THE ROLE OF TC99M MDP SKELETAL SCINTIGRAPHY AND MRI IN ASSESSMENT OF OSTEOPROTIC VERTEBRAL COLLAPSE

Maged Abdel Galil, Ayman F Ahmed

Lecturers of radiology , Faculty of medicine , Zagazig University.

ABSTRACT

Accurate diagnosis of osteoporotic vertebral collapse of the symptomatic vertebra is essential prior to deciding the treatment protocols

The purpose of the present study to evaluate the efficacy of Tc 99m MDP bone scanning and MRI to diagnose symptomatic vertebra induced by new fracture, in elderly patients with osteoporotic vertebral compression fracture.

Methods Among the patients diagnosed with osteoporotic vertebral compression fracture from November 2009 to February 2012, 39 patients (77 vertebral bodies) were performed a bone scan and MRI within a 3 month interval period, and we retrospectively examined and analyzed these patients. according to the number of the vertebral bodies showing active uptake lesions in linear pattern, the cases were divided into a single vertebral body group, a 2 vertebral body group and a more than 3 vertebral body group. **Results** Among the 39 patients (77 vertebral bodies) who underwent a bone scan and MRI,76% of the linear active uptake lesions determined by a bone scan were confirmed to be new fracture by MRI, 100%, 69% and 33% of the cases with a hot uptake on a bone scan in 1, 2 and 3 more than vertebral bodies, respectively, were confirmed to be new fracture by MRI

Conclusion: Bone scan could play an important role as an initial diagnostic tool and help decide the appropriate treatment protocols. These also applied but to a lesser extent in two levels vertebral fracture but , but for the fracture involving more than 2 vertebral bodies, the possibility of confirming the hot uptake lesion as a new fracture by bone scanning is low, and so MRI is required to make the diagnosis.

(Key words: Tc99m MDP skeletal scintigraphy, Osteoprosis, vertebral collapse**)**

INTRODUCTION

Vertebral collapse induced by compression fracture of the vertebral body is common, especially in older adults. Vertebral compression fractures usually are caused by osteoporosis, and range from mild to severe. More severe fractures can cause significant pain, leading to inability to perform activities of daily living, and life-threatening decline in the elderly patient who already has decreased reserves. [1]

The incidence and risk of vertebral compression fracture have recently shown a trend to rise due to the increased number of elderly people. The prevalence of this condition steadily increases with advancing age, reaching 40 percent in women 80 years of age.[2]

Vertebral compression fractures are recognized as the hallmark of osteoporosis, and many of the risk factors are the same. Risk factors are categorized as those not modifiable and those that are potentially modifiable.[3]

Acute fractures occur when the weight of the upper body exceeds the ability of the bone within the vertebral body to support the load. Generally, some trauma occurs with each compression fracture. In cases of severe osteoporosis, however, the cause of trauma may be simple, such as stepping out of a bathtub, vigorous sneezing, or lifting a trivial object, or the trauma may result from the load caused by muscle contraction. In cases of moderate osteoporosis, more force or trauma is required to create a fracture, such as falling off a chair, tripping, or attempting to lift a heavy object. Of course, a healthy spine can sustain a compression fracture from severe trauma such as an automobile crash or a hard fall.[4,5]

For such osteoporotic vertebral compression fracture patients, accurate diagnose of the symptomatic vertebra is essential prior to deciding the treatment protocols. However, it is not easy to find the symptomatic vertebra with using only simple X-rays. Simple X-rays as well as computed tomography (CT) are primarily performed in elderly patients with osteoporotic vertebral compression fracture and for whom the trauma history is difficult to assess, yet supplement tests such as a bone scan and magnetic resonance imaging (MRI) are sometimes performed to determine the symptomatic vertebra.[6]

Diffusion-weighted MRI is a recent tool that may help to distinguish metastatic from osteoporotic vertebral compression fractures. Malignant compression fractures demonstrate hypointense or isointense signals compared to adjacent vertebrae on diffusion-weighted MR sequences. However, in some patients.[7]

Bone scan imaging with Tc 99m-MDP evaluates qualitatively the activity of osteoblastic cells through uptake of the tracer within the vertebral body. Bone scans provide useful

information about bone turnover and, thereby, identify any vertebral fracture that has an ongoing healing process. Bone scans are sensitive for the detection of fractures, but they have low specificity for the diagnosis of underlying disease.[8] There are several studies that have compared the usefulness of bone scan with MRI for elderly patients without an apparent trauma history and who are suspected to have osteoporotic vertebral compression fracture. These studies reported that studies are needed to compare MRI with bone scans for detecting osteoporotic vertebral compression fracture.[9,10] Therefore, we evaluated the efficacy of Tc 99m MDP bone scanning and MRI to diagnose symptomatic vertebra induced by new fracture, in elderly patients with osteoporotic vertebral compression fracture.

MATERIALS AND METHODS

Among the patients diagnosed with osteoporotic vertebral compression fracture from November 2009 to February 2012, 39 patients (77 vertebral bodies) were performed a bone scan and MRI within a 3 month interval period, and we retrospectively examined and analyzed these patients. The mean age of the patients was 66 years (range, 50 to 80 years), and there were 4 male patients and 35 female patients.

Bone scanning was performed on an average of 33 days (range, 8 to 87 days) from the day of manifesting symptoms, and MRI was performed on an average of 29 days (range, 2 to 80 days) from the day of manifesting symptoms. Plain X-rays were available for all patients the presence of vertebral body compression fracture was assessed by plain X-rays, and bone scan was then performed to confirm it. The typical bone scan appearance of a vertebral fracture is intense linearly increased tracer uptake with partial or complete loss of its volume substance, Bone scans also can differentiate between an acute versus healed compression fracture because new fractures will appear overactive "hot." On occasion, the bone scan will identify coexistent disease such as a rib fracture or metastases that may be the cause of, or contribute to, symptom.

MRI was additionally performed for the cases that required differentiation of simple compression fracture from other metabolic diseases, or for the cases that required the examination of other adjacent tissues. A new and old fracture can be differentiated on MRI by the change of signal intensity as represented by a geographic pattern or a linear pattern. The new fracture is deduced from a geographic pattern exhibited low intensity on the T1-weighted image and high intensity on the T2-weighted image. The old fracture showed low intensity on the T1-weighted image and this changed to high intensity or low intensity on the T2-weighted image as a linear pattern, and particularly normal bone marrow intensity was seen on the T1-weighted image . The cases showing signal intensity limited to the upper and lower end plates of a vertebral body were determined to be disc degenerative lesions .

On bone scan we analyze the pattern and intensity of Tc99m MDP uptake, it was considered positive (overactive) when its uptake higher than the anterior superior iliac spine and the posterior superior iliac spine .

According to the number of the vertebral bodies showing active uptake lesions in linear pattern, the cases were divided into a single vertebral body group, a 2 vertebral body group and a more than 3 vertebral body group.

All the lesions were evaluated depending on the change of signal intensity on MRI, based on the formentioned features of the signal intensity of the new fractures, old fractures and degenerative lesions.

For the statistical analysis, chi-square tests were performed using the Epi 6 and a p-value less than 0.05 was considered to be significant

RESULTS

Among the 39 patients (77 vertebral bodies) who underwent a bone scan and MRI, 30 patients (59 vertebral bodies) showed abnormally increases uptake by the bone scan and acute fracture by the MRI. 9 patients (18vertebral bodies) showed a hot uptake by the bone scan, but no new fracture by MRI, and 76% of the linear active uptake lesions determined by a bone scan were confirmed to be new fracture by MRI (fig 1).

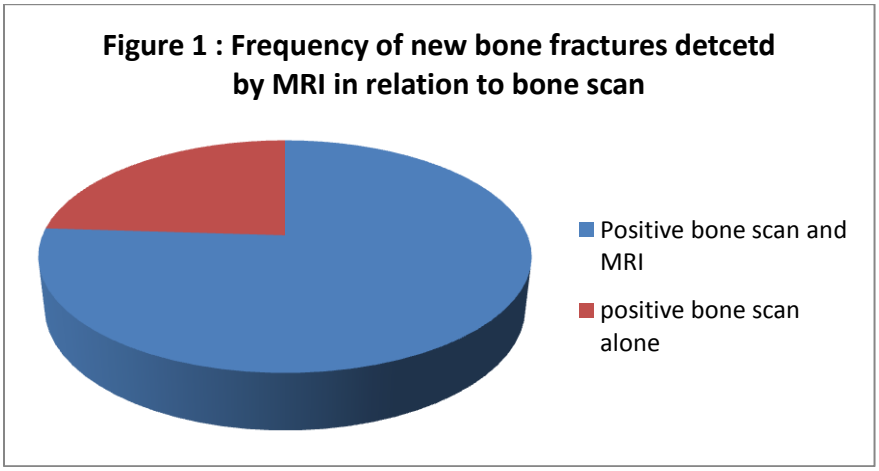


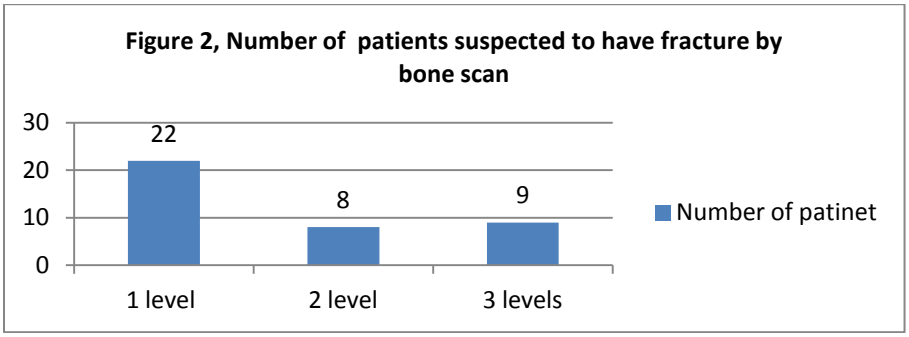
Table 1. *Magnetic resonance imaging (MRI) findings of the vertebrae based on the number of hot uptakes in bone scan*

MRI FINDINGS	1 level (N= 22)	2 level (16)	3 level (39)
Recent	22	11	13
Old	0	3	20
Degenerative	0	2	6

Table 2. *The number of patients with recent vertebral fractures confirmed by magnetic resonance imaging (MRI) according to the number of overactive uptakes in bone scan*

Findings MRI /Bone scan	1 level (N= 22)	2 level (N= 8)	3 level (N=9)
1 level recent fractures	22	4	3
2 level recent fractures		2	4
3 level recent fractures			1

Among the 22 patients (22 vertebral bodies) who were determined by bone scanning to have a hot uptake lesion in a single vertebral body, 22 patients (22 vertebral bodies) were determined to have a new fracture by MRI. There were no discrepant patient was found to have a degenerative lesion by or other lesion by MRI. Six patients (11 vertebral bodies) among the 8 patients (16 vertebral bodies) with hot uptake in 2 vertebral bodies showed new fracture by MRI. Among the 5 discrepant vertebral bodies, 3 vertebral bodies had old fracture and 2 vertebral bodies were observed to have degenerative lesions. Among the 39 vertebral bodies with hot uptake lesion in more than 3 vertebral bodies, the concurrent cases were 13 vertebral bodies. Among the 26 discordant vertebral bodies, 20 vertebral bodies had old fracture and 6 vertebral bodies were found to have degenerative lesions.



Among the 22 patients determined to have overactive uptake in a single vertebral body by a bone scan, 22 patients were determined to have new fracture by MRI. Among the 8 patients shown to have hot uptake in 2 vertebral bodies, 4 patients showed new fracture findings in a single vertebral body by MRI, and 2 patients showed new fracture in 2 vertebral bodies. Among the 9 patients who showed hot uptake in more than 3 vertebral bodies, 4 patients were shown to have new fracture in a single vertebral body by MRI ,1 patients were shown to have new fracture in 2 vertebra bodies by MRI and 2 patients were shown to have new fracture in 3 vertebral bodies by MRI (figure 2). 100%, 69% and 33% of the cases with a hot uptake on a bone scan in 1, 2 and 3 more than vertebral bodies, respectively, were confirmed to be new fracture by MRI. We found that when hot uptake lesions were detected in more than 2 vertebral body, the possibility of confirming this as new fracture via MRI became lower, and this was statistically significant ($p < 0.002$) .

Table 3. *The rate of vertebral fractures confirmed by MRI according to the number of hot uptakes in bone scan*

MRIfindings/Bone scan	**1 level (N= 22)**	**2 level (N= 8)**	**3 level (N=39)**
Recent fractures	100%	69%	33%

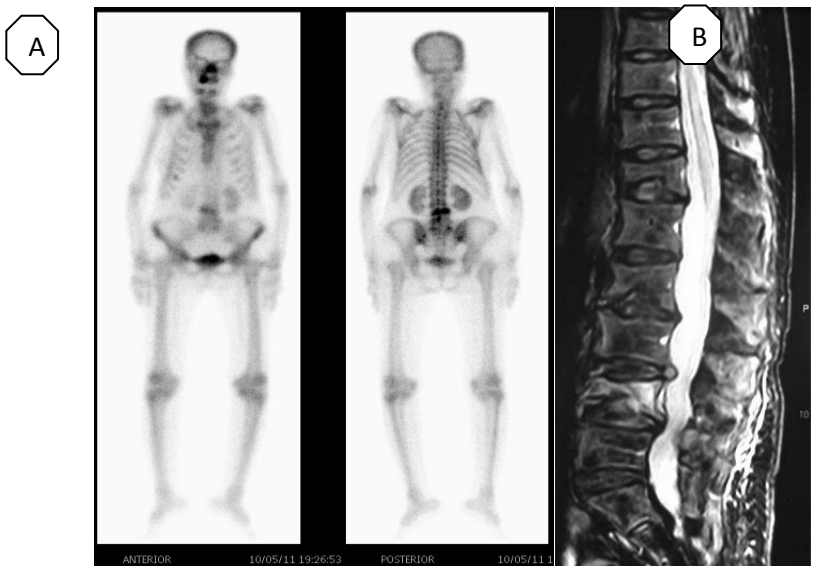
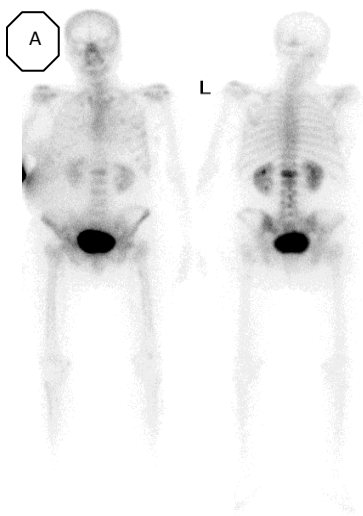


Figure 3 : Female Patient, 69 years old, had history of breast cancer and complains of back pain, bone scan (a) revealed single osseous lesion at the level of LV4 with partial volume loss attributed to vertebral compression fracture of due to osteoporosis; Sagittal MRI (b) (T2-weighted TSE with fat suppression sequence) shows increased signal intensity in the whole vertebra revealing the presence of intraspongious edema.



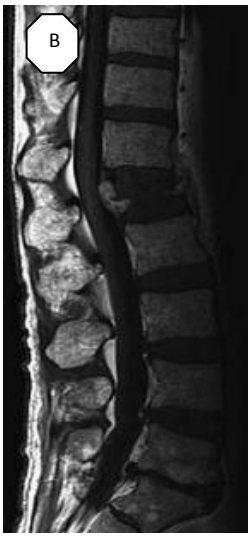


Figure 4 : 63 years old, complains of sever persistent back pain and referred for skeletal survey, bone scan (a) linear overactive osseous lesion at the level of LV1 with features of vertebral collapse attributed to vertebral compression fracture of due to osteoporosis; MRI thoracolumbar spine: sagittal TSE T1 (b) and axial TSE T1 images (c). Acute grade III biconcave fracture of L1 with retropulsion of the posterior wall and fluid sign on STIR images.

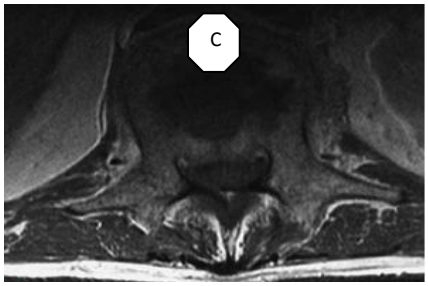


Figure 5 : A case of multiple levels overactive uptake on bone scan (a) include the lower aspect of LV1 down to LV3, The uptake on LV4 and LV5 is a low grade active, and MRI of the lumbar spine: sagittal TSE T1 (b), TSE T2 (c),The cortical disruption at the lower endplate of L3, and sclerosis of the upper end plate of L2 and lower endplate of L1 suggest acute fractures. This is confirmed by MRI (low signal bands on T1 in the L1, L2 and L3 bodies; fluid sign on T2 the L1 and L3 bodies). no focal bone lesions. Note the retropulsed bony fragment at the superior edge of the posterior wall of L2 and L5

DISCUSSION

The initial diagnosis of osteoporotic vertebral compression fracture by Plain X-ray and CT is important yet CT can not differentiate old fracture from new fracture and further radiological workup is essential for such differentiae.

Magnetic resonance imaging (MRI) and bone scan may rule out a malignant tumor, identify the presence of a new fracture, and help identify appropriate treatment.bone scan and MRI are often recommended for the elderly patients with spinal compliant and there is no definite history of trauma.

The bone scan reflects any osteoblastic reactions and changes in the bone metabolism, it actually has an important role in the differentiation of old fractures and to detect metabolic, neoplastic diseases or fracture that is undetermined by simple X-rays. Many studies discussed the role of bone scan in vertebral fracture and the accuracy specificity and sensitivity was varied from one study to the other. Clarke et al [11] has observed the cases of vertebral body fracture over 3 year by bone scan they found that 90% of the cases showed normal findings within 2 years while 97% showed normal findings within 3 years.Kim et al. [12], studies the appearance of positive scan finding after exposure to fracture and the found that from day 10 after spinal and pelvic bone fractures, the probability of seeing a positive reaction on a bone scan is high, unfourtently few cases was shown as negative on a bone scan in some cases. Thus, fracture could not be safely excluded even if the findings are free on skeletal scintigraphy.

Other studies compared the role of bone scan and MRI in the diagnosis of vertebral fracture among these studies Schweickert et al. [13] have reported that bone scanning better represented the function of bone metabolism and it could diagnose the fracture site earlier than MRI. However the main limitation of bone scan is that the overactive uptake on a bone scan persists for 2 years after fracture, and so a bone scan was not of great help for diagnosing vertebral body fracture older than 6 months [13]. Cook et al. [14] have reported that for osteoporosis patients who present with back pain, the bone scan could distinguish the cause of back pain among fracture, facet joint arthritis and disc degenerative lesions and so it is of great help to administer appropriate treatments, but Cook et al. [14] didn't suggest clear objective standards that distinguish individual diseases.

MRI also has an important role in diagnosis of vertebral compression fracture, and MRI can be an important diagnostic test depending on the presence or absence of the change of signal intensity and the altered patterns, In addition to assess soft tissue injuries accurate delineation of pathological areas can be confirmed by MRI. Furthermore, new fracture, old fracture and degenerative lesions can be differentiated because of MRI's good resolution. Several studies have assessed the value of MRI in diagnosis of vertebral fracture Perkash et al. [15], shows the MRI finding of acute traumatic compression fracture (swelling and inflammation) shows low intensity on T1-weighted images and high intensity on T2-weighted images, and upon entering the chronic phase at 1-3 months after injury, the intensity of the vertebral body was normalized. Frager et al. [16] also reported that for acute and subacute osteoporotic vertebral compression fracture, low intensity was observed on the T1-weighted images and high intensity was observed on the T2-weighted images. Acute fracture causes bleeding and edema, and it increases the local water content, and so high intensity is seen on the T2-weighted images. When the bleeding becomes organized and the edema subsides, low intensity or iso-signal intensity is observed on the T2- weighted images [16].

Do [17] classified vertebral compression fracture by MRI is useful for this, and according to the change of signal intensity, into acute, subacute and chronic fracture, and pathologic fractures such as metastatic lesions could also be differentiated.

Some authors added the quantitive parameters to the qualitive analysis , Nishimura et al. [18] established a quantitative standard for the ratio of the change of signal intensity in the vertebral body by classifying the change of signal intensity into geographical patterns as G1 (change in the entire vertebral body), G2 (change in more than 50% of the vertebral body), G3 (change in 25-50% of the vertebral body), and G4 (change in less than 25% of the vertebral body), and such change of signal intensity as geographical patterns gradually lessened after the acute phase, and linear changes were substituted after 2-5 months.

In our study, 76 % of the cases that showed overactive osseous uptake on a bone scan were confirmed to have new fracture by MRI, and only in approximately more than half cases was the lesion observed on a bone scan found to concur with a lesion observed on MRI. In addition, for the cases showing hot uptake in a single vertebral body on a bone scan, the possibility of this being a new fracture as assessed on MRI was 100%, yet the concurrence rate was 69% for hot uptake in 2 vertebral bodies and 33% for hot uptake in more than 3 vertebral bodies.

Thus, it was observed as the number of the vertebral bodies showing hot uptake lesions was increased, the possibility of observing new fracture on MRI was decreased. In cases with suspected solitary vertebral compression fracture, a bone scan could be usefully

applied to detect a new fracture that is causing symptoms. And to a lesser extent with compression fracture in 2 vertebral bodies, yet more attention has to be paid to accurately assess the fractured areas in more than 2 vertebral bodies .

In addition, it was found that for patients with compression fracture in more than 3 vertebral bodies, 51% of the overactive uptake on the bone scan was old fracture, and so old fracture should be considered in the patients with fracture in more than 3 vertebral bodies, as observed on a bone scan. With such data, bone scanning could play an important role as an initial diagnostic tool and help decide the appropriate treatment protocols.

CONCLUSIONS

With an increase in the aging population, vertebral compression fractures have become increasingly prevalent. Our ability to diagnose these fractures is improving with better awareness of the value of each diagnostic modality and how and when we can use. For single osteoporotic vertebral compression fracture, MRI and a bone scan are useful as complementary diagnostic modality which greatly improve the diagnostic outcome. Bone scan in addition to simple X-rays, could play an important role as an initial diagnostic tool and help decide the appropriate treatment protocols. These also applied but to a lesser extent in two levels vertebral fracture but , but for the fracture involving more than 2 vertebral bodies, the possibility of confirming the hot uptake lesion as a new fracture by bone scanning is low, and so MRI is required to make the diagnosis.

REFERENCES

1. International Osteoporosis Foundation. Osteoporosis in the workplace. The social, economic and human costs of osteoporosis on employees, employers and governments. Invest in your bones 2000. Available at *http://www.osteofound.org/publications/pdf/workplace_report.pdf*.
2. Melton LJ III, Cooper C. Magnitude and impact of osteoporosis and fractures. In: Marcus R, Feldman D, Kelsey J, eds. Osteoporosis. 2nd Edition; Vol.1. New York, NY: Academic Press *2001: 557-567.*
3. Kado DM, Browner WS, Palermo L, Nevitt Mc, Genant HK, Cummings SR for the Study of Osteoporotic Fractures Research Group. Vertebral fractures and mortality in older women: A prospective study. Arch Intern Med *1999;159;1215-1220.*
4. Ismail AA, Cooper C, Felsenberg D :Number and type of vertebral deformities: Epidemiological characteristics and relation to back pain and height loss. Osteoporosis Int *1999; 9:206-213.*
5. National Osteoporosis Foundation. Physicians guide to prevention and treatment of osteoporosis. Washington, D.C.: National Osteoporosis Foundation, *1998.*
6- Papaioannou A, Watts NB, Kendler DL, Yuen CK, Adachi JD and Ferko N: Diagnosis and management of vertebral fractures in elderly adults. Am J Med , 2002. 113: 220-228
7. Cuénod CA, Laredo JD, Chevret S: Acute vertebral collapse due to osteoporosis or malignancy: Appearance on unenhanced and gadolinium-enhanced MR images. Radiology 1996, 199:541-549,
8- Kucukalic-Selimovic E and Begic A: Value of bone scintigraphy for detection and ageing of vertebral fractures in patients with severe osteoporosis and correlation between bone scintigraphy and mineral bone density. *Med Arh 2004 58: 343-344,.*
9. An HS, Andreshak TG, Nguyen C, et al: Can we distinguish between benign versus malignant compression fractures of the spine by magnetic resonance imaging? Spine 1995; 20:1776-1782
10. Nevitt MC, Ettinger B, Black DM, Stone K, Jamal SA, Ensrud K, et al. The association of radiographically detected vertebral fractures with back pain and function: a prospective study. Ann Intern Med. *1998;128:793–800.*
11-Clarke SE, Cook GJ, Hannaford E, See M, Fogelman I. The value of bone scintigraphy in the evaluation of osteoporotic patients with back pain. Scand J Rheumatol *2002;31:245-8.*
12. Kim JY, Choi YA, Noh BK, Kong BS. The clinical significance of bone scan in fracture diagnosis. J *Korean Soc Fract 1988;1:102-128.*
13 Schweickert PA, Marx WF, Short JG, Kallmes DF. Value of bone scan imaging osteoporotic vertebral fractures. *AJNR Am J Neuroradiol 2002;11:1707-22.*
14. Cook GJ, Hannaford E, See M, Clarke SE, Fogelman I. The value of bone scintigraphy in the evaluation of osteoporotic patients with back pain. Scand J Rheumatol *2002; 31:245-8.*
15 Perkash I, Lane B, Enzmann DR. Benign collapse of vertebral bodies: assessment with MR imaging. Radiograph *2004; 150:321-332.*
16 Frager D, Elkin C, Swerdlow M, Bloch S. Subacute osteoporotic compression fracture: misleading magnetic resonance appearance. *Skeletal Radiol 1988;17:123-6.*
17. Do HM. Magnetic resonance imaging in the evaluation of patients for percutaneous vertebroplasty. *Top Magn Reson Imaging 2000;11:235-44.*
18. Nishimura G, Kuramochi E, Saiki N, Fujioka M. MR appearance at different ages of osteoporotic compression fractures of the vertebrae. *Radiat Med 1998;16:329-334.*

دور المسح الذري علي العظام والتصوير بالرنين المغناطيسي في تقييم الانهيار الفقري نتيجة هشاشة العظام

ماجد عبدالجليل حامد – ايمن فتحي احمد
قسم الاشعة التشخيصية -كلية الطب – جامعة الزقازيق

الهدف من البحث
تقييم فعالية المسح الذري علي العظام والتصوير بالرنين المغناطيسي في تشخيص الأعراض الناجمة عن كسر جديد في الفقرات وخصوصا في المرضى المصابين بهشاشة العظام .
طرق البحث
أجريت الدراسه علي ٣٩ مريضا (٧٧ فقرة) من نوفمبر ٢٠٠٩ إلى فبراير ٢٠١٢، حيث تم عمل فحص العظام والتصوير بالرنين المغناطيسي خلال فترة ٣ أشهر ، وتحليل هؤلاء المرضى بأثر رجعي و تم تقسيم الحالات إلى مجموعة الجسم الفقري واحد أو مجموعة ٢ جسم فقري وأكثر ٣ من فقرات.
النتائج
وأظهرت النتائج بين التطابق بين نتائج المسح الذري علي العظام والرنيين المغناطيسي في حالة اصابة فقرة واحدة بنسبة ١٠٠% وقلت هذه النسبة ل ٦٧% في حالة فقرتين و ٣٣ % في حالة ٣ فقرات
الخلاصة
يعتبر المسح الذري وسيلة حيدة لتشخيص الكسر في مستوي واحد من الفقرات وتقل هذه الدقة عند الاصابة باكثر من مستوي بالمقارنة بالرنين المغناطيسي.