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Fragility fractures: the future epidemic and its challenges

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Fragility fractures contribute significantly to the morbidity and mortality of older individuals, and in a growing segment of the senior population a marked increase in these fractures is expected in the next 20 years [1, 2]. The most rapidly growing segment of the senior population consists of men and women aged 85 years and older [2]. This translates in a rising number of all fragility fractures, especially those of the hip.

Hip fractures are the most serious and most frequent fractures occurring among seniors aged 75 years and older [3, 4], and an estimated 1 in 3 women, and 1 in 6 men will have sustained a hip fracture by their 90th decade [5]. Muscle weakness [6] and falling [7] are closely related to fragility fractures, and are critical in understanding them. Both muscle weakness and falling have been linked to the broad prevalence of vitamin D deficiency among the senior population.

Severe vitamin D deficiency (serum concentrations < 10 ng/ml or < 25 nmol/l 25-hydroxyvitamin D) in the senior population causes secondary hyperparathyroidism, osteoporosis, and osteomalacia [8]. Histological osteomalacia, characterized by the accumulation of unmineralized matrix or osteoid in the skeleton, has been found to be common in several hip fracture case studies (12–44 %) [9–14]. At the same time it is well recognized that severe vitamin D deficiency is prevalent in about 60 % of hip fracture patients [15, 16] and that vitamin D supplementation reduces the risk

of hip fracture by 30 % [17]. Thus, it is conceivable that a significant number of hip fractures occurring in seniors are explained by osteomalacic changes that soften the bone. Additionally, as a primary clinical sign of osteomalacia, muscle weakness may contribute to the risk of fracture [18], and vitamin D supplementation may not only mineralize bone, but has been shown to reduce the risk of falling by up to 34 % [19, 20].

Apart from hip fractures, the two other most common fragility fractures at non-vertebral sites are distal forearm and proximal humerus fractures, and, similar to hip fractures, distal forearm and proximal humerus fractures show a steep increase with age [3]. Notably, the circumstances of these fractures are strikingly different. Hip fractures tend to occur in less active individuals falling indoors from a standing height with little forward momentum, and they tend to fall sideways or straight down on their hip [21–23]. However, distal forearm or humerus fractures tend to occur among more active older individuals who are, correspondingly, more likely to be outdoors and have a greater forward momentum when they fall [24–26]. This may also explain why hip fracture incidence shows little to no seasonal change, while the winter/summer seasonal swing is pronounced in distal forearm and humerus fractures, and more so in men than in women [27]. Men aged 65 years and older are at a 51 % greater risk of sustaining a distal forearm fracture and a 23 % greater risk of sustaining a proximal humerus fracture in the winter compared with during the summer [27]. Women aged 65 years and older are at a 15 % greater risk of sustaining a distal forearm fracture and a 19 % greater risk of sustaining a proximal humerus fracture in the winter compared with during the summer [27]. In the same study, in winter, total snowfall was associated with a reduced risk of hip fracture (–5 % per 20 inch), but an increased risk of distal forearm and proximal humerus fractures (6–12 %; $p < 0.05$ at all sites) [27].

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Compared with the three most common fragility fractures at non-vertebral sites (hip, distal forearm, and proximal humerus) the epidemiology of vertebral fractures is challenging with less than 30 % of vertebral fractures coming to clinical attention [4]. Similar to the three nonvertebral fragility fractures, vertebral fractures increase exponentially after the age of 65 years among men and women, and incidence rates for vertebral fractures project between hip and radius fractures for both genders after the age of 75 years [4]. Women with a first vertebral fracture, are at more than a 19 % risk of developing a second vertebral fracture during the following year [28], a 2.5-fold increased risk for any subsequent fracture [29], and a 2.8-fold increased mortality rate within the following 10 years [30].

Notably, in men older than 80 years, vertebral fracture rates have been reported to be similar to those in women [31]. However, mechanistically there are gender-specific differences: more than 90 % of vertebral fractures in women result from mild-to-moderate trauma, while, among men, this proportion is only 55 % [32]. Severe vertebral deformities in both genders appear to have a predilection between T10 and L1 [32].

For a future perspective on the fragility fracture epidemic, it is important to note that fragility fractures are often followed by a second fragility fracture, and drawing attention to that first fracture and the need for secondary prevention is key in fragility fracture care. Based on a 16-year follow-up of one large population-based study in Australia [29], the absolute risk of a repeat fracture increases steeply and equally in men and women with age, despite a lower absolute risk of a first fracture among men. The relative risk of a repeat fracture among women aged 60–69, 70–79, and 80+ years is 1.65 (95 % CI: 1.18–2.32), 2.36 (1.91–2.92), and 1.80 (1.45–2.25) respectively. The relative risk of a repeat fracture among men aged 60–69, 70–79, and 80+ years is 3.75 (2.19–6.43), 4.32 (3.00–6.21), and 2.77 (1.69–4.54) respectively.

In summary, we will see many more fragility fractures in the coming 20 years and an interdisciplinary approach, including radiology, will be needed to face this challenge and prevent both first and repeat fragility fractures. From a radiology perspective, future approaches may include screening for signs of osteomalacia and the prevalence of vertebral fractures in any musculoskeletal radiology performed. Alternatively, new technologies for bone quality assessment, such as Xtreme computer tomography (CT) measurement, must find its way into clinical practice, and we extend the common use of dual-energy x-ray absorptiometry (DEXA) measurements to include vertebral morphometry and, depending on the further development of this technology, screening for signs of osteomalacia.

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