Editorial

What is changed in the diagnosis of osteoporosis: the role of radiologists

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Osteoporosis (OP) is a very common condition with several repercussions on patients' quality of life and health systems (1). OP is secondary to changes in normal bone turnover for decreased activity of osteoblasts (which produce bone matrix) or increased osteoclastic activity (2,3). These changes determine variation in bone mineral content (BMC) and then bone mineral density (BMD); thus, quantification of BMD correlate to changes in bone matrix.

These metabolic alterations induce reduction in the bone strength which in turn determines increased the risk of future fractures, to even low energy traumas; the most frequent sites are hip, forearm and the thoracolumbar spine (4).

Diagnosis of OP, even can be suspected on standard radiograms, is generally achieved using quantitative methods, among which dual-energy X-ray absorptiometry (DXA) is the most validated; moreover, some other novel techniques also provide further information on bone changes (5,6).

DXA is still the referring method for the quantification of BMD: it is defined as the BMC per square centimeter (g/cm^2)—as its values are calculated on a plane image—and according to the World Health Organization (WHO) values are normal if they are above –1 standard deviations (SD)—in comparison of values obtained from a referring population (T-score), values ranging from –1 to –2.5 SD are considered osteopenic; while OP is defined if BMD value is below –2.5 SD (7-9). DXA examination is performed on the lumbar spine (evaluating vertebrae from L1 to L4), at the hip (evaluating the femoral neck and the total hip) and the distal third of radius. DXA has still its importance for the low dose delivered to the patient, the time of acquisition and its reproducibility; some limits consist in the presence of degenerative bone changes (such as marginal osteophytes) which can influence BMD value (10).

Some of these limitations can be bypassed using quantitative computed tomography (QCT), which consists in a volumetric of an anatomical bone region, then the BMD is expressed in term of g/cm^3; BMD values lower than 80 g/cm^3 are considered osteoporotic (11). The advantage of QCT is its capability to distinguish cortical and trabecular bone, that can be separately evaluated; however, its main limit is the high radiation dose delivered to the patient (12).

Quantitative ultrasound (QUS) is a radiation-free technique which exploits the variation of US wave while passing through the bone micro-architecture. QUS is usually performed at peripheral sites such as phalanges, distal radius, distal tibia and calcaneus; in particular, the evaluation of this latter has shown good correlation with risk fracture prediction (13-16).

Insufficiency vertebral fractures are a common complication of OP, their detection has been challenging in the past years, but has improved for the diffusion of vertebral morphometry, which can be applied on both conventional and DXA images (delivering only a small amount of radiation dose), but also using CT scouts; vertebral morphometry uses a semi-quantitative method to characterize vertebral fractures which helps the radiologist

in the diagnosis (17-20).

The increased risk of future bone fractures, in course of OP, does not only depends on BMD, but also on the "quality" of bone: this characteristic is determined by several factors, such as the number and thickness of bone trabeculae and their micro-architectural organization, which are also related to bone turnover and matrix mineralization (21,22). Novel techniques have been developed in the recent years to investigate on bone quality (23). Among these, trabecular bone score (TBS) is applied to DXA images and provide a valued which is indirectly correlated to the trabecular network within the vertebral bone (24).

Other imaging methods consist of CT and magnetic resonance imaging (MRI). In the recent years, new kinds of CT technologies have been studied to evaluate bone micro-architecture (and then bone strength) to assess the risk of bone fractures; in particular finite element modeling (FEM) and multi-detector CT (MDCT) have shown their importance in the evaluation of BMD even in other regions besides lumbar spine, such as the hip; the quantification of BMD with this technique has been correlated to the increased risk of fracture in osteoporotic patients, showing a good correlation (25-31).

Another CT technique which has been developed in the last years and has the advantage of delivering low radiation dose to patients is the high-resolution peripheral QCT (HR-pQCT): this method allows the quantification of cortical and trabecular BMD in peripheral sites (radius, tibia, calcaneus?) and the obtained values have been correlated to the risk of bone fracture (32,33).

Advantages in MRI and the development of new sequences have been experimented to evaluate bone micro-architecture and metabolism in several sites. MRI findings may correlate to the clinical aspects of OP and predict the risk of bone fracture (34-41).

In conclusion, with the fast development of new technologies and their application to the diagnostic imaging, the radiologist plays a central for the correct interpretation of imaging data, which can be further correlated to the clinical scenario; for this reason, an adequate updating on the most recent methods is recommended, to seek the correct diagnosis of OP and eventually predict the risk of bone fracture.

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Footnote

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