Background: The incidence of unspecific back pain and osteoporotic vertebral compression fractures increases significantly with age. Considering the difficulties in the diagnosis of spontaneous osteoporotic vertebral fractures, this retrospective study aimed to compare the characteristics of back pain in women with postmenopausal osteoporosis with and without vertebral compression fractures.

Material/Methods: This study enrolled 334 women with postmenopausal osteoporosis; 150 had vertebral fractures, and 184 had no vertebral fractures. Densitometric vertebral fracture assessment and bone mineral density measurements in the central skeleton were performed for each patient. The participants completed a survey about features of their back pain.

Results: Patients with vertebral fractures had more severe back pain based on the numeric rating scale: 6.14 vs 4.33 (P<0.001, odds ratio [OR]=1.43, 95% confidence interval [CI]: 1.29-1.59). Among these individuals, back pain caused reduction in normal activity during the day (P<0.001, OR=4.68, 95% CI: 2.86-7.68), and pain occurred more often (P<0.001, OR=1.77, 95% CI: 1.47-2.13), lasted longer (P<0.001, OR=2.01, 95% CI: 1.65-2.46), predominantly occurred in the lumbar spine (P<0.001, OR=4.70, 95% CI: 1.96-11.29), and intensified during normal everyday activities (P<0.001). Based on these results, a new survey was created. It demonstrated a sensitivity of 70.67% and a specificity of 67.37% in predicting a current compression fracture.

Conclusions: Patients with vertebral compression fractures experience higher pain intensity and exhibit specific features of back pain. The new survey can be considered a supportive tool in assessing the possibility of vertebral compression fractures.

Keywords: Back Pain • Spinal Fractures • Osteoporosis • Pain Measurement

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/929853
Background

Back pain is a common problem among elderly patients [1,2]. Pain is most frequently caused by degenerative changes in the vertebrae, spinal nerve compression, and radiculopathy [3,4]. It could be the result of injury caused by actions such as lifting a heavy object or making a sudden movement [5-7]. Unfortunately, these situations can also be the cause of a vertebral compression fracture, which is a complication of unrecognized and untreated osteoporosis [8-12]. A large number of compression fractures are spontaneous [13,14] and therefore difficult to diagnose. Another reason for difficulties in diagnosing this type of fracture is the variety of methods recommended for the diagnosis of osteoporosis and vertebral compression fractures. While the diagnosis of vertebral compression fractures is based on radiographic examination [15], the diagnosis of osteoporosis should be confirmed by central dual-energy X-ray absorptiometry [16]. The aim of this study was to look for specific features of back pain associated with vertebral compression fractures [17].

Material and Methods

Study design and subjects

This comparative study of 334 postmenopausal women was performed between June 2018 and August 2019 in Warsaw, Poland, and was approved by the Ethics Committee of the Center of Postgraduate Medical Education in Warsaw (no. 64/PB/2018). Participants with osteoporosis diagnosed according to World Health Organization definitions of osteoporosis and osteopenia [18] (inclusion criterion) were recruited from among patients hospitalized in the Bone Metabolic Department or remained under the care of the Osteoporotic Clinic. The exclusion criteria were (1) taking steroids, (2) suspected or diagnosed secondary osteoporosis, (3) high-energy, nonosteoporotic vertebral fractures, and (4) presence of severe scoliosis or overlapping calcifications or structures in the mediastinum and abdominal cavity that precluded identification of the borders of vertebral bodies. Informed written consent was obtained from all participants before measurements and data collection.

Diagnosis of Osteoporosis and Vertebral Fractures

The diagnosis of osteoporosis was confirmed by measuring the bone mineral density of the hip and spine, using dual-energy X-ray absorptiometry [18,19]. For identification of vertebral compression fractures, all patients underwent thoracic and lumbar spine morphometry by a densitometric vertebral fracture assessment tool. All densitometric measurements were provided through use of a Horizon W dual-energy bone densitometer (Hologic, Inc., Bedford, MA, USA). The vertebrae T6–L4 were assessed. A compression fracture was diagnosed when the anterior, middle, or posterior height of the vertebral body was reduced by at least 25% [20]. To ensure repeatability of measurements, all tests were performed by the same highly qualified technician using the same device. Based on the results of the morphometric examination, patients were divided into 2 groups: those with vertebral fractures (n=150), regardless of the number of fractures, and those without vertebral fractures (n=184).

Questionnaire

Participants were asked to complete a questionnaire about their symptoms (Table 1). Pain assessment was conducted using an 11-point numeric rating scale (NRS) that patients with chronic pain prefer over a visual analog scale [21]. The questionnaire was validated by the authors using Cronbach's alpha test (obtained coefficient for the entire questionnaire was 0.757); it was not a modification of questionnaires concerning the quality of life [22], disability [23], or the effectiveness of osteoporosis treatment [24]. A different number of responses was assigned to subsequent questions in the questionnaire because some patients did not answer all questions.

In the next stage, based on statistically significant results, a new 5-point survey was created, characterizing the back pain after a compression fracture.

Statistical Analysis

Continuous data in the text and Table 2 are presented as mean-standard deviation, and categorical data in Table 3 are shown as percentages. For the variable determining the intensity of back pain on the NRS, after excluding the normality of the distribution using the Shapiro-Wilk test, a nonparametric analysis was conducted, with the P value of the Kolmogorov-Smirnov test results shown as p(1), that of the Mann-Whitney U test results as p(2), and that of the Wald-Wolfowitz test results as p(3). For the densitometric measurement results, a Kolmogorov-Smirnov test was conducted. For categorical data, the significance was verified by the chi-square test, with p(4) indicating the P value, and for the individual answers in Table 3, the structure indicators test was used, with the P value indicated as p(5). In addition, the Kendall tau correlation coefficient was calculated along with the gamma coefficient as appropriate. For selected variables, univariate logistic regression analysis with the odds ratio (OR) and 95% confidence intervals (CIs) was conducted. The 5 most differentiating questions were selected from the survey presented in Table 1 for assessing the risk of undiagnosed vertebral fractures. After statistical analysis was performed, the questions were reformatted to allow only "yes" or "no" answers. The new questionnaire was created in such a way that only a positive answer to all questions...
was considered diagnostic for a compression fracture. Then, the results of the vertebral fracture assessment were compared with the results of the questionnaire and the sensitivity and specificity of the new method were calculated. Statistical analysis was performed using Statistica TIBCO Software Inc. (data analysis software system, version 13.3, Palo Alto, CA, USA). A P value <0.05 was considered statistically significant.

**Results**

The results for bone mineral density, T-score, and Z-score in the lumbar spine, femoral neck, and hip are presented in Table 2. A summary of the analyzed responses from the questionnaire is presented in Table 3. Increased severity of pain was found among patients with vertebral fracture (Figure 1) compared with patients without vertebral fracture (6.14±2.10 vs 4.33±0.03), [p(1)<0.001, p(2)<0.001, p(3)<0.001, respectively, OR=1.43, 95% CI: 1.29-1.59]. Patients with a compression fracture had limitations to daily activity more frequently than patients without a fracture [p(4) and p(5) < 0.001, Kendall tau b coefficient 0.35, gamma coefficient 0.65, OR=4.68, 95% CI: 2.86-7.68]. Frequency of back pain that limited activity during the day was higher for subjects with vertebral fracture [p(4)<0.001, Kendall tau c coefficient 0.38, gamma coefficient 0.51, OR=1.77, 95% CI: 1.47-2.13]. The difference between

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**Table 1.** Questions included in the questionnaire with possible answers.

| Questions                                                                 | Possible answers                          |
|--------------------------------------------------------------------------|------------------------------------------|
| On a Numeric Rating Scale from 0 to 10, how sever is your back pain?     | A number from 0 to 10                     |
| Does your back pain limit your activity during the day, ie, make it necessary to stop (even for a moment) regular household activities? | 2 possible answers: yes; no               |
| If there is back pain, that limits your activity, how long does it last during the day? | 4 possible interval answers: 1-2 hours; 3-4 hours; 5-8 hours; round the clock |
| How often does the severity of your back pain limit your daily activity? | 4 possible answers: not at all; once a week; more often than once a week; every day |
| In which part of the spine the back pain is most severe?                | 3 possible answers: cervical, thoracic, lumbar |
| Does the back pain occur at night?                                      | 3 possible answers: no; yes, but does not wake up; yes and wake up |
| During which part of the day is back pain most severe?                  | 4 possible answers: morning; during the day; in the evening; at night |
| Do you remember ever experiencing an episode of sudden and more severe than usual back pain that could have occurred spontaneously or was associated with an injury? | 2 possible answers: yes; no |

**Table 2.** Comparison of densitometric parameters of spine, femoral neck and hip in 334 osteoporotic women with (n=150) and without (n=184) vertebral fractures.

| Parameter                  | Patients with vertebral fractures | Patients without vertebral fractures | p(1) value |
|----------------------------|-----------------------------------|-------------------------------------|------------|
| BMD – vertebrae L1–L4 (g/cm²) | 0.74±±0.079                      | 0.74±±0.068                        | >0.1       |
| T-score – vertebrae L1–L4  | -2.78±±0.71                      | -2.75±±0.61                        | >0.1       |
| Z-score – vertebrae L1–L4  | -0.58±±0.92                      | -0.73±±0.84                        | =0.1       |
| BMD – femoral neck (g/cm²)  | 0.59±±0.078                      | 0.61±±0.069                        | <0.025     |
| T-score – femoral neck     | -2.28±±0.72                      | -2.11±±0.64                        | <0.025     |
| Z-score – femoral neck     | -0.41±±0.80                      | -0.36±±0.69                        | =0.1       |
| BMD – hip (g/cm²)          | 0.70±±0.11                       | 0.73±±0.08                         | <0.005     |
| T-score – hip              | -1.89±±0.78                      | -1.69±±0.69                        | <0.025     |
| Z-score – hip              | -0.34±±0.84                      | -0.20±±0.77                        | =0.01      |

**Table 3.** Questions included in the questionnaire with possible answers.
Table 3. The summary analysis of categorical data of the responses provided in the questionnaire.

| Questions                                                                 | Answer                        | Patients with compression fractures | Patients without compression fractures | p(5) value |
|---------------------------------------------------------------------------|-------------------------------|-------------------------------------|---------------------------------------|------------|
| Does your back pain limit your activity during the day, ie, make it necessary to stop (even for a moment) regular household activities? | Yes                           | 118 (79.19%)                        | 82 (44.81%)                           | <0.001     |
|                                                                           | No                            | 31 (20.81%)                         | 101 (55.19%)                         | <0.001     |
|                                                                           | n=149                         | n=183                               |                                       |            |
| If there is back pain, that limits your activity, how long does it last during the day? | Not at all                    | 29 (19.73%)                         | 101 (55.19%)                         | <0.001     |
|                                                                           | 1-2 hours                     | 37 (25.17%)                         | 49 (26.78%)                          | 0.866      |
|                                                                           | 3-4 hours                     | 37 (25.17%)                         | 17 (9.29%)                           | 0.177      |
|                                                                           | 5-8 hours                     | 16 (10.88%)                         | 9 (4.92%)                            | 0.612      |
|                                                                           | Round the clock               | 28 (19.05%)                         | 7 (3.83%)                            | 0.326      |
|                                                                           | n=143                         | n=183                               |                                       |            |
| How often does the severity of your back pain limit your daily activity?   | Not at all                    | 32 (21.77%)                         | 101 (55.19%)                         | 0.001      |
|                                                                           | Once a week                   | 14 (9.52%)                          | 15 (8.20%)                           | 0.900      |
|                                                                           | More often than once a week   | 37 (25.17%)                         | 31 (16.94%)                          | 0.410      |
|                                                                           | Every day                     | 64 (43.54%)                         | 36 (19.67%)                          | 0.016      |
|                                                                           | n=147                         | n=183                               |                                       |            |
| In which part of the spine the back pain is most severe?                  | Cervical spine                | 4 (3.36%)                           | 30 (17.65%)                          | 0.464      |
|                                                                           | Thoracic spine                | 13 (10.92%)                         | 14 (8.24%)                           | 0.813      |
|                                                                           | Lumbar spine                  | 102 (85.72%)                        | 126 (74.11%)                         | 0.016      |
|                                                                           | n=119                         | n=170                               |                                       |            |
| Does the back pain occur at night?                                        | No                            | 92 (63.45%)                         | 131 (71.58%)                         | 0.199      |
|                                                                           | Yes, but does not wake up     | 6 (4.14%)                           | 9 (4.92%)                            | 0.945      |
|                                                                           | Yes and wake up               | 47 (32.41%)                         | 43 (23.50%)                          | 0.348      |
|                                                                           | n=145                         | n=183                               |                                       |            |
| During which part of the day is back pain most severe?                    | Morning                       | 14 (9.33%)                          | 36 (19.57%)                          | 0.383      |
|                                                                           | During the day                | 107 (71.33%)                        | 82 (44.57%)                          | <0.001     |
|                                                                           | In the evening                | 27 (18%)                            | 57 (30.98%)                          | 0.210      |
|                                                                           | In the night                  | 2 (1.34%)                           | 9 (4.89%)                            | 0.822      |
|                                                                           | n=150                         | n=184                               |                                       |            |
| Do you remember ever experiencing an episode of sudden and more severe than usual back pain that could have occurred spontaneously or was associated with an injury? | Yes                           | 77 (54.23%)                         | 43 (24.02%)                          | <0.001     |
|                                                                           | No                            | 65 (45.77%)                         | 136 (75.98%)                         | <0.001     |
|                                                                           | n=142                         | n=179                               |                                       |            |
3. If back pain that limits your daily activity occurs, does it last the following questions:

- Is back pain strongest in either thoracic or lumbar spine?
- In case of back pain, which limits your daily activity, does pain have the average severity or exceed 5 (0 to 10 scale)?

Discussion

Researchers have reported many features that distinguish the character of back pain of patients with compression fracture from that of patients without this type of injury. A seemingly simple assessment of the intensity of pain on NRS performed among women with vertebral fractures due to osteoporosis [25,26] demonstrated that patients with vertebral fractures experience much more severe pain compared with patients without fractures. This finding leads to the conclusion that osteoporotic fractures of the spine are in fact not asymptomatic [27,28]. Instead, the severity of back pain is underreported owing to the spontaneous character of fractures [13,14,29,30], the lack of awareness of patients about the existence and high frequency of spontaneous vertebral fractures, and the widespread occurrence of back pain in the elderly [31-35]. If a patient seeks medical advice due to back pain, the severity of the symptoms may be interpreted as the progression of degenerative changes or radiculopathy. As a result, the patient will receive only symptomatic treatment instead of further diagnostics [36,37].

Moreover, given that patients with a present compression fracture more often report an episode of sudden, severe back pain in the past [38], the view that osteoporotic fractures of the spine are mostly asymptomatic is incorrect [39]. This misperception is mainly due to their spontaneous character [30] and the fact that most individuals experienced nontraumatic vertebral fractures [40].

In addition to revealing the greater intensity of pain among patients with a compression fracture, our study demonstrated that these patients had more frequent occurrence of back pain, as well as a longer duration of pain, which significantly increased during daily activities and made rest necessary. Pain was most often localized in the lumbar spine. Therefore, the obtained results confirmed that back pain in patients with a compression fracture is significantly different from back pain caused by other pathologies such as degenerative changes [39]. The features of back pain in patients with a compression fracture, such as intensity or activity limitation, have been confirmed in another study [41], but our survey is one of the first tools that may be applicable in clinical practice for the early diagnosis of vertebral compression fractures and improved management of patients experiencing such fractures [42,43].

The questionnaire can be used in women with diagnosed postmenopausal osteoporosis and without any previously diagnosed
vertebral fracture. The last exclusion criterion must be imposed in each case, because the high sensitivity and specificity of the created questionnaire resulted from a comparison of participants from 2 groups, those with a current compression fracture and without such a fracture.

Limitations of the Study

This study has several limitations. The study did not determine whether back pain varies depending on the number of fractures. This requires further investigations. Other study limitation is the method used to detection of vertebral fractures (ie, densitometric vertebral fracture assessment). Although conventional radiography still remains the standard in diagnostics of vertebral fractures [44], the agreement between radiography and densitometric vertebral fracture assessment can reach 98.76% [45]. The research included only hospitalized patients and patients under the care of one osteoporosis clinic, so the results cannot be extended to the whole population. The study was based on one of the first such surveys conducted in Poland, and the sample size was relatively small. Therefore, future research is needed to verify our findings.

Conclusions

Patients with vertebral compression fracture are characterized by higher pain intensity and specific features of back pain. The new 5-point survey that we presented can be considered as a supportive tool in assessing the possibility of vertebral compression fractures.

Conflict of Interest

None.

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