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Review Article

Osteoporosis Screening: A Review

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Abstract

Increased fragility fracture rates, increased morbidity and mortality, and a tremendous economic burden are all linked to osteoporosis and poor bone health. Osteoporosis, like many other diseases, benefits from early detection and prevention. The imaging and quantification of bone and bone mineral density are crucial in the diagnosis of osteoporosis. Abdominal and thoracic CT provide a valuable opportunity for osteoporosis screening. Despite the significant prevalence and effect of osteoporosis, screening and treatment rates are still low. Apart from abdominal and thoracic CT which provide a valuable opportunity for osteoporosis screening, it is possible to perform fully automatic osteoporosis screening in routine CT scans of the spine, brain, tooth or some other body parts.

Keywords: Osteoporosis screening, diagnosis, strategies, opportunistic screening

INTRODUCTION

One of the most frequent chronic metabolic illnesses is osteoporosis (Na et al., 2018). It's a common and hidden metabolic bone disorder characterized by a decrease of bone mass and increased fracture risk (Pan et al., 2020). Mobility difficulties, persistent impairment, loss of independence, and a lower quality of life are all linked to osteoporotic fractures, particularly hip fractures (Crandall & Ensrud, 2020). For home-dwelling patients, fragility fractures linked with osteoporosis often result in loss of independence and increased mortality, presenting a significant socioeconomic cost on society (Kwok et al., 2020). Around 200 million individuals worldwide suffer from osteoporosis and poor bone health, with the number anticipated to rise as the population ages. Increased fragility fracture rates, increased morbidity and mortality, and a tremendous economic burden are all linked to osteoporosis and poor bone health. Screening for osteoporosis and following treatment guidelines are currently underutilized, posing a public health risk. Osteoporosis impose a significant financial and health-care burden. The best way to deal with bad bone health is to go to a professional health care facility. There are a variety of drugs available to promote bone health and minimize the risk of fragility fractures. Primary care professionals are in a good position to enhance osteoporosis outcomes (Goode et al., 2020). Osteoporosis, like many other diseases, benefits from early detection and prevention. As a result, early detection of osteoporosis cases by measuring postmenopausal women's bone mineral density and commencing appropriate treatment by assessing fracture risk becomes increasingly important (Mehmet et al., 2017). Osteoporotic fractures, particularly hip fractures, are linked to limits in ambulation, persistent pain and disability, loss of independence, and lower quality of life, with 21 percent to 30 percent of patients in the United States dying within a year after sustaining a hip fracture. Primary osteoporosis (osteoporosis without underlying disease) is more common as people get older and varies by race/ethnicity. In both women and men, bone measuring tests are reliable for identifying osteoporosis and predicting osteoporotic fractures. Clinical risk assessment techniques are only somewhat effective at detecting osteoporosis and osteoporotic fractures. In postmenopausal women, drug interventions minimize the number of subsequent fractures (Curry et al., 2018). In the orthopaedic field, osteoporosis is an underrecognized and undertreated disease entity that causes significant long-term morbidity and mortality. Multiple fractures are frequently not recognized or treated until osteoporosis has progressed. The most common sentinel fracture is a vertebral compression fracture, which allows doctors to treat with antiresorptive therapy before more disabling fractures develop. Patients with osteoporosis who are not properly treated are more likely to suffer further fractures (Barton et al., 2019). Osteoporosis is a common yet underdiagnosed disease (Zhang et al., 2020). When vertebral fracture assessment is included in routine osteoporosis screening in community-dwelling women aged 65 years, it is cost-effective, according to the National Osteoporosis Foundation (NOF), which supports guidelines for the diagnostic use of vertebral fracture assessment as an important addition to fracture risk assessment (Yang et al., 2020).

DIAGNOSIS AND SCREENING STRATEGIES

Regardless of the clinical need for imaging, abdominal and thoracic CT provide a valuable opportunity for osteoporosis screening (Jang et al., 2019). In CT images, a deep learning–based system could fully automate the detection of osteoporosis, osteopenia, and normal bone mineral density (Fang et al., 2021). Despite the significant prevalence and effect of osteoporosis, screening and treatment rates are still low, with only a small percentage of women aged 65 and older using osteoporosis screening as a major preventive measure. Much more effort needs to be done to build and validate effective primary screening and prevention techniques, as well as to translate these into high-quality guidelines (Leslie & Crandall, 2019). It is of paramount importance to build consistent international protocol to help clinicians to diagnose medical conditions in a timely and accurate way and subsequently treat them effectively (Yılmaz, 2022). In the US Medicare population, for example, osteoporosis screening rates by DXA (dual energy x-ray absorptiometry) are as low as 9.5 percent for women and 1.7 percent for men aged 65 and over. As a result, osteoporosis screening with biomechanical computed tomography may be a cost-effective alternative to current standard therapy for individuals who have had an abdomen CT and have not had a recent DXA (Pisu et al., 2019). The imaging and quantification of bone and bone mineral density are crucial in the diagnosis of osteoporosis. Over the last half-century, scanning technologies such DXA and quantitative CT have been developed and refined to offer assessments of bone mineral density and microarchitecture for clinical practice and research. These characteristics, when combined with fracture prediction techniques like the Fracture Risk Assessment Tool (FRAX), have resulted in a paradigm shift in the ability to diagnose osteoporosis and forecast persons who are at risk of fragility fracture. Despite these advancements, there is still a treatment gap between people at risk of osteoporotic fracture and those who are receiving treatment (Fuggle et al., 2019). The best way to test for osteoporosis and treat it in postmenopausal women remains unknown. Crandall et al., (2019) examined the USPSTF (United States Preventive Services Task Force) and Osteoporosis Canada osteoporosis screening methodologies, as well as the National Osteoporosis Foundation and Canadian treatment strategies. Researchers looked at women aged 50 to 79 years old at the start of the study (n = 117,707 for self-reported fractures; n = 8134 for the bone mineral density subset). During a 10-year follow-up, researchers examined the effectiveness of screening and treatment strategies in identifying women who suffered major osteoporotic fractures. The USPSTF plan selected 23.1 percent of women aged 50 to 64 years for bone mineral density testing, while the Canadian strategy identified 52.3 percent. Under the USPSTF and Canadian methods, 100 percent of women aged 65 were identified for testing, 35 percent to 74 percent were identified for treatment under National Osteoporosis Foundation, and 16 percent to 37 percent were identified for treatment under CAROC (Canadian Association of Radiologists and Osteoporosis Canada) (range among 5-year age subgroups). The USPSTF strategy identified 6.7 percent of women 50 to 54 years old and 49.5 percent of women 60 to 64 years old for bone mineral density testing among women who suffered major osteoporotic

fracture during follow-up (versus 54.4 percent and 60.6 percent for the Canadian strategy, respectively). However, among women aged 50 to 64, the specificity of the USPSTF approach was higher than that of the Canadian strategy. Sensitivity for identifying women as treatment candidates was lowest in women aged 50 to 64 (National Osteoporosis Foundation 10% to 38 percent; CAROC 1% to 15%) and highest in women aged 75 to 79 (National Osteoporosis Foundation 82.8 percent; CAROC 51.6 percent); specificity declined with advancing age and was lower with the National Osteoporosis Foundation compared to the CAROC strategy. The screening and treatment options studied demonstrated low sensitivity for detecting individuals who went on to develop major osteoporotic fracture in women aged 50 to 64 years; however, sensitivity was higher in women aged 65 years than in younger women. There is a need for new screening and therapy algorithms (Crandall et al., 2019). Because of population aging, urbanization, and associated sedentary lifestyles, osteoporotic hip fractures are predicted to rise rapidly in the Asia-Pacific region (International Osteoporosis Foundation, 2013). In the Asia-Pacific area, doctors' guidelines for addressing osteoporosis differ greatly. Chandran et al., (2021) evaluated 18 guidelines in five main categories for similarities and variances. The study found significant differences in risk factor advice, the use of biochemical markers, patient self-care information, osteoporosis therapy indications, the use of fracture risk assessment tools, and treatment monitoring methods. There was little guidance on long-term management plans or clinical quality improvement techniques and systems.

OPPORTUNISTIC SCREENING

Many osteoporosis patients have computed tomography (CT) scans, which can be used for opportunistic (non-dedicated) screening (Valentinitsch et al., 2019). The use of computed tomography (CT) for opportunistic reasons allows for the assessment of bone status from studies performed for other purposes. The Hounsfield unit is the linear x-ray attenuation coefficient (HU). Standard imaging software can be used to calculate HU values for any location of interest. Bone mineral density and HU levels are highly correlated. The L1 vertebral body has a 135 HU threshold, which suggests a risk of osteoporosis. Other bone areas, such as the wrist, proximal and distal ends of the femur, and the sacral, have been assessed using HU values to predict future fractures and the prevalence of osteoporosis. The use of CT when it is appropriate aids in the identification of patients who are not otherwise suspected of having osteoporosis (Anderson et al., 2018). It is possible to perform fully automatic osteoporosis screening in routine CT scans of the spine. CT-based measurements are more effective than DXA at identifying people with low bone mass who have had vertebral fractures. Using a deep learning-driven system, opportunistic osteoporosis screening of spinal bone measurements derived from clinical routine CT may be done completely automatically. With the exception of bone mineral content, all CT-based bone measurements outperformed DXA-based measures (Löffler et al., 2021). A deep learning-based model based on chest radiographs has the potential to be employed in clinical settings for opportunistic automated screening of patients with osteoporosis (Jang et al., 2022). Clinical brain CT scans can aid in the identification of osteoporosis, and

patients with a HU value of 610 on a brain CT scan should be evaluated further for potential osteoporosis (Na et al., 2018). Converted bone mineral density derived from contrast-enhanced dual-layer spectral CT examinations and adjusted for individual vessel iodine concentrations agrees well with non-enhanced dual-layer spectral CT-bone mineral density, implying that opportunistic bone mineral density measurements are possible even in non-dedicated contrast-enhanced dual-layer spectral CT examinations. Independent of the scan phase, accurate bone mineral density measurements can be converted from contrast-enhanced dual-layer spectral CT scans. Iodine concentrations in the portal vein and/or abdominal aorta should be adjusted with dual-layer spectral CT-bone mineral density measurements from contrast-enhanced scans, which considerably enhances the goodness-of-fit of conversion models (Roski et al., 2021). The attenuation of the L1 vertebrae on abdominal computed tomography (CT), which correlates with the DXA T-score, is used for opportunistic osteoporosis screening. This method is beneficial for diagnosing low bone mass in diabetic patients, and it proposes a threshold of L1 attenuation of 135 Hounsfield units (HU) for which DXA should be carefully evaluated (Jain et al., 2020). Before any type of spine surgery, a magnetic resonance imaging (MRI) scan is performed. With a threshold value of VBQ > 3.0, opportunistic use of MRI with the vertebral bone quality score offers high diagnostic capacity in selecting patients who may need additional osteoporosis evaluation. The opportunistic use of MRI is a simple, effective approach that can help identify people who are at risk of bone disease complications (Kadri et al., 2022). Incidental results, such as measurements of the inferior cortex of the mandible and the alveolar trabecular bone pattern of the mandible found on panoramic radiographs, are thought to be a useful tool for identifying asymptomatic patients at risk of osteoporosis and/or fragility fractures. Low skeletal bone mineral density or osteoporosis may be a danger for postmenopausal female dental patients with a mandibular inferior cortical width of less than 3 mm on panoramic radiographs, but not fragility fractures. Furthermore, people with a significantly degraded mandibular inferior cortex are more likely to have poor skeletal bone mineral density, osteoporosis, and fragility fractures. Although more research is needed to validate this potential, the alveolar trabecular bone architecture of the mandible may be useful in identifying female dental patients at risk of fragility fractures. When used in general dental practice to identify asymptomatic postmenopausal female patients at risk of osteoporosis, these incidental findings on panoramic radiographs may be useful in reducing the incidence of first fractures, as well as secondary fractures, medical costs, and mortality associated with osteoporotic fragility fractures, without incurring any additional cost (Taguchi et al., 2021). In general, osteoporosis is diagnosed by examining bone mineral density measures (reported as a T-score) with dual-energy X-ray absorptiometry (DXA), which is the gold standard for determining bone mineral density. However, this technique is difficult to master, costly, and only a small percentage of the population can benefit from it. Dental panoramic radiographs give the information needed to assess bone density changes on a mandible using a textural and morphological feature analysis (Lee et al., 2020). Rheumatoid arthritis is a chronic inflammatory disease that puts

individuals at risk for osteoporosis. Systemic inflammation and glucocorticoid usage play key roles in the etiology of osteoporosis in rheumatoid arthritis. Recent research has found an intriguing link between rheumatoid arthritis autoantibodies and osteoporosis development. Clinical and vitamin D testing, biochemical markers of bone remodeling, and bone imaging studies, notably dual-energy X-ray absorptiometry, are all used to screen for osteoporosis in rheumatoid arthritis patients (DXA). Rheumatoid arthritis is associated with a high rate of fragility fractures. Most specialized groups suggest osteoporosis screening procedures in rheumatoid arthritis patients because they are both feasible and effective. Given the significant exposure to variables linked to osteoporosis development, such as pro-inflammatory cytokines and glucocorticoid treatment, biochemical and DXA results in rheumatoid arthritis patients should be given extra attention (Adami & Saag, 2019).

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