Role of Non Pharmacological Measures in Prevention and Treatment of Primary Osteoporosis

Essay

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Introduction

Osteoporosis is a chronic metabolic disorder characterized by low bone mass, disruption of the micro architecture of bone tissue and compromise of bone strength which lead to an increased risk for fracture ***(Dawson et al., 2005).*** It affect one in three women and one in five men over age of 50 years ***(Melton et al., 1998).*** The disease is classified as primary type 1, primary type 2, or secondary osteoporosis. The form of osteoporosis most common in women after menopause is referred to as primary type 1 or postmenopausal osteoporosis. Primary type 2 osteoporosis or senile osteoporosis occurs after age of 75 years and is seen in both females and males at a ratio of 2:1. Finally, secondary osteoporosis may arise at any age and affect men and women equally. This form results from chronic predisposing medical problems or disease, or prolonged use of medications such as glucocorticoid, oral anticoagulant, or anticonvusant ***(Briank et al., 2009).***

There are three main mechanisms by which osteoporosis develops either an inadequate peak bone mass (the skeleton develops insufficient mass and strength during growth), excessive bone resorption, or inadequate formation of new bone during remodeling. An interplay of these three mechanisms underlies the development of fragile bone tissue. Hormonal factors strongly determine the rate of bone resorption; lack of estrogen (e.g. as a result of menopause) increases bone resorption as well as decreasing the deposition of new bone that

normally takes place in weight-bearing bones. The amount of estrogen needed to suppress this process is lower than that normally needed to stimulate the uterus and breast gland. The α-form of the estrogen receptors appear to be the most important in regulating bone turnover, In addition to estrogen, calcium metabolism plays a significant role in bone turnover, and deficiency of calcium and vitamin D leads to impaired bone deposition. Moreover, the parathyroid glands react to low calcium levels by secreting parathyroid hormone, which increases bone resorption to ensure sufficient calcium in the blood. The role of calcitonin, a hormone generated by the thyroid gland, is to increase bone deposition ***(Raisz, 2005).***

Osteoporosis itself has no symptoms; its main consequence is the increased risk of bone fractures. Osteoporotic fractures are those that occur in situations where healthy people would not normally break a bone; they are therefore regarded as fragility fractures. Typical fragility fractures occur in the vertebral column, rib, hip and wrist ***(Calvert, 2004).***

The diagnosis of osteoporosis can be made by measuring the bone mineral density (BMD) ***(Guglielmi and Scalzo, 2010).*** The most popular method of measuring BMD is dual-energy x-ray absorptiometry (DEXA). Osteoporosis is diagnosed when the bone mineral density is less than or equal to 2.5 standard deviations below that of a young adult reference population.

This is translated as a T-score. The World Health Organization (WHO) has established the following diagnostic guidelines:

- T-score -1.0 or greater is "normal"
- T-score between -1.0 and -2.5 is "low bone mass" (or "osteopenia")
- T-score -2.5 or below is osteoporosis

When there has also been an osteoporotic fracture, the term severe osteoporosis is used.

Several drugs are used in prevention and management of osteoporosis as bisphosphonates, calcitonin, raloxifene and teriparatide. The availability of most of these drugs makes it easy for the clinician to find an appropriate treatment for most patients ***(Lewiecki, 2003).*** Unfortunately, in the daily practice, osteoporosis treatment too often consists of drug prescription, without any other preventive or therapeutic measure. Besides drug prescription, non-pharmacological osteoporosis management is very important, it must be considered as a part of the long-term prevention of fractures for men and for women, not only for postmenopausal women, but from childhood through adolescence, pre- and perimenopause. All currently available agents have several side effect that limit their efficacy and underscore the urgent need for new treatment options. The non-pharmacological measures include; nutrition, exercise, life style habits, physical agents and fall prevention strategies ***(Boonen et al., 2010).***

Aim of the Work

The aim of this work is to review the non pharmacological measures in case of primary osteoporosis, in order to assess its value in prevention and treatment of primary osteoporosis.

Nutrition

As many other chronic conditions, osteoporosis (OP) has a multifactorial origin. If it is admitted that at least 46–62% of the variance in bone mineral density (BMD) depend on genetic factors, consequently around 38–54% of the variance of BMD can be modified by environmental factors ***(Rizzoli et al., 2001)***, in which nutrition plays a large part. Regarding the skeleton, nutrition could theoretically have a direct and indirect role: firstly, to maximize bone strength during growth through the amelioration of the peak bone mass, by improving the mineralization, and by decreasing the rate of bone loss with ageing; secondly, to maintain the muscle strength ***(Bass et al., 2007).***

The nutritional factors that affect bone health include:

1-Calcium:

The mineral calcium plays a major role in bone strength and is of prime nutritional importance in osteoporosis, being essential for bone health throughout life. The primary role of calcium in the body is structural, providing the rigidity necessary for the skeleton and teeth to function mechanically. (Bone contains about 99% of the body's calcium).

Calcium is required for normal growth and development of the skeleton. Adequate calcium intake is critical for

achieving optimal peak bone mass and modifies the rate of bone loss associated with aging. Over the past decade, convincing evidence has emerged with respect to effects of dietary calcium on bone health in all age groups. After menopause, changes in sex hormone levels are associated with an increase in bone remodeling, leading thereby to an increase in bone fragility. Epidemiological studies report that a lifetime of high calcium intakes can reduce fracture risk by as much as 60% ***(Heaney, 1992).*** In adults, obligatory calcium losses have to be offset by sufficient calcium intakes and efficacious intestinal absorption. Otherwise, bone is used as a source of calcium to maintain homeostasis in extracellular concentration ***(Rizzoli, 2008).***

Table (1): Recommended calcium intake in different age:

Life-stage group	mg/day
Infants 0 to 6 months	200
Infants 6 to 12 months	260
1 to 3 years old	700
4 to 8 years old	1000
9 to 13 years old	1300
14 to 18 years old	1300
19 to 30 years old	1000
31 to 50 years old	1000
51- to 70-year-old males	1000
51- to 70-year-old females	1200
70 years old	1200
19 to 50 years old, pregnant/lactating	1000

(Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, 2010).

In a review of 52 calcium intervention studies, 50 showed that increasing calcium intakes resulted in reduced bone remodeling, better calcium retention, reduced age related bone loss, and reduced fracture risk ***(Heaney, 2000).*** The positive effects of calcium supplementation have essentially been ascribed to a reduction in bone remodeling. However, calcium supplements may be associated with mild gastrointestinal disturbances such as constipation, flatulence, nausea, gastric pain, and diarrhea. Calcium may also interfere with the intestinal absorption of iron and zinc. Additionally, it has been reported that calcium supplementation in healthy postmenopausal women was associated with an increased risk of cardiovascular events in women with more than 80 years of age and a previous cardiovascular event ***(Bolland et al., 2008)***. Milk and other dairy foods are the most readily available sources of calcium in the diet. Dairy foods have the additional advantage of being good sources of protein and other micronutrients (besides calcium) that are important for bone and general health. Other good food sources of calcium include certain green vegetables (e.g. broccoli); whole canned fish with soft, edible bones such as sardine.

In a cross-sectional study performed on 494 Egyptian students aged between 16-24 years about 25% of the participants were aware about the benefits of calcium nutrition in preventing osteoporosis, but knowledge about recommended daily intake, is very poor, the respondents were not able to identify food rich in calcium other than milk. The mean estimated intake was found to be 470 + 311.8 mg/day, More than 60% of the respondent had <50% of their adequate intake and 86.5% had calcium intake less

than their recommendation. Only 13.4% had their recommended intake of calcium ***(Salem et al., 2000)***. Therefore we should aware adolescents about calcium enriched foods and clarifying the role of calcium in preventing osteoporosis and decrease risk of fracture.

Table (2): Approximate calcium levels in foods:

Food	Serving size	Calcium (mg)
Milk, whole	236 mL/8 fl oz	278
Milk, semi-skimmed	236 mL/8 fl oz	283
Milk, skimmed	236 mL/8 fl oz	288
Yoghurt, low fat, plain	150 g/5 oz	243
Yoghurt, low fat, fruit	150 g/5 oz	210
Cheese, cheddar type	40 g/medium-size chunk	296
Cheese, cottage	112 g/4 oz	142
Cheese, mozzarella	28 g/1 oz	101
Cheese, Camembert	40 g/average portion	94
Ice cream, dairy, vanilla	75 g/average serving	75
soya bean, steamed	100 g/3.5 oz	510
Soya drink	236 mL/8 fl oz	31
Broccoli, cooked	112 g/4 oz	45
Apricots, raw, stone removed	160 g/4 fruit	117
Orange, peeled	160 g/1 fruit	75
Figs, ready to eat	220 g/4 fruit	506
Almonds	26 g/12 whole	62
Sardines, canned in oil	100 g/4 sardines	500
Whitebait, fried	80g/average portion	688
Bread, white, sliced	30 g/1 medium slice	53
Pasta, plain, cooked	230 g/medium portion	85
Rice, white, basmati, boiled	180 g/medium portion	32

(Adapted from International Osteoporosis Foundation, 2006)

Although some other plant foods also contain appreciable amounts of calcium, some contain substances that bind to the calcium and prevent it from being absorbed; e.g. compounds called oxalates in spinach, and phytates in dried beans, cereal husks and seeds ***(Weaver et al., 1999).*** However, oxalates and phytates only bind the calcium in the foods they are in – they do not interfere with calcium absorption from other foods or drinks. Calcium-fortified foods and drinks, including breads, cereals, orange juice, soy beverages and commercial brands of mineral waters are also available in some countries ***(International Osteoporosis Foundation, 2006).***

2-Vitamin D

Vitamin D is also essential for the development and maintenance of bone, both for its role in assisting calcium absorption from the diet, and for ensuring the proper renewal and mineralization of bone tissue. Vitamin D deficiency is characterized by inadequate mineralization, or demineralization, of the skeleton. In adults, severe vitamin D deficiency leads to a mineralization defect in the skeleton causing osteomalacia

In addition, the secondary hyperparathyroidism associated with low vitamin D status enhances mobilization of calcium from the skeleton. There is a considerable evidence that vitamin D deficiency is an important contributor to osteoporosis through less efficient intestinal absorption of calcium, increased bone loss,

muscle weakness, and a weakened bone microstructure ***(International Osteoporosis Foundation, 2006).***

Increasing vitamin D intake can significantly reduce the risk of osteoporosis and bone fracture in older people. A study of Caucasian postmenopausal women from the National Osteoporosis Risk Assessment study (NORA) reported that lifetime current vitamin D intakes were also associated with reduced risk for osteoporosis over three years ***(Nieves et al., 2008)***.

Table (3): According to Health Canada the Recommended Dietary Allowances (RDA) for vitamin D:

Age group	Recommended dietary allowances	Tolerable Upper Intake
Infants 0–6 months	400 IU	1000 IU
Infants 7–12 months	400 IU	1500 IU
Children 1–3 years	600 IU	2500 IU
Children 4–8 years	600 IU	3000 IU
Children and Adults 9–70 years	600 IU	4000 IU
Adults > 70 years	800 IU	4000 IU
Pregnancy & Lactation	600 IU	4000 IU

(Nutrition and Healthy Eating, Health Canada, 2012)

The antifracture efficacy of oral vitamin D supplementation in older persons evaluated by ***Bischoff-Ferrari et al. (2005),*** the author showed that vitamin intakes of 700-800 IU/day reduced the relative risk of hip fracture by 26% compared with calcium or

placebo. Scientific evidence suggests that on a global level, vitamin D insufficiency is widespread, even in very sunny regions such as the Middle East, Latin American and Asian countries, and in Australia. This is clearly demonstrated in a cross-sectional observational international study in 1,285 community-dwelling, postmenopausal women with osteoporosis, in 18 countries. The prevalence of vitamin D inadequacy (defined as < 30 ng/mL) was over 50% in all five world regions, and was highest in the Middle East (81%) and Asia (63%) ***(Lim et al., 2005).***

A review summarized evidence from studies that evaluated thresholds for serum 25(OH)D concentrations in relation to bone mineral density (BMD), lower-extremity function, dental health, and risk of falls, fractures, and colorectal cancer, it was observed that for all endpoints, the most advantageous serum concentrations of 25(OH)D begin at 75 nmol/L, and the best are between 90 and 100 nmol/L. A large part of the population is currently below the 75 nmol/L threshold and could certainly benefit from appropriate vitamin D supplementation ***(Bischoff-Ferrari, 2006).*** For most patients with vitamin D deficiency, correcting vitamin D serum levels as quickly as possible is the goal as vitamin D insufficiency was also observed in 24% of women with osteoporosis ***(Genaro et al., 2007).***

Aloia and Cols (2008) suggest a dose of 3800 IU/day of vitamin D for individuals with serum 25(OH)D levels above 55 nmol/L and a dose of 5000 IU/day for those below that

threshold, with the purpose to attain a serum 25(OH)D concentration >75 nmol/L. ***Mosekilde (2008)*** suggests that in adults, a minimum dietary intake of 700-1000 IU/day is necessary to achieve levels between 75 and 100 nmol/L. ***Cashman et al. (2009)*** recommend that the vitamin D intake necessary to maintain the vast majority of elderly aged ≥64 years of age during winter with serum 25(OH)D levels > 80 nmol/L should be of 1,548IU/day.

Sources of vitamine D:

a-Sunlight (the main source):

Most people meet at least some of their vitamin D needs through exposure to sunlight. Ultraviolet (UV) B radiation with a wavelength of 290–320 nanometers penetrates uncovered skin and converts cutaneous 7-dehydrocholesterol to previtamin D3, which in turn becomes vitamin D3. Season, time of day, length of day, cloud cover, smog, skin melanin content, and sunscreen are among the factors that affect UV radiation exposure and vitamin D synthesis.

Complete cloud cover reduces UV energy by 50%; shade (including that produced by severe pollution) reduces it by 60%. Ultraviolet B radiation does not penetrate glass, so exposure to sunshine indoors through a window does not produce vitamin D**.** Sunscreens with a sun protection factor (SPF) of 8 or more appear to block vitamin D-producing UV rays, although in practice people

generally do not apply sufficient amounts, cover all sun-exposed skin, or reapply sunscreen regularly. Therefore, skin likely synthesizes some vitamin D even when it is protected by sunscreen as typically applied ***(Holick, 2005).***

The factors that affect UV radiation exposure and research to date on the amount of sun exposure needed to maintain adequate vitamin D levels make it difficult to provide general guidelines. It has been suggested by some vitamin D researchers, for example, that approximately 5-30 minutes of sun exposure between 10 AM and 3 PM at least twice a week to the face, arms, legs, or back without sunscreen usually lead to sufficient vitamin D synthesis and that the moderate use of commercial tanning beds that emit 2%-6% UVB radiation is also effective ***(Holick, 2007).*** Individuals with limited sun exposure need to include good sources of vitamin D in their diet to achieve recommended levels of intake. Despite the importance of the sun for vitamin D synthesis, it is prudent to limit exposure of skin to sunlight and UV radiation from tanning beds. Ultraviolet radiation is a carcinogen responsible for most of the estimated 1.5 million skin cancers and the 8,000 deaths due to metastatic melanoma that occur annually in the United States. Lifetime cumulative UV damage to skin is also largely responsible for some age-associated dryness and other cosmetic changes. The American Academy of Dermatology advises that photoprotective measures be taken, including the use of sunscreen, whenever one is exposed to the sun ***(Wolpowitz and Gilchrest, 2006).***

b-Nutrition:

Very little vitamin D is naturally present in our food, which includes oily (or fatty) fish such as salmon, tuna, sardines and mackerel, egg yolk and liver.

Table (4): Selected Food Sources of Vitamin D:

Food	IUs per serving
Cod liver oil, 1 tablespoon	1,360
Swordfish, cooked, 3 ounces	566
Salmon (sockeye), cooked, 3 ounces	447
Tuna fish, canned in water, drained, 3 ounces	154
Sardines, canned in oil, drained, 2 sardines	46
Liver, beef, cooked, 3 ounces	42
Egg, 1 large (vitamin D is found in yolk)	41
Cheese, Swiss, 1 ounce	6

(U.S. Department of Agriculture, 2011)

- Effect of veil on Vitamin D synthesis:

After controlling for other osteoporosis risk factors such as time since menopause, number of pregnancies, smoking, personal and familial history of osteoporotic fractures, osteoporosis risk was found to be significantly associated with veil wearing.

It is well known that natural nutrients are not sufficient sources of vitamin D to supply the body requirements. The main production of vitamin D is provided by UV sunlight.