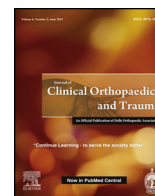


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## Case report

# The importance of pelvic ring stabilization as a life-saving measure in pre-hospital – A case report commented by autopsy



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## ABSTRACT

Hip fractures with unstable pelvic ring have great morbidity and mortality rates. These fractures result from high energy trauma such as falls from heights, road accidents and collapsing structures or other similar mechanisms of action. We report the case of a 63 years old man, construction worker, who stood inside a ditch during a wall construction when he was surprised by this collapse, which resulted in direct trauma to the right thigh and pelvis. The autopsy revealed diaphysis fracture of the right femur with an open book pelvic fracture with severe hemorrhagic infiltration and hematoma of the pelvic muscles without arterial injury. Bone bleeding and the vascular damage associated with disruption of the sacroiliac ligaments promote a very significant bleeding. Simple maneuvers such as sheet circumferential compression to promote pelvic ring closure are effective on stabilizing and closure of the sacroiliac joint. Hip manipulation of the fracture was performed during the necropsy to demonstrate and prove how a simple sheet contention can promote stabilization of the pelvic ring by closing the sacroiliac joints in open book fractures.

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## 1. Introduction

Almost 3% of all skeletal fractures are pelvic ring disruptions,<sup>1</sup> and these are frequently associated with high morbidity and mortality (reports from 20% to 80% death rates).<sup>2</sup> These fractures result from high energy trauma such as falls from heights, road accidents and collapsing structures or other similar high kinetic action mechanisms.<sup>3</sup> Pelvic fractures resulting from these scenarios are often associated with abdominal, pelvic or chest injuries. Vascular lesions and consequent blood loss are the fiercest complications. Hemodynamic instability and hypovolemic shock due to difficulty in containing these hemorrhages into the pelvic cavity can rapidly lead to death. Hemorrhagic shock is the most common cause of death in the first 24 h.<sup>4</sup> This is the main reason why these lesions should be early diagnosed and stabilized in the pre-hospital setting. A wide variety of pelvic binders together with pelvic sheets is available and offer an adjunct to the initial management of trauma patients with pelvic fractures. These devices are referred to as pelvic circumferential compression devices (PCCDs). The main goal is to achieve fracture stability and

regain intrapelvic pressure, which can reduce hemodynamic compromise.

## 2. Case report

We report a case of a 63-year-old construction worker, who was working inside a ditch in a standing position. There was 20 cm depth concrete wall on his right side which suddenly collapsed (Fig. 1) with direct impact over its right side torso and lower limb. The victim got trapped in the debris but was promptly removed by its non-medically trained co-workers. According to their reports, immediately after the accident the patient was conscious and well-oriented, breathing spontaneously and with no external signs of massive hemorrhage. The emergency team was called and arrived on site in fifteen minutes. At its arrival, the patient was still well oriented, with a normal breathing rate and apparent circulatory integrity (BP of 110/72 mmHg and 93 bpm; and well perfused extremities). He was complaining of pain on his right pelvis and thigh – areas with large bruises and hematomas but no external considerable hemorrhage; the right lower limb perfusion and neurologic status were intact. Over the course of one hour his blood pressure gradually decreased and cardiac rhythm raised, developing hemodynamic instability. There was no response to fluid reposition with Ringer lactate, and eventually ended in cardiac arrest; resuscitation maneuvers performed by the

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**Fig. 1.** Death scene demonstrating wall collapse.

emergency team on the way to the hospital were unsuccessful. The death occurred just over an hour after the accident and was confirmed upon hospital arrival.

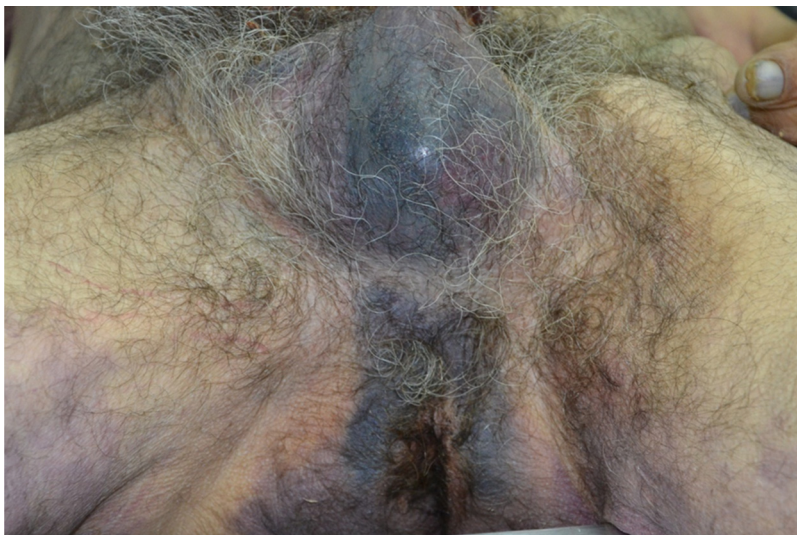
The autopsy revealed an open-book pelvic ring fracture (Young-Burgess lateral-compression type III, Tile type B1) with severe hemorrhagic infiltration and extensive hematoma of the pelvic muscles. There was no recognizable arterial injury – superior gluteal, pudenda, and common, external and internal iliac arteries were intact. The only identifiable hemorrhage sources were the venous and bone bleeding – which resulted in about 800 ml blood loss. No visceral lesions were observed. Noticeably, the patient presented a considerable perineal ecchymosis, as a translation of hemorrhage, typically associated with pelvic ring fractures – Destot sign (Fig. 2). The patient also suffered an oblique diaphyseal fracture of the right femur (AO 32-B1). Unequivocally, the determined cause of death was hemorrhagic shock.

### 3. Discussion

Pelvic ring fractures can be classified based on type of mechanical instability, according to Tile's classification<sup>5</sup> (A: stable,

B: rotationally unstable, C: vertically and rotationally unstable); or based on the energy vector, according to Young and Bruggess classification<sup>6</sup> – lateral compression types (LC), anterior-posterior types (AP), vertical shears (VS) and combined mechanism (CM).

Both classifications are ordered according to the injury severity, in tight relation to the fracture stability. While the pelvic ring lacks inherent bony stability, it is held together by a network of interosseous ligaments. The pubic symphysis is the weakest link of the structure, representing only about 15% of its stability. The posterior elements – sacroiliac, sacrospinous, and sacrotuberous ligaments – are the strongest, contributing to the vertical and anterior-posterior stability of the pelvis. These findings correlate with blood transfusion and total fluid resuscitation requirements.<sup>7</sup> During the necropsy, pelvic manipulation was performed, and the mechanism of lesion was clearly traceable, as described by the Young and Bruggess classification. In these lateral compression type III lesions, the first anterior-lateral impact causes the rupture of the anterior hemi-pelvis, and continued force application is transmitted to the posterior sacroiliac complex – the pelvic ring becomes disrupted in two points, and opens, hence the name “open-book fracture”.



**Fig. 2.** Perineal ecchymosis (*Destot signal*) as a translation of hemorrhage and associated pelvic fractures.

Besides the fracture itself, associated lesions are also in contribution for unfavorable outcomes. Gansslen et al. report that mortality is closely associated with the presence of concomitant soft tissue injury.<sup>8</sup> Burges et al., describes that each pelvic ring fracture has an average of one additional orthopedic injury and 1.6 non-orthopedic injuries.<sup>9</sup> Particularly open book fractures were associated with more severe injuries of the abdomen, spine, and extremities in both classification systems.<sup>10</sup> It is crucial to note the importance of the anatomic relationships between the pelvis bones and articulations, vessels and organs. The higher the energy associated with such fractures, the greater is the risk of adjacent lesions. Nevertheless, most deaths are related not with organ lesions, but with free space available for the potential internal uncontrolled bleeding.<sup>11</sup> Bleeding usually originates from cancellous bone, presacral venous plexus, and/or iliac vessels.<sup>12</sup> Hemorrhage can also occur in other locations to the high-energy trauma history – most frequently long bones and abdominal viscera.<sup>13</sup> Mortality rates are markedly dependent on the achievement of hemodynamic stability – there have been many attempts to develop a treatment that could rapidly reduce and stabilize the disrupted pelvic ring.<sup>6,14</sup>

Even though a wide array of external devices is available (most common brands are: Pelvic Binder<sup>®</sup>, T-POD<sup>®</sup> and SAM Sling<sup>®</sup>), the provisory use of a compressive sheet, when correctly placed, is reported as being enough to maintain fracture stability until a definitive fixation is achieved. However, until now there was no cadaveric study report clearly demonstrating the success of these maneuvers.

In this case, the lack of a correct initial evaluation, delayed the diagnose of a deathly injury, which passed unidentified and untreated. After assuring the initial respiratory and hemodynamic stability, the patient should have been completely exposed and observed – the identification of the Destot sign, as was seen in cadaver, would have alerted the emergency team for the possible pelvic injury. Nevertheless, pelvic pain seems to be the highest reliable finding in unstable pelvic injuries with sensitivity and specificity at 97% and 93%, respectively.<sup>15</sup>

In case of pelvic ring fractures, Advanced Trauma Life Support recommends the application of a circumferential sheet pelvic wrap.

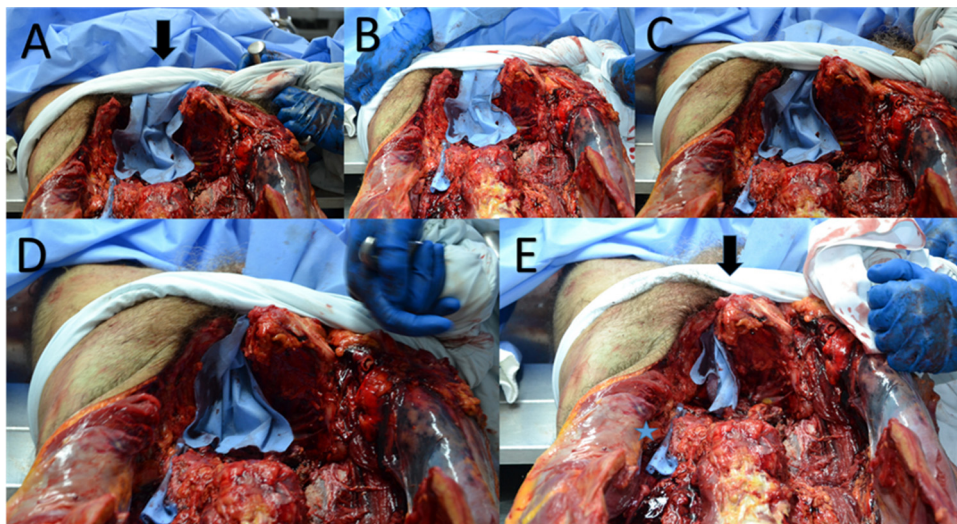
A common hospital draw sheet can be setup quickly at the scene by the emergency team – it will promote a temporary pelvic ring fracture reduction. With this early measure, it is possible to avoid

blood accumulation and achieve a relative bleeding control, during the transportation of the patient to the hospital for definitive care.<sup>11</sup> The available pelvic binders studies show advantages of pelvic binders in bleeding control.<sup>16,17</sup>

Manipulation of the fracture was performed during the necropsy to demonstrate and prove how a simple sheet contention can promote stabilization of the pelvic ring by closing the sacroiliac joints in open book fractures – allowing an early control of life-threatening bleeding on-site (Fig. 3/video). It is the fastest way to provide immediate stabilization for hemodynamic instability secondary to pelvic ring disruption.<sup>10</sup> A sheet was placed under the body, centered over the greater trochanters and crossed anteriorly<sup>18</sup> (application of the binder above the level of the greater trochanter is a common mistake and results in poor reduction of the pelvic diastasis and inadequate hemodynamic control<sup>19</sup>); both sides were then rolled together over the inguinal region in order to compress de pelvic ring. The amount of pressure to apply is hard to determine, as an equilibrium should be obtained in order to maintain enough pressure to close the open-book lesion, but assuring that it doesn't compromises skin vascularization. The result of the sheet compression under direct observation in the cadaver is impressive, as one can see all the circumferential compression mechanism working, becoming easier to understand the advantages of its application in a live patient with life-threatening unstable pelvic fractures. Without it the pelvic space increases significantly, diminishing local pressure, allowing substantial blood accumulation, which may lead to hemorrhagic shock.

In a cadaveric study reported by DeAngelis et al. there was a superiority of T-POD when compared to pelvic sheet wrapping in reduction of symphysis diastasis.<sup>20</sup> Knops et al. demonstrated effective reduction and stability of all types of devices (T-POD, SAM-sling and pelvic binder) in reducing all types of pelvic fractures.

Literature is favorable for the physiological effect of these devices during an early phase of resuscitation; however, the overall outcome, regarding mortality and hospital stay, remains controversial – some studies point to fewer transfusions, shorter intensive care duration and shorter hospital stay, when compared to no compression application.<sup>21</sup> Results seem to be better in stable fractures. Cost-effective studies are needed in order to justify broader applications of PCCDs in pre-hospital setting.



**Fig. 3.** Pelvic manipulation of the fracture was performed during the necropsy to demonstrate and prove how a simple sheet contention can promote stabilization of the pelvic ring by closing the sacroiliac joints in open book fractures (A–E).

However, mechanical stabilization should be viewed as an adjunctive treatment, not as a sole procedure. Aggressive resuscitation measures seem to have the highest impact on patients outcomes, although the optimal transfusion protocol is still subject of ongoing research.<sup>10</sup>

#### 4. Conclusion

The vascular damage and bone bleeding that are associated with pelvic ring disruption may lead to a very significant, potentially fatal, hemorrhagic shock. Modest maneuvers such as sheet circumferential compression are effective on closing and stabilizing the sacroiliac joint, and can be applied by anyone in pre-hospital care or at emergency room. This simple procedure is extremely effective in obtaining pelvic ring closure as demonstrated in our cadaveric case description.

#### Conflicts of interests

No conflicts of interests.

#### Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.jcot.2017.05.011>.

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