Management of Partial Traumatic Hemipelvectomy

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abstract

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Partial traumatic hemipelvectomy is a devastating condition. Although by definition the affected limb is not totally transected from the trunk because of retained soft tissue, the reported mortality rate is actually higher than in complete traumatic hemipelvectomy. Between January 2000 and December 2011, a total of 917 patients were admitted to the authors’ institution for pelvic fracture. Seven of these patients met the criteria for partial traumatic hemipelvectomy. All 7 patients had multiple associated injuries and met the criteria for Baskett class IV hypovolemic shock on arrival at the emergency department. The amount of bleeding was the greatest issue, and control of hemorrhage and rapid blood transfusion were the initial goals. Abdominal aorta balloon occlusion, laparotomy and packing, and pelvic external fixation were useful to control bleeding. Two patients died during the initial resuscitation phase. Angiography (digital subtraction or computed tomographic) was performed in 4 patients but did not provide any treatment-altering information. Limb preservation was attempted in 2 patients; both of these patients eventually required hindquarter amputation. One patient died, and the second patient survived after a difficult postoperative course. The best results were obtained in 3 patients who underwent completion of the hindquarter amputation within 24 hours of trauma. All patients became wheelchair dependent, and no patient was able to return to work. Early completion of hindquarter amputation after hemorrhaging has been controlled is recommended in patients with partial traumatic hemipelvectomy. Angiography did not prove useful in decision making.

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Figure: Anteroposterior radiograph showing an open book injury, Tile C1 pelvic fracture (A). Computed tomographic angiography showing complete disruption of iliac vessels (B).
Traumatic hemipelvectomy, also known as traumatic hindquarter amputation, was first reported in 1915. It is a devastating injury, with disruption of the pelvic ring at the pubic symphysis and sacrum combined with rupture of the iliac vessels and nerves. The etiology is high-energy trauma, usually traffic accidents or industrial crush injuries. Combined with associated injuries of the head, thorax, abdominal organs, and other extremities, it is not surprising that most patients die before arrival at the hospital.

Survivors experience the complications of devascularization, muscle necrosis, and genitourinary tract and anorectal bowel injury.

In 1991, Klingman et al used the term partial traumatic hemipelvectomy to describe cases in which the bony pelvis is fractured both anteriorly and posteriorly and accompanied by irreparable vascular injury, yet the affected limb is not totally transected from the trunk because of retained soft tissue. They noted that patients with partial hemipelvectomy had a higher mortality rate than patients with complete limb avulsion. It has been postulated that the injured vessels can retract and be closed by muscle contraction in patients with complete hemipelvectomy, whereas vessel damage may be missed in cases of partial hemipelvectomy, leading to a higher mortality rate.

Few reports in the literature focus on partial hemipelvectomy, with most articles being case reports. This article presents the authors’ experience in the emergency assessment and treatment of 7 patients with partial traumatic hemipelvectomy.

**MATERIALS AND METHODS**

Between January 2000 and December 2011, a total of 917 patients were admitted to the authors’ hospital for pelvic fractures. Of these patients, 2 patients sustained complete traumatic hemipelvectomy and 7 met the criteria for partial traumatic hemipelvectomy. Permission to conduct this retrospective study was obtained from the hospital ethics committee.

Of the 7 patients with partial traumatic hemipelvectomy, 3 were men and 4 were women. Median age was 28 years (range, 21-35 years). Five patients were involved in motor vehicle accidents, 1 patient fell from a height, and 1 patient was crushed by industrial machinery. Six patients were brought directly to the hospital emergency department, and 1 patient was transferred from another hospital at 6 days postinjury for management of infection. Medical records were obtained for the latter patient from the transferring hospital.

Initial treatment was damage control. All patients underwent management following Advanced Trauma Life Support Guidelines. The initial diagnostic steps included obtaining thoracic and pelvic radiographs (Figure 1A) and performing focused assessed sonography in trauma (FAST). Visible bleeders were clamped and ligated. Laparotomy and retroperitoneal and wound packing were performed as needed (Figure 1B). Balloon occlusion of the abdominal aorta was performed in selected cases via normal limb femoral artery cutdown placement of a Fogarty catheter balloon. The balloon was placed between the renal arteries and the iliac bifurcation (Figures 1C, D). Pelvic external fixation was applied on an individual basis for temporary stabilization of the bony pelvis. Massive amounts of blood products were required. The transfusion target was 1:1 volume replacement during the resuscitation period. Hindquarter amputation was performed after hemorrhage control was achieved (Figure 1E). As soon as feasible, digital subtraction angiography or computed tomographic angiography was performed to assess pelvic vascular damage before hindquarter amputation (Figure 2). This usually took 30 minutes or longer.

Depending on the associated injuries, treatment priorities were adjusted. Ruptured urethrae were stented with a Foley catheter, and urine was diverted via a suprapubic catheter. Intraperitoneal bladder ruptures were sutured during laparotomy. Ureter injuries were repaired primarily. A diverting colostomy was routinely performed. Vacuum-assisted closure (VAC; KCI, San Antonio, Texas) was used in several patients. For patients who survived the first few days, multiple subsequent surgeries were undertaken, including completion of the hindquarter amputation and frequent second-look debrideims. Closure of the wound was individualized and always required some type of musculocutaneous flap.

**RESULTS**

All 7 patients met the criteria for Baskett class IV hypovolemic shock on arrival at...
the emergency department. Time from trauma to arrival was less than 2 hours in 4 patients and between 2 and 3 hours in the remaining 3 patients. Mean Injury Severity Score was 54±8 points (range, 42-67 points) for the 6 patients directly admitted to the hospital.

All 7 patients sustained unilateral partial traumatic hemipelvectomy. Patient demographics are summarized in the Table. By the Tile classification, 5 cases were C1 type and 2 were C2 type. The fracture line in the posterior pelvic ring was in the Denis zone II of the sacrum in 1 patient and passed through the sacroiliac joint in 6 patients. Anteriorly, superior and inferior pubic ramus fractures occurred in 5 patients (3 were bilateral and 2 were unilateral), and pubic symphysis diastasis occurred in 2 patients.

Bleeding was the major problem. Abdominal aorta balloon occlusion was needed in 5 patients; mean occlusion time was 51 minutes (range, 34-62 minutes). For patients who survived, mean units of packed red blood cells and fresh-frozen plasma transfused per patient within the first 24 hours was 26±4 and 17±4 units, respectively. The volume replacement ratio of transfusion was 1:1 during resuscitation. Pelvic external fixation was used as a method to stabilize the pelvis and decrease the pelvic cavity volume prior to hindquarter amputation. Laparotomy and packing of the abdominal or retroperitoneal cavity also were performed in all 7 patients. Two patients died in the emergency department during the resuscitation phase.

Six patients had genitourinary tract injuries, all 7 patients had anorectal or colon injuries, 5 patients had perineum tears, and 4 patients had Morel-Lavallée lesions. Three patients sustained thoracic injuries, 3 had head injuries, 5 had abdominal injuries, and 6 had additional extremity injuries (Table).

Urgent digital subtraction or computed tomographic angiography was performed for the 4 surviving patients who were admitted directly to the hospital. Blood flow blockage at the iliac artery level was observed in all 4 patients, with contrast agent diffusion around the iliac vessel noted in 1 patient. Severe vessel damage, rupture, and thrombosis were diagnosed.

Surgical completion of the hindquarter amputation was performed on the first day of admission in 3 patients and on the fifth day in 1 patient. In the latter patient, amputation was delayed in an attempt to save the limb; however, the patient developed massive infection and died from sepsis on the 10th day of hospitalization. The 3 patients who received immediate amputation required multiple additional second-look exploration and debridement, but all 3 of these patients survived.

The patient who was transferred from another hospital on postinjury day 6 had undergone a hip disarticulation (instead of a hindquarter amputation) in an effort to preserve the hemipelvis. However, tissue necrosis and uncontrolled infection developed in this patient (Figures 3A, B). A formal hindquarter amputation was performed in this patient, and the infection eventually was controlled after 21 visits to the operating room (Figures 3C, D).

A rectus abdominis flap was used to close the wound in 3 patients, a composite island flap was used in 2 patients, and split-thickness skin grafting was used in 4 patients (more than 1 modality was needed per patient). Large wounds with excessive exudate are, in theory, good candidates for vacuum-assisted closure. In 2 of our patients, vacuum-assisted closure was attempted, but the sheer size of the wounds and the need for frequent surgical debridements made vacuum-assisted closure impractical.

Follow-up in the 4 patients who survived ranged from 17 to 41 months. A hindquarter amputation prosthesis was fabricated for 1 of the patients but proved to be awkward and was soon discarded by the patient. All 4 patients are wheelchair dependent, and none of the patients have been able to return to work.

**DISCUSSION**

Traumatic hemipelvectomy is the most severe type of pelvic fracture. In the current study, the incidence was 0.98% (9 of 917) for all pelvic injuries, which is consistent with the incidence of 0.6% to 1.8% reported in the literature. The true mortality rate is unknown because many, if not most, of these patients die before reaching the hospital. For those who reach the emergency department, the statistics are better; in 104 documented cases, 71 patients survived.

The etiology is high-energy trauma, usually motor vehicle accidents or industrial crush injuries. In motor vehicle accidents, the force vector is believed to pass from an abducted and external rotated lower limb to the pelvis. In a fall from a height, the mechanism is probably an ipsilateral knee-contact ground strike with
the hip and knee flexed. Previous studies have shown that the fracture line usually crosses the pubic symphysis and sacroiliac joint. In the current 7 patients, only 2 had symphysis separation; the remaining 5 had pubic ramus fractures.

Severe soft tissue damage involving the pelvic vessels, nerves, genitourinary tract, anorectal bowel, and muscles, along with the fracture, results in massive bleeding and subsequent hypovolemic shock. Despite the large amount of blood transfused, 2 patients in the current series died during resuscitation. Laparotomy and packing of the abdominal and retroperitoneal cavity were necessary to control hemorrhage. During laparotomy, clamping of the abdominal aorta is usually necessary for hemostasis. The current authors also have found intra-aortic balloon occlusion helpful for hemostasis during emergency resuscitation.

![Table](https://example.com/table.png)

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<th>Patient No./Sex/Age, y</th>
<th>ISS</th>
<th>Mechanism of Injury</th>
<th>Rectal &amp; Colon</th>
<th>Genit</th>
<th>Assoc Injuries</th>
<th>Open Wound</th>
<th>Complications</th>
<th>Outcome</th>
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<tr>
<td>1/F/35</td>
<td>56</td>
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<td>Yes</td>
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<td>Infection, sepsis</td>
<td>Survived</td>
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<td>Yes</td>
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<td>Fall from a height</td>
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<td>Yes</td>
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<td>11-cm laceration over left knee</td>
<td>Infection due to delayed amputation, meningitis, septic shock</td>
<td>Died</td>
</tr>
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</table>

Abbreviations: Assoc, associated; Genit, genitourinary; ISS, Injury Severity Score.

The role of urgent angiography (digital subtraction or computed tomographic) after initial resuscitation is debated. Although these studies may provide additional information regarding the status of the pelvic vessels, obtaining the studies require time when time is of the essence. Proponents believe angiography aids in identifying bleeding points and may help to decide which patients have a real chance at limb salvage. Detractors believe that the
extra time spent waiting for the study results can be better used, and in cases of true traumatic hemipelvectomy, completion of amputation is inevitable and angiography serves no purpose. In the current series, angiography was performed in 4 patients, and all showed irreparable vessel damage. The procedure takes longer than 30 minutes and hinders other resuscitation efforts. The authors originally believed angiography could provide information to help decide which limbs could be preserved, but unfortunately, it confirmed that amputation was necessary. Angiography is no longer part of their treatment protocol. Schoderbek et al\textsuperscript{24} proposed angiographic embolization to achieve emergency hemostasis; however, the current authors have no experience with that procedure.

Because a hemipelvectomy is at stake, the differential diagnosis between partial traumatic hemipelvectomy and open Tile C pelvic injury is of utmost importance. The use of digital subtraction or computed tomographic angiography to determine the severity of vascular injury in this situation is controversial. Williams et al\textsuperscript{25} advocated angiography before completing a partial hemipelvectomy to confirm the diagnosis; however, this recommendation was made based on their experience with only 2 patients. Labler et al\textsuperscript{2} reviewed 96 cases and found that angiography did not increase the rate of lower limb salvage. They further stated that hemipelvectomy should be completed as a life-saving intervention when bleeding is difficult to control. Schoderbek et al\textsuperscript{24} published their experience in using angiographic embolization to achieve emergency hemostasis, but they also ultimately decided to remove it from their treatment protocol. It was found that early completion of hemipelvectomy resulted in a lower complication rate and smoother hospital course than initial management with angiography and attempted reconstruction.

Genitourinary tract injury and anorectal or colon injury is to be expected in traumatic hemipelvectomy, occurring in all of the patients in the current series and in more than 80\% of patients reported by Rieger and Dietl.\textsuperscript{17} A diverting colostomy is recommended to prevent further fecal contamination.\textsuperscript{26,27} Placement of the colostomy stoma should take into consideration the condition of the abdominal wall and the location of the fracture, especially when the hemipelvectomy is on the left side.

Surgeons are trained to save life and limb, and every extra joint preserved improves quality of life. Unfortunately, evidence suggests that attempts to preserve the limb, or even just to try to preserve the fractured hemipelvis and buttocks (ie, hip disarticulation instead of hemipelvectomy), leads to necrosis and infection.\textsuperscript{2} In the current study, the best results were obtained in the 3 patients who underwent completion of hindquarter amputation within 24 hours after trauma. The patient who underwent delayed amputation died days later from sepsis, and the patient who initially underwent hip disarticulation eventually required conversion to hindquarter amputation. The authors now recommend early completion of the hindquarter amputation.

Because of its traumatic nature, it is impossible to plan wound closure as one would for elective hemipelvectomy in cases of tumor. Due to ongoing tissue necrosis and infection, aggressive second-look exploration and debridement should be performed after hindquarter amputation surgery.\textsuperscript{5} Closure of the amputation wound must be tailored individually. Musculocutaneous flaps are usually necessary to cover the wound.\textsuperscript{9,16} Many variations have been described, including the gluteus, thoracoabdominal, rectus abdominis, latissimus dorsi, and composite island flaps.\textsuperscript{28-30} Skin grafting may be sufficient if patients have viable muscular coverage.\textsuperscript{5,10,31} The current authors prefer the rectus abdominis flap. Vacuum-assisted closure is a well-established technique, but during the acute phase of treatment, it
proved technically difficult to use due to the presence of massive amounts of necrotic tissue and fluid exudate, and it also was a hindrance during the frequent debridements.

Even when performed electively, hemipelvectomy is a mutilating procedure. Prosthetic fitting is difficult. Several designs are available, but all are cumbersome, heavy, and impractical for daily use. The literature indicates that almost all patients prefer to use a wheelchair, and the current authors’ experience confirms this. Severe depression is common, and few, if any, patients are able to return to work.

**REFERENCES**