

Falls and fractures

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Introduction

The incidence of fractures of the hip, forearm, vertebra, humerus, pelvis and ankle increases with advancing age, but rises particularly rapidly after the age of 75 years [1]. The lifetime risk of symptomatic fracture for a 50-year-old white woman in the UK has been estimated to be 13% for the forearm, 11% for the vertebra, and 14% for the hip, whereas the corresponding figures for a 50-year-old man are 2%, 2%, and 3% respectively [2]. These fractures are a major cause of mortality, morbidity and health and social service expenditure in older people, but this is particularly the case with hip fractures. The excess mortality after hip fracture is 10–20% [2], but is generally higher in men than women. Up to 50% of patients become more dependent after hip fractures, many requiring placement in a residential or nursing home [3]. The annual cost of osteoporotic fractures in the UK has been estimated at £942 million, of which 87% is attributable to hip fractures [4].

Osteoporosis

Women lose 35–50% of trabecular and 25–30% of cortical bone mass with advancing age, whereas men lose 15–45% and 5–15% respectively. It is widely considered that this bone loss and the resulting osteoporosis is the major cause of fractures after minimal trauma in older people. Osteoporosis has been qualitatively defined as a systemic bone disease characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to enhanced bone fragility and consequent increase in fracture risk [5]. The World Health Organisation [6] has defined osteoporosis quantitatively as a bone mineral density (BMD) 2.5 standard deviation units or more below the mean value for young adults (T score < -2.5). These definitions highlight the importance of low bone density in the development of fractures after minimal trauma, but it is important to critically review the relationship between bone density and fracture risk.

Bone density and fracture risk

There is a strong inverse relationship between bone density and fracture risk, with a two- to three-fold

increase in fracture incidence for each standard deviation reduction in BMD [7]. The relationship between bone density and fracture risk is comparable to that between blood pressure and incidence of stroke and superior to that between serum cholesterol and myocardial infarction [8]. Nevertheless, the fracture risk at any BMD increases with advancing age, suggesting that other factors affect fracture risk independently of bone density [9]. These include skeletal factors such as bone turnover, trabecular architecture, skeletal geometry and bone quality, together with non-skeletal factors which may increase the risk of falls.

Other risk factors for fracture

Studies from Europe, the USA and Australia show that the risk of fracture is determined not only by BMD, but also by factors associated with physical frailty and an increased risk of falls [10–12]. A prospective study from Australia showed that BMD and body sway both predict the risk of osteoporotic fractures [12], but the combination of low BMD and high body sway conferred a greater risk of fracture than either alone. The Study of Osteoporotic Fractures in the USA confirmed that bone density predicted the future risk of hip fracture, but identified a number of other important risk factors [11]. Although women with low calcaneal BMD had a two- to three-fold higher incidence of fractures than those with high BMD, the presence of other risk factors had a major effect on the incidence of fractures. Women with five or more of these risk factors had at least a nine-fold higher risk of fracture than those with 0–2 risk factors [11].

Falls and fractures

The prevalence of falls increases with advancing age, but is generally higher in women than men [13, 14]. It has been suggested that the gender specific differences in the risk of falls may account in part for the difference in fracture rates between men and women. The risk of both falls and forearm fractures increases in middle-aged women, but this is not seen in men in this age group [14]. In contrast, there is a marked increase in the proportion of men and women above the age of 80 years

who fall [14], which may contribute to the exponential rise in hip fracture incidence in both sexes [1].

A number of risk factors for falls have been identified, the most common of which are muscle weakness, history of falls, gait and balance deficit, visual impairment, arthritis, impaired activities of daily living, depression, cognitive impairment and aged over 80 years [15].

A case-control study examined risk factors for falls in 174 women with hip fractures and 174 age matched control subjects [16]. This showed an increased risk of fracture with lower limb dysfunction (Odds Ratio [OR] 1.7, 95% Confidence Intervals [CI] 1.1–2.8), visual impairment (OR 5.1, CI 1.9–13.9), previous stroke (OR 2.0, CI 1.0–4.0) and Parkinson’s disease (OR 9.4, CI 1.2–76.1).

About 20% of falls require medical attention, but <10% result in a fracture. What therefore determines the risk of fracture among those who fall? A case-control study in 205 patients with hip fracture and 207 control subjects showed a strong relationship between the number of falls and hip fracture risk [17]. This study also compared the type of fall in 125 fallers with hip fracture and 84 control fallers who had not sustained fractures. This demonstrated that falling while turning was associated with an increased risk of hip fracture (OR 7.9, 1.4–43.0). Another study in ambulatory nursing home residents compared 32 patients who sustained a hip fracture after a fall with 100 control patients who fell without developing hip fracture [18]. This showed an increased risk of hip fracture with falls to the side (OR 3.9, 1.3–11.0), low hip bone density (OR 1.8, 1.03–3.0) and impaired mobility (OR 6.4, 1.9–21.0).

Osteoporosis treatment and prevention of fractures

The Royal College of Physicians and Bone and Tooth Society of Great Britain have recently published evidence-based guidelines on the management of

osteoporosis [19]. These conclude that there is randomized controlled trial (RCT) evidence that oestrogen, raloxifene, cyclical etidronate, alendronate, risedronate and calcitonin all have a beneficial effect on bone density and vertebral fracture incidence (Table 1). Alendronate, risedronate and calcium and vitamin D have also been shown in RCTs to decrease the incidence of hip fractures, but epidemiological studies suggest that oestrogen, cyclical etidronate and calcitonin may also reduce the risk of hip fractures (Table 1).

The largest study to examine the effect of osteoporosis treatment on the incidence of hip fractures was an RCT comparing risedronate with a placebo preparation in two groups of women [20]. The first group comprised 5,445 women aged below 80 years with low femoral neck bone density (T score < -3.0) and at least one additional clinical risk factor for hip fracture. The second group of 3,886 women were recruited on the basis of having a clinical risk factor for hip fracture. Overall, there was a 40% reduction in hip fractures in women in the first group, with a 60% reduction in women with a prevalent vertebral fracture at baseline [20]. There was no significant decrease in hip fracture incidence in the second group however, suggesting that bone density measurement may be better than clinical risk factors at identifying patients who will respond to osteoporosis treatment.

Although osteoporosis treatments decrease bone resorption and increase bone density, in some cases the observed reduction in fracture incidence may be due in part to non-skeletal mechanisms. A French RCT in 3,270 women living in nursing homes and apartment blocks for the elderly, showed that 800 iu vitamin D₃ and 1.2 g elemental calcium daily reduced the risk of hip fracture by 27%, with only modest improvement in hip bone density [21, 22]. A subsequent RCT in 148 healthy women aged over 70 years compared the effects of 600 mg of elemental calcium alone with 600 mg of elemental calcium and 400 iu vitamin D₃ on body sway and the number of falls [23]. The addition of vitamin D₃ was associated with a 9% reduction in body sway and 53% decrease in the number of falls reported.

Table 1. Recommendations on the effect of drug treatment on BMD and the incidence of vertebral, non-vertebral and hip fractures [19]

	BMD	Vertebral Fractures	Non-Vertebral Fractures	Hip Fractures
Oestrogen	A	A	A	B
Raloxifene	A	A	ND	ND
Etidronate	A	A	B	B
Alendronate	A	A	A	A
Risedronate	A	A	A	A
Calcitonin	A	A	B	B
Calcium & Vitamin D	A	ND	A	A

Grade A recommendations are based on randomized controlled trials, whereas Grade B recommendations result from controlled studies without randomization, studies with a quasi-experimental design and epidemiological studies. Grade C recommendations are based on expert committee reports or the clinical experience of recognized authorities. ND indicates that a beneficial effect has not been demonstrated.

These changes may account in part for the benefit of calcium and vitamin D supplementation on fracture risk.

Prevention of falls and fractures

A number of measures have been advocated for the prevention of falls, including exercise programmes, environmental modification, review of medications, the use of appropriate walking aids and assistive devices and behavioural and educational programmes [15]. Randomized controlled trials have assessed the effect of multifactorial interventions on the risk of falls, although the results have not all been consistent. In an American study of 301 elderly patients with an apparent risk factor for falling, the intervention group underwent geriatric assessment, with modification of risk factors for falling, whereas the control group had the usual health care and social visits [24]. Over the 12 months' follow up period, 35% of the intervention group had falls compared to 47% in the control group. A more recent British study examined the effectiveness of a detailed medical and occupational therapy assessment in 397 older patients presenting to an Accident and Emergency Department with a fall [25]. There was a significant 61% reduction in the risk of falls in the intervention group over 12 months, compared with the control group. Although both studies showed a significant decrease in falls, neither had the statistical power to detect a meaningful reduction in fracture incidence [24, 25].

Reducing the impact of falls

An alternative approach to fracture prevention is to decrease the impact of falls using external hip protectors, which are incorporated into specially designed underwear. A Danish study block randomized 665 elderly residents of nursing homes to receive external hip protectors or to serve as controls [26]. Over the 12 month study there was a reduction in hip fracture risk of over 50% in those using the hip protectors. In the group randomized to receive hip protectors, the only patients who fractured were not using hip protectors at the time. A systematic review of 5 RCTs of hip protectors has recently been published, involving 1,681 participants living in nursing or residential home [27]. This showed an overall prevalence of hip fractures of 2.1% in the hip protector group, compared with 6.2% in the control group. Due to the large number of participants allocated to intervention by cluster randomization, it was not possible to demonstrate conclusively that this difference between groups was statistically significant.

Conclusions

Osteoporotic fractures are a major cause of morbidity, excess mortality and health and social service expenditure in older people. The risk of osteoporotic fracture is determined by skeletal and non-skeletal risk factors, but further research is needed to examine the relationship between these factors and to explore how these may be modified most effectively to decrease the risk of fracture. In the meanwhile, clinicians involved in the care of older people at increased risk of fracture, should consider not only treatment for osteoporosis, but also measures to decrease the incidence and reduce the impact of falls.

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