Correlation between Spine Bone Density to Patient's Age, Classification, Pain and Disability Score in Thoracolumbar Compression Fracture Due to Osteoporosis

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Abstract: Osteoporosis is one of the most common public health issues. Osteoporosis marked by a low bone density and quality leading to compression fracture. Computed Tomography (CT) scan with Hounsfield Unit (HU) can be used to assess bone density of the spine also to screen osteoporosis condition. This research was focused on determining the correlation between spine bone density to patient's age, classification, pain, and disability score in thoracolumbar compression fracture due to osteoporosis. This research was an analytic observational study with cross sectional approach, using total sampling technique during January to May 2023. The subjects were patients who diagnosed with thoracolumbar compression fracture in Dr. Moewardi General Hospital Surakarta and Dr. Soeharso Orthopedic Hospital Kartasura. Statistical analysis using Spearman and Gamma correlation tests. There were 25 thoracolumbar compression fracture patients who met all criteria. Correlation analysis showed a significant relation between patient's spine HU with patient's age ($p<0.001$), Oswestry Disability Index score ($p=0.001$), Visual Analogue Scale score ($p=0.002$), and compression fracture classification ($p<0.001$). Lower patient's spine HU strongly correlate with older patient's age, higher ODI score, higher VAS score, and higher compression fracture classification.

Keywords: Compression Fracture, Hounsfield Unit, Osteoporosis.

INTRODUCTION

Osteoporosis is currently one of the most common public health problems. Clinical and epidemiological evidence is needed to support the diagnosis of a vertebral fracture. Although vertebral fractures are common and associated with reduced quality of life, they often go unnoticed by clinicians and are underdiagnosed by radiologists. Osteoporosis itself is characterized by low bone density and low bone quality resulting in fractures and is the most common bone metabolic disease. In America more than 10 million population is diagnosed as osteoporosis, 80% are women and 2.2 million osteoporotic fractures occur annually in the United States. Despite the significant amount of morbidity associated with these fractures, osteoporosis and osteopenia are still frequently missed in the diagnosis. Compression fractures occur while patients with decreased bone quality doing activities that support the body. Around 30% to 50% of women and 20-30% of men experience vertebral fractures. These events are often asymptomatic and only 30% come to health services. Most of the existing cases are still not diagnosed and treated (Emohare, *et al*., 2014; Lenchik, *et al*., 2004; St. Jeor, *et al*., 2020; Williams, *et al*., 2009). Changes in bone structure can cause compression fractures, where the most common locations are in the thoracic and thoracolumbar region. Compression fractures can cause pain and kyphotic deformity and has a high risk of fracture at several levels (Emohare, *et al*., 2014).

The use of Computed Tomography (CT) Scan with Hounsfield Unit values to assess the bone density of the spine has been described by several previous studies. As described by Pickhardt, *et al*., While CT scan is used for other clinical indications, it also can be used to screening for osteoporosis (Johnson, *et al*., 2016)(Schreiber, *et al*., 2014).

In this study we aimed to determine the correlation between spinal density values on CT scans and thoracolumbar compression fractures due to osteoporosis. We hope that this will be useful in the examination and diagnosis of compression fractures due to osteoporosis in elderly patients.

MATERIAL AND METHODS
Study Design
This research was an observational analytic study with a cross-sectional approach. This research was conducted at the Dr. Moewardi General Hospital Surakarta and Prof. Dr. R. Soeharso Orthopedic Hospital Surakarta. All this study procedures have been reviewed and approved by The Ethical Review Committee of Dr. Moewardi General Hospital Surakarta by approval number 731/ VII/ HREC/ 2021.

Subject

The research subjects were patients who diagnosed with thoracolumbar compression fracture in Dr. Moewardi General Hospital Surakarta and Prof. Dr. dr. Soeharso Orthopedic Hospital Kartasura during January to May 2023. The inclusion criteria were patients aged 60 years old or above and confirmed diagnosed with thoracolumbal compression fracture. The exclusion criteria were patients with history of underwent any spine surgery, patients with history of trauma or vehicle collision, and patients who has history of any disease that affect bone's metabolism and density, including spondylosis tuberculosis, bone tumor, and ankylosing spondylosis. Samples were taken using a total sampling technique. Total subjects who met all the criteria were 25 patients. The data were obtained from patients' medical records.

Variables

The independent variable of this study was the value of spinal bone density in the form of Hounsfield Unit (HU) as a numerical variable, while the dependent variables were the classification of osteoporotic thoracolumbar spine compression fracture by the Spine Section of the German Society for Orthopedics and Trauma (DGOU) as a categorical variable, pain scale scores using Visual Analogue Scale (VAS), age, and level of disability due to compression fractures using The Oswestry Disability Index (ODI) as a numerical variable.

Statistical Analysis

Normality test of Shapiro-Wilk was carried out for numerical variables. The Spearman correlation test was used to determine the relationship between Hounsfield Unit value with age, ODI and VAS score. The Gamma correlation test was used to determine the relationship between Hounsfield Unit value with the compression fracture classification. The results of statistical analysis were defined as significant at $p<0.05$. Statistical data analysis had been done using SPSS Statistic for MacOS version 29.

RESULTS

There were 25 thoracolumbar compression fracture patients in Dr. Moewardi General Hospital Surakarta and Dr. R. Soeharso Orthopedic Hospital Kartasura during January-May 2023 who met all the criteria. Patient's data served as frequencies (%) for categorical variable and as mean ± standard deviation for numerical variable.

Table 1: Patient's Data

Variable	Total (N=25)
Hounsfield Unit	108.64 ± 41.31
Age (year)	69.44 ± 7.65
Oswestry Disability Index	50.16 ± 10.93
Visual Analogue Scale	4.96 ± 1.67
DGOU Compression Fracture Classification	
Grade 1	4 (16)
Grade 2	5 (20)
Grade 3	2 (8)
Grade 4	5 (20)
Grade 5	9 (36)

Abbreviation: N, total patients

Patient's characteristics in table 1 shows mean patient's HU was in osteopenia range with 108.64 ± 41.31 HU, mean patient's age was in seventh decade which is an elderly patient, mean patient's ODI score was in severe disability range with score of 50.16 ± 10.93 %, man patient's VAS score was in moderate pain range with score of 4.96 ± 1.67, and compression fracture classification mostly in grade 5.

Correlation of Spine Bone Density with Thoraco-lumbal Compression Fracture

Patient's Spine Hounsfield Unit, age, ODI score, VAS score, and compression fracture classification are an independent variable. The significance and strength of the relationship or correlation of Patient's spine HU with the other variables in this study were analysed using the Spearman test and Gamma test which are shown in Table 2.

Table 2: Correlation Between Hounsfield Unit with Age, ODI, VAS, and Compression Fracture Classification

Variables	Correlation with Spine Hounsfield Unit			
	Test	Correlation	p-value	Significancy
Age	Spearman	-0.728	<0.001	Significant
ODI	Spearman	-0.616	0.001	Significant
VAS	Spearman	-0.581	0.002	Significant
DGOU Compression Fracture Classification	Gamma	-0.924	<0.001	Significant

Abbreviation: ODI, Oswestry Disability Index; VAS, Visual Analogue Scale.

There were significant and strong correlations between patient's spine HU with age (CC= -0.728; p <0.001), ODI score (CC= -0.616; p= 0.001), VAS score (CC= -0.581; p= 0.002), and compression fracture classification (v= -0.924; p <0.001).

DISCUSSION

Osteoporosis is a condition where the bone density is reduced which causes fragility of the bones. The lower the bone density value, the higher the risk of compression fracture, which then affects the severity of the fracture (Yaprak, *et al*., 2020). Osteoporotic fractures of the spine increase the potential for mortality and morbidity. The management of spinal cord fractures in osteoporosis patients is complicated by the presence of pre-existing morbidity, reduced cognitive function and frequent multipharmaceuticals. Many of the existing trauma classifications (AO spine, Dennis, TLICS, etc.) do not address to osteoporosis. The existence of a classification for osteoporotic fractures from the German Society for Orthopedics and Trauma can help in determining management (Schnake, *et al*., 2018).

Hounsfield Unit (HU) are clinically used for differentiating the type of the tissue to reconstructed CT image. Several studies have examined the effectiveness of CT HU to identify patients with decreased BMD and osteoporosis. Pickhardt, *et al*. clearly defines how bone HU values can be measured and used as an alternative to DEXA examinations to diagnose BMD and osteoporosis (Pickhardt, *et al*., 2013). Bone HU values below 100 indicated osteoporosis, HU values between 100 and 160 were indicated osteopenia, and HU values above 160 indicated normal bone mineral density. Patients who have HU values between 100 and 160 are considered osteopenia, and they need early intervention to prevention osteoporosis and future fracture risk.

Patients with HU values below 100 should be considered as osteoporosis. A low HU value indicates a hidden risk of fracture in the bony area (Batawil & Sabiq, 2016).

In this study, correlation tests were carried out to assess the strength and significance of the relationship between patient's spine HU with patient's age (CC= -0.728; p <0.001), ODI score (CC= -0.616; p= 0.001), VAS score (CC= -0.581; p= 0.002), and compression fracture classification (v= -0.924; p <0.001). The results of the Spearman correlation test and Gamma correlation test analysis showed that lower patient's spine HU in CT scan results was strongly and significantly correlate with older patient's age, higher ODI score, higher VAS score, and higher compression fracture classification.

Many studies stated Vertebral Compression Fracture (VCF), especially in the thoracolumbar region, are commonly occurred in the elderly. The most common etiology of this is osteoporosis. Osteoporosis has been characterized as a skeletal disorder of reduced bone strength that increases risk of fracture. Decreased bone mineral density because of osteoporosis disrupts the bone microarchitecture and alters non-collagenous proteins in the bone matrix. Bone density of the vertebrae column decreases constantly with the older age. Elderly women have lost almost half of their axial bone mass in their eighties. Bone density usually begins to reduce in the age of forty for both men and women. Vertebral compression fracture potentially makes patients become vulnerable to significant pain, disability, and mortality (Alexandru & So, 2012; Clinical, *et al*., 2022; Wong & McGirt, 2013). Vertebral compression fracture known to affects various physical performance and reported to be predictors of impaired function or disability. The changes of the spine alignment led to a reduction in motion and strength. The forward shift in center of gravity

that occurs progressively with the kyphosis from the VCF makes trunk movement in a forward direction more unsteady and limited (Arima, *et al.*, 2017).

CONCLUSION

Lower patient's spine bone density marked by lower Hounsfield Unit in CT scan examination significantly and strongly correlated with older patient's age, higher Oswestry Disability Index score, higher Visual Analogue Scale score, and higher compression fracture classification in thoracolumbar compression fracture patients.

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STATEMENTS

We want to declare that the work described is original research that has not been published previously and is not under consideration for publication elsewhere. All the authors listed wish to be considered for publication in *Tissue and Cell*. No conflict of interest exists in submitting this manuscript; all authors have approved the paper for publication. The authors declare that there is no conflict of interest associated with this study.

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