Editorials

Bone Mineral Health of Indians

Bone mineral disorders in Indians can broadly be divided into four categories: (i) *osteoporosis* characterized by low bone density and poor bone quality, predominantly age-related or menopausal. It results in fragility fractures, of which hip fractures are particularly devastating; (ii) *osteomalacia* and *rickets*—disorders of mineralization, predominantly nutritional (vitamin D deficiency) in origin. These result in bone softening, deformity and fractures in children and adults; (iii) s*keletal fluorosis* which results in poor bone quality due to environmental (usually drinking water) fluoride toxicity. It often leads to deformity and can be crippling, even in children; and (iv) less common disorders such as primary hyperparathyroidism, hypophosphataemic osteopathies, fibrous dysplasias, vitamin D-dependent rickets, osteogenesis imperfecta and Paget disease. I will focus mainly on the first of these, i.e. osteoporosis.

With increasing longevity of the Indian population, it is now being realized that, as in the West, osteoporotic fractures are a major cause of morbidity and mortality in the elderly. Osteoporosis is a silent disease, reflected only in a low bone density, till a fracture occurs. Much in the manner that asymptomatic conditions such as hypertension and dyslipidaemia predispose to stroke and myocardial infarction, respectively, a low bone density (reflecting poor bone health) predisposes to osteoporotic fractures. During puberty and adolescence, the skeleton takes up calcium avidly and builds up its reserves. This uptake of calcium into the bone is largely dependent on calcium and vitamin D nutrition, as well as exercise. Peak bone mass is usually achieved by the age of 20 years. From the mid-thirties there is a gradual, progressive bone loss, which continues throughout life and is accelerated at the menopause in women. The fracture prevention strategy therefore consists of increasing peak bone mass in the growing years and reducing subsequent bone loss throughout life. Thus, the importance of achieving and maintaining good bone health cannot be overemphasized.

Although reliable epidemiological data are lacking, hospital data suggest that hip fractures are common in India. Data also suggest that men are probably more commonly affected than women, although this may be because the likelihood of men seeking hospital attention is greater than that for women. Almost four decades ago, Nordin reviewed 119 hip fractures and found that, in India, they occur at all ages, with two peaks at 30–39 years and again at 50–70 years. There was no attempt to distinguish traumatic from fragility fractures.[1] Around the same time, Gupta *et al*. from Kanpur analysed 425 hip fractures, 63% of which were in men. The average age at fracture was 55 years.[2] Vaishnava and Rizvi found osteoporosis based on iliac crest biopsies in 141 out of 421 hip fracture patients, and again more than half their patients were men.[3] Indians living in Singapore were also found to have hip fractures at an average age of 58 years.[4] More recent data from Sankaran, involving 1393 patients of hip fractures from 3 large Delhi hospitals, also indicate that these fractures are common in both sexes, although the sex ratio in different subgroups was variable, and not always in favour of men. The peak age at which these fractures occurred was 60–70 years.[5] In western countries, women suffering from osteoporosis far outnumber men, and this is largely thought to be due to the effects of the menopause. Some authors conclude that:[6]

1. osteoporosis is prevalent in India;
2. osteoporotic fractures occur more commonly in Indian men than in women; and
3. in India, osteoporotic fractures occur 10–20 years earlier than in the West.

While these are reasonable conclusions, we must keep in mind that there are no epidemiological data on fracture prevalence, although most clinicians would agree that hip fractures are common. The men:women ratio may be distorted because men are more likely to be brought for hospital care. The lower peak age as compared to

the West may simply be linked to a shorter life span, as also to the inclusion of traumatic/non-fragility fractures in the analysis. Perhaps it is best to conclude that *osteoporotic fractures are common in India and occur in both sexes.*

Dual energy X-ray absorptiometry (DEXA) technology, the gold standard for diagnosing osteoporosis by measuring bone density, became available in India only in 1997 at the Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow. Subsequently, several other machines became available and the past 2 years have seen their number grow to almost 100. These are still mostly in the larger cities—Delhi and Mumbai alone account for more than 20 of these installations. Thus, while certain segments of the Indian population do have access to diagnosis and treatment, these techniques remain inaccessible to the majority of Indians. The most important question in this regard is the appropriateness (or otherwise) of western standards for diagnosing osteoporosis in Indians. Single-centre studies on bone mineral density (BMD) in Indians (from Lucknow, Delhi, Bangalore, Chennai) using DEXA have started appearing in the literature and have consistently shown a lower BMD in Indian women. Overall, the BMD at all sites seems to be 5%–15% lower than that in Caucasians.[7–11] However, there are differences in BMD between different centres, and a recent study involving healthy subjects presenting for a preventive health check in Delhi has suggested that differences with western populations in BMD may be minimal, and could be related to the smaller skeletal size of Indians.[12] Studies on expatriate Indians, although on a limited number of subjects, have also shown a lower BMD as compared to that in Caucasians.[13,14] The issue of appropriate BMD normative data for Indians remains open. There is a need to study the BMD–fracture relationship in Indians (fracture threshold) to determine the ideal normative data for the Indian population.[15] If Indians fracture at the same level of BMD as Caucasians, there would be no reason to have separate normative data for Indians.

What could be the reasons for these differences in bone density? Is it genetic? Or is it related to skeletal size? Both are likely reasons. However, calcium and vitamin D nutrition plays an important role in determining bone health. Recent data indicate a high prevalence of vitamin D deficiency in urban Indians, despite the availability of abundant sunshine. Studies have shown that the majority of urban office workers and hospital staff have moderate to severe vitamin D deficiency, which is usually asymptomatic.[16,17] Arya *et al*. used a serum 25(OH) vitamin D level of 15 ng/ml as a cut-off, and found 66.3% of subjects to be vitamin D deficient. Of these, 20.6% had severe vitamin D deficiency (<5 ng/ml), 27.2% had moderate (5–9.9 ng/ml) while 18.5% had mild vitamin D deficiency (10–14.9 ng/ml). When a serum 25(OH) vitamin D level of 20 ng/ml was used as a cut-off, 78.3% subjects were diagnosed to be vitamin D deficient/insufficient. The serum 25(OH) vitamin D level correlated with sunlight exposure and femoral neck BMD. Inadequate calcium intake was proposed as an additional factor contributing to the low BMD. Thus, low vitamin D levels (and low calcium intake) could also be major contributing factors to poor bone health and osteoporosis in India.[17]

Poor sunlight exposure, skin pigmentation and a vitamin D-deficient diet are some obvious causes for this finding. Atmospheric pollution has also been suggested as a contributor to vitamin D deficiency in children from Delhi.[18] Low serum 25(OH) vitamin D levels have also been reported in expatriate Indians from the UK and USA.[12,19] Lo *et al*. showed that Indian and Pakistani immigrants in the USA have the same capacity to produce vitamin D in response to ultraviolet light though longer exposure to sunlight is required.[20] One study reported altered vitamin D metabolism in cultured skin fibroblasts from Indians.[21]

The spectrum of vitamin D deficiency in India extends from asymptomatic deficiency, described above, to frank osteomalacia, a crippling disorder, which continues to be seen, even in 'tertiary care' corporate hospitals.[22] Another reflection of the poor bone health of Indians is the severe bone disease seen in Indians with primary hyperparathyroidism, who have consistently been shown to have low serum levels of 25(OH) vitamin D.[23] Vitamin D replete 'western' patients of primary hyperparathyroidism typically have no symptoms at all and are diagnosed on routine

laboratory screening for serum calcium level.

In this issue of the *Journal*, Tandon *et al*. report their findings on the bone health of Indians with optimal vitamin D availability.[24] Their subjects were healthy young adults, both men and women, from the Indian paramilitary forces. They consumed a nutritious, balanced diet, with average calcium intakes of over 750 mg/day in women and 1000 mg/day in men. They performed regular physical exercise and had adequate exposure to sunlight. The authors report a serum 25(OH) vitamin D level of 18.4 ng/ml in the subjects studied in winter and 25.3 ng/ml in those studied in summer. These levels are much higher than those reported in previous studies from India, which is probably simply related to greater exposure to sunlight in this study population. Although the sample size is small, the differences in BMD as compared to western controls were also less than those reported earlier. The BMD of women was comparable at all sites, while the BMD of men was different only at the lumbar spine. The minor differences in BMD could possibly be related to lower peak bone mass attained during puberty, since these subjects were recruited to the service after 18 years of age. They could also reflect differences in skeletal size. The study is of importance because it has shown that a healthy lifestyle (diet, exercise and sunlight exposure) can have a major positive impact on the bone metabolism and bone health of Indians.

It appears that typical urban ('white collar') Indians have poor bone health, and osteoporosis is common in India. However, adequate calcium intake, regular physical exercise and exposure to sunlight can go a long way in improving the bone health of Indians and potentially reducing the risk of fracture. There is thus an urgent need for greater public awareness in this regard, particularly about the benefits of sunlight exposure.

REFERENCES

1 Nordin BEC. International patterns of osteoporosis. *Clin Orthop* 1966;**45:**17–30.
2 Gupta AK, Samuel KC, Kurian PM, Rallan RC. Preliminary study of the incidence and aetiology of femoral neck fracture in Indians. *Indian J Med Res* 1967;**55:**1341–8.
3 Vaishnava H, Rizvi SNA. Frequency of osteomalacia and osteoporosis in fractures of proximal femur. *Lancet* 1974;**1:**676–7.
4 Wong PCN. Femoral neck fractures among major racial groups in Singapore: Incidence pattern compared with new Asian communities. *Singapore Med J* 1964;**5:**150–4.
5 Sankaran B. Clinical studies: Incidence of fracture neck of femur and intertrochanteric fractures in three Delhi hospitals. In: Sankaran B (ed). *Osteoporosis*. New Delhi:South East Asia Regional Office, World Health Organization; 2000: 9–18.
6 Gupta A. Osteoporosis in India—the nutritional hypothesis. *Natl Med J India* 1996;**9:**268–74.
7 Mithal A, Nangia S, Arya V, Verma BR, Gujral RB. Spinal bone mineral density in normal Indian females [abstract]. *J Bone Miner Res* 1998;**13** (Suppl 1):S591.
8 Reddy PG, Mithal A, Rao DS. Bone mineral density in healthy Asian Indian women: Development of a reference database and implications for diagnosis of osteoporosis in Indian women living in the United States [abstract]. *J Bone Miner Res* 2002;**17** (Suppl 1):SA270.
9 Ravishankar U. Bone mineral density in normal Indian women: Assessment by dual energy X-ray absorptiometry. In: Sankaran B (ed). *Osteoporosis*. New Delhi:South East Asia Regional Office, World Health Organization; 2000: 20–2.
10 Dharmalingam M, Prasanna Kumar KM, Patil J, Karthikshankar S. Study of bone mineral density in postmenopausal women [abstract]. *Bone* 2003;**32** (Suppl):S178.
11 Anburajan M, Rethinasabapathi C, Korath MP, Ponnappa BG, Kumar KS, Panickar TM, *et al*. Age-related proximal femur bone mineral loss in South Indian women: A dual energy X-ray absorptiometry study. *J Assoc Physicians India* 2001;**49:**442–5.
12 Keramet A, Bhambhri R, Chakravarty D, Mithal A. Spinal bone mineral density in healthy urban Asian Indian women presenting for a preventive health check-up [abstract]. *J Bone Miner Res* 2003;**18** (Suppl 1):SA083.
13 Alekel DL, Mortillaro E, Hussain EA, West B, Ahmed N, Peterson CT, *et al*. Lifestyle and biologic contributors to proximal femur bone mineral density and hip axis length in two distinct ethnic groups of premenopausal women. *Osteoporosis Int* 1999;**9:**327–38.
14 Cundy T, Cornish J, Evans MC, Gamble G, Stapleton J, Reid IR. Sources of interracial variation in bone mineral density. *J Bone Miner Res* 1995;**10:**368–73.
15 Usha G, Krishnaswamy B. Bone mineral density and fracture threshold in South Indian elderly. *J Assoc Physicians India* 2002;**50:**247–9.
16 Goswami R, Gupta N, Goswami D, Marwaha RK, Tandon N, Kochupillai N. Prevalence and significance of low 25 hydroxyvitamin D concentrations in healthy subjects in Delhi. *Am J Clin Nutr* 2000;**72:**472–5.
17 Arya V, Bhambri R, Godbole MM, Mithal A. Vitamin D status and its relationship with bone mineral density in healthy Asian Indians. *Osteoporos Int* 2003 (in press) (online version released).
18 Puliyel JM, Agarwal K, Upadhyay P, Mawer EB, Berry JL, Mughal Z. The impact of atmospheric pollution related haze on vitamin D status of two-year olds in Delhi, India. *J Bone Miner Res* 2000;**15** (Suppl 1):S356.
19 Sheran E, Newton O, Ali HA, Walford S, Singh BM. Prevalence of hypovitaminosis D in Indo-Asian patients attending a rheumatology clinic. *Bone* 1999;**25:**609–61.
20 Lo CW, Paris PW, Holick MF. Indian and Pakistani immigrants have the same capacity as Caucasians to produce vitamin D in response to ultraviolet irradiation. *Am J Clin Nutr* 1986;**44:**683–5.

21 Awumey EMK, Mitra DA, Hollis BW, Kumar R, Bell NH. Vitamin D metabolism is altered in Asian Indians in the southern United States: A clinical research centre study. *J Clin Endocrinol Metab* 1998;**83:**169–73.
22 Bhambri R, Naik V, Taneja S, Rastogi S, Mithal A. Change in bone mineral density following treatment of osteomalacia and rickets. Endocrine Society (US), Philadelphia, Pennsylvania, June 19–22, 2003: P-3/560 (abstract).
23 Rao DS, Agarwal G, Talpos GB, Phillips ER, Bandeira F, Mishra SK, Mithal A. Role of vitamin D and calcium nutrition in disease expression and parathyroid tumor growth in primary hyperparathyroidism: A global perspective. *J Bone Miner Res* 2002;**17** (Suppl 2):N75–N80.
24 Tandon N, Marwaha RK, Kalra S, Gupta N, Dudha A, Kochupillai N. Bone mineral parameters in healthy young Indian adults with optimal vitamin D availability. *Natl Med J India* 2003;**16:**298–302.

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