

Prevention of hip fracture with hip protectors

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Abstract

The prevention of fractures amongst older people consists of (i) prevention and treatment of osteoporosis, (ii) prevention of falling and (iii) prevention of fractures using injury-site protection. As the great majority of hip fractures are caused by a sideways fall with direct impact on the greater trochanter of the proximal femur, one approach to prevention is the use of an adequately configured padded, firm-shield external hip protector. With this type of two-part design, the impacting force and energy are, at the time of the fall-impact, first weakened by the padding part of the protector and then diverted away from the greater trochanter by the shield part of the same. Following this line, a series of consecutive studies by the Accident & Trauma Research Center at the UKK Institute, Tampere, Finland, found that a padded, strong-shield hip protector was effective in preventing hip fractures. In the context of the wider literature on hip protectors, these more encouraging results suggest the need for a more rigorous regulation of protector design and characteristics. Alongside inadequacies of design, the other most frequent general problem with hip protectors is compliance. Not all elderly people with a high risk of hip fracture will agree to use hip protectors and in those who do, long-term adherence may decrease. Caregiver motivation and involvement appear therefore to be crucial.

Keywords: *hip fracture, hip protector, prevention*

Introduction

Fractures amongst older people are a major public health problem. This is true not only economically but also for the health and well-being of older adults because fractures cause long-standing pain, functional impairment and disability, and have a high mortality rate [1, 2]. Moreover, a fracture and the fear of its consequences, such as isolation, loss of independence and admission to a nursing home, can cause significant mental and psychological suffering [3].

Worldwide, over 8 million fractures occur annually among persons 60 years of age or older, with a sharply increasing trend over recent decades [2, 4]. Age-adjusted fracture rates are rising in many populations, and this trend must be superimposed on the rapidly increasing number of older people in both developed and developing countries [2, 5]. There is therefore a real risk that health care systems may become (or indeed may already be) unable to carry out the necessary standard treatments or cope with the financial burden.

Given that each hip fracture costs almost \$20,000 [6] and the estimated lifetime cost for all hip fractures in the United States in 1997 likely exceeded \$20 billion [7], all individual methods and population-level interventions that might reduce the risk of fractures and their costs warrant critical appraisal [5, 8]. There is thus an urgent need to

understand better the aetiology, risk factors, pathogenesis and injury mechanisms of fractures in order to provide important clues and possibilities for fracture prevention.

This presentation focuses on the authors' over 10-year research work on epidemiology, aetiology and prevention of hip fractures, rather than on any in-depth critique of the wider literature.

Aetiology and pathogenesis of fractures among elderly people

Compromised bone strength (osteoporosis) and falling, alone or more frequently in combination, are the two independent and immediate risk factors of elderly people's fractures through which all the other, more distant risk factors (such as ageing, inactivity, poor nutrition, smoking, use of alcohol, diseases, medications, functional impairments and disabilities) operate [2]. Of these two, falling (rather than osteoporosis) is the strongest single risk factor for fracture [2, 9–13], and when a person falls, the type and severity of falling (fall height and energy, fall direction, breaking of the fall, anatomical site and direction of the impact, and energy absorption capacity and impact force attenuation of the body-landing surface system) are crucial in determining whether or not a fracture occurs [12, 14, 15].

The most usual event resulting in a fracture of an older adult is a 'simple' fall to the floor from standing height or less [9, 10, 12, 14, 15]. Although in general terms, this type of common trauma is 'mild' or 'moderate' (compared with, e.g. motor vehicle collisions), it has to be kept in mind that to the specific injury site, such as the greater trochanter of the proximal femur, these traumas are high-impact injuries often creating forces clearly exceeding the breaking strength of the bone [14, 15]. Our most recent in-house observations [16] suggest that a sideways fall directly onto the hip is indeed a serious injury capable of fracturing the proximal femur of even a young healthy adult. The proximal femur is also weakest and the primary bone loss greatest at this unusual loading direction [17]. Thus, fractures in older people should be termed 'fall-induced high-impact injuries' instead of the commonly used and rather misleading 'osteoporotic fractures', 'minimal-trauma fractures', 'low-energy fractures' or 'age-related fractures'.

Viewed in this context, it is appropriate in injury prevention to understand the majority (80–85%) of fractures in the elderly community as not primarily or predominantly attributable to osteoporosis [18, 19]. This is because low bone mineral density (BMD) is only a moderate-level risk factor for a typical fracture of an older adult: in non-spinal fractures, the relative hazard per 1 SD decrease in BMD has been found to be 1.4–1.5 only [18, 20]. Stone *et al.* [18] concluded that finding effective fracture prevention strategies in older women will require additional interventions besides treatment of osteoporosis, such as prevention of falls and other risk factors. Clearly, therefore, both immediate risk factors (falling and osteoporosis) should receive parallel priority [2].

Preventing hip fracture of elderly people with hip protectors

Prevention consists of three independent elements: (i) prevention and treatment of osteoporosis, (ii) prevention of falling and (iii) prevention of fractures despite osteoporosis and falling (injury site protection). This presentation focuses on the findings of the author's own group specifically with the use of padded firm-shield hip protectors.

Since the great majority of hip fractures are caused by a sideways fall with direct impact on the greater trochanter of the proximal femur [12, 14], one option to prevent the fracture is a specially designed external hip protector, so that at the time of the fall impact, the impacting force and energy are weakened and diverted away from the greater trochanter by the protector. Our research team conducted a large ($n = 1,801$) randomised multicentre trial with a padded, shield-type KPH Hip Protector (Figure 1) and showed, with intention-to-treat analysis, that the risk of hip fracture was 60% less in the protector group than in the control group (adjusted relative hazard 0.4, 95% CI = 0.2–0.8), and that by protector efficacy or active treatment analysis, the risk reduction was >80% if the protectors were actually worn at the time of falling (adjusted relative hazard 0.1, 95% CI = 0.03–0.5)

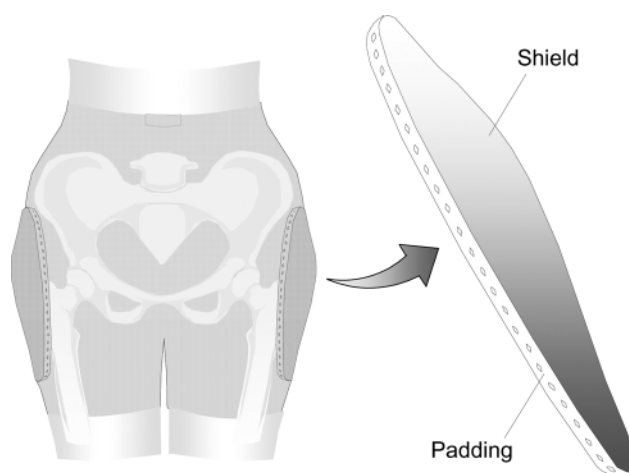


Figure 1. The KPH Hip Protector (HRA Pharma, Paris, France, <http://www.kph-hip-protector.com>) for prevention of hip fracture. The two padded shields are worn in pockets of the undergarment.

[21]. According to the intention-to-treat analysis, the number needed to treat (NNT) to avoid one hip fracture was 41 persons for one year (95% CI = 25–115), or eight persons for 5 years (95% CI = 5–23).

Our own findings, therefore, support the use of scientifically tested, firm-shield hip protectors for high-risk frail elderly people, especially those who have fallen before, had fractures, and have poor balance and impaired mobility. The wider results of randomised studies with mechanically weaker hip protectors have, however, been less encouraging [22–27].

After publication of the first randomised controlled trials evaluating the effects of shield-type hip protectors on the risk of hip fracture, there has been a rapid increase in a wide variety of hip pads and protectors on the market. Unfortunately, for most commercially available hip protectors there is a spectacular dearth of basic science and clinical research. This is evident on the Internet, where many types of hip devices are available with unsubstantiated claims for fracture prevention. Very few models of protectors have been studied systematically [5].

Based on our experience, therefore, a satisfactory hip-protector research and development programme should ensure documentation of the biomechanical anti-fracture efficacy of the selected protector *in vitro* and in actual falls, continuing with compliance and adherence amongst users, and ending with a user-control comparison in a randomised trial [21, 28–31]. The newest hip protectors that emphasise a thin design seem to seek increased user-comfort and compliance, but this is probably achieved at the cost of reduced force attenuation, efficacy and safety. In our view, therefore, there is a case to be made for a regulatory Food and Drug Administration (FDA)-type device approval process. This would be based on a protector-specific application detailing the biomechanical and clinical studies that verify the effectiveness of the protector in

question. Studies with negative results should be included in the application. It would be consistent with the requirements of evidence-based medicine and provide important quality control for elderly users and those paying for the products [5].

A recent Cochrane review on hip protectors included 15 randomised trials and concluded (without setting apart the different protector designs) that in institutions with very high rates of hip fracture, the use of hip protectors may help to reduce the risk of fracture, while there is no evidence of benefit from hip protectors for lower-risk older people [32]. This conclusion is also consistent with a recent cost–benefit analysis, in which external hip protectors were shown to be a cost-saving intervention in US nursing-home setting [33].

In addition to the possibility of substandard protector characteristics, the commonest general problem with hip protectors is related to compliance. Not all elderly people with a high risk of hip fracture will agree to use hip protectors. In our randomised study, the initial acceptability rate was 69% [21]. Also, in the long term, compliance or adherence can decrease—especially if caregivers' motivation and interest in fracture prevention reduce over time. Specific strategies to address these issues are a key requirement for future intervention studies.

Conflicts of interest

The mentioned organisations have played a role neither in the design, execution, analysis and interpretation of data, nor in the writing of the studies.

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Key points

- Hip fractures affecting frail older people constitute a major public health burden worldwide.
- The great majority of hip fractures are caused by a sideways fall with direct impact on the greater trochanter of the proximal femur.
- A padded, strong-shield hip protector has been shown to be effective in preventing hip fracture.
- Lack of efficacy in clinical trials may reflect inadequate protector design and characteristics.
- A further common problem with hip protectors is related to user compliance.
- Caregivers' motivation and interest in fracture prevention are of great importance in maintaining compliance among protector users.

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