

Low-energy osteoporotic pelvic fractures

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Abstract The vast majority of pelvic fractures in geriatric patients are classified as stable injuries. The current treatment strategies of these fractures involve pain management and mobilization. Pain-related immobility may pose a serious hazard to patients with severe preexisting comorbidities. There is paucity of literature on the outcome and mortality after osteoporotic pelvic fractures in the elderly. This review aims to provide an overview of epidemiology, injury mechanism, fracture patterns, management and outcome after osteoporotic pelvic fractures.

Keywords Osteoporosis · Mobilization · Pelvic hemorrhage · Comorbidity

Introduction

Studies on pelvic fractures deal mostly with the emergency management [2, 4, 6, 8, 17, 25–27, 33, 34] and surgical stabilization [14, 15, 20, 48, 52, 70] of unstable pelvic

fractures. Patients sustaining these injuries are typically male and young. They are frequently polytraumatized after high-energy trauma [19, 48, 62]. Unstable pelvic fractures are rare injuries with a high mortality of 19–31% [31, 35, 53, 62].

In contrast, low-energy osteoporotic pelvic fractures occur with far greater frequency [31, 53, 62]. They result from simple falls and show an increasing incidence in the elderly. Fractures of the pubic rami are the most common osteoporotic pelvic fractures (Fig. 1). They are classified as stable injuries (type A2 according to the AO/ASIF classification). Stable osteoporotic pelvic fractures are typically treated nonoperatively. Pain control and mobilization are mandatory in order to avoid secondary complications due to immobility [73, 76]. Despite their frequency, there is a paucity of literature concerning osteoporotic pelvic fractures [1, 10, 16, 21, 38, 40, 47, 51, 55, 57, 76].

Epidemiology

The elderly represent the fastest growing population group. Since 1900, the number of people aged >70 has shown an 11-fold increase, compared to only a threefold increase for the entire population [45]. This trend will accelerate during the next several decades, and it is estimated that 25% of the entire population will be older than 65 years by 2030 [74]. As a result of aging population, the incidence of osteoporotic fractures has and will continue to increase. Kannus [45] defines osteoporotic fractures as fractures occurring in patients >65 years after simple falls. These fractures typically involve proximal fractures of the femur and humerus as well as distal radius fractures and compression fractures of the thoracolumbar spine [10, 71]. Elderly osteoporotic patients are also susceptible to sustaining pelvic fractures in

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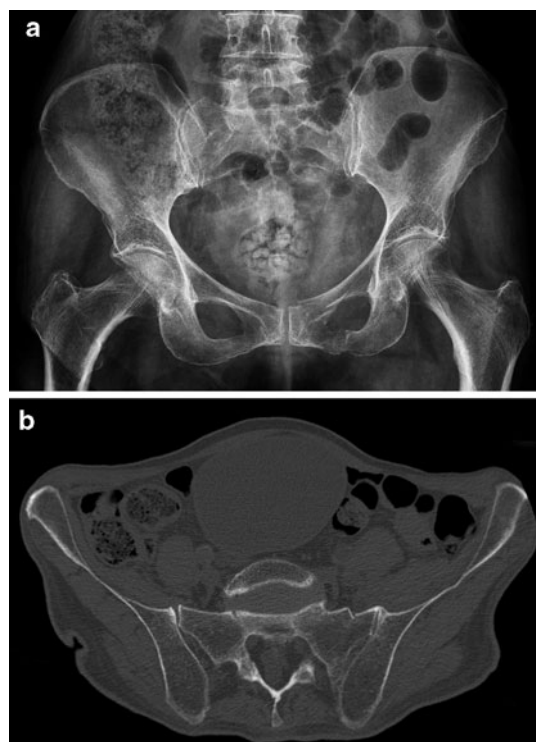


Fig. 1 Fractures of the pubic rami on the left side in an 87-year-old female after a simple fall (a). CT shows an associated ipsilateral sacral compression fracture (b)

falls, but this injury has received less attention than the more common extremity injuries.

The incidence of pelvic fractures increases with age. For the entire population, the incidence is 20–37/100,000 per year [53, 65], whereas it is 92/100,000 per year in patients >60 years [45] and rises to 446/100,000 per year in patients >85 years [53]. Pelvic fractures occur at a rate of approximately one-third to one-fifth of the incidence of proximal femur fractures [59]. 64% of all pelvic fractures are osteoporotic fractures, whereas 94% of pelvic fractures in patients >60 years are defined as osteoporotic fractures [45]. Women are more often affected than men with a gender ratio of 1.25 in the age group 60–69 years and 2.7 in patients >80 years. The mean age is 81 years for women and 76 years for men [45]. Between 1970 and 1997, an annual increase of 23% was observed, resulting in a 4.6-fold increase of osteoporotic pelvic fractures in this period. Demographic developments as well as an increase of the age-dependent incidence account for these findings [45].

Injury mechanism and fracture patterns

Osteoporotic pelvic fractures typically result from simple falls from standing [1, 10, 12, 40, 77]. Traffic accidents and high-energy traumata are infrequent injury mechanisms in

the elderly patient [1, 12, 77]. The incidence of simple falls increases with age [13]. Cognitive and motor skill impairments as well as vertigo and sedative medication may account for these findings. Runge [67] summarizes these conditions as “age-associated multifactorial gait disorder”. 30% of the people aged >65 years and 40% in the age group >80 years fall at least once per year [63]. Approximately one-fourth of all falls result in injuries and about 6% in osteoporotic fractures [75].

Fractures of the pubic rami account for two-third, while acetabular fractures account for only 11–19% of osteoporotic pelvic fractures [10, 12]. Pubic rami fractures typically occur as lateral compression fractures (LC injury) after direct impact on the injured side (Fig. 1a) [16]. LC injuries are five times more frequent than anteroposterior compression (APC) injuries in geriatric patients with pelvic fractures [12]. Fractures of the pubic rami are defined as stable type A2 fractures according to the AO/ASIF classification [3, 12, 42, 77]. However, some authors classify fractures of the pubic rami with concomitant sacral compression fractures as internal rotation injury (type B2) [42, 76]. Both pubic rami are typically involved with a displacement in the anterior pelvic ring of generally just a few millimeters.

In 1980, Pennal [60] pointed out that disruptions of the pelvic ring on one site, e.g., fractures of the pubic rami, have to be associated with an injury on another site of the ring. Scintigraphic studies with small sample sizes from the 1970s and early 1980s confirm this hypothesis [32, 56]. Cosker [16] studied 50 elderly patients with fractures of the pubic rami with MRI and found associated posterior ring injuries in 45 of 50 patients (90%). In clinical practice however, computed tomography is the preferred imaging method for the assessment of the posterior pelvic ring. Thus, Schadel-Hopfner [69] found a rate of 53% for associated injuries of the posterior pelvic ring. These injuries typically involve compression fractures of the lateral mass of the sacrum and less frequently transforaminal sacral fractures (Fig. 1b). Bilateral fractures of the pubic rami are generally associated with posterior ring injuries [16, 69]. Cosker [16] describes two cases with bilateral fractures of the pubic rami and associated bilateral posterior ring injury. According to the injury mechanism (fall into a sitting position on the floor), the authors speculate that these injuries might represent “mild vertical shear-type fractures”.

Diagnosis

Patients commonly present with pain and local tenderness in the hip and the inguinal region after a simple fall, and may be unable to comfortably bear weight. Some patients with underlying dementia may be brought in with inability

to bear weight without a known fall history. Generally there are no obvious clinical signs of injury such as hematoma or limb shortening. Communication with these patients may be difficult or even impossible due to dementia or other underlying conditions. Imaging includes a plain radiograph of the pelvis and optionally a hip radiograph in order to rule out proximal femur fractures. Computed tomography or magnetic resonance imaging may be used in specific cases to identify occult injuries that may not be visualized on plain radiographs.

Is a CT scan mandatory for the assessment of associated posterior pelvic ring injuries in patients with fractures of the pubic rami? The decision should be based on the clinical relevance of these associated injuries, which is controversially discussed in literature [16, 32, 42, 69, 76]. Schadel-Hopfner [69] does not recommend CT scans in the routine diagnosis of pubic rami fractures. Cosker [16] supposed that associated posterior ring injuries may be responsible for delayed mobilization and chronic pain. Accordingly, assessment of the posterior pelvic ring may allow for an optimized nonoperative treatment of stable osteoporotic pelvic fractures. Tosounidis [76] even classifies fractures of the pubic rami with associated posterior injuries as internal rotation injury (type B2) and recommends supraacetabular external fixation for patients with persistent pain for longer than 2 weeks.

If the injuries are assessed as stable fractures the patient is allowed to be weight-bearing as tolerated. They may need to be admitted as an inpatient for pain control and mobilization, alternatively they may be treated as an outpatient. Some authors have recommended observation for at least 24 h to rule out hemorrhage [18, 37]. This may be especially important in patients on anticoagulants or in patients in whom drop in hematocrit may not be tolerated.

Initial management

While unstable pelvic injuries resulting from high-energy trauma require emergent management and resuscitation, patients with an osteoporotic pelvic fracture typically present in less critical condition [19, 62]. Patients with osteoporotic pelvic fractures typically present to the hospital with normal vital signs. However, the interpretation of vital signs in geriatric patients may be challenging [22, 23, 46]. Normal systolic blood pressure may indicate hypotension in patients with preexisting hypertension (Fig. 2) [23]. The lack of tachycardia may result from β -blockade [38]. In addition, due to limited physiologic reserve cardiovascular dysfunction may occur even in the presence of normal blood pressure and hemoglobin levels [38, 43]. During inpatient admission, geriatric patients with pelvic hemorrhage typically show a continuous deterioration of their

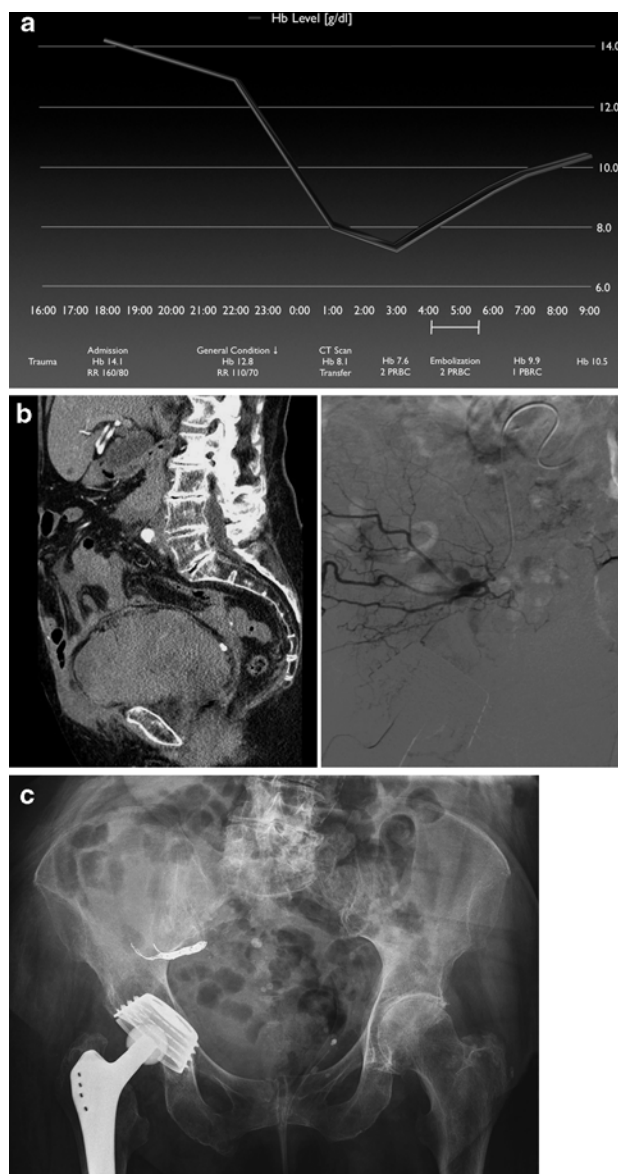


Fig. 2 88-year-old female who sustained a fracture of the inferior pubic ramus on the right side after a simple fall (a). CT shows a massive pelvic hematoma. Angiography shows contrast medium extravasation of the right superior gluteal artery (b). X-ray control after successful embolization. Mind the bladder displacement to the left side due to the hematoma (c)

general condition combined with decreasing Hb levels. Reduced cognitive abilities must not be misinterpreted as cerebral insult or beginning delirium. Computed tomography is the preferred imaging method for the assessment of pelvic hemorrhage. The pelvic fracture accompanying hematomas are displayed as hyperdense areas, active bleedings as contrast medium extravasations. Localization and extension of the hematoma allows in drawing a conclusion of blood loss [9, 72].

While hemorrhage and hemodynamic instability is a frequent concern in high-energy unstable pelvic fractures,

hemorrhage in the presence of a stable pelvic ring typically is only seen in elderly patients [38, 46, 78]. Venous bleeding and bleeding from cancellous bone are less relevant in these patients. It is reasonable to assume that bleeding from small vessels may spontaneously suspend in younger patients due to vasospasm, local tamponade and clotting [38]. In geriatric patients, though, arteriosclerosis may impair vasospasms, the lack of soft tissue turgor limits local tamponade effects and clotting is frequently modified by anticoagulants [46]. Velmahos [78] found an eightfold increased odds of pelvic hemorrhage in patients >55 years. These patients generally sustain lateral compression fractures after simple falls rather than APC injuries. Hemorrhage typically stems from small branches of the iliac artery [78]. Accordingly, fulminant hemorrhage with rapidly developing hemorrhagic shock is rare. However, avulsions of the corona mortis artery (large-bore anastomosis between the inferior epigastric artery and the obturator artery) secondary to fractures of the pubic rami have been described [18, 37].

Transcatheter arterial embolization has proved to be effective in the management of pelvic arterial hemorrhage [6, 7, 27, 36–38, 46, 54, 68, 79, 81]. External fixation is irrelevant for hemostasis in the presence of a stable pelvic ring [80]. However, the optimal timing for arterial embolization remains unclear. A liberal use of angiography increases the number of unnecessary procedures [46]. Delayed intervention in a patient with cardiac decompensation results in higher mortality and worse outcome [1, 22, 38, 58]. However, the question about optimal timing of angiography cannot be conclusively answered according to the data in the literature. Decisions have to be made on an individual basis and have to include considerations about the patient's status and the availability of angiography. Cardiac decompensation, which may occur in geriatric patients rapidly and without warning, must be avoided by all means. Accordingly, several authors recommend early angiography, before patients show "hard signs" of pelvic hemorrhage [22, 23, 38, 43, 46].

Figure 2 shows a representative case of an 88-year-old female with preexisting arterial hypertension who sustained a fracture of the inferior pubic ramus on the right side and a contusion of the skull at 4 p.m. after a simple fall in her own home (Fig. 2a). At 6 p.m. she was admitted to a peripheral hospital with an initial hemoglobin (Hb) level of 14.1 and a blood pressure of 160/80. She complained about pain in the inguinal region, but apart from that her condition was unremarkable. From 10 p.m. however, she showed a continuous deterioration of her general condition. At that time, the Hb level was 12.8 and the blood pressure was 110/70, which was interpreted as a normal value. Subsequently the patient showed progressive tachycardia, tachypnea and cognitive deficits and complained of increasing pelvic pain.

At 1 a.m. the Hb level was 8.1. A CT scan of the pelvic and the skull was performed which showed a massive pelvic hematoma (Fig. 2b). The patient was subsequently transferred to a university hospital. Angiography started at 4 a.m. and showed contrast medium extravasation from the superior gluteal artery (Fig. 2b). Embolization of the artery was successful (Fig. 2c). After receiving five units of packed red blood cells (PRBC), the patient showed an adequate rise of the Hb level. The pelvic hematoma was evacuated on day 16 and further course was uneventful.

Clinical management

The current treatment strategies of osteoporotic pelvic fractures generally involve pain management and mobilization. There is no need for surgical stabilization in the presence of a stable pelvic ring. Secondary displacement and nonunion are rare [5, 73]. Adequate analgesia is a critical and often overlooked topic in geriatric fracture patients. Insufficient pain management results in delayed mobilization and therefore increases the risk of complications following prolonged bed rest [41]. In addition, different studies show that cognitively impaired patients receive less pain therapy [24, 28]. The main reason might be that nursing and medical staff less frequently consider behavioral (moaning, sighing, guarded posture) or physiologic (tachycardia, high blood pressure) signs of pain than they do the patients' self-reporting of pain [39]. On the other hand, different treatment protocols of pain management are mandatory compared to younger patient due to the high rate of relevant comorbidities [66]. Side effects of pain medication are more common in geriatric patients and include worsening of cognitive deficits (NSAIDs and opioids), gastrointestinal bleeding (NSAIDs) and constipation (opioids) [11]. Most notably, NSAIDs should generally be avoided due to the high risk of renal failure in these patients. Other analgesic techniques that can be considered in problematic cases include intrathecal opioid analgesia and local nerve blocks.

While surgical stabilization of most of these osteoporotic pelvic fractures may not be required based on stability, internal fixation may be advocated in some instances to provide pain relief and improve the patient's ability to mobilize. The need for pain relief may be a reasonable indication for operative intervention, similar to the use of vertebroplasty for vertebral compression fractures. In addition to the prevention of posttraumatic kyphosis, injection of PMMA cement or other material into the collapsed vertebral body provides rapid reduction in pain and therefore improves mobilization [50, 61, 64]. A similar percutaneous method, which might be called "ramoplasty" [5], could be used for pain reduction after failure of pain medication to provide sufficient relief of pubic rami fractures. Two case

Table 1 Summary of recent studies on the outcome after osteoporotic pelvic fractures

Study	Study design	Injury	Patients number	Main results	Conclusion
Alost et al. [1]	Retrospective	All pelvic fractures	120 patients <65 years versus 80 patients >65 years	Patients >65 years: Less severe pelvic injuries and fewer associated injuries. Mean length of hospital stay was 9.6 days. Higher inpatient mortality despite less severe injuries mainly due to exacerbation of preexisting cardiovascular diseases	Care must be taken to prevent morbidity caused by exacerbation of preexisting morbidities in geriatric patients with pelvic fractures
Dechert et al. [21]	Retrospective	All pelvic fractures	1,066 patients <65 years versus 157 patients >65 years	Patients >65 years: Increased length of hospital stay (12.5 vs. 11.5 days). Higher mortality (20.4 vs. 8.3%) More likely to die from multi-system organ failure (25 vs. 10.2%) Less likely to die from exsanguination (21.9 vs. 45.5%)	Elderly patients with pelvic fractures have worse outcomes despite management at a level I trauma center
Hill et al. [40]	Retrospective	Fractures of the pubic rami	286 patients with a mean age of 74.4 years	Mean length of hospital stay was 9.3 days. 139 patients (48.6%) spent an average of 41.1 days in a geriatric rehabilitation unit after discharge from hospital. 1-year mortality (13.3%) was higher when compared with an age-matched cohort from the general population and lower when compared with patients sustaining from a fracture of the hip. 5-year mortality (54.4%) was higher when compared with an age-matched cohort from the general population, but there was no significant difference to the hip fracture group. Age and dementia were significant factors to be predictive of mortality. Level of mobility deteriorated and social dependency increased from before injury to final follow-up	Admission of patients with isolated fractures of the pubic rami to a geriatric unit is sensible. Orthopedic treatment should be limited to patients with additional fractures
Koval et al. [47]	Retrospective	Fractures of the pubic rami	63 patients with a mean age of 79 years	Mean length of hospital stay was 14 days. Patients with 3 or more preexisting comorbidities were more likely to have a longer hospital stay. 1-year mortality was 9.5%. 95% of the patients returned to prefracture function in daily activities	Elderly patients with fractures of the pubic rami use substantial healthcare resources. 1-year mortality is similar to that reported after hip fractures. Patients who survive have a good prognosis with regard to functional outcome
Leung et al. [51]	Retrospective	All pelvic fractures	60 patients with a mean age of 78 years	Two patients died of causes related to the pelvic fracture (one uncontrolled bleeding and one pulmonary embolism) during hospital admission. Mean length of hospital stay was 20.8 days. Patients with preexisting comorbidities, complications or associated injuries had a longer stay. 36% of the patients experienced a decline in ambulatory status, especially for patients with two or more comorbidities and acetabular involvement. 1-year mortality was 11.7% and 2-year mortality was 19.6% Most deaths were due to prefracture medical conditions	Preexisting medical conditions are the major determining factors for length of hospital stay and ambulatory status. Scoring systems that include these factors are mandatory for a better prediction of the outcome. Further studies are required to develop effective management protocols

Table 1 continued

Study	Study design	Injury	Patients number	Main results	Conclusion
Morris et al. [55]	Retrospective	All pelvic fractures	148 patients with a mean age of 83 years	Mean length of hospital stay was 21.3 days with an inpatient mortality of 7.6%. Before trauma, 53.4% patients were able to walk unaided. At discharge, all patients needed at least a walking stick and 51.1% needed assistance for mobility. Rates of institutionalism rose from 20.9% before trauma to 35.8% at discharge. 1-year mortality was 27%	Pelvic fractures after low-energy trauma are associated with a relevant 1-year mortality. Patients show a decrease in mobility and an increase in social dependency
O'Brien et al. [57]	Retrospective	All pelvic fractures	248 patients <55 years versus 57 patients >55 years	Patients >55 years: Patients were significantly more often transferred to the ICU. Mean length of hospital stay was 10.9 days with an inpatient mortality of 12.3%. Age was the only significant predictor of mortality	Caring for the geriatric pelvic trauma patient requires major hospital resources. Elderly patients sustaining pelvic fractures may require special protocols for management. Further studies in this area is warranted

series of this type of technique has shown promising results [5, 44]. As an alternative to the “ramoplasty” technique, Tosounidis [76] recommends supraacetabular external fixation for patients with pubic rami fractures with associated sacral fractures and persistent pain for longer than 2 weeks. All reports on surgical procedures of pubic rami fractures represent small case series without control groups. Prospective controlled studies are needed to better gauge the efficacy of these procedures prior to a recommendation of their use in patients with failure of standard management with pain medication.

Additionally, modern treatment aspects should involve strategies to address comorbidities of the patients and to avoid iatrogenic illness. Different models of integrated care (orthogeriatric co-management) aim to provide standardized protocols which are tailored to the needs of geriatric fracture patients. The importance and effectiveness of such a model was pointed out for hip fracture patients [30]. The standardized protocols involve pain therapy, DVT prophylaxis, antibiotic prophylaxis, perioperative timing, prevention and treatment of delirium, osteoporosis therapy, management of malnourishment and early discharge management. After discharge, a fall risk assessment within a geriatric rehabilitation unit could uncover different disorders triggering a fall such as neurologic diseases (e.g. Parkinson's disease or peripheral neuropathy) or cardiac diseases (e.g., atrial fibrillation). These protocols combined with an integration of a geriatrician in the trauma team and a geriatric rehabilitation could be an advantage for geriatric pelvic fracture patients and might lead to better functional outcomes and lower overall complication rates [29, 30, 39].

Outcome

Despite the increasing incidence of osteoporotic pelvic fractures, current literature includes only a few retrospective studies dealing with this issue. The results of some recent studies are summarized in Table 1 [1, 21, 40, 47, 51, 55, 57]. The mean length of hospital stay in these six studies was 13.4 days ($n = 694$). The mean 1-year mortality was 16.3% ($n = 557$) and is therefore comparable to the 1-year mortality after proximal femur fractures [29, 30, 49]. In fact, the patients are themselves comparable due to their preexisting impairment. Typical injury mechanisms are falls from standing height with direct impact to the hip [71]. This fall can either lead to a hip fracture or an osteoporotic pelvic fracture. From the general conditions, these patients are worse than others because they cannot firm up the fall, as this would more likely lead to a distal radius fracture [49]. Interestingly, hip fractures have to be treated operatively, whereas osteoporotic pelvic fractures are treated

nonoperatively. These findings, however, do not show up in different 1-year mortality rates.

Despite differences in patient groups and study goals the authors agree on several aspects:

- Osteoporotic pelvic fractures may lead to a decrease in mobility and an increase in social dependency.
- They are associated with an increased mortality.
- Preexisting medical conditions are the major determining factors for the outcome after osteoporotic pelvic fractures.
- Elderly patients with osteoporotic pelvic fractures use substantial healthcare resources, which will further increase in the future as the average age of the population continues to increase.

Conclusion

Low-energy osteoporotic pelvic fractures, despite being stable injury patterns that do not require surgical fixation for stability, pose a serious health hazard to elderly patients with severe preexisting comorbidities. The current literature includes only a few retrospective studies of low-energy osteoporotic pelvic fractures. Thus, according to the data in the literature we are not able to provide evidence-based algorithms in the management of these injuries. We recommend a liberal use of CT for the assessment of posterior ring injuries and pelvic hematoma and early angiography in the treatment of pelvic hemorrhage. However, prospective studies are needed to better gauge the outcome after low-energy osteoporotic pelvic fractures in elderly patients.

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