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Pelvic X-ray misses out on detecting sacral fractures in the elderly – Importance of CT imaging in blunt pelvic trauma

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ABSTRACT

Patients aged 75 years and older with blunt pelvic trauma are frequently seen in the ER. The standard diagnostic tool in these patients is the plain a.p.-radiograph of the pelvis. Especially lesions of the posterior pelvic ring are often missed due to e.g. bowel gas projection and enteric overlay. With a retrospective study covering these patients over a 3 year period in our level I trauma centre, we were able to evaluate the rate of missed injuries in the a.p.-radiograph whenever a corresponding CT scan was performed. Age, gender, and accompanying fractures of the pelvic ring were recorded. The intrinsic test characteristics and the performance in the population were calculated according to standard formulas. Thus, 233 consecutive patients with blunt pelvic trauma with both conventional radiographic examination and computed tomography (CT) were included. Thereof, 56 (23%) showed a sacral fracture in the CT scan. Of 233 pelvic X-ray-images taken, 227 showed no sacral fracture. 51 (21.7%) of these were false negative, yielding a sensitivity of just 10.5%. Average age of patients with sacral fractures was 85.1 ± 6.1 years, with 88% being female. Sacral fractures were often accompanied by lesions of the anterior pelvic ring with pubic bone fractures in 75% of sacrum fracture cases. Second most concomitant fractures are found at the acetabulum (23.3%).

Plain radiographic imaging is especially likely to miss out fractures of the posterior pelvic ring, which nowadays can be of therapeutic consequence. Besides the physicians experience in the ED, profound knowledge of insensitivity of plain radiographs in finding posterior pelvic ring lesions is crucial for a reliable diagnostic routine. Since the high mortality caused by prolonged immobilisation due to pelvic ring injuries, all fractures should be identified. We therefore provide a diagnostic algorithm for blunt pelvic trauma in the elderly.

Introduction

Blunt pelvic traumata are a common complaint among elderly patients attending the emergency department. Most are sent for radiography, but conventional X-ray often fails to detect sacral fractures, because of enteric gas and bowel projections and overlay, or degenerative bony alterations.

Osteoporosis and attenuated reflexes in a population aged 75 years and older make sacral or lumbar pain highly suspicious of fractures. As sacral fractures are of biomechanical and thus interventional therapeutical relevance, they must not be missed in the diagnostic pathway. As a source of functional disability, pelvic fractures causing pain or functional disability deserve special attention to avoid persistent immobilisation and pain. In contrast to 1992, when missing the diagnosis had no influence on patients therapy or management [1], nowadays percutaneous sacroiliac screw placement is a safe and sound treatment for sacral fractures enabling fast recovery, mobilisation, and pain reduction [2] in some cases. Fragility fractures of the posterior pelvic ring with weak cancellous bone may also be stabilised by a transsacral bar implantation via a limited access approach [3].

To establish a diagnostic routine for symptomatic blunt pelvic trauma in the elderly, we set up a retrospective analysis of sacral fracture cases to gain a solid data basis for a diagnostic pathway recommendation.

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Material and methods

We analyzed the radiological reports, all validated by a board certified radiologist, for patients aged 75 years and older who had a blunt pelvic trauma (including fall from standing height) and had both a standard a.p. pelvic X-ray and pelvic CT scan in the emergency department over a 3-year period in our German level I trauma centre. Patients with only either X-ray or CT scan were disregarded, and histories of inadequate (no direct blow to the pelvis or hip) or missing trauma were excluded. Age and gender were recorded and cases were analyzed overall and according to the following age groups 76–80, 81–85, 86–90, 91–95 and 96+. The intrinsic test characteristics (sensitivity and specificity) and the performance in the selected population (positive and negative predictive values) were calculated according to standard formulas. In case of positive sacral fracture finding, both X-ray report and CT report were scrutinised for accompanying fractures of os ilium, pubis, ischium, coccyx, lumbar spine, acetabulum, and femur. The study was approved by the local ethic's committee in charge (No. 183/14).

Results

233 consecutive patients with symptomatic blunt pelvic trauma with both conventional radiographic examination and computed tomography (CT) were included. Thereof, 56 (24%) showed a sacral fracture in the CT scan.

There were 233 pelvic X-ray-images taken of which 227 showed no sacral fracture. 51 (21.7%) of these were false negative and just 1 X-ray was false positive.

Thus, sensitivity of pelvic radiographs for detecting sacral fractures was 10.5%, while specificity was high (99.4%), with negative- and positive predictive values of 77.8% and 85.5%, respectively (Table 1). Average age of patients with sacral fractures was 85.1 ± 6.1 years, with 88% being female. Age distribution shows no definite peak within the population aged 75 and older; two higher values of 31.4% and 35.3% are found in the groups 76–80 years and 91–95 years, respectively (Fig. 1). Mean ASA classification in sacral fractures was 3.2, body height 1.62 m and body weight 59.2 kg yielding an average BMI of 22.5. The mean length of hospitalisation was 11.8 days in case of a sacral fracture.

Of 233 pelvic X-ray-images, in 128 a fracture of the pubic bone was suspected with 115 being correct positive and 13 being false positive. CT scan revealed 175 fractures, making 60 radiographs being false negative and 121 correct negative. Thus, for fractures of the pubic bone sensitivity was 65.7%, specificity 90.3%, positive and negative predictive values as performance in the population were 84.3% and 76.8%, respectively (Table 1).

Sacral fractures often were accompanied by other fractures of the pelvic ring: lesions of the anterior pelvic ring with pubic bone fractures were found in 75% of sacrum fracture cases. Second most concomitant fractures are seen at the acetabulum (23.3%; Fig. 2). Fractures of os ischii (1.8%), proximal femur (5.4%), and lumbar spine (8.9%) were of subordinate occurrence. In our population of 233 consecutive patients over a three year period, no case of sacrum fracture showed an additional fracture of os ilium or coccyx.

Table 1
Intrinsic characteristics and performance in the population of plain X-ray for sacral and pubic bone fractures.

	os sacrum (%)	os pubis (%)
Intrinsic characteristics		
Sensitivity	10.5	65.7
Specificity	99.4	90.3
Performance in the population		
Positive predictive value	85.5	84.3
Negative predictive value	77.8	76.9

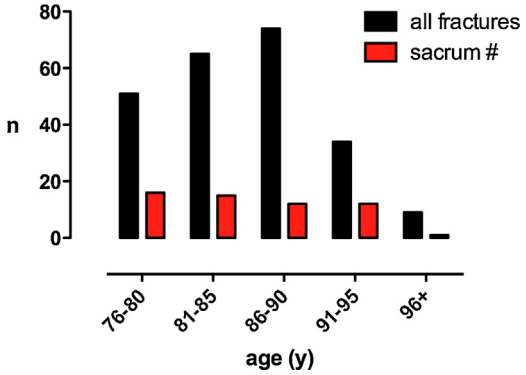

Fig. 1. Age distribution of fractures identified all pelvic fractures (black) according to age groups compared to fractures of the sacrum (red). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Discussion

Our results show that the standard X-ray of the pelvis misses sacral fractures in a large percentage, which can be of individual and therapeutical consequence. Nowadays, some sacral fractures can be treated by s1, s2, or combined s1 + 2 screw placement or transsacral bar implantation, enabling pain free or drastically pain reduced early mobilisation which reduces immobilisation related mortality [4,5].

There is a variety of reasons for fractures being missed in the conventional radiograph of the pelvis. While some of these can be directly influenced others are inherent and have to be dealt with. Bad imaging technique, wrong exposure time or voltage have to be improved. The key to missed fractures seems to be the patient and pelvis itself: gas and bowel overlay makes the sacrum hard to evaluate, osteochondrotic and osteoporotic changes of the bone texture can cover up damages, even of the cortical bone. In case of reduced or altered mental status, the patient is not able to give proper signs in clinical examination or anamnesis, which both are of importance at the edge of diagnostics.

In 2012, Scheyerer et al. reported an enormous 96.8% of posterior pelvic ring fractures being missed in patients with diagnosed fracture of the pubic rami [6]. When compared to magnetic resonance imaging (MRI) in the depiction of sacral fractures, reaching a sensitivity of 98.6%, CT yields only 66.1%

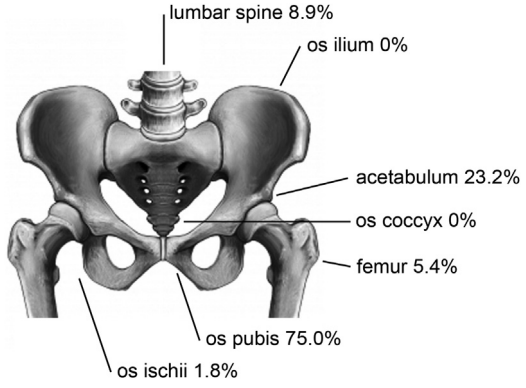

Fig. 2. Distribution of fractures accompanying a fracture of the sacrum.