Section: Respiratory Medicine

Original Research Article

EVALUATION OF BONE MINERAL DENSITY IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISORDER: A CROSS-SECTIONAL STUDY

P. Hemalatha[1], G.K. Balaji[2], Anand. K.R[3]

[1]Assistant Professor, Department of Respiratory Medicine, Government Stanley medical college, Tamilnadu, India.
[2]Assistant Professor, Department of Respiratory Medicine, Government Stanley medical college, Tamilnadu, India.
[3]Assistant Professor, Department of Respiratory Medicine, Government Stanley medical college, Government Hospital of thoracic medicine Tamilnadu, India.

Received : 05/01/2024
Received in revised form : 24/02/2024
Accepted : 10/03/2024

Keywords:
Osteoporosis, COPD, Extrapulmonary manifestation, Physical activity, Bone marrow density, Osteopenia.

Corresponding Author:
Dr. Anand.K.R,
Email: anand86.kr@gmail.com

DOI: 10.47009/jamp.2024.6.2.214

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (2); 1060-1063

Abstract

Background: Osteoporosis is a condition outside the lungs that occurs in COPD patients, limiting their physical activity. This study aimed to assess bone density in patients with COPD and determine the occurrence and impact of osteopenia and osteoporosis. **Material and Methods**: We conducted a cross-sectional observational study involving COPD patients aged > 40 years. After obtaining detailed medical histories, we performed spirometry to categorise COPD severity. A bone densitometer was used to perform DEXA scans of the calcaneus to diagnose osteoporosis. Statistical methods were used for data analysis. **Results**: We included 42 patients, of which 28 (67%) had osteopenia and 21 (%) had osteoporosis. Most patients with osteopenia and osteoporotic disease had stages 3 and 4 COPD. Additionally, bone mineral density decreased as COPD severity increased. Patients with a lower BMI had a higher prevalence of osteopenia and osteoporosis, especially in stages 3 and 4 COPD. Furthermore, the incidence of osteoporosis was higher in patients with severe COPD than in non-COPD individuals of the same age. **Conclusion**: As COPD severity increased, so did the likelihood of osteopenia and osteoporosis. A high level of suspicion, early diagnosis, and prompt treatment are crucial for assessing osteoporosis and osteopenia in elderly COPD patients.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is characterised by irreversible airflow restriction.[1] Although the primary symptoms are respiratory, COPD is considered a systemic disease, and COPD patients have a variety of comorbidities, including osteoporosis.[2,3] According to a meta-analysis, approximately 35% of COPD patients have osteoporosis, and the prevalence of osteoporosis is higher in women, patients in advanced stages of COPD, and patients with a low body mass index.[4] Patients with COPD have a higher prevalence of osteoporosis than healthy people, which has been ascribed to the systemic use of oral corticosteroids, tobacco use, systemic inflammation, and decreased ability to exercise.[5]

Dual-energy X-ray absorptiometry (DXA) is the gold standard for evaluating the bone density. The procedure is currently the preferred examination for diagnosing and monitoring osteoporosis patients, according to the International Society for Clinical Densitometry, owing to its global availability, minimal radiation dose, and repeatability of results.[6] However, the technical limitations of this technology are well known.[7] Because it is a two-dimensional method for evaluating bone mineral density (BMD), overlaid tissue can result in artefacts and inadequate observations.[6]

Quantitative computed tomography (QCT) may be a useful alternative for measuring bone density because its results are independent of extraperitoneal diseases such as aortic calcification.[8-10] It has been shown that QCT results in the spine are reproducible and are used as prognostic factors related to pathological tumours.[6,11] Indeed, a comparison of QCT and DXA has shown that the former is more effective in detecting vertebral fractures.[12] Despite its technological superiority, widespread adoption of the method has been hampered by the need for standardisation and post-image processing, as well

as its high cost and air consumption. Studies based on DXA measurements have long been confirmed, whereas studies on the use of QCT are fewer and have fewer subjects.8 However, QCT measurements permit volumetric trabecular bone evaluation without superimposing the cortical bone and different tissues, rendering the approach powerful in estimating bone energy.[13]

The current study aimed to analyse the bone mass density (BMD) in patients diagnosed with COPD.

MATERIALS AND METHODS

Our study employed a cross-sectional observational design to investigate a cohort of 42 patients with COPD aged 40 years and older. Proper ethical approval was obtained from the hospital ethics committee and patient enrolment was conducted after obtaining consent. The study protocol included several essential steps to ensure a comprehensive data collection and analysis.

Inclusion Criteria

Patients aged ≥ 40 years, diagnosis of COPD as defined by the Global initiative for chronic obstructive lung disease guidelines were included in the study.

Exclusion Criteria

Patients aged < 40 years with COPD. Subjects with known diagnosis or receiving treatment for osteoporosis. Neoplastic disease or any disorder with an inflammatory or metabolic component. Subjects with cardiac failure or requiring long term oxygen therapy or on inhaled corticosteroids were excluded from the study.

Data Collection

Each participant underwent a thorough assessment of their medical history, including past diagnoses, treatments, and medication usage. Pulmonary function testing using spirometry was conducted to assess and categorise COPD severity in each participant. Key parameters such as forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) were measured. Dual-energy X-ray Absorptiometry (DEXA) scans targeting the calcaneal region were performed using a specialised bone densitometer. DEXA scanning is considered the gold standard for evaluating bone mineral density (BMD) and diagnosing osteoporosis owing to its precision and accuracy. Focusing on the calcaneum allowed us to obtain reliable data on bone health, specifically related to osteoporosis prevalence among patients with COPD.

Data Analysis

Rigorous statistical methods were used to analyse the collected data. Statistical analyses were conducted to explore the correlations, trends, and associations between COPD severity, BMD measurements, and the prevalence of osteoporosis in our study population.

RESULTS

This study included 42 patients diagnosed with COPD at a tertiary care centre. A majority of patients were in the age group of 51-60 years of age accounting for a total of 14 patients, followed by the age group of 61-70 years of age with 13 patients, and 41-50 years of age with 12 patients. Only 3 patients were aged >70 years.

Evaluation of GOLD staging revealed that the majority of patients with COPD were stage 4 (31.7%) and stage 2 (31.7%). In addition, stage 3 GOLD staging was reported in 12 patients. Only three patients were reported with the stage 1 GOLD standard. [Table 1]

Of the total participants, five individuals (12%) had normal BMD values, falling within the range greater than or equal to -1.0. The majority of participants, accounting for 28 individuals (67%), were classified as having osteopenia, with BMD values ranging from -1.1 to -2.5. Additionally, nine participants (21%) were diagnosed with osteoporosis, characterised by BMD values lower than -2.5. A total of 16 patients (38%) had a BMI below 18.5, indicating an underweight BMI, followed by 19 patients (45%) who fell within the BMI range of 18.5 to 24.9, with a normal BMI, and 7 patients (17%) who had a BMI above 25, indicating overweight or obesity [Table 1].

Among the COPD patients studied, 5 individuals showed normal BMD, 28 were diagnosed with osteopenia, and 9 were diagnosed with osteoporosis [Table 2].

Table 1: Demographic data of the study

		Number	Percentage
Age group	41 – 50	12	29%
	51 – 60	14	33%
	61 – 70	13	31%
	Above 70	3	7%
Gold staging	1	3	7%
	2	13	31%
	3	12	29%
	4	13	31%
BMD	Normal (< - 1.0)	5	12%
	Osteopenia (-1.1 to – 2.5)	28	67%
	Osteoporosis (less than -2.5)	9	21%
BMI	< 18.5	16	38%
	18.5 to 24.9	19	45%
	Above 25	7	17%

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 2: Correlation of BMD, gold staging, and osteopenia

Gold staging	Normal BMD	Osteopenia	Osteoporosis
1	2 (40%)	1 (3.5%)	1 (11%)
2	2 (40%)	10 (35.7%)	1 (11%)
3	1 (20%)	8 (28.5%)	3 (33%)
4	0	9 (32.3%)	4 (45%)
Total	5	28	9

DISCUSSION

Our study investigated the demographic and clinical characteristics of COPD patients in a tertiary care setting, focusing on age distribution, GOLD staging, BMD, BMI, and their correlations. Our findings are consistent with those of Li et al., who examined DXA and QCT measurements in postmenopausal women and discovered that QCT may overcome the aforementioned projection errors that can cause erroneous diagnosis of DXA in the lumbar spine.[14] Another study by Liu et al. found that QCT measurements were more useful than DXA in assessing bone loss in the lumbar spine among patients with spinal cord injury.[15]

The age distribution among our patients with COPD revealed a predominant presence of individuals in the 51-60 years age group, followed closely by those aged 61-70 years. This demographic trend aligns with established epidemiological patterns, indicating that COPD prevalence tends to increase with age.12,14 In addition, similar study findings were also reported by Fountoulis et al., where the most common age for COPD was between 51 and 70 years of age with an increased risk of osteopenia and osteoporosis due to low BMI.[16]

Our assessment of GOLD staging revealed that a significant proportion of patients had GOLD Stages 2 and 4, reflecting varying degrees of disease severity. Notably, a considerable number of patients are diagnosed at more advanced stages, warranting attention toward optimising treatment strategies for these individuals. For instance, patients in higher GOLD stages tend to have lower BMD and a higher prevalence of osteopenia or osteoporosis, indicating a potential relationship between disease severity and bone health in COPD. However, we did not report a significant correlation between GOLD staging and advancing age or incidence of osteopenia.

The multicentric Towards a Revolution in COPD Health (TORCH) research, which included 658 COPD patients, revealed osteoporosis in 23% and osteopenia in 43% of patients at the hip or lumbar spine on DEXA scans. A higher prevalence of osteoporosis and osteopenia was reported at baseline in patients with a confirmed diagnosis of COPD, with no correlation with FEV1 impairment or BMD.[17]

In contrast, Hattiholi et al. reported a significant correlation between the stages of COPD and osteoporosis.18 Silva et al. found osteoporosis and osteopenia in 42% of the patients with clinically stable COPD who underwent DEXA. There was a strong relationship between BMD, BMI, amount of physical activity, body mass index (BMI), airflow obstruction, dyspnoea, and exercise. They also found that patients with low BMD had considerably poorer lung function test results than those with normal BMD. However, no link was discovered between BMD and sun exposure, corticosteroid use, or smoking status.[19]

Bhattacharyya et al. used an ultrasonic bone densitometer to measure BMD in a small group of patients with advanced COPD and found osteopenia/osteoporosis in 27 patients (73%). Both investigations showed a predominance of masculinity. There were certain limitations to Bhattacharyya et al. ’s study. First, they included only patients with advanced COPD. Second, BMD was assessed using an ultrasound bone densitometer rather than a DEXA scan. Finally, only one heel measurement was used in the investigation.[20]

The assessment of BMI highlighted a significant proportion of patients in the underweight and normal BMI categories. However, a notable number also fell within the overweight or obese BMI range. Low BMI has been recognised as a critical risk factor for low BMD and future risk of fragility fractures, while a high BMI is protective against osteoporosis.[21]

Limitations and Future Directions

Despite providing significant information, our study has certain limitations. The sample size was modest, limiting the generalisability of our results. Future studies should include larger cohorts from different populations to validate these findings. Longitudinal studies are needed to explore the long-term impact of COPD, GOLD staging, and associated comorbidities on patient outcomes and quality of life.

CONCLUSION

Our study provides a comprehensive snapshot of the demographic, clinical, and correlational aspects of COPD management. These findings emphasise the necessity of comprehensive care methods that consider not only respiratory function but also bone health, nutritional condition, and disease severity. Addressing these issues can lead to better results and a higher quality of life for patients with COPD.

REFERENCES

1. Vestbo J, Hurd SS, Agustí AG, Jones PW, Vogelmeier C, Anzueto A, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. Am J Respir

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Crit Care Med 2013; 187:347–65. https://doi.org/10.1164/rccm.201204-0596pp.
2. García-Olmos L, Alberquilla Á, Ayala V, García-Sagredo P, Morales L, Carmona M, et al. Comorbidity in patients with chronic obstructive pulmonary disease in family practice: a cross-sectional study. BMC Fam Pract 2013;14. https://doi.org/10.1186/1471-2296-14-11.
3. Romme EA, Smeenk FW, Rutten EPA, Wouters EFM. Osteoporosis in chronic obstructive pulmonary disease. Expert Rev Respir Med 2013; 7:397–410. https://doi.org/10.1586/17476348.2013.814402.
4. Graat-Verboom L, Wouters EFM, Smeenk FWJM, van den Borne BEEM, Lunde R, Spruit MA. Current status of research on osteoporosis in COPD: a systematic review. Eur Respir J 2009; 34:209–18. https://doi.org/10.1183/09031936.50130408.
5. Ward KD, Klesges RC. A meta-analysis of the effects of cigarette smoking on bone mineral density. Calcif Tissue Int 2001; 68:259–70. https://doi.org/10.1007/bf02390832.
6. International Society for Clinical Densitometry. ISCD Official Positions, 2013. http://www.iscd.org/official-positions/2013-iscd-official-positions-adult/. Accessed March 31, 2024.
7. Bolotin HH. DXA in vivo BMD methodology: An erroneous and misleading research and clinical gauge of bone mineral status, bone fragility, and bone remodelling. Bone 2007; 41:138–54. https://doi.org/10.1016/j.bone.2007.02.022.
8. Adams JE. Quantitative computed tomography. Eur J Radiol 2009; 71:415–24. https://doi.org/10.1016/j.ejrad.2009.04.074.
9. Guglielmi G, Schneider P, Lang TF, Giannatempo GM, Cammisa M, Genant HK. Quantitative computed tomography at the axial and peripheral skeleton. Eur Radiol. 1997;7 Suppl 2: S32-S42. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=9.%09Guglielmi+G%2C+Schneider+P%2C+Lang+TF%2C+et+al.+Quantitative+computed+tomography+at+the+axial+and+peripheral+skeleton.+Eur+Radiol.+1997%3B7+Suppl+2%3AS32-S42&btnG=
10. Gudmundsdottir H, Jonsdottir B, Kristinsson S, Johannesson A, Goodenough D, Sigurdsson G. Vertebral bone density in Icelandic women using quantitative computed tomography without an external reference phantom. Osteoporos Int 1993; 3:84–9. https://doi.org/10.1007/bf01623378.
11. Engelke K, Adams JE, Armbrecht G, Augat P, Bogado CE, Bouxsein ML, et al. Clinical use of quantitative computed tomography and peripheral quantitative computed tomography in the management of osteoporosis in adults: The 2007 ISCD official positions. J Clin Densitom 2008; 11:123–62. https://doi.org/10.1016/j.jocd.2007.12.010.
12. Rehman Q, Lang T, Modin G, Lane NE. Quantitative computed tomography of the lumbar spine, not dual x-ray absorptiometry, is an independent predictor of prevalent vertebral fractures in postmenopausal women with osteopenia receiving long-term glucocorticoid and hormone-replacement therapy. Arthritis Rheum 2002; 46:1292–7. https://doi.org/10.1002/art.10277.
13. Schreiber JJ, Anderson PA, Rosas HG, Buchholz AL, Au AG. Hounsfield units for assessing bone mineral density and strength: A tool for osteoporosis management. J Bone Joint Surg Am 2011; 93:1057–63. https://doi.org/10.2106/jbjs.j.00160.
14. Li N, Li XM, Xu L, Sun WJ, Cheng XG, Tian W. Comparison of QCT and DXA: osteoporosis detection rates in postmenopausal women. Int J Endocrinol. 2013; 2013:895474. https://doi.org/10.1155/2013/895474.
15. Liu CC, Theodorou DJ, Theodorou SJ, Andre MP, Sartoris DJ, Szollar SM, et al. Quantitative computed tomography in the evaluation of spinal osteoporosis following spinal cord injury. Osteoporos Int 2000; 11:889–96. https://doi.org/10.1007/s001980070049.
16. Fountoulis G, Kerenidi T, Kokkinis C, Georgoulias P, Thriskos P, Gourgoulianis K, et al. Assessment of bone mineral density in male patients with chronic obstructive pulmonary disease by DXA and quantitative computed tomography. Int J Endocrinol 2016; 2016:1–6. https://doi.org/10.1155/2016/6169721.
17. Ferguson GT, Calverley PMA, Anderson JA, Jenkins CR, Jones PW, Willits LR, et al. Prevalence and progression of osteoporosis in patients with COPD. Chest 2009; 136:1456–65. https://doi.org/10.1378/chest.08-3016.
18. Hattiholi J, Gaude GS. Prevalence and correlates of osteoporosis in chronic obstructive pulmonary disease patients in India. Lung India 2014; 31:221-227. https://doi.org/10.4103/0970-2113.135759.
19. Silva DR, Coelho AC, Dumke A, Valentini JD, de Nunes JN, Stefani CL, et al. Osteoporosis prevalence and associated factors in patients with COPD: A cross-sectional study. Respir Care 2011; 56:961–8. https://doi.org/10.4187/respcare.01056.
20. Bhattacharyya P, Paul R, Ghosh M, Dey R, Dey R, Barooah N, et al. Prevalence of osteoporosis and osteopenia in advanced chronic obstructive pulmonary disease patients. Lung India 2011; 28:184. https://doi.org/10.4103/0970-2113.83974.
21. Ong T, Sahota O, Tan W, Marshall L. A United Kingdom perspective on the relationship between body mass index (BMI) and bone health: A cross-sectional analysis of data from the Nottingham Fracture Liaison Service. Bone 2014; 59:207–10. https://doi.org/10.1016/j.bone.2013.11.024.

ISSN (O): 2687-5365; ISSN (P): 2753-6556