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Review

Usefulness of bone density measurement in fallers

Hubert Blain ^{a,b,*}, Yves Rolland ^c, Olivier Beauchet ^d, Cedric Annweiler ^d, Claude-Laurent Benhamou ^e, Athanase Benetos ^f, Gilles Berrut ^g, Maurice Audran ^h, Sauveur Bendavid ⁱ, Valérie Bousson ^j, Karine Briot ^k, Michel Brazier ^l, Véronique Breuil ^m, Laure Chapuis ⁿ, Roland Chapurlat ^o, Martine Cohen-Solal ^p, Bernard Cortet ^q, Patricia Dargent ^r, Patrice Fardellone ^s, Jean-Marc Feron ^t, Jean-Bernard Gauvain ^u, Pascal Guggenbuhl ^v, Olivier Hanon ^w, Michel Laroche ^x, Sami Kolta ^k, Éric Lespessailles ^s, Brigitte Letombe ^y, Eric Mallet ^z, Christian Marcelli ^{aa}, Philippe Orcel ^{ab}, François Puisieux ^{ac}, Patrick Seret ^{ad}, Jean-Claude Souberbielle ^{ae}, Bruno Sutter ^{af}, Florence Trémolières ^{ag}, Georges Weryha ^{ah}, Christian Roux ^{ai}, Thierry Thomas ^{ah}, Pour le Groupe de recherche et d'information sur les ostéoporoses et la Société française de gérontologie et gériatrie

^a Pôle de Gérontologie, Centre Antonin-Balmes, CHU de Montpellier, 39, avenue Charles-Flahault, 34395 Montpellier Cedex 5, France

^b Laboratoire Movement to Health, Euromov, Université Montpellier 1, Site de Référence MACVIA-LR, Contre les Maladies Chroniques pour un vieillissement actif en Languedoc-Roussillon, 700, avenue du Pic-Saint-Loup, 34090 Montpellier, France

^c Gérontopôle de Toulouse, Hôpital La Grave-Casselardit, CHU de Toulouse, Toulouse, France

^d UPRES EA 4638, Service de gérontologie, CHU d'Angers, Angers, France

^e EA4708 I3MTO, University of Orleans, Orleans, France

^f Service de Gérontologie, CHU de Nancy, Inserm U1116, Université de Lorraine, Nancy, France

^g Service de gérontologie, CHU de Nantes, Nantes, France

^h Service de rhumatologie et GEROM, CHU d'Angers, Angers, France

ⁱ Médecine Générale, Paris, France

^j Service de Radiologie Ostéoarticulaire, Hôpital Lariboisière, Paris, France

^k Service de rhumatologie, hôpital Cochin, université Paris-Descartes, Paris, France

^l Service de rhumatologie, Hôpital Nord, Amiens, France

^m Service de rhumatologie, CHU de Nice-1, université Nice Sophia-Antipolis, Nice, France

ⁿ Service de rhumatologie, 35500 Vitry, France

^o Service de rhumatologie, CHU de Lyon, Lyon, France

^p Inserm U606, Université Paris-Diderot Paris 7, hôpital Lariboisière, Paris, France

^q Service de gérontologie, hôpital Broca, université Paris Descartes, Paris, France

^r Université Paris-Sud, UMR 1018, Villejuif, France

^s Inserm ERI 12, service de rhumatologie, CHU d'Amiens, Amiens, France

^t Service de chirurgie orthopédique, hôpital Saint-Antoine, Paris, France

^u Centre de médecine gériatrique, CHR d'Orléans, Orléans, France

^v Inserm UMR 991, Service de rhumatologie, CHU de Rennes, Rennes, France

^w Service de gérontologie, hôpital Broca, Paris, France

^x Centre de Rhumatologie, CHU Purpan, Toulouse, France

^y Service de gynécologie médicale et médecine du couple, hôpital Jeanne-de-Flandre, CHRU de Lille, Lille, France

^z Centre de référence des maladies rares du calcium et du phosphore, CIC Inserm 204, CHU de Rouen, Rouen, France

^{aa} Service de rhumatologie, hôpital Côte-de-Nacre, Caen, France

^{ab} Service de rhumatologie, hôpital Lariboisière, Paris, France

^{ac} Service de Gérontologie, CHU de Lille, Lille, France

^{ad} Service de rhumatologie, Angers, France

^{ae} Laboratoire d'Explorations Fonctionnelles, Inserm U845, Hôpital Necker-Enfants-Malades, Paris, France

^{af} Service de chirurgie orthopédique des adultes de l'Institut Calot-de-Berck, Berck-sur-Mer, France

^{ag} Centre de ménopause, hôpital Paule-de-Viguier, Toulouse, France

^{ah} Service d'endocrinologie, CHU de Nancy, Vandoeuvre-lès-Nancy, France

^{ai} Inserm U1059, Service de Rhumatologie, CHU de Saint-Étienne, 42055 Saint-Étienne Cedex 2, France

* Corresponding author. Pôle de Gérontologie, Centre Antonin-Balmes, CHU de Montpellier, 39, avenue Charles-Flahault, 34395 Montpellier Cedex 5r, France.
Tel.: +33 4 67 33 67 90.

E-mail address: h-blain@chu-montpellier.fr (H. Blain).

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ABSTRACT

The objective of this systematic literature review is to discuss the latest French recommendation issued in 2012 that a fall within the past year should lead to bone mineral density (BMD) measurement using dual-energy X-ray absorptiometry (DXA). This recommendation rests on four facts. First, osteoporosis and fall risk are the two leading risk factors for nonvertebral fractures in postmenopausal women. Second, BMD measurement using DXA supplies significant information on the fracture risk independently from the fall risk. Thus, when a fall occurs, the fracture risk increases as BMD decreases. Third, osteoporosis drugs have been proven effective in preventing fractures only in populations with osteoporosis defined based on BMD criteria. Finally, the prevalence of osteoporosis is high in patients who fall and increases in the presence of markers for frailty (e.g., recurrent falls, sarcopenia [low muscle mass and strength], limited mobility, and weight loss), which are risk factors for both osteoporosis and falls. Nevertheless, life expectancy should be taken into account when assessing the appropriateness of DXA in fallers, as osteoporosis treatments require at least 12 months to decrease the fracture risk. Another relevant factor is the availability of DXA, which may be limited due to geographic factors, patient dependency, or severe cognitive impairments, for instance. Studies are needed to better determine how the fall risk and frailty should be incorporated into the fracture risk evaluation based on BMD and the FRAX® tool.

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Osteoporosis is a generalized bone disease in which a decrease in bone strength translates into an increased risk of fractures [1]. Postmenopausal women are predominantly affected. Dual-energy X-ray absorptiometry (DXA) measurement of bone mineral density (BMD) is currently the best tool for identifying patients at high fall risk because of a low bone mass. Despite reimbursement of DXA by the French statutory health insurance system since 2006 in patients with one or more clinical risk factors (*Journal Officiel*, June 30, 2006; Appendix 1) [2], the use of DXA is declining in France [3], although the incidence of nonvertebral fractures has not diminished [4,5]. These facts raise concern that the management of patients at high fracture risk warranting osteoporosis drug therapy may be suboptimal.

To incorporate recent evidence on fracture risk and prevention into recommendations for postmenopausal osteoporosis management, in 2012 the French Society for Rheumatology (SFR), Osteoporosis Research and Information Group (GRIO), National Organization of French Obstetricians/Gynecologists (CNGOF), Menopause and Hormonal Aging Study Group (GEMVI), French Society for Orthopedic Surgery (SOFCOT), French Society for Endocrinology (SFE), and French Society for Geriatrics and Gerontology (SFGG) issued new recommendations about the indications of DXA and osteoporosis therapy [6]. According to these 2012 recommendations, patients without contraindications or other causes of bone fragility should receive osteoporosis therapy if they experience a severe fracture associated with a high risk of mortality, such as a vertebral, femoral, pelvic, or humeral fracture [7].

In this situation, DXA is not needed to determine that treatment is in order, although it remains valuable as a monitoring tool.

In contrast, DXA plays a key role in determining whether osteoporosis therapy is appropriate in patients who have clinical risk factors other than a severe fracture (Table 1). The 2012 recommendations indicate that DXA should be performed in postmenopausal women at substantial risk for falls, most notably those with a fall within the past year, which is the leading risk factor for incident falls [8,9].

Here, we discuss the 2012 recommendation that DXA be performed in patients with a history of one or more falls. In this situation, DXA is not currently reimbursed by the French statutory health insurance system.

1. Association between osteoporosis and falls in postmenopausal women

A history of falling within the past year is twice as common among osteoporotic women aged 60 years or over than among non-osteoporotic women [10]. This association between osteoporosis and falls is largely ascribable to shared risk factors such as older age, several genetic and anthropometric characteristics (e.g., weight loss and small muscle mass), low muscle strength, low physical exercise levels, limited mobility, and deficiencies in several hormones (e.g., the GH/IGF1 axis, vitamin D, and sex hormones) [11–20]. In addition, osteoporotic vertebral fractures with thoracic kyphosis can impair balance and muscle strength, (grip

Table 1

Indications in which the French statutory health insurance system reimburses dual-energy X-ray absorptiometry (DXA) for bone mineral density measurement (Agence française de sécurité sanitaire des produits de santé, 2006, <http://www.grio.org/documents/rcd-3-1263309626.pdf>).

1. DXA is reimbursed in members of the general population with any of the following criteria

Signs of osteoporosis

Radiological discovery or confirmation of a vertebral fracture (vertebral body deformity) in the absence of detectable trauma or tumor
History in the patient of a peripheral fracture in the absence of major trauma (except at the skull, toes, fingers, and cervical spine)

Disease or treatment known to induce osteoporosis

Systemic glucocorticoid therapy (preferably at treatment initiation) prescribed for at least 3 consecutive months in a dosage > 7.5 mg/day prednisone equivalent
Documented history of a disease or treatment known to induce osteoporosis: active untreated hyperthyroidism, hypercorticism, primary hyperparathyroidism, prolonged primary hypogonadism (including androgen deprivation therapy by surgery [orchidectomy] or pharmacotherapy [long-term Gn-RH analog therapy]), and osteogenesis imperfecta

2. Situations added and allowing DXA reimbursement in postmenopausal women

History of femoral neck fracture without major trauma in a first-degree relative

Body mass index < 19 kg/m²

Menopause before 40 years of age for any reason

History of long-term glucocorticoid therapy (> 3 months) in a dose ≥ 7.5 mg/day prednisone equivalent

strength, trunk extension, and lower limb strength), and cause back pain and a fear of falling, all of which increase the fall risk [10,21–23].

On the other hand, the prevalence of osteoporosis is not increased among postmenopausal women who fall [24]. This fact is probably ascribable to the presence in older individuals of multiple causes of falls including factors that have no direct effect on BMD, such as visual disturbances [9].

Thus, the evidence that osteoporosis and falling share several risk factors indicates that the presence of one should prompt investigations for the other. On the other hand, a history of falls does not necessarily indicate osteoporosis and a need for osteoporosis therapy. Performing DXA to assess the appropriateness for osteoporosis therapy in a patient who falls is crucial, since osteoporosis therapy has not been proven to diminish the fracture risk among patients selected based solely on the fall risk [25,26]. Osteoporosis therapy significantly decreases the fracture risk only among patients with DXA BMD values in the osteoporosis range and/or osteoporotic fractures [26–29].

2. Does BMD measurement using DXA provide information on the fracture risk in patients who fall?

In unselected postmenopausal women, the strongest risk factor for fractures is a BMD decrease as determined using DXA [30]. The fracture risk also varies with other bone parameters such as geometry, microarchitecture, and turnover, which are difficult to assess in large-scale screening programs aimed at identifying patients at risk for fractures [12]. In addition to these parameters associated with bone strength, the fracture risk depends on the mechanical loads through the bone segment of interest. The substantial overlap between BMD values of patients with and without fractures [31] and the absence of osteoporosis as defined by DXA in 50% of hip fracture patients [32,33] are ascribable in part to the fact that a fracture occurs only when the intensity of the mechanical load applied to the bone is greater than the mechanical strength of the bone.

Falling from standing height is by far the most common low energy injury sustained during daily activities by postmenopausal women in France. Falls from standing height occur in about 30% of women older than 65 years and 40% of those older than 75 years [34]. These epidemiological data explain why a fall from standing height is among the most common causes of nonvertebral fractures [35].

Several studies have established that BMD measurement supplies significant information on the fracture risk among postmenopausal women living at home, independently from the history and risk factors of falls such as neuromuscular dysfunction [36], impaired mobility [36], poor balance [11], cognitive impairments [37], visual disturbances [11], and use of sedatives [12]. Most residents of nursing homes for dependent elderly individuals are at risk for falls. The annual fall risk has been estimated at 1.5/bed in elderly nursing homes [38,39], more than half of whose residents fall repeatedly [40]. As with community-dwelling individuals, the hip fracture risk is increased in nursing home residents with low BMD values, independently from mobility impairments and direction of the impact on the bone [41].

Overall, these data support BMD measurement for assessing the fracture risk among high fall risk individuals or fallers living in the community or in nursing homes. However, circumspection may be in order regarding the appropriateness of DXA BMD measurement when access to a DXA machine is limited (e.g., by a high level of patient dependency, severe cognitive impairments, or residence at a considerable distance from the nearest DXA center).

3. Is DXA useful in frail postmenopausal women with a history of falls?

As mentioned above, the prevalence of osteoporosis is increased in elderly fallers who have risk factors shared by falling and osteoporosis such as advanced age, weight loss, low body weight, small muscle mass with low muscle strength (sarcopenia), a low level of physical exercise, and impaired mobility, since mechanical loading is crucial to bone mass maintenance [12–18]. These parameters are markers for frailty in elderly individuals. The recently introduced concept of frailty in elderly people is defined as a state of vulnerability with an impaired ability to recover homeostasis after a stressor event. Frailty results in a downward spiral of adverse health events that include falls and the potential resulting fractures, loss of self-sufficiency, institutionalization, and death [42–44].

Several studies found a close association between a high level of frailty and low BMD values in elderly individuals [45,46]. BMD values were lower in elderly frail patients with recurrent falls than in non-fallers [47], suggesting that an assessment for osteoporosis may be particularly useful in patients who are frail and who fall repeatedly [16]. In addition, significant information on the fracture risk can be obtained by assessing risk factors that are independent from BMD [48]. Finally, in postmenopausal women with osteoporosis, the number-needed-to-treat to prevent one fracture may be lower among those with frailty compared to those without frailty [49].

The frailty concept is particularly valuable given that appropriate management of the underlying causes and potential consequences – including falls and osteoporotic fractures – can reverse aspects of frailty [43,44]. Thus, the detection and management of osteoporosis is but one component of the multidimensional management strategy required in frail osteoporotic fallers to halt the vicious circle involving sarcopenia, falls, low activity levels, decreased energy expenditures, and diminished food intake, which, in the absence of treatment, result, in turn, in weight loss and further sarcopenia [44].

4. Does a diagnosis of osteoporosis in a postmenopausal woman who falls affect the nonpharmacological treatment strategy?

A number of measures are effective in decreasing the incidence of new falls in elderly fallers. They include changes to the home environment, at best designed by an occupational therapist, particularly for individuals who are at high fall risk and have visual disturbances. Patients should be screened for cataract and cataract surgery should be performed if appropriate. Multifocal lenses should be replaced by progressive lenses in patients who fall outdoors. Medications that increase the fall risk, such as psychotropic agents, should be gradually discontinued. Vitamin D insufficiency or deficiency should be corrected (French National Health Authority recommendations, http://www.has-sante.fr/portail/jcms/c_1356838/fr/utilite-clinique-du-dosage). A pacemaker should be implanted in patients with carotid sinus hypersensitivity [19,50]. Appropriate physical activity programs including balance training and at least one other type of exercise to develop muscle strength, coordination, and/or endurance have been proven effective in diminishing the incidence of falls and fall-related fractures [50,51].

Although programs designed to improve balance, coordination, and endurance decrease the incidence of falls, they have no significant effect on BMD. In contrast, BMD can be improved by weight-bearing exercises associated with bone loading of sufficient intensity and duration, such as jumping or, in a manner better suited to older individuals, strengthening the muscles

overlying the loaded bony segments [52,53]. When these measures were combined in women aged 65 years or over who had low BMD values, the fall rate decreased and BMD values improved, provided the programs were followed for longer than 6 months [45,54–56]. In patients with kyphosis due to osteoporotic fractures, exercises to strengthen the trunk extensors improved trunk mobility and back pain, two important factors for fall prevention [22,23].

5. Conclusion

DXA measurement of BMD in patients with a history of falls was recommended recently by a group of experts in France, in keeping with UK National Service Framework recommendations [57]. The rationale for this recommendation is 2-fold: BMD measurement in a patient who falls supplies significant information on the fracture risk, independently from other fall risk factors; and proof of osteoporosis drug efficacy in preventing fractures has been obtained only in patients with osteoporosis defined based on BMD values or fracture history. The prevalence of osteoporosis detected by DXA BMD measurement is highest in fallers who have other signs of frailty such as sarcopenia, impaired mobility, and weight loss, which are risk factors for both falls and osteoporosis. The management of frail patients must include, not only osteoporosis therapy, but also a multidimensional strategy designed to prevent new falls by targeting the causative factors and other potential consequences of frailty. However, the appropriateness of DXA should be evaluated carefully in fallers who have a short life expectancy, as the fracture risk decrease induced by osteoporosis drugs requires 12 months to develop [49,58,59]. Finally, studies on how to incorporate the fall risk and frailty into the BMD- and FRAX®-based fracture risk evaluation would be welcome [60,61]. Although the data discussed herein support DXA to look for osteoporosis in older individuals at high fall risk, this investigation is not currently reimbursed in this indication by the French statutory health insurance system.

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