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Original Research Article.

Comparison of Dual Energy CT and MRI Imaging in Research of Bone Marrow Edema at a Tertiary Care Teaching Hospital

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ABSTRACT

Background: Compared with Magnetic resonance imaging, computed tomography benefits from ultrafast examination times and is less susceptible to patient motion. But single-energy CT cannot display bone marrow edema. Conversely, dual-energy (DE) CT facilitates the differentiation between several tissues to determine their material composition. Hence; the present study was undertaken for assessing and comparing the efficacy of dual energy CT and MRI imaging in research of bone marrow edema.

Materials & Methods: A total of 60 patients were enrolled in the present study. Only those patients were enrolled in which recent history (a week before radiological examination) of episodes of articular and/or bone pains were present. MRI images were obtained. In patients with presence of edema on MRI, dual energy computed tomography was carried out for researching CT bone marrow edema with Spectral images. Among these 60 patients, edema in MRI was found to be present in 12 patients. DECT was performed in these 12 patients.

Results: 60 patients were analyzed. Edema on MRI was found to be present in 12 patients. Among these 12 patients, 4 were vertebral columns, 1 knee, 2 ankles, 2 foot, 3 shoulders and 1 wrist. In all the patients with edema (n=12), measurement of the density of the pathologic bone was done. After measurement, the mean value for pathologic bone edema was found to be 1015.46 while for healthy bone marrow, it was found to be 913.44. DECT demonstrated lesser artifacts and higher detailed findings with more spatial resolution.

Conclusion: In comparison to MRI, DECT exhibits an outstanding capability to identify the bone marrow edema.

Key words: Bone Marrow, Dual Energy, Magnetic Resonance Imaging.

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INTRODUCTION

Unenhanced computed tomography (CT) of the spine is the standard examination for fast exclusion or closer assessment of suspected or known vertebral fractures. Additional examination with magnetic resonance (MR) imaging is helpful and sometimes required for further patient treatment.[1-3] Compared with MR imaging, CT benefits from ultrafast examination times and is less susceptible to patient motion. But single-energy CT cannot display bone marrow edema. Conversely, dual-energy (DE) CT facilitates the differentiation between several tissues to determine their material composition.[4,5]

Fat-suppressed T2-weighted MR imaging is the standard of reference for differentiating between acute and old fractures because it can depict vertebral hemorrhages and edema, a so-called bone bruise. A few previously published studies have shown that bone marrow edema after acute trauma of the hip, ankle, knee, and spine can be successfully detected with DE CT by using the virtual noncalcium technique.[6]

Hence; the present study was undertaken for assessing and comparing the efficacy of dual energy CT and MRI imaging in research of bone marrow edema.

MATERIAL & METHODS

The present study was undertaken in the Department of Radiology, G B Pant Institute of Postgraduate Medical Education & Research, New Delhi (India) for comparing the efficacy of dual energy CT and MRI imaging in research of bone marrow edema. A total of 60 patients were enrolled in the present study. Only those patients were enrolled in which recent history (a week before radiological examination) of episodes of articular and/or bone pains were present. MRI images were obtained.

In patients with presence of edema on MRI, dual energy computed tomography was carried out for researching CT bone marrow edema with Spectral images. Ethical approval was obtained from institutional ethical committee and written consent

was obtained from all the patients after explaining in detail the entire research protocol. Patients of more than 70 years of age and less than 20 years of age were excluded. Among these 60 patients, edema in MRI was found to be present in 12 patients. DECT was performed in these 12 patients. All the radiological images were analyzed by certified and experienced radiologist. All the results were recorded in Microsoft excel sheet and were analyzed by SPSS software.

Table 1: Presence of edema as detected by MRI

Variable	Number	Percentage
Total patients	60	100
Edema present	12	20

Table 2: Demographic profile of patients with edema

Parameter		Number	Percentage
Age group (years)	**Less than 40**	4	33.33
	40 to 55	5	41.67
	More than 55	3	25
Gender	**Males**	8	66.67
	Females	4	33.33

Table 3: Discrepancy between density measurements made in healthy and pathological bone marrow edema

Value	Healthy bone marrow	Bone marrow edema
Mean	913.44	1015.46
SD	110.7	125.3
p- value	0.00 (Significant)	

RESULTS

In the present study, a total of 60 patients were analyzed. Edema on MRI was found to be present in 12 patients. Among these 12 patients, 4 were vertebral columns, 1 knee, 2 ankles, 2 foot, 3 shoulders and 1 wrist. In all the patients with edema (n=12), measurement of the density of the pathologic bone was done. After measurement, the mean value for pathologic bone edema was found to be 1015.46 while for healthy bone marrow, it was found to be 913.44. Findings of the measurement of the pathologic bone were different from those of healthy bone (p-value < 0.05). On interpreting the radiographic findings, it was observed DECT demonstrated lesser artifacts and higher detailed findings with more spatial resolution.

DISCUSSION

Bone marrow edema (BME) is a biomarker of arthritis (e.g., as a component in the rheumatoid arthritis MRI score, RAMRIS), occult fractures and other bone trauma, and bone infarcts and metastases. BME forms lesions of decreased fat (yellow marrow) content and increased fluid (soft-tissue-like) content in cancellous bone. Owing to the low radiation dose, simplified patient workflow, and high spatial resolution, extremities CBCT provides an attractive platform for longitudinal imaging of arthritis and fracture healing, where monitoring of bone marrow edema would be especially valuable. Although magnetic resonance imaging (MRI) is the usual diagnostic imaging modality for depicting bone marrow edema, it is more time consuming and expensive than other modalities. Dual-energy CT can differentiate various scanned materials based on the energy dependence of the photoelectric effect at different X-ray spectra and its dependence on the atomic number of substances.[8-11]Hence; the present study was undertaken for assessing and comparing the efficacy of dual energy CT and MRI imaging in research of bone marrow edema.

In the present study, a total of 60 patients were analyzed. Edema on MRI was found to be present in 12 patients. Among these 12 patients, 4 were vertebral columns, 1 knee, 2 ankles, 2 foot, 3 shoulders and 1 wrist. .Chien-Kuo Wang et al assessed the use of the dual-energy computed tomographic (CT) virtual noncalcium technique in the evaluation of bone marrow edema in vertebral compression fractures. Sixty-three consecutive patients with 112 thoracic and/or lumbar vertebral compression fractures were studied. All patients underwent both dual-energy CT (100 kV and Sn140 kV, where Sn indicates the use of a 0.4-mm tin filter) and magnetic resonance (MR) imaging. CT numbers for the diagnosis of bone marrow edema on the basis of MR imaging revealed areas under the receiver operating characteristic curve of 0.799 and 0.841 for readers 1 and 2, respectively (P = .56). Dual-energy CT virtual noncalcium images were able to depict bone marrow in the collapsed vertebral bodies, especially in those with less than 50% sclerosis and/or air.[12]

In the present study, in all the patients with edema (n=12), measurement of the density of the pathologic bone was done. After measurement, the mean value for pathologic bone edema was found to be 1015.46 while for healthy bone marrow, it was found to be 913.44. Findings of the measurement of the

pathologic bone was different from those of healthy bone (p- value < 0.05). Kaup M et al. evaluated whether a dual-energy (DE) computed tomographic (CT) virtual noncalcium technique can improve the detection rate of acute thoracolumbar vertebral compression fractures in patients with osteoporosis compared with that at magnetic resonance (MR) imaging depending on the level of experience of the reading radiologist. Forty-nine patients with osteoporosis who were suspected of having acute vertebral fracture underwent DECT and MR imaging. Although the diagnostic accuracy of the least experienced reader with virtual noncalcium CT (accuracy with CT alone, 61%; accuracy with virtual noncalcium technique, 83%) was within the range of that of the most experienced reader with CT alone, the latter improved his accuracy with the noncalcium technique (from 81% to 95%), coming close to that with MR imaging. The number of vertebrae rated as unclear decreased by 59%-90% or from 15-53 to 2-13 in absolute numbers across readers. The number of patients potentially referred to MR imaging decreased by 36%-87% (from 11-23 to 2-10 patients). Considering the gain in true decisions with the virtual noncalcium technique on a patient level, between 12 (most experienced reader) and 17 (least experienced reader) MR examinations could have been avoided. The DE CT-based virtual noncalcium technique may enable depiction of bone marrow edema in thoracolumbar vertebral compression fractures in patients with osteoporosis, with good accordance with MR imaging when images are read by experienced radiologists.[13] Zbijewski W et al investigated the feasibility of DE imaging of BME on a dedicated flat-panel detector (FPD) extremities cone-beam CT (CBCT) with a unique x-ray tube with three longitudinally mounted sources. For a low-dose scan (36 mAs in the HE and LE data), DE CBCT achieved combined accuracy of ~0.80 for a pattern of BME spherical lesions ranging 2.5 – 10 mm diameter in the knee phantom. Detection of BME and quantification of water and fat content were achieved in extremities DE CBCT with a longitudinal configuration of sources providing DE imaging in a single gantry rotation.[14]

CONCLUSION

From the above results, it can be concluded that in comparison to MRI, DECT exhibits an outstanding capability to identify the bone marrow edema. However; further studies are recommended.

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