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Assessment of Bone Density of Patients Referred to Arak Densitometry Center from 2016 to 2017: A Cross-sectional Study

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Abstract

Background: Osteoporosis and subsequent fractures increased mortality and disability. Along with this fact, the demand for diagnostic tests has also increased in recent years, which has created a heavy financial burden on the health system.
Objectives: The aim of this research was to evaluate the compatibility of the indications of performing the bone density measurement in Arak city with the criteria of the international sociality of clinical densitometry (ISCD).
Methods: This cross-sectional study was performed from 2016 to 2017. Patients' information was extracted from checklists recorded by a bone density measurement expert. Patients who lived in Arak and did not have an underlying condition that reduced the value of the bone mineral densitometry (BMD) test were studied. We collected the information of the patients who had undergone a bone density test at the discretion of their physician.
Results: Here, 816 out of 1,354 bone density tests, requested by non-rheumatologists, were abnormal, and 538 were normal. In the abnormal group, 800 (98%) cases had ISCD indications for BMD application, and only 16 (2%) cases had no indication. However, 636 bone density tests were requested by rheumatologists that 474 were abnormal and 162 were normal, and in the abnormal group, 471 (99.4%) had ISCD indications for BMD, and only 3 (0.6%) cases had no indications.
Conclusions: In many cases, bone mineral density has been requested based on ISCD indications (85.13%), and bone disorders have been well identified (64.83%). The study also demonstrates that BMD requests are common among different specialized groups, and when rheumatologists request a bone density, the test is highly sensitive (99.37%).

Keywords: Bone Density Measurement, Indication, Fractures, Osteoporosis, Osteopenia

1. Background

Osteoporosis is one of the diseases that increases the risk of fractures and primarily affects the elderly and women after menopause and in middle age (1). Pelvic and vertebral fractures lead to increased mortality and disability and consequently increased health costs (2). The number of bone fractures due to osteoporosis has increased over the past 50 years in industrialized countries, and a similar trend is expected in developing countries (3, 4). In 2001, a comprehensive definition of osteoporosis was introduced: "osteoporosis is a bone disorder in which bone strength is impaired and predisposes a person to an increased risk of fracture"(5). It is important to note that when we examine patients with suspected osteoporosis, the signs and symptoms of any other disorders, which are secondary to osteoporosis, including malabsorption (e.g., celiac disease or inflammatory bowel disease), hyperthyroidism, parathyroidism, Cushing's disease, hypogonadism, rheumatoid arthritis, alcoholism, and chronic obstructive pulmonary disease (COPD) should also be considered (6). Bone mineral density (BMD) testing is an international standard for clinical evaluation of bone health. An important physical principle used in dual energy X-ray absorption (DEXA) systems is the measurement of the amount of X-rays passing through the body with low- and high-energy photons. Since the attenuation coefficient of X-ray depends on the atomic number of the absorbent and the photon energy, measuring the quantities of photons passed through it at two different energies makes it possible to distinguish the surface density in two different tissues, soft tissue and mineral material. DEXA is used to diagnose osteoporosis, assess fracture risk, and monitor changes in BMD (7). The World Health Organization (WHO) fracture risk assessment algorithm uses femoral neck BMD, measured by DEXA, as the only valid measurement of bone

density (8, 9). In fact, DEXA sequential measurement of BMD is used to monitor the treatment of patients receiving osteoporosis drugs (10). DEXA has also been introduced by the United State (US) Preventive Services Working Group as a technology that can be used for community screening (11). Because BMD screening for osteoporosis is cost-effective (12). The debate over bone fractures and their impacts on life, as well as how to identify them, are widespread. A noteworthy point that medical staff, especially physicians, are expected to pay special attention is "how many of the requests of bone mineral density measurements are made base on the indications?". Because economic and funding problems are major challenges in Iran's health system, we can point to the irregularity of diagnostic and treatment requests of physicians as the main factors. Recently, there has been an interest in reducing the overuse of health services (13-15).

2. Objectives

In this study, we aimed to examine the compatibility of the indications for bone density testing in Arak, a city in Iran, according to ISCD criteria, to determine the frequency of bone density tests based on gender and age, as well as the frequency of the group of physicians requesting bone density tests.

3. Methods

3.1. Research Design, Population, and Sampling

This cross-sectional study was performed based on the information of 1,990 patients who had a bone density test based on the diagnosis of their physician from 2016 to 2017. After approving the research plan, receiving the ethics code, and obtaining written permission from the authorities, the researchers collected the information of patients who had undergone a bone density test by the order of their physician. In this study, we extracted data using a checklist for data collection. The request for a bone density test was based on indications (85.13%), and bone disease was well diagnosed in many cases (64.83%). The sensitivity of WHO clinical guideline for predicting bone density needs BMD when the diagnosis is done by a non-rheumatologist (test is 98.04% sensitivity and 46.28% specificity), indicating a test with high sensitivity and relative specificity. WHO clinical guideline for predicting needs BMD and when the diagnosis is done by a rheumatologist (test is 99.37% sensitivity and 17.28% specificity), which indicates the test is very sensitive, but the specificity of the indication is low compared to non-rheumatologists so when the rheumatologists use the indication, it has a higher sensitivity (99.37%).

Patients' information was extracted from checklist recorded by a bone mineral density expert. Osteoporosis is characterized by low bone mass, microarchitectural disruption, and increased skeletal fragility. A clinical diagnosis of osteoporosis may be made in the presence of: (1) fragility fracture, particularly at the spine, hip, wrist, humerus, rib, and pelvis; (2) T-score $\leq$ -2.5 standard deviations (SDs) at any site based upon BMD measurement by DEXA.

Inclusion criteria: (1) records and information that can be cited by patients who have had a bone density test at the discretion of their physician; (2) patients who do not have an underlying condition that reduces the value of BMD test; (3) patients who live in Arak.

Exclusion criteria: (1) patients whose information cannot be cited; (2) people with an underlying disease that reduces the value of BMD test.

3.2. Indication for Bone Mineral Density (BMD) Testing

Postmenopausal women younger than 65 years old if they have risk factors such as: (1) low body weight; (2) prior fractures; (3) high-risk medication use; (4) disease or condition associated with bone loss; (5) women during the menopausal transition with clinical risk factors for fracture; (6) men aged 70 or older; (7) for men < 70 years old BMD test is indicated if they have a risk factor for low bone mass such as: (1) low body weight; (2) prior fractures; (3) high-risk medication use; (4) diseases or conditions associated with low bone mass or bone loss; (5) adults taking medications associated with low bone mass or bone loss; (6) anyone being considered for pharmacologic therapy; (7) anyone being treated, to monitor treatment effect; (8) anyone with bone loss evidence who did not receive therapy.

3.3. Ethical Consideration

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The ethics code of the project is IR.ARAKMU.REC.1395.191.

3.4. How to Analyze Data

All statistical analyses were performed using SPSS software version 23 and MedCalc software version 7. The mean and standard deviation were used to present continuous variables, while categorical variables were shown as frequency and percentage. Univariate analysis was done using non-parametric tests (chi-square test). Odds ratio was

also estimated using logistic regression, the charts and analysis receiver operating characteristic (ROC) curve to calculate sensitivity, specificity, negative and positive predictive value (NPV and PPV, respectively) were prepared using MedCalc software. P-values < 0.05 were considered significant.

4. Results

This cross-sectional study was performed on 1,990 patients who underwent a bone density test based on the diagnosis of their physician. This study included 199 (10%) males and 1,791 (90%) females. The mean age of patients was 55.75 $\pm$ 13.48 years. The mean age of menopause in women is 46.76 $\pm$ 5.94 years. In this study, we found that 1,271 out of 1,694 positive indications that doctors have diagnosed in different specialized groups, were abnormal and 423 were normal, and also out of 296 negative indications 19 were abnormal, and 277 were normal. This means that the request for a bone density test was based on indications in many cases (85.13%), and bone disease was well diagnosed in many cases (64.83%). Also, attention to BMD application indications was different among different specialized groups, and the test had a high specificity (82.72%) when rheumatologists request bone density tests. According to these results, of 1,791 females for whom a bone graft test was requested, only 253 (14.1%) subjects did not have an indication for BMD according to ISCD criteria. Forty-three males (21.6%) had this condition. The results indicated that the frequency distribution of fractures in both genders was not statistically significant, and 93.4% of the females and 93.5% of the males for whom bone mineral density testing has been requested had no history of previous fractures. The findings show that the frequency distribution of density measurement results between the two sexes is statistically significant. In this study, 1,791 (90%) of the subjects were women, of which the results of bone density test for 1,204 (67.2%) were abnormal, while 56.8% of the male group had a normal test. The results of Table 1 show that the frequency distribution of bone density measurement results in the two groups, that were or were not indicated for BMD, is statistically significant. Of 1,694 positive indications diagnosed by physicians in different specialized groups, 1,271 (64.8%) were abnormal, and 423 (35.2%) were normal, and out of 296 negative indications, 19 (6.4%) were abnormal, and 277 (93.6%) cases were normal. This means that the request for a bone density test was based on the indications in many cases as well as the bone disease was well diagnosed in many cases.

The results of Table 2 show that the frequency distribution of bone density measurement results and indication is statistically significant. Moreover, 816 out of 1,354 bone density tests, requested by non-rheumatologists, were abnormal, and 538 ones were normal. In addition, 800 (98%) out of 816 cases with abnormal tests had ISCD indications for BMD requests and only 16 (2%) cases had no indication. This study showed that the sensitivity of ISCD clinical guideline for predicting bone density needed BMD when the diagnosis was done by a non-rheumatologist (test has 98.04% sensitivity and 46.28% specificity), indicating high sensitivity and relative specificity test. The results of Table 3 show that the frequency distribution of the results of bone density measurement and indication is statistically significant. Moreover, 474 out of 636 bone density tests requested by rheumatologists were abnormal, and 162 were normal. In addition, 471 (99.4%) out of 474 cases with abnormal tests had ISCD indications for requesting BMD, and only 3 (0.6%) had no indication.

The results of Table 4 show that the sensitivity of ISCD clinical guideline for predicting needs BMD and when the diagnosis is done by a rheumatologist (test has 99.37% sensitivity and 17.28% specificity), which indicates the test is very sensitive, but the specificity of the indication is low in comparison to non-rheumatologists; so when rheumatologists use the indication, it has a higher sensitivity (99.37%). The results indicated that 1,354 out of 1,990 bone density tests were requested by non-rheumatologists, 1,089 had a positive indication for BMD, and 265 were requested irrespective of ISCD guidelines. Also, 636 tests were requested by rheumatologists, and 605 cases were positive indications for BMD, and 31 were requested irrespective of ISCD guidelines.

5. Discussion

In this study, we found that a total of 1,990 bone density measurement tests were requested by physicians in different specialized groups. Bone density T-score is a method to diagnose osteoporosis because it reports the bone density. This test is a measurement of the difference or deviation of a patient's bone mass in comparison to the bone mass of a healthy person who is, on average 30 years old. In fact, the results of bone density are around the average score for the entire population like other medical tests and measurements, and a T-score is a standard deviation and a mathematical term that calculates the difference between the test result and the mean. In addition to the T score in the BMD report, there is another score called Z-score, which is a measure of the patient's bone mineral density compared to the average bone mineral density of people of the same age and sex, e.g. a 60-year-old woman. The Z-score compares this person's bone density to the average bone density of a 60-year-old woman. It is important to note that T-scores should always be requested for postmenopausal

Table 1. Comparison of Frequency Distribution and Bone Density Results Based on ISCD Indication [a]

Bone Density	Indication		OR	P-Value (OR)	P-value (Chi-Square)
	Yes	No			
Osteopenia	682 (34.9)	12 (4.1)	37.217	0.0001	0.0001
Osteoporosis	589 (29.9)	7 (2.4)	55.101	0.0001	
Normal	423 (35.2)	277 (93.6)			

[a] Values are expressed as No. (%).

Table 2. Comparison of Frequency Distribution of Bone Mineral Density and ISCD Indication Based on Non-rheumatologists [a]

Bone Density	Indication			
	Abnormal BMD	Normal BMD	Total	P-Value (Chi-Square)
Compatible with ISCD recommendation	800 (98)	289 (53.7)	1089	0.0001
Incompatible with ISCD recommendation	16 (2)	249 (46.3)	265	
Total	816 (100)	538 (100)	1354	

[a] Values are expressed as No. (%).

Table 3. Comparison of Frequency Distribution of Bone Mineral Density and WHO Indication by Rheumatologists [a]

Bone Density	Indication			
	Abnormal	Normal	Total	P-Value (Chi-Square)
Positive	471 (99.4)	134 (82.7)	605	0.0001
Negative	3 (0.6)	28 (17.3)	31	
Total	474 (100)	162 (100)	636	

[a] Values are expressed as No. (%).

Table 4. Sensitivity, Specificity, Negative and Positive Predictive Value of WHO Indication in Terms of Prediction, When the Diagnosis is Done by a Rheumatologist

95% Confidence Interval for Negative Predictive Value	Negative Predictive Value	95% Confidence Interval for Positive Predictive Value	Positive Predictive Value	95% Confidence Interval for Specificity	Specificity (%)	95% Confidence Interval for Sensitivity	Sensitivity (%)
74.25 - 97.96	90.32	74.33 - 81.10	77.85	11.8 - 24	17.28	98.16 - 99.87	99.37

women. In general, a Z-score is useful in diagnosing secondary osteoporosis and monitoring bone density in children and young adults who have not reached maximal adult bone mass (16). These definitions were presented to decrease the overuse of health services. The overuse of health services leads to physical, psychological, and financial harm to patients and the loss of opportunities to provide more beneficial care (17, 18). A retrospective cohort study by Fenton et al. (19) estimated the prevalence of overdose of women with osteoporosis in the health system where DEXA and T-scores were performed for anatomical sites (e.g., the lateral lumbar spine) whose results are not recommended for the diagnosis of osteoporosis. They studied a 5-year use of electronic health records and radiology records of women aged 40 to 85 years who received initial DEXA screening. Two-thirds of 6,150 females potentially received new prescriptions for osteoporosis medications because the diagnosis of osteoporosis based on DEXA results was in areas that were undiagnosed under international guidelines. Also, half of those who received inappropriate medication included young females who had no risk factors for osteoporosis. Finally, in this study, it was mentioned that health systems can take two steps to prevent excessive and inappropriate treatments: (1) ensuring the reports of radiologists based on the locations recommended for DEXA by the ISCD; and (2) forcing physicians not to diagnose osteoporosis based on non-diagnostic sites (19).

5.1. Limitations

The most important limitation of this study was the existence of deficiencies in the existing files and the lack of information network in this area. For example, we could not determine the specialty of BMD doctor in some cases. In observational studies, our results may be influenced by confounding factors. Questionnaire-derived study variables may also be prone to measurement error.

5.2. Conclusions

In this study, we found that the request for bone density test was based on the indications in many cases, and also bone disease was well diagnosed in many cases. Also, it was found that among different specialized groups, attention to BMD application indications is different, and the test is very sensitive when rheumatologists request bone density tests.

Footnotes

Authors' Contribution: All authors contributed to this work equally.

Conflict of Interests: The authors declare no conflict of interest.

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Informed Consent: Written informed consent was obtained from all participants.

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