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Prevalence of pelvic insufficiency fracture in patients investigated by CT or MRI for pelvis or bone scan after pelvic irradiation at King Chulalongkorn Memorial Hospital (KCMH)

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Eowchye S, Vasavid P, Numkarunarunrote N, Raiyawa T. Prevalence of pelvic insufficiency fracture in patients investigated by CT or MRI for pelvis or bone scan after pelvic irradiation at King Chulalongkorn Memorial Hospital (KCMH). Chula Med J 2014 Jul – Aug; 58(4): 371 - 82

Background : *Pelvic insufficiency fracture (PIF) is one of the common complications in patients who have received pelvic irradiation. If clinicians and/or radiologists misunderstand the pathophysiology and associated radiographic findings, the diagnosis of this condition is delayed or misdiagnosed as pathologic fractures from metastasis.*

Objective : *To evaluate prevalence and distribution of pelvic insufficiency fracture in patients who have been investigated by CT or MRI for pelvis or bone scan after pelvic irradiation.*

Design : *Retrospective study.*

Setting : *Department of Radiology, Faculty of Medicine, Chulalongkorn University.*

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Materials and Methods : *We retrospectively reviewed 260 patients with known history of primary pelvic cancer who received external beam radiation (40 - 64 Gy). The imaging findings were retrospectively reviewed on the PACS system and nuclear medicine workstation by an experienced radiologist, nuclear medicine physician and researcher. The prevalence of pelvic insufficiency fracture, frequency of distribution sites and average patients' age were calculated and analyzed.*

Results : *Twenty of 260 patients (7.69%) showed pelvic insufficiency fracture after pelvic irradiation. Ninety-five percent of the fracture sites are the sacral alar. The second most frequent fracture sites are the upper sacral body (55%) and pubis (55%). Seventy-five percent of the cases showed more than one fracture sites in the pelvis, either symmetric or asymmetric. Among them, 65% had bilateral symmetric lesions in the sacral alar. A single lesion was noted in five cases (25%), at the sacral alar and the left parasymphyseal region.*

Conclusion : *Our study found the prevalence of pelvic insufficiency fracture in patients investigated by CT or MRI for pelvis or bone scan after pelvic irradiation at King Chulalongkorn Memorial Hospital is about 7.69%. The most common site involved is the sacral alar followed by the upper sacral body and the pubis which are weight bearing areas. Most cases had multiple sites of insufficiency fractures, usually bilateral involvement.*

Keywords : *Pelvic insufficiency fracture, radiation therapy, prevalence.*

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สวรินทร์ เอี้ยวฉาย, ภัทรมน วาศวิท, น้ำผึ้ง นำการุณอรุณโรจน์, ทัศน์พงศ์ รายยวา. การศึกษาความชุกของภาวะกระดูกเชิงการหักในผู้ป่วยที่ได้รับการรักษาโรคมะเร็ง โดยการฉายรังสีรักษาบริเวณอุ้งเชิงกราน และมีการตรวจติดตามด้วยเอ็กซเรย์คอมพิวเตอร์ของอุ้งเชิงกรานหรือสแกนคลื่นแม่เหล็กไฟฟ้าของอุ้งเชิงกรานหรือสแกนกระดูกในโรงพยาบาลจุฬาลงกรณ์. จุฬาลงกรณ์เวชสาร 2557 ก.ค. – ส.ค.; 58(4): 371 – 82

เหตุผลของการทำวิจัย : *ภาวะกระดูกเชิงการหักในผู้ป่วยที่ได้รับการรักษาโรคมะเร็งโดยการฉายรังสีรักษาบริเวณอุ้งเชิงกรานเป็นภาวะแทรกซ้อนหนึ่งที่เกิดขึ้นได้หลังการรักษา อาการและลักษณะที่พบทางภาพเอ็กซเรย์คอมพิวเตอร์สแกนคลื่นแม่เหล็กไฟฟ้า หรือสแกนกระดูก อาจทำให้มีความสับสนกับการแพร่กระจายของมะเร็งไปที่กระดูกอุ้งเชิงกรานได้*

วัตถุประสงค์ : *เพื่อศึกษาความชุก และการกระจายตำแหน่งรอยโรคของภาวะกระดูกหักบริเวณอุ้งเชิงการหักภายหลังได้รับการรักษาโรคมะเร็ง โดยการฉายรังสีรักษาบริเวณอุ้งเชิงกรานในโรงพยาบาลจุฬาลงกรณ์ โดยการใช้เอ็กซเรย์คอมพิวเตอร์หรือสแกนคลื่นแม่เหล็กไฟฟ้า หรือสแกนกระดูกอย่างใดอย่างหนึ่งหรือร่วมกัน*

สถานที่ทำการศึกษา : *ภาควิชา/ฝ่ายรังสีวิทยา คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย/โรงพยาบาลจุฬาลงกรณ์ สภากาชาดไทย*

รูปแบบการวิจัย : *การศึกษาแบบย้อนหลัง*

วิธีการศึกษา : *ได้ทำการศึกษาย้อนหลังในผู้ป่วย 260 คน ที่ได้รับการรักษาโดยการฉายรังสีรักษาบริเวณอุ้งเชิงกรานในโรงพยาบาลจุฬาลงกรณ์ ระหว่าง 1 มกราคม พ.ศ. 2551 ถึง 31 ธันวาคม พ.ศ. 2553 โดยการทบทวนภาพเอ็กซเรย์คอมพิวเตอร์ หรือสแกนคลื่นแม่เหล็กไฟฟ้าหรือสแกนกระดูก อย่างใดอย่างหนึ่งหรือร่วมกัน และนำมาคำนวณหาความชุก และวิเคราะห์การกระจายตำแหน่งรอยโรค*

ผลการศึกษา : *พบภาวะกระดูกอุ้งเชิงกรานหักภายหลังการฉายรังสีรักษาในผู้ป่วย 20 คน จากผู้ป่วยที่ได้รับการฉายรังสีรักษาทั้งหมด 260 คน โดย พบว่า 95% ของรอยโรคเกิดบริเวณ sacral alar, 55% เกิดที่ sacral body และ 55% เกิดที่ pubis โดยพบว่าสามในสี่ของรอยโรคพบรอยหักมากกว่า 1 ตำแหน่ง และ 65% เกิดทั้งสองฝั่งของ sacral alar อย่างไรก็ตาม ยังสามารถพบบริเวณที่มีกระดูกหักเพียงตำแหน่งเดียวได้ถึงหนึ่งในสี่*

สรุป : *จากการศึกษาพบว่าความชุกของภาวะกระดูกหักภายหลังได้รับการรักษาโรคมะเร็ง โดยการฉายรังสีรักษาบริเวณอุ้งเชิงกรานในโรงพยาบาลจุฬาลงกรณ์ คิดเป็น 7.69% โดยพบมากที่สุดบริเวณ sacral alar, upper sacral body และ pubis ตามลำดับ โดยรอยโรคส่วนมาก มักเกิดมากกว่า 1 ตำแหน่งและมักเกิดทั้ง 2 ด้านของกระดูกอุ้งเชิงกราน*

คำสำคัญ : *Pelvic insufficiency fracture, การรักษาโดยการฉายรังสีรักษา, ความชุก.*

Insufficiency fractures are subclass of stress fractures that occur after stress is repeatedly applied to non-elastic resistant bones.[1] Elderly and patients who possess a predisposing factor such as postmenopausal state, osteoporosis, corticosteroid use, rheumatoid arthritis and local irradiation aggravating bone injury are at risk of severe hip and lower back pain which are commonly caused by pelvis insufficiency fractures (PIF).

As for patients who have a history of pelvic irradiation for malignancy, bone metastasis may bethe cause. If clinicians misunderstand the pathophysiology of this condition and its associated radiographic findings, the diagnosis can be delayed or misdiagnosed as pathologic fractures from metastasis. Also, any further irradiation for misdiagnosed insufficiency fractures as metastatic pathologic fracture will weaken the bone strength.[2 - 4]

A combination of injuries of the blood vessels supplying the bone and direct injury to osteoblastsand osteoclasts leads to radiation-induced bone injury. Because of the skeletal structure being irradiated and the radiation dose, the specific changes vary in part. A dosage of more than 40 Gy is normally associated with radiologic changes and cell death normally occurs when the radiation dose is higher than 50 Gy. Nevertheless, for conventional pelvic radiation with various fields and megavoltage, mature bone receives around 60 - 70% of the prescribed dose and mature bone usually has a tolerance of 65 - 70 Gy.[2, 5, 6] Radiation-induced bone changes are not normally detected by radiographic changes or other clinical methods during the first 12 months after irradiation since they are slow to develop.[3,4,7] The progression of the radiographic changes may occur up to 3 to 5 years after irradiation; and, fractures mostly occur between 3 - 5 years after pelvic irradiation.[4, 8]

According to the reasons mentioned above, pelvic insufficiency fractures are challenges to diagnosis. Plain radiographs may not clearly reveal the sacral fracture, and fracture affecting the pelvic bone may provide a misleading appearance.[9 - 11] In terms of diagnostic management and prognosis, it is important to be able to distinguish insufficiency fractures from metastasis for patients with known primary cancer. Thus, recognition of the spectrum of imaging findings and the prevalence for pelvic insufficiency fracture will bring about correct identification and appropriate treatments.[12,13]

Patients and methods

Having received the approval from the Ethics Committee of the Faculty of Medicine, 880 patients who received whole pelvic radiotherapy for primary malignancies at King Chulalongkorn Memorial Hospital (KCMH) between January 2008 and December 2010 were retrospectively reviewed. The primary tumors treated were rectal carcinoma, cervical cancer and corpus cancer. A total of 267 patients who had imaging were available from the database of the Department of Radiology. Seven of 267 patients were excluded because of 2 patients had bony metastases, 4 patients had indeterminate lesions and 1 patient with a history of pelvic exenteration with sacrectomy. The remaining 260 patients met the inclusion criteria: patients with known history of primary pelvic cancer who received external beam radiation (40 - 64 Gy), daily fraction size was 1.8 - 2 Gy, the irradiation field included the entire sacrum and pelvic bone and the medial portion of the ilium adjacent to the sacroiliac joint, the patients had to be investigated with at least one of the three imaging modalities (pelvic CT or pelvic MRI or bone scan).

The imaging findings were retrospectively reviewed on the PACS system and nuclear medicine workstation by an experienced radiologist, nuclear medicine physician and researcher. All CT examinations were performed in 16-MDCT scanner (Somatom sensation 16, Siemens) or 320-MDCT scanner (Aquilion ONE, Toshiba) and MRI examinations were performed in 1.5T GE Signa. All anterior and posterior whole body planar bone scan was acquired 2 – 4 hours after intravenous administration of approximately 20 mCi of Tc-99m pertechnetate into a 256 × 1024 matrix using gamma camera equipped with low energy high resolution collimator.

The diagnostic criteria included presence of typical pelvic insufficiency fracture in imaging findings (presence of a fracture line with adjacent soft tissue edema, fat stranding or hematoma on CT or presence of a fracture line, bone marrow edema or soft tissue abnormalities on MRI or presence of typical H-shaped pattern, incomplete sacral pattern or linear iliac uptake on bone scan) with or without negative pelvic bone pathologic findings for malignancies or without imaging follow ups suggestive of bone metastasis in one year. The location of the lesions was classified according to the site of the abnormality in the pelvis as sacral alar, pubis, iliac bone, acetabulum, upper and lower sacrum. The appearances of the fracture were classified as single, multiple, unilateral and bilateral. The prevalence of the pelvic insufficiency fracture, frequency of distribution site and average patient's age were calculated and analyzed.

Results

There are 260 patients who received whole pelvic radiotherapy for primary malignancies and met the inclusion criteria. Insufficiency fractures were diagnosed in 20 patients after pelvic radiationat the cumulative radiation dosage of external radiation was at ranging from 41.4 Gy to 64 Gy (average cumulative dose 53.87 Gy). The prevalence of the pelvic insufficiency fractures in patients investigated by CT or MRI of pelvis or bone scan after pelvic irradiation is about 7.69%. Among patients who were diagnosed with pelvic insufficiency fracture, there were 19 females and 1 male with the age range of 25 - 78 years old (mean age 60 years old, median age 65 years old). Of all 19 female patients, 16 (84.2%) were in post-menopausal state and only one in pre-menopausal state. Two female patients had no any menstrual status in their medical records. The demographic data are shown in Table 2.

Table 1. Imaging modality of pelvic insufficiency fracture patients (n = 20).

Modalities	Number of patients (n)
MRI and CT and bone scan	3
MRI and bone scan	1
CT and bone scan	4
MRI only	1
CT only	11

Table 2. Demographic data of pelvic insufficiency fracture patients and radiation dose received.

Patient	Sex	Age	Primary tumor site	Menopausal status	External radiation Dose (Gy)
1	F	57	Rectum	Menopause	41.4
2	M	67	Rectum	-	50
3	F	76	Rectum	Menopause	50
4	F	49	Corpus	Menopause	50
5	F	67	Corpus	Menopause	60
6	F	45	Corpus	-	50
7	F	46	Corpus	Menopause	50
8	F	65	Corpus	Menopause	50
9	F	63	Corpus	Menopause	60
10	F	25	Cervix	Menopause	58
11	F	40	Cervix	Premanopause	54
12	F	66	Cervix	Menopause	50
13	F	71	Cervix	Menopause	56
14	F	74	Cervix	Menopause	54
15	F	52	Cervix	Menopause	60
16	F	70	Cervix	Menopause	64
17	F	71	Cervix	Menopause	60
18	F	53	Cervix	Menopause	56
19	F	78	Cervix	Menopause	50
20	F	65	Cervix	Menopause	54

Table 3. Frequency of distribution of pelvic insufficiency fractures (n = 20).

Distribution	Number of cases (Frequency %)
Sacral alar	19 (95%) (Bilateral = 13, Unilateral = 6)
Pubis	11 (55%) (Bilateral = 5, Unilateral = 6)
Upper sacrum (S1-2)	11 (55%)
Iliac bone	9 (45%) (Bilateral = 5, Unilateral = 4)
Lower sacrum (S3-5)	5 (25%)
Acetabulum	1 (5%)

Table 4. Prevalence of the pelvic insufficiency fracture, compare to the previous study.

Authors	Primary malignancy	Number of case (n)	Post menopausal women with positive PIF (%)	Prevalence / Incidence %	Dose (Gy) (Median dose)
Jong Won Kwon, et al.	Ca cervix	510	-	45.2	30.6 - 66.6 (50.4)
Abe, et al.	CA cervix CA corpus	80	100	34	10 - 60 (46)
Ikushima, et al.	Gynecologic malignancy	158	100	11.4	40 – 50 (50)
Bromlie, et al.	CA cervix	18	100	89	46
Bliss, et al.	CA cervix	183	-	2.7	45 – 50 (50)

The modality of imaging acquired in 20 patients diagnosed with pelvic insufficiency fracture is shown in Table 1. Three of 20 patients had all the 3 modalities (CT + MRI + bone scan). Five patients had 2 imaging modalities, either pelvic CT and bone scan or pelvic MRI and bone scan. All patients with more than one imaging modality have congruent diagnoses from each imaging modality.

In 20 patients diagnosed with pelvic insufficiency fracture, 8 patients who had bone scan had pelvic bone lesion. Four of the 8 patients (50%) showed the classic H-pattern, the characteristic appearance of sacral insufficiency fracture (Figure1).

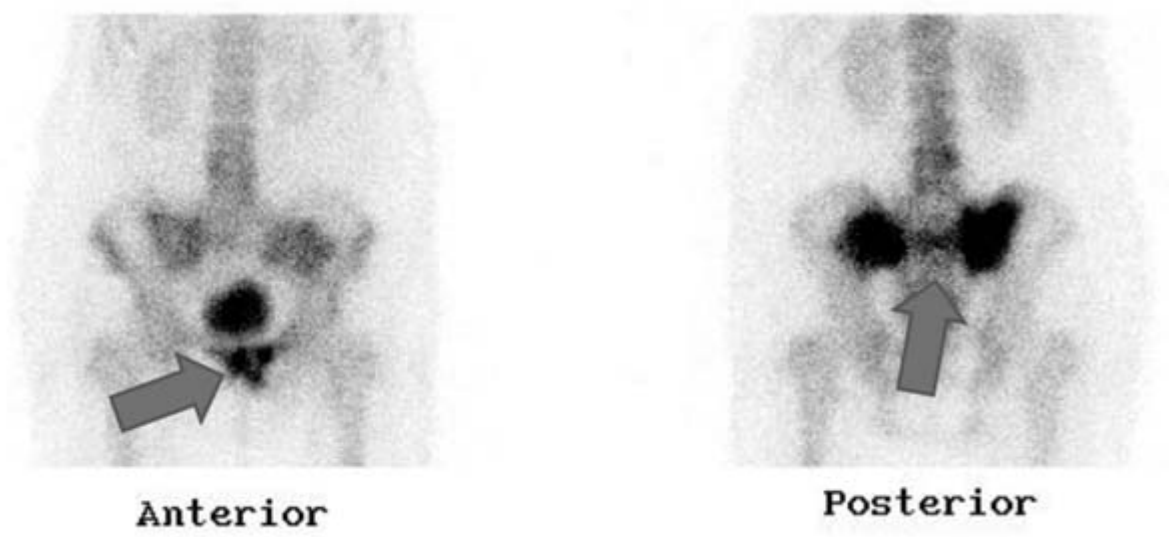

Figure 1. Anterior and posterior views of the bone scan. The anterior views show increase radiotracer uptake on bilateral parasymphyseal regions. The posterior views show H-shaped radiotracer uptake, the classic appearance of a sacral insufficiency fracture.

The MRI findings show diffuse decrease in signal intensity on T1-weighted images and diffuse increase signal intensity on T2-weighted images due to marrow edema. A fracture line sometimes presents within an area of marrow edema as a thin hypo signal intensity line. No abnormal associated soft tissue mass is seen adjacent to the fracture site (Figure 2).

The CT findings show one or more fracture lines with disruption of the cortex without or without displacement of the bony fragment. No evidence of osteolytic or osteoblastic lesion is detected at the fracture site (Figure 3).

The distribution of the pelvic insufficiency fractures is shown in Table 3 and Figure 4.

The appearances of the fracture were as follows; the single site of fracture was observed in 5 of 20 patients (25%). More than one site of fractures were observed in 15 of 20 patients (75%); most of the lesions (65%) were bilateral involvement.

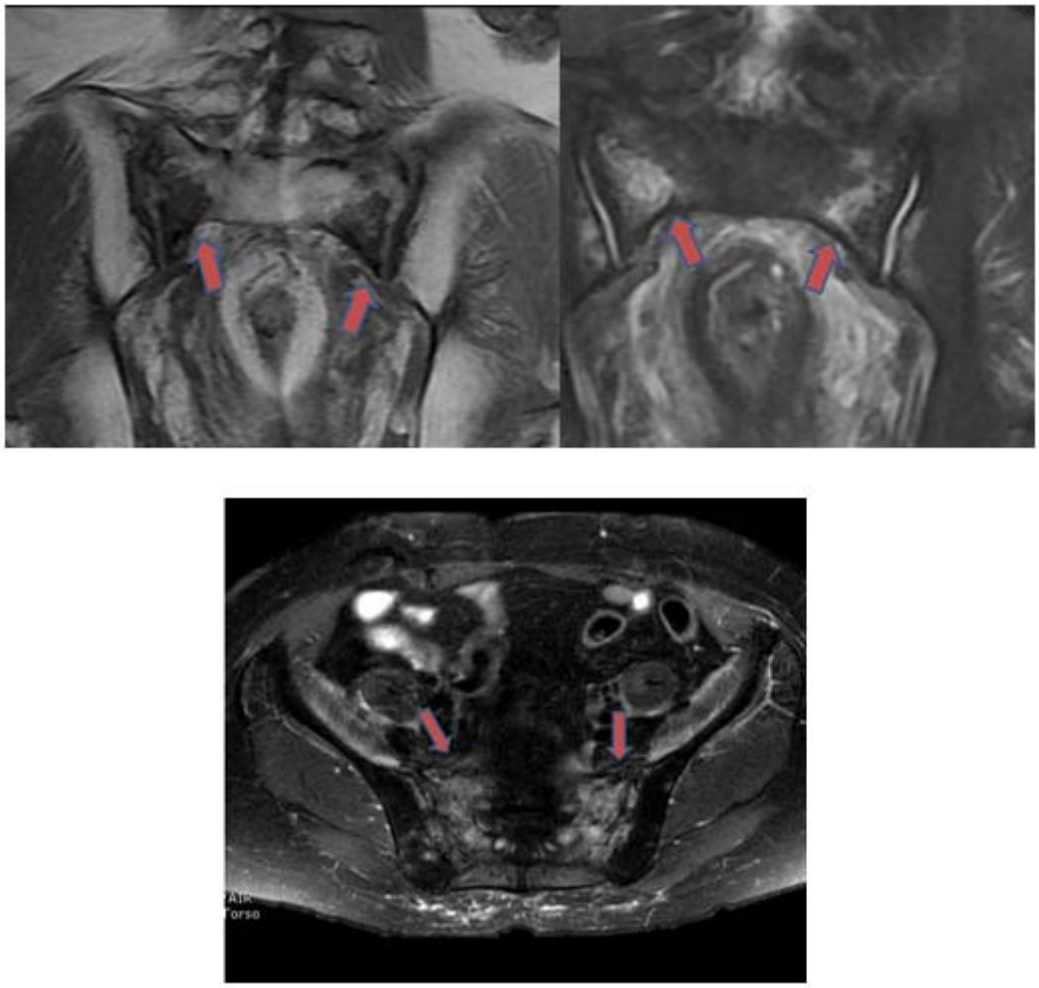

Figure 2. Axial T2WI SPAIR, Coronal oblique T1W and Coronal oblique T2WI with FS shows diffusely increased signal intensity on bilateral sacral alae, representing marrow edema in bilateral sacral alae.

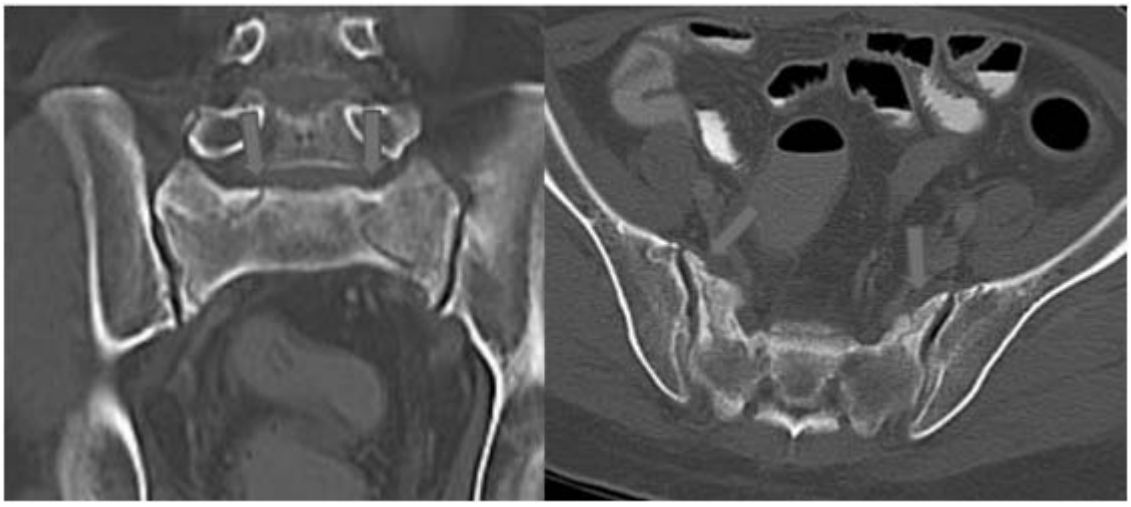

Figure 3. Coronal and Axial CT scan showing fracture line along bilateral sacral alae with interruption of the anterior cortex of the sacrum. They extend posteriorly, parallel to the sacroiliac joints.

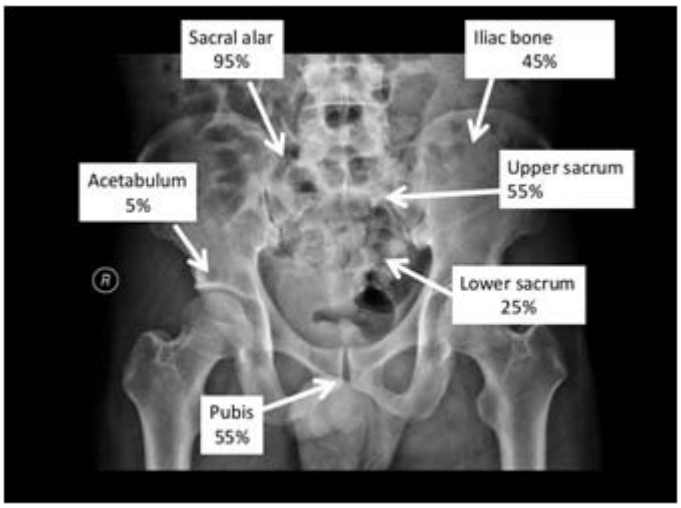

Figure 4. Frequency and distribution of the pelvic insufficiency fracture.

Discussion

Pelvic insufficiency fracture is a common complication occurs in patients who received pelvic radiation. Most patients present with low-back pain or non-specific sacral pain. It is important to distinguish this condition from bony metastasis because of the different treatments and prognostic outcomes.[12,13]

We found that the prevalence of pelvic insufficiency fractures in patients investigated by CT or MRI of pelvis or bone scan after pelvic irradiation in KCMH is about 7.69%. More than 2/3 of patients with pelvic insufficiency fractures are in post-menopausal state (84.2%).

Although there are many previous studies relate to the prevalence of pelvic insufficiency fracture

in patients who received pelvic radiation in different conditions, the prevalence of the pelvic insufficiency fracture quite varies and ranges from 2.7 - 89% (Table 4). The difference among several reports may be resulting from several difference factors in each study such as different sample sizes and multi-factor on which PIF depends. These include menstrual status, osteoporosis of the underlying bone, history of corticosteroid use, local irradiation dose and also other underlying disease(s) of the patient.[14]

In terms of location and distribution of the disease, the most frequent fracture site is sacral alar (95%) compatible with findings from several previous studies.[3, 6,11] The second most frequent fracture sites are the upper sacral body (55%) and pubis (55%) in congruent with the studied by Ikushima *et al*. and Abe *et al*.[3,11]The common involvement of sacral alar, sacral body and pubis are weight bearing areas. Besides the common location of sacral alar, the fracture could also occur in other parts such as the lower sacrum and acetabulum.

Most cases (75%) showed more than one fracture sites in the pelvis, either symmetric or asymmetric. Among them, 65% had bilateral symmetric lesions in the sacral alar. A single lesion was noted in five cases (25%) in the sacral alar and left parasymphyseal region. Besides the sacrum, the other common sites found in this study were the pubic and lilac bone. Acetabular fractures (5%) were found minority of pelvic insufficiency fracture patients. From our study, there was an obvious diagnostic correlation between different imaging modalities similar to previous studies.

In conclusion, our study found the prevalence of pelvic insufficiency fracture in patients investigated by CT or MRI of the pelvis or bone scan after pelvic irradiation at King Chulalongkorn Memorial Hospital is about 7.69%. The most common site involved is the sacral alar followed by the upper sacral body and the pubis. Most cases had multiple pelvic insufficiency fractures, usually with bilateral involvement. However, single fracture can also be found.

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