Original Article

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Internal Medicine Section

Prevalence of Bone Mineral Density Abnormalities and Factors Affecting Bone Density in Patients with Chronic Obstructive Pulmonary Disease in a Tertiary Care Hospital in Southern India

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ABSTRACT

Introduction: Chronic Obstructive Pulmonary Disease (COPD) is a disease of wasting with airflow limitation, associated with a variety of systemic manifestations such as reduced Bone Mineral Density (BMD). There is a paucity of Indian studies on the effects of COPD on BMD.

Aim: This study was conducted to estimate the prevalence of osteopenia and osteoporosis in COPD patients and the correlation between bone density and severity of COPD classified according to GOLD Global initiative for chronic Obstructive Lung Disease guidelines (GOLD).

Materials and Methods: A prospective study of 60 patients diagnosed to have COPD, was conducted in the outpatient department of Respiratory Medicine, at a tertiary care hospital in Southern India, between September 2012 and September 2013. BMD was measured using ultrasound bone densitometer (ACHILLES GE HEALTH CARE). Patients with a T-score between -1 and -2.5 were considered to be osteopenic while patients with a T score less than -2.5 were considered to be osteoporotic (WHO criteria).

Results: Overall, 40 (67%) patients had an abnormal bone mineral density. A total of 21 (35%) patients were osteoporotic while 19 (33%) were osteopenic. BMD levels correlated with severity of obstruction ($p<0.001$), smoking status ($p=0.02$), age ($p=0.05$) and number of pack years ($p=0.001$).

Conclusion: Patients with COPD are at an increased risk for lower BMD and osteoporotic fractures and the risk appears to increase with disease severity. Further studies are required to assess whether routine BMD measurements in COPD patients is beneficial to diagnose osteoporosis and reduce morbidity.

Keywords: FEV1, Osteopenia, Osteoporosis

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a major cause of morbidity and mortality in adults and is the fourth leading cause of death in the world [1]. COPD is now considered as a multi-component disorder associated with systemic inflammation and extra pulmonary manifestations [2]. Though osteoporosis has been found to be one of the systemic effects of COPD, the precise mechanisms are still unclear [3]. The prevalence of osteoporosis is estimated to be 2 to 5 times higher in COPD patients as compared to healthy subjects [4,5]. COPD has been identified as a disease associated with osteoporosis and has been included in the fracture risk assessment in a few guidelines on osteoporosis and fracture prevention [6]. However, Indian data is scarce on the association between COPD and BMD and hence, we aimed to assess the relationship between these two common entities. The aim of the study was to estimate the prevalence of osteopenia and osteoporosis in patients with COPD.

The primary objective of the study was to evaluate BMD in COPD patients using qualitative ultrasonic bone densitometer. The secondary objective was to determine the correlation between BMD and COPD severity, smoking status.

MATERIALS AND METHODS

This prospective cross-sectional study of 60 patients was conducted in the Department of Respiratory Medicine at a tertiary care hospital in Southern India from 1st September 2012 to 31st August 2013. Consecutive patients with COPD confirmed by clinical examination and subsequent spirometry as per GOLD guidelines were included in the study [2]. Patients with: 1) Spirometry proven bronchial asthma; 2) Patients on long term oral steroids; 3) Patients with coexisting lung diseases such as pulmonary tuberculosis and bronchiectasis; 4) Patients with chronic co-morbidities including congestive heart failure, chronic liver disease and 5) Patients with recent acute coronary syndrome, unstable angina were excluded. Informed consent was obtained from all patients. The study protocol was approved by the institutional ethics committee board.

All included patients underwent a detailed clinical evaluation including collection of details such as age, sex, residence, smoking history and disease severity followed by thorough examination. Subsequently, they underwent spirometry using 'KOKO legend' desktop spirometer, model no. 314000 that satisfied the American Thoracic Society performance criteria [7].

Spirometry was performed again after 20 minutes following the administration of Salbutamol (5mg) nebulisation for assessing reversibility. The following parameters were noted: Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), FEV1/FVC ratio, Forced Expiratory Flow 25%-75% (FEF) and Peak Expiratory Flow Rate (PEFR). The procedure was repeated thrice and the average values were taken.

Bone mineral density was assessed in the left heel bone (calcaneus) using ACHILLES quantitative ultrasound bone densitometer produced by GE HEALTH CARE. According to WHO criteria [8], patients with T score more than -1.0 were considered to possess normal bone density; those with T score between -1.0 and -2.5 were considered to be osteopenic and those less than -2.5 were considered to be osteoporotic.

STASTISTICAL ANALYSIS

Descriptive statistics including mean and standard deviation were used to summarize the baseline characteristics of the patients. For analysis of factors affecting BMD, we used the Pearson's Chi Square test to estimate the difference in BMD score according to disease severity and smoking status. Pearson's correlation coefficient was used to measure the correlation between BMD score and increasing age, number of pack years and FEV1%.

RESULTS

Baseline characteristics are shown in [Table/Fig-1]. Most of the patients were males (85%) and aged 61 years and above (47%) while 37% were between 50 and 60 years. A large number of patients 46 (77%) were smokers (current 38, reformed 8) comprising only of male patients. None of the female patients were smokers. Based on FEV1, 43 (72%) patients had moderate obstruction, 16 (26.7%) had severe obstruction while only 1 (1.7%) had very severe obstruction. There were no patients with mild obstruction. Overall, 40 (67%) patients had an abnormal BMD of which 21 had osteoporosis and 19 patients had osteopenia. Among the osteoporotic patients, 13 (62%) patients had severe obstruction while 8 (38%) had moderate obstruction (p<0.001). Out of the 20 patients with normal BMD scores, 19 (95%) had moderate obstruction while only 1 (5%) had severe obstruction. Out of 16 patients with severe obstruction, 13 (81%) had osteoporosis (p<0.001).

Among the patients who smoked, 34 (74%) had abnormal BMD scores while 6 (37%) non-smokers had abnormal BMD. The mean number of pack years was inversely related to BMD scores. Only one female patient had osteoporosis while three females had osteopenia [Table/Fig-2]. We found a significant correlation between age, FEV1%, Number of Pack Years (NPY) and BMD scores [Table/Fig-2].

Characteristics	Males, n (%)*	Females, n (%)	Total, n (%)
Total	51 (85)	9 (15)	60(100)
Mean age	61.2±10.2	57.6±7.1	
Age groups			
40-50	8(16)	2 (22)	10 (17)
50-60	18(35)	4 (44)	22(37)
>61	25(49)	3 (33)	28 (47)
Smokers	46 (90)	0	46 (77)
Current	38 (75)		
Reformed	8 (15)		
Mean NPY†	17.9±12.9		
Mean FEV1 %‡	53.59+10.6	60.33±7.7	
Mean FEV1/FVC§	63.04±9.1	67.67+8.2	
Mean BMD‖	-1.63±1.2	-0.8±1.26	

[Table/Fig-1]: Baseline characteristics of the study population (n=60).
*n (%) = number (percentage) of given characteristics, † = No.of pack years, ‡ = Forced Expiratory Volume at 1 second, §=Forced Vital Capacity, ‖ = Bone Mineral Density

Factors	BMD Score			
	Normal (n=20) (> -1.0)	Osteopenia (n=19) (-1.0 to -2.5)	Osteoporosis (n=21) (< -2.5)	p-value
FEV1 %				
Mild (>80%)	-	-	-	
Moderate (50-79%)	19 (44.2%)	16 (37.2%)	8 (18.6%)	<0.001
Severe (30-49%)	1(6.3%)	2 (12.5%)	13 (81.3%)	
Very severe (<30%)	0	1	0	
Non smokers	8 (57.1%)	5 (35.7%)	1(7.1%)	0.02
Smokers	12 (26.1%)	14 (30.4%)	20(43.5%)	
Mean NPY	16	22	28	
Females	5(56%)	3(33%)	1(11%)	
	Correlation coefficient(r) BMD score			
Age	-0.253			0.05
FEV1%	0.497			0.0001
NPY (Number of Pack Years)	-0.591			0.0001

[Table/Fig-2]: Factors affecting BMD score among the study population.

DISCUSSION

Osteoporosis is a disease with features of microarchitectural destruction of bone tissue leading to a low bone density, increased bone fragility and thus increased fracture risk [9]. Osteopenia is the preclinical stage of osteoporosis. Multiple mechanisms have been postulated to explain the high prevalence such as smoking, inflammatory cytokine production, vitamin D deficiency, physical inactivity and use of steroids.

We used the ultrasound bone densitometer to assess BMD in our patients. Similar studies using the same mechanism have been done by Parthasarathi et al., [3] and Vrieze et al., [10] to estimate the prevalence of osteopenia and osteoporosis in COPD patients.

We found a 67% prevalence of osteopenia and osteoporosis among COPD patients in our study. The prevalence of osteopenia and osteoporosis in the general population varies between 35% and 56% in Indian studies [11], much lower than the prevalence we found in our study. There is very little data on the prevalence of these abnormalities in COPD patients especially in Southern India. A recent study by Hattiholi et al., demonstrated the prevalence to be as high as 86% among their patients [12].

Importantly, we found a large difference in the prevalence of osteoporosis between patients with moderate and severe obstruction (18.6 % vs. 81.2%, p<0.001) which indicates a significant negative correlation between BMD and COPD severity. Moreover, we also found a positive correlation between FEV1% values and BMD scores (p=0.0001). Patients with mild obstruction were not encountered in our study as this was a hospital based study and they may have been asymptomatic or had mild symptoms not requiring access to health care. In a study done by Sin et al., in 2003, patients with severe airflow obstruction were at an increased risk for osteoporosis (Odds Ratio 2.4, 95% CI: 1.3 to 4.4) [13]. However, patients with mild obstruction had no increased risk of osteoporosis.

Age is an established risk factor for osteoporosis and in our study 47% were > 60 years of age and 37% were between 50 and 60 years of age. We found a significant negative correlation between increasing age and lower BMD values (p=0.05). Graat-Verboom et al., found patients between 55 and 65 years and over 65 years

Studies done in India	Total No.	Mean Age Total	Mean BMD in Osteoporotic Patients	Correlation between COPD Severity and Lower BMD	Correlation between Smoking and Lower BMD	Osteoporosis n (%)*
Present study	60	60.7±9.9	-2.72±0.15	Yes	Yes	21(35)
Hattiholi et al., [12]	102	M†-66.6±7.8 F‡-64.4±11.5	0.74±0.12	Yes	Yes	68(66.7)
Bhattacharya et al., [3]	37		-2.84±0.23	No	Not done	8(22)

[Table/Fig-3]: Comparison between various Indian studies.
*n (%) = number (percentage) of given characteristics†=M – male ‡ = F – female

had a 6-fold and 11 increased risk respectively for developing osteoporosis [14].

In our study, 77% were smokers out of which 30% were osteopenic and 45% were osteoporotic. Patients with osteoporosis had a higher NPY (28) when compared to those with osteopenia (16) and normal BMD (22). We found a significant negative correlation between NPY and BMD (p=0.0001) indicating that smoking is a major risk factor for low bone mineral density. It is pertinent to note that a meta-analysis by Ward and Klesges concluded that tobacco smoking was an independent risk factor for low BMD and also had a cumulative, dose-dependent effect [15].

We compared our results with data from other recent Indian studies and found similar results (correlation between COPD severity, smoking and lower BMD) have been reported by Hattiholi et al., [Table/Fig-3] [12].

Female gender is a well-known independent risk factor for osteoporosis and consequent fractures [16]. In our study, there were only nine females and only one patient had osteoporosis while three had osteopenia. This could be due to the small number of female patients included in our study.

LIMITATION

This study included a relatively small number of patients. We used the ACHILLES clinical bone sonometer to assess skeletal status although dual energy X-ray absorptiometry is the preferred quantitative technique.

CONCLUSION

Our study has demonstrated a high prevalence of BMD abnormalities among COPD patients which increases with disease severity, smoking and age. Large studies are required on an emergent basis to identify the extent of the problem and consider whether routine BMD screening is necessary for this high risk group of patients especially in low income countries.

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