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Review Article

Osteoporosis and Osteoporotic Fractures in the Elderly

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With increased longevity, the elderly constitute a growing segment of the community. Bone mineral density (BMD) decreases with aging, and osteoporosis (low bone mass or density) is one of the most prevalent chronic health conditions among the elderly. Since fractures due to osteoporosis lead to considerable disability and many premature deaths, osteoporosis and osteoporotic fractures are major public health concerns. Vertebral deformities are very common among the elderly, and are associated with back pain and impairment. The incidence rates of hip fracture increase with age, and show a significant increase after ages 70. Post-fracture disability at multiple skeletal sites, especially the hip and vertebrae has been reported, and clinical vertebral fractures and hip fractures are associated with a substantial increase in mortality. The appropriate lifestyles for people of all ages, such as adequate intake of calcium, vitamin D and vitamin K should be recommended, in order to maintain bone strength (bone mass and bone quality). Physical activity increases BMD and decreases the risk of falls and fractures. In contrast, excess intake of caffeine and alcohol, as well as smoking, which is associated with low bone density and increased fracture risk, should be avoided. Although obesity is associated with higher BMD, adequate BMI (prevention of leanness) is recommended for general health. Furthermore, a simple risk assessment questionnaire helps to target high-risk women for BMD measurements. Effective drug treatment and prevention of falls are required for high-risk patients. Patients with both low BMD and susceptibility to falls should consider using a hip protector.

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Introduction

With increased longevity, the elderly constitute a growing segment of the community. Bone mineral density (BMD) decreases with aging, and osteoporosis (low bone mass or density) is one of the most prevalent chronic health conditions among the elderly.[1,2] Since fractures due to osteoporosis lead to considerable disability and many premature deaths, osteoporosis and osteoporotic fractures are major public health concerns.[1] BMD and other risk factors can be used to identify high-risk patients.[2] Recently, due to effective interventions, many of these fractures have become preventable.

Prevalence of vertebral deformity (fractures) in Japan

Vertebral deformities are very common among the elderly, but many people are unaware that they have vertebral deformities; therefore, radiographic evidence is useful of its evaluation. Jinbayashi et al.[3] reported on the prevalence of vertebral deformity among Japanese women aged 40 years and over. None of the women had vertebral deformity among ages 40-49, but the prevalence of vertebral deformities increased progressively with age (3% in 50s, 11% in 60s, 25% in 70s and 50% in 80s). Comparisons of the prevalence of vertebral deformities between studies is complicated by the use of different methods of identifying deformities. Thus, comparing the results with those from an earlier study that used the same methodology,[4] the prevalence of vertebral deformities among women aged 50 years and over was essentially identical to that of native Japanese living in Hiroshima, and similar to Caucasian women in Minnesota.

Incidence of hip fracture in Japan

The third nationwide survey for hip fracture incidence was conducted in 1997 following the first in 1987 and the second in 1992.[5] The number of new patients was estimated to be 89,900-94,900 [mean, 92,400; 20,100-21,400 (20,800) men and 69,600-73,600 (71,600) women]. The number of cases in 1997 was about 1.7 times

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higher than that in the first survey and 1.2 times higher than that in the second survey. The age-specific incidence (per 10,000 per year) in men and women in 1997 was 0.30 and 0.13, respectively, for age under 40 years; 0.91 and 0.60, 40-49 years; 2.00 and 2.39, 50-59 years; 5.12 and 9.07, 60-69 years; 17.3 and 40.8, 70-79 years; 57.4 and 147.8, 80-89 years; and 128.9 and 281.0, for age over 90 years. The incidence was increased compared with that of the first survey, and similar to the second survey, excepting that of women aged 80 years or older. Concerning regional differences, hip fracture incidence was relatively low in the eastern area compared to the western area in Japan.

Another survey of hip fracture was performed in Tottori Prefecture, Japan.[6] The age-adjusted incidence rates of hip fracture (per 100,000 person-years) were 40.7 and 114.1 in 1986 and 57.1 and 145.2 in 1994 for men and women, respectively, showing a significant increase with time for women. Upon examination of individual fracture types, there was no significant increase in cervical fractures, whereas a significant increase was observed in trochanteric fractures for women. The age- and gender-specific incidence rate of hip fracture among Japanese was substantially lower than those of whites living in North America or northern Europe.

Disability and mortality

Prospective studies have shown strong associations of new vertebral fractures with back pain and impairment,[7,8] and cross-sectional studies reported weaker associations with vertebral deformities.[9-13] A recent study in Japan demonstrated that women with multiple vertebral deformities had significantly greater impaired function.[3] After adjusting for age, the odds of impaired function were increased by 1.4 times (95% confidence interval (CI): 0.7, 2.9) in women with a single vertebral deformity, and 3.1 times (1.4, 6.8) in those with multiple deformities.

Post-fracture disability at multiple skeletal sites was assessed in community-dwelling women.[14] Hip fracture resulted in the highest percentage of subjects with any bed days or limited activity days after fracture (94% with any bed days and 100% with any limited activity days), though the mean number of bed days and limited activity days appeared highest after lumbar vertebral fractures (25.8 mean bed days and 158.5 mean limited activity days). Substantial disability was also reported after fractures of the thoracic vertebrae, humerus, distal forearm, ankle and foot.

Clinical vertebral and hip fractures are associated with a substantial increase in mortality among a group of relatively healthy older women.[15] The age-adjusted relative risk (95% CI) of dying following a clinical fracture was 2.15 (1.36, 3.42). This primarily reflected the higher mortality following a hip fracture, 6.68 (3.08, 14.52); and clinical vertebral fracture, 8.64 (4.45, 16.74). There was no increase in mortality following a forearm or other fracture (non-hip, non-wrist, non-vertebral fracture).

Nutrition

Adequate dietary levels of calcium and vitamin D were associated with slower rates of bone loss and fewer fractures in some, but not all, studies.[16-20] In one prospective study of postmenopausal women in the north-eastern United States,[20] a decrease in BMD was reported during a period from December to June. The seasonal decrease in BMD was eliminated when vitamin D supplements were provided, suggesting that low sunlight exposure during winter may lead to vitamin D deficiency. Furthermore, several studies have reported a positive effect of calcium intake on BMD in children and adolescents,[21] and calcium is required for normal growth and development of the skeleton.[22]

Vitamin K mediates the gamma-carboxylation of glutamyl residues on several bone proteins, notably osteocalcin. It was reported that high serum concentrations of undercarboxylated osteocalcin and low serum concentrations of vitamin K were associated with lower BMD and increased risk of hip fracture.[23,24]

Caffeine, Alcohol, and Smoking

Caffeine consumption was reported to be associated with low bone density and increased fracture risk.[25,26] Alcohol abuse is a strong risk factor for bone loss and fractures among men and women, but moderate alcohol intake have been inconsistent.[2] In a recent meta-analysis, Law et al.[27] showed no difference of bone density in premenopausal women, but postmenopausal bone loss was greater in current smokers than non-smokers. In current smokers relative to non-smokers, the risk of hip fracture was similar at age 50, but greater thereafter by an estimated 17% at age 60, 41% at 70, 71% at 80, and 108% at 90.

Physical activity

Physical activity helps to increase or maintain BMD at skeletal sites that are subjected to loading.[28,29] Measurements of BMD in different regions could possibly have yielded different results; physical activity may have significant effects on a weight-bearing bone, as compared with a non weight-bearing bone.[28-30] In addition, physical activity may be beneficial for improving muscle strength and coordination to decrease the risk of fall-related fractures.[31]

Body mass index (BMI)

Many studies reported that obesity (greater body weight or BMI) is associated with higher BMD.[32-37] The protective effect of obesity on bone loss appears to be related both to mechanical factors and to estrogen synthesis in adipose tissue;[38] however, since obesity is an important risk factor for cardiovascular disease and diabetes, adequate BMI (prevention of leanness) should be recommended for general health.

Simple risk assessment questionnaire

Simple questionnaires have been designed to help to target high-risk women for BMD measurements, thereby avoiding the cost of measuring women at low risk.[39,40] However, such tools have been focused on evaluation of non-Asian women. Recently, a simple questionnaire for Asians (the Female Osteoporosis Self-assessment Tool: FOSTA) was developed.[41] The FOSTA is calculated from the patient's weight and age: FOSTA = [(weight×0.2), truncated to an integer] - [(age×0.2), truncated to an integer]. Three risk categories were created with cutoffs of -1 and -4 (low > -1, moderate = -1 to -4, high < -4). This assessment tool performed well for classifying the risk of osteoporosis among postmenopausal Asian women, and may encourage appropriate use of BMD technology.[41,42]

Medication

In meta-analysis of therapies for postmenopausal osteoporosis,[43] calcium, fluoride, and hormone replacement therapy showed trends toward reduction in vertebral fractures, but did not show the statistical significance; the impact of these agents on vertebral fracture is weak. There was a significant reduction in the risk for vertebral fractures with vitamin D, alendronate, etidronate, risedronate, raloxifen, and calciton. Alendronate and risedronate were the only two therapies that had significant treatment effects on nonvertebral fracture reduction.

In Japan, Shiraki et al.[44] evaluated the efficacy of alendronate and alfacalciol in a total of 210 Japanese patients with osteoporosis, and found that alendronate was effective in increasing BMD, and more efficacious than alfacalcidol in increasing BMD. Fukunaga et al.[45] demonstrated the clinical benefit of risedronate in the treatment of involutional osteoporosis, compared with that of etidronate in a total of 235 Japanese patients with involutional osteoporosis, and found that daily oral risedronate exhibited efficacy superior to that of intermittent cyclical etidronate in increasing BMD. Kushida et al.[46] reported on the efficacy of alendronate in reducing the risk for vertebral fracture in Japanese patients with osteoporosis. Patients were randomized to receive alendronate or alfacalcidol. The incidence of vertebral fracture > 6 months after randomization was significantly reduced by 66% (relative risk: 0.34, 95% CI: 0.15, 0.74) in the alendronate group (4.3% vs. 12.7% incidence).

Falls

Falls can be markers of poor health and declining function, and they are often associated with significant morbidity, especially fractures.[47] Risk factors for falls in the elderly include increasing age, medication use, cognitive impairment and sensory deficits.

Approximately 20 to 40 percent of people aged 65 years and over living in the community experience falls each year[48-51] and the incidence of falls increases with age.[52] Nevitt et al.[53] reported that 6 percent of the falls resulted in major injury. Even when no physical injury occurs, falls can lead to fear of falling, activity limitations and loss of confidence, mobility and independence.[51,54,55]

Standardized physical performance measures have been applied in geriatric assessment settings and aging research.[56,57] Several studies have demonstrated that poor physical performance is associated with increased risk of falls.[54,55]

The Japanese have a lower incidence of hip fracture than Caucasians, despite having lower bone mass. Hip fractures usually occur after a fall, and differing incidence rates of falls might explain the observed differences in hip fracture rates. Aoyagi et al.[51] studied falls and related conditions among community-dwelling men and women aged 65 years and over in Japan, and compared the prevalence of falls to Japanese-Americans living in Hawaii and to published studies of Caucasians. Compared with native Japanese, the age-standardized prevalence of falls among Japanese-Americans was similar, but about twice as high for Caucasians, which may explain the lower hip fracture risk of the Japanese. The difference in prevalence of falls may in part be related to lifestyle (environmental) factors and/or ethnicity (genetics). Two factors that might account for the reduction of risk of falling among the Japanese compared with people in western countries are better neuromuscular function from sitting directly on the floor (a traditional Japanese custom) plus the shorter legs of Japanese (at least partly related to genetics). A recent study examining the relationship between height, lower extremity length, and hip fracture demonstrated that lower extremity length was a better predictor of hip fracture risk than height among older women.[58]

Bischoff et al.[59] studied elderly women receiving 1200 mg calcium plus 800 IU cholecalciferol or 1200 mg per day in long-stay geriatric care. The intervention with vitamin D plus calcium over a three-month period reduced the risk of falling by 49% compared with calcium alone, and improved musculoskeletal function. Recurrent fallers seem to benefit most from the treatment.

Hip protector

Several studies[60-62] have reported the effectiveness of external hip protectors on the prevention of hip fractures in the frail elderly. In Japan, Harada et al.[63] reported the results of the hip protector trial. They examined 164 elderly female residents of nursing homes, with activities of daily living above the wheelchair level. Among study participants, 88 were randomly selected to wear a hip protector and 76 controls did not. During an average of 377 days, the wearers and the non-wearers fell a total of 131 and 90 times, respectively. Among the wearers, there were two non-hip fractures and one hip fracture, so the annual hip fracture rate was calculated at 1.2%, against 8 hip fractures among the non-wearers, or 9.7% per year. The hip fracture rate was significantly lower among the wearers than non-wearers, while the annual number of falls per subject and the distribution of fallers remained the same. Moreover, even after limiting the subjects to fallers only, the annual hip fracture rate in non-wearers was higher than in wearers (19.8% vs. 2.0%) and the

annual hip fracture rate per fall in wearers was lower than that in non-wearers (0.8% vs. 8.2%).

On the other hand, one study[64] failed to demonstrate the effectiveness of hip protector in reducing the incidence of hip fractures; however, the study had low statistical power, and there was limited adherence with its use, resulting in a large number of falls occurring without hip protectors in place. All hip fractures in the intervention group occurred when hip protectors were not being used. With improved compliance, external hip protectors should be effective prophylactics against hip fractures.

Conclusion

Vertebral deformities are very common among the elderly, and associated with back pain and impairment. Post-fracture disability at multiple skeletal sites, especially hip and vertebrae was reported, and clinical vertebral fractures and hip fractures are associated with a substantial increase in mortality. It is reasonable to recommend an appropriate lifestyle, such as adequate nutrition and physical activity for people of all ages in order to maintain bone strength (bone mass and bone quality). A simple risk assessment questionnaire helps to target high-risk women for BMD measurements. Effective drug treatment and prevention of falls are required for high-risk patients. Patients with both low BMD and susceptibility to falls should consider using a hip protector. Because effective interventions exist, many of osteoporosis and osteoporotic fractures are now preventable.

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