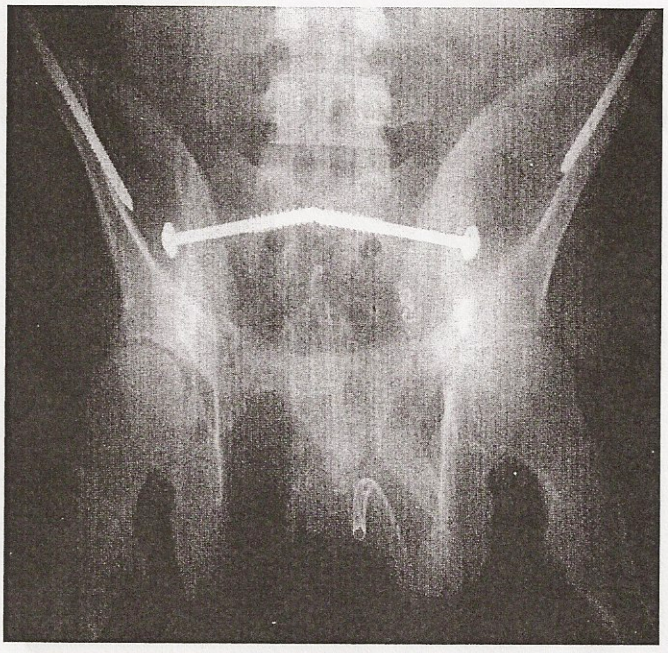

Fig. 4. Anteroposterior radiograph with a simple two-pin anterior frame applied (with the sheet secured). The sheet was then removed, and bilateral percutaneous sacroiliac screws were inserted.

The importance of low-pressure sources has been highlighted by postmortem angiographic studies in patients who sustained blunt pelvic trauma. Multiple small-caliber vessels within the disrupted cancellous surfaces, especially posterior, accounted for most of the extravasation seen.[23] This finding is substantiated by the intraoperative findings of Pohlemann et al., who propose aggressive surgical hemostasis to arrest otherwise uncontrollable retroperitoneal bleeding.[21] In the majority of their cases, an identifiable source was not found and diffuse hemorrhage from the venous plexus and fracture sites was encountered.

Accurate reduction and stabilization of the pelvic disruption allows for tamponade of low-pressure bleeding through normalization of pelvic volume and protection of the hematoma. The limitation of volume in hemorrhage control is important because the pelvis is roughly spherical and its volume, therefore, is proportional to the radius to the third power.[15] Hemorrhage control from low-pressure sources has been attempted with MAST, hip spica casting, external fixation, resuscitation clamps, early open reduction/internal fixation and by open packing.[1,2,6,8,10,12,13,15,20,26–29]

Although MAST has been shown to decrease pelvic volume in the disrupted pelvis, its use also increases prehospital time and mortality. It affords no survival advantage and can raise systemic blood pressure, worsening intra-abdominal or thoracic bleeding,[30] and makes access to the abdomen and extremities difficult.[14] Its use has been associated with compartment syndrome even in uninjured extremities.[12,31,32] Hip spica casts can

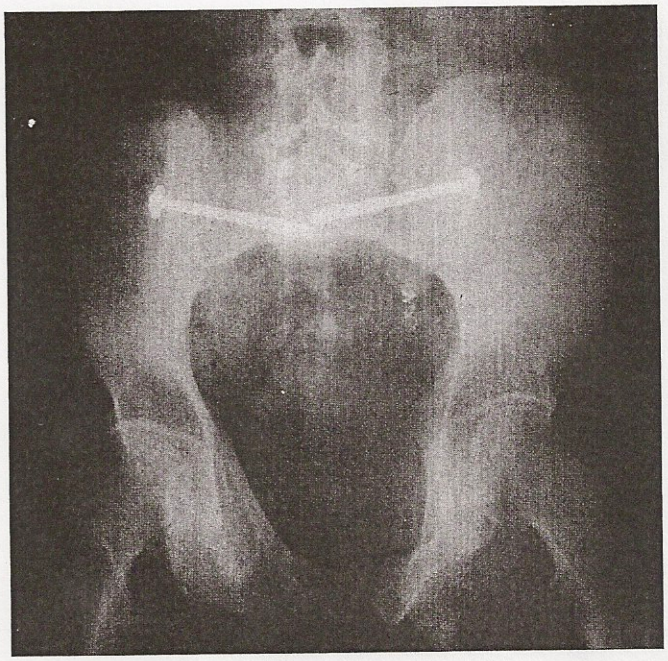

Fig. 5. Radiograph at 5 months demonstrating consolidated fractures except for a fibrous union of the right inferior pubic ramus. The patient was full weight bearing and had a nonantalgic gait.

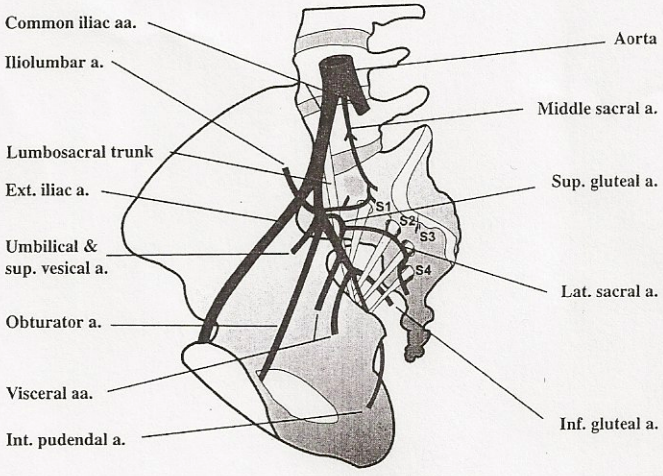

Fig. 6. Anatomy of the intrapelvic "vascular sink."

be useful in transportation of the patient from suburban facilities to regional trauma centers.[2,6] Casting has the disadvantages of concealing large portions of the patient, including the abdomen, and limiting mobilization.[2]

External fixation has been shown to decrease mortality rates,[10] transfusions,[16] and pain.[15] Superficial pin infections[2,11,29] are common, but pelvic osteomyelitis is rare.[33] External fixation of a pelvic fracture is an equipment-intensive endeavor and may require application in an operating room.[12-14,24] Pin sites quickly become colonized with skin flora and nosocomial organisms which may compromise subsequent surgical approaches. Pin insertion errors have been associated with visceral injury.[2] Frames can be cumbersome and may obstruct abdominal or genitourinary procedures. Clinical and biomechanical studies demonstrate poor posterior pelvic control with external fixation.[5,10,28,29]

Pelvic resuscitation clamps theoretically stabilize the posterior pelvis.[26] However, their use has been associated with intrapelvic pin protrusion[24] and holds the risk of damage to internal structures. These clamps should not be used in cases of posterior ilial comminution and are probably best applied using fluoroscopic guidance.

Early pelvic open reduction/internal fixation has been promoted by several authors who note increased survival rates, rapid mobilization, and fewer respiratory complications.[5,6,27,34] Its use may be limited by the patient's overall condition and the type of fracture. Aggressive surgical hemostasis or open packing has been shown to decrease mortality in patients with continued hemodynamic instability after clamping or external fixation.[8,20] This method of ligation and sequential packing at 48- or 72-hour intervals is similar to the management of a massive intra-abdomenal solid visceral injury[9] but is not universally accepted.

None of these interventions can be used in the field or prehospital setting. The application of a circumferential bed sheet between the iliac crests and the greater trochanters is simple, inexpensive, and universally available. Alternatively, any appropriately-sized piece of clothing available, such as a battle dress uniform top, may be used (Fig. 7). Additional stabilization can be provided by placing a pillow between the legs and gently approximating them with an ace bandage or another sheet. Litter straps, although usually readily available, should not be used because their edges can exert excessive pressure and cause skin breakdown. With the sheet or equivalent applied, the skin is not violated and the lower extremities are not prone to the development of compartment syndrome. Access is afforded to the abdomen, perineum, and lower extremities. Once a pelvic radiograph is obtained closed reduction of the pelvic fracture is performed to correct cephalad or caudal displacement by applying traction to the appropriate leg. Sheet application stabilizes the pelvic volume and allows for early definitive fixation through standard incisions. Application in the field by first responders is encouraged when a grossly unstable pelvis is encountered. If necessary, the sheet can be adjusted under fluoroscopy at the receiving hospital to improve the reduction.

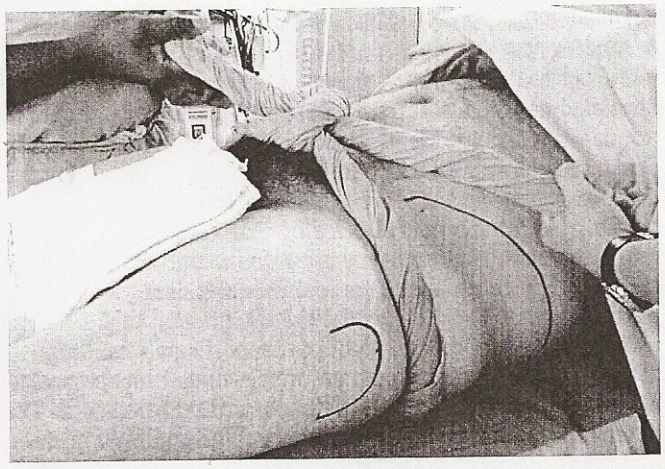

Fig. 7. Demonstration of a bed sheet correctly applied with the iliac crest and greater trochanter marked. A clamp or a square knot can be used to secure the device.

Conclusion

Sheets or equivalents should be used in the prehospital setting to stabilize grossly unstable fractures in lieu of MAST. Closed pelvic reduction and application of a circumferential antishock sheet coupled with stabilization of the lower extremities are simple, expedient interventions that improve patient comfort and decrease hemorrhage and mortality. Medics, emergency room physicians, and orthopedic surgeons will find this simple technique valuable in the management of victims of blunt trauma.

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