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Clinical Issues

Relationship Between Vertebral Fracture Burden, Height Loss, and Pulmonary Function in Postmenopausal Women With Osteoporosis

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Abstract

The purpose of this analysis was to assess the association of osteoporosis-related vertebral fracture burden and pulmonary function. This study also examined the relationship between vertebral fracture burden and height loss, estimated by arm span − height. This was a single-site and single-visit study. Patients had a history of at least 1 moderate or severe vertebral fracture. Vertebral fracture burden was quantified using the spinal deformity index (SDI). Pulmonary function during inspiration was determined by spirometry. Forty-one women aged 70−91 completed the study. Vertebral fracture burden negatively correlated with forced inspiratory vital capacity and inspiratory time. For each unit increase in SDI, forced inspiratory vital capacity decreased by 1.62%, and inspiratory time decreased by 2.39%. There was no correlation between SDI and measures of inspiratory flow. For each unit increase in SDI, height decreased by about 0.5 cm. Vertebral fractures were associated with decreased lung volume and height loss.

Key Words: Height loss; lung volume; osteoporosis; pulmonary function; vertebral fractures.

Introduction

Vertebral fractures are common among people with osteoporosis. In the year 2000, there were an estimated 1.4 million osteoporosis-related vertebral fractures worldwide *(1)*. Individuals with a vertebral fracture have an increased risk of future vertebral fractures and other types of fractures *(2,3)*. Vertebral fracture risk is also increased among patients with chronic obstructive pulmonary disorder (COPD), attributed to their risk for osteoporosis brought on by numerous factors, including glucocorticoid treatment, smoking, and physical inactivity *(4−8)*. Most guidelines, including International Society for Clinical Densitometry positions, emphasize the importance of vertebral fractures in the identification of patients requiring pharmacotherapy. In addition, the combination of vertebral fractures and osteoporosis is associated with increased morbidity and mortality *(7,9−11)*.

This single-visit study was originally conducted to compare 2 inhalation devices for potential use by elderly women with osteoporosis and a history of at least 1 moderate or severe vertebral fracture. Patients also had pulmonary function testing without in line inhalers, and these are the data reported here. Study measures included quantification of vertebral fracture burden using the spinal deformity index (SDI) *(12,13)*, height, arm span, and pulmonary function during inspiration by spirometry. The purpose of this post hoc analysis is to assess the association of osteoporosis-related vertebral fracture burden and pulmonary function and to examine the relationship between vertebral fracture burden and height loss, determined by arm span − height. Arm span is commonly used as a surrogate for maximum adult height for individuals with spinal deformity, and the difference between arm span and height serves as a measure of

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height loss *(14–16)*. We hypothesized that increased spine fracture burden would be associated with decreased lung volume and height loss.

Materials and Methods

Study Design

This was a single-visit study at a single site. No investigational product was administered.

Patients

Subjects were required to be women aged 70 yr and older with osteoporosis and a history of at least 1 moderate or severe vertebral fracture as determined by the investigator. Patients could not enter the study if they were active smokers or had a history of moderate to severe asthma, COPD, pulmonary fibrosis, emphysema, or other major lung disease. In addition, study participants could not have taken inhaler-delivered medications within the past 3 mo or have any severe or chronically disabling conditions other than osteoporosis, such as congestive heart failure. Patients were not selected for this study based on their need for an inhaler.

Measures

Spinal Deformity Index

SDI was assessed as described (Fig. 1) *(12,13,17)*. Briefly, using lateral radiographs of the thoracic and lumbar spines, the investigator visually scored each vertebra as semiquantitative grade 0, 1, 2, or 3. Grade 0 indicates an unfractured vertebra, grade 1 is mild compression (approx 20%–25%), grade 2 is moderate compression (approx 25%–40%), and grade 3 is severe compression (>40%). For each patient, the number of mild, moderate, and severe vertebral fractures was recorded. The SDI is the sum of the semiquantitative scores of T4–L4 vertebrae. All patients had an SDI score of ≥2 because study inclusion criteria required patients to have at least 1 moderate vertebral fracture.

Height Loss

In this study, estimated height loss was calculated as the difference between arm span and height *(14–16)*. Arm span was measured to the nearest centimeter from the tips of the middle fingers of maximally outstretched hands, with the patient standing facing the wall. Height was measured using a Harpenden stadiometer (Holtain Ltd., Crosswell, Crymych, UK). According to a standardized protocol, patients were measured in bare feet or thin socks, with their back against the wall-mounted stadiometer, heels together, and head positioned in the Frankfort horizontal plane. The patient was asked to breathe in, and height was noted and recorded at peak inspiration. Arm span and height measurements were taken one time.

Pulmonary Function

All pulmonary function measures were performed with patients seated upright. Patients were directed by trained staff on proper use of the spirometer. Each measurement was repeated 3–5 times, with at least 1 min between inhalations. The spirometry variables included peak inspiratory flow rate (L/min), forced inspiratory vital capacity (L), average flow rate of inspiration (L/min), forced inspiratory flow 25%–75% (L/s), forced inspiratory flow 50% (L/s), forced inspiratory volume in 1 s (L), and total inspiratory time (s). Expiratory measures were not taken.

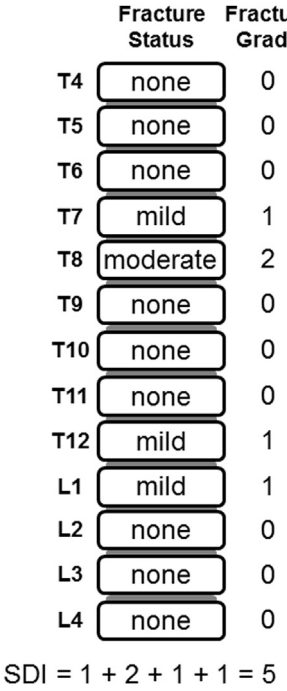

Fig. 1. Spinal deformity index is the sum of fracture grades for T4 to L4 vertebrae. In the example shown, the patient has three mild and one moderate vertebral fracture, for an SDI of 5. SDI, spinal deformity index.

Statistical Analysis

All tests of treatment effects were conducted at a 2-sided alpha level of 0.05 unless otherwise stated. Methods included descriptive statistics, Pearson correlation and regression analysis, and individual patient listings.

Graphs were constructed to illustrate the relationship between SDI and other measured variables, and regression analysis was performed to quantify the relationships. Fitted

Table 1
Patient Characteristics

Patient characteristics (N = 41)	Mean ± SD	Range
Spinal deformity index	7.4 ± 5.6	2.0–22.0
Weight (kg)	59.2 ± 8.7	40.1–77.8
BMI	24.1 ± 3.1	15.1–29.7
Age (yr)	77.8 ± 4.6	70.8–91.3

Abbr: BMI, body mass index; SD, standard deviation.