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ORIGINAL ARTICLE

How much intravenous contrast media affect bone mineral density (BMD) assessed by routine computed tomography (CT)

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Abstract *Purpose:* The data from routine abdominal multi-detector CT (MDCT) examinations provide information to diagnosis of the bone mineral density (BMD). The aim of this study was to measure the effect of intravenous contrast media on the BMD measuring of lumbar spine vertebrae (L1–L3) with CT densitometric data, Hounsfield unit (HU), obtained by routine abdominal examinations.

Patients and methods: The data on abdominal CT scans of 261 adults (150 females and 111 males) with a mean age of 59.6 years who underwent both unenhanced and enhanced abdominal CT examinations, with a 16-slice CT system (Toshiba Alexion Advance Edition 16, Japan), were evaluated for measuring the bone mineral density.

Results: Using trabecular region of interest (ROI), CT attenuation considerably differed between the unenhanced and enhanced abdominal scans for each imaging.

Conclusions: BMD values derived from the routine abdominal MDCT can be affected by intravenous contrast media in enhanced abdominal CT scanning. The impact of contrast media on the BMD decreases with increasing age of patients.

1. Introduction

Osteoporosis is a systemic skeletal disease, which is characterized by bone fragility and fracture sensitiveness (1). Patients with decreased BMD have an increased risk of fracture, the incidence of which particularly at the hip and spine increases

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with age in both women and men. Bone mineral density can be measured in a variety of sites with several techniques.

For BMD assessment of the lumbar vertebrae and proximal femur, Quantitative computed tomography (QCT) is one of the standard techniques (2). QCT has grown from its initial introduction in the 1970s to become an established technique for evaluating both skeletal condition and response to treatment for osteoporosis and other metabolic bone disease. It is accepted that QCT is the most sensitive method available to detect osteoporosis (2–5). While QCT technology delivers a higher dose than DXA, DXA still represents the "gold standard" for diagnosis of osteoporosis and as a technique of choice. QCT is inimitable between modern noninvasive measurements of bone mineral as that measures true three-dimensional BMD as opposed to the area (two-dimensional) density measures obtained from some protection techniques. QCT has the ability to measure cortical, trabecular or integral (cortical plus trabecular) bone at any site of body (6,3).

During the non-contrast abdominal CT examination when the lumbar vertebrae are in view, the real-time BMD measurement of the lumbar vertebrae by QCT analysis without being subjected to additional radiation exposure and additional radiologic examination is defined in the medical literature as potentially beneficial and superior to Dual-energy X-ray absorptiometry (DXA) (7,8,5,9).

Because osteoporosis is prevalent and treatable and conveys a considerable lifetime fracture risk, yet it remains substantially under diagnosed and undertreated (10–13). Safe and cost-effective alternatives to increase detection of this condition are needed.

Abdominal CT is the most frequent radiologic studies, which are used to assess mass lesions in CT centers. In a research conducted by Pickhardt et al. (5), it is reported that the abdominal CT images can be used to Screen patients with osteoporosis or normal Bone mineral density (5).

Retrieval of BMD data available on body CT examinations ordered for other indications requires no additional expense, software package, patient time, medical equipment, or radiation dose, and these data can be retrospectively achieved. Therefore, it could expand population screening efforts for osteoporosis.

2. Aims and objective

The purpose of our study was to evaluate the influence of intravenous contrast media on the BMD of lumbar spine (L1–L3) vertebrae by generating CT densitometric data (HU) based on routine abdominal with and without contrast examinations and to investigate whether these data can be affected on bone density condition.

3. Patients and methods

This retrospective single-institute study, approved by the institutional review board, was conducted in accordance with the ethical standards of the Declaration of Helsinki.

All CT studies were accomplished with a 16-slice CT system (Toshiba Alexion Advance Edition 16, Japan). A routine MDCT protocol of abdominal examination was used for the study of all patients. CT parameters were including the following: 120 kVp, 160 mA s, 16 × 1 mm, 0.938 mm respectively for tube voltage, tube current, beam collimation and pitch factor. Two dimensional reconstructions (image slice 5 mm, window width 1500 and window level 300) were obtained in the axial planes. Elliptical ROI (20 * 10 mm) located in the middle trabecular portion of each vertebral body before and after IV contrast injection and the mean CT attenuation were measured in HU. All ROIs were placed by a radiologist.

Two hundred and sixty-one adults (150 females and 111 males) with a mean age of 59.6 years who underwent both the unenhanced and enhanced abdominal CT examinations were evaluated for measuring the bone mineral density. All patients received VISIPAQUE with an iodine concentration of 320 mg/ml (iodixanol; GE Healthcare Ireland, Ireland). The rate of intravenous injection of contrast material was set

Table 1 The data of HU values in abdominal examinations before and after IV contrast administration (portal phase) in females. ROI at L1–L3 vertebrae.

Age	Unenhanced			Enhanced		
	L1 ROI	L2 ROI	L3 ROI	L1 ROI	L2 ROI	L3 ROI
40–49	190 ± 42	184 ± 41	179 ± 43	220 ± 45	215 ± 43	209 ± 42
50–59	169 ± 40	165 ± 37	158 ± 38	197 ± 43	193 ± 39	185 ± 41
60–69	127 ± 43	121 ± 43	116 ± 42	147 ± 49	140 ± 48	136 ± 57
70–79	100 ± 47	95 ± 46	90 ± 45	111 ± 50	107 ± 49	103 ± 50

Table 2 The data of HU values in abdominal examinations before and after IV contrast administration (portal phase) in males. ROI at L1–L3 vertebrae.

Age	Unenhanced ROI			Enhanced ROI		
	L1 ROI	L2 ROI	L3 ROI	L1 ROI	L2 ROI	L3 ROI
40–49	191 ± 40	184 ± 39	180 ± 40	221 ± 41	215 ± 42	210 ± 40
50–59	169 ± 41	164 ± 39	158 ± 40	195 ± 43	192 ± 41	185 ± 42
60–69	163 ± 43	157 ± 41	150 ± 42	190 ± 45	187 ± 41	179 ± 43
70–79	114 ± 56	110 ± 55	103 ± 49	127 ± 57	126 ± 58	119 ± 55