# The role of assistive devices in frail elderly people with fragility fractures: a narrative review

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**ABSTRACT**

Fragility fractures commonly lead to disability. To improve and/or maintain physical function and independence in patients with bone fragility, several aids and orthoses are often prescribed in clinical practice for different purposes. Walking aids such as crutches, canes, walkers and wheelchairs are designed to assist walking and prevent falls in people with gait and balance impairments, or who are unable to walk alone. To facilitate transfers in patients with balance and coordination disorders, muscle weakness and impaired respiratory function, mobility devices such as toilet, shower and bed aids may be useful. Hip protectors are designed to decrease the impact forces generated by a fall on the greater trochanter. Wearing these devices at the time of a fall can decrease the risk of hip fracture. Spinal orthoses support a specific vertebral region, and they are worn, in the case of fractures, with the aim of providing stability, relieving pain and improving mobility. However, to maximise the beneficial effects and reduce the risk of adverse events, physicians need to promote correct use of assistive devices, as their incorrect use may increase the risk of both falls and of fall-related injuries.

**KEYWORDS**

Frail elderly, osteoporosis, fragility fractures, assistive devices.

## Introduction

Fragility fractures are a huge public health problem, as they can lead to hospitalisation, disability and death, generating high costs linked to both conservative and surgical management, including the post-operative phase and the prevention of new fractures.

Patients who experience a fragility fracture, particularly at the hip, commonly suffer from multiple health problems, including sarcopenia and frailty, that have a significant impact on the occurrence of complications, and carry increased risks of disability and mortality.

Frailty is an important but still incompletely understood clinical concept that lacks an internationally agreed definition [1]. It is a geriatric syndrome that develops as a consequence of an age-associated decline in physiological reserve and function across multiple organ systems, leading to increased vulnerability to adverse health outcomes and reduced capacity to cope with internal or external stressor events [2]. The global incidence of frailty was estimated at 43.4 new cases per 1000 person-years, with a significantly higher incidence in women than in men [3]. Its prevalence is expected to increase in the future, given that the proportion of the world's population aged over 60 years of age is set to nearly double between 2015 and 2050, from 12% to 22% [4].

Among European countries, Italy has one of the highest prevalence rates of a prodromal stage called pre-frailty (49.7%) [5]. The estimated healthcare cost of frailty in a 9-month period is US$ 10,690 due to comorbidities, multiple drug therapies and the use of potentially inappropriate medications [6]. Frail older people have an increased risk of falls, accident-related-disability, hospitalisation, and mortality [7]. Sarcopenia and osteoporosis are major contributors to disability and frailty. These conditions are associated with age-related chronic inflammation, also called "inflammaging", that leads to changes in body composition (decrease in both muscle mass and strength and bone loss) and hormonal imbalance (such as declining levels of sex steroids and GH) [8]. Frail elderly people are likely to experience recurrent falls [9]. According to the WHO, a fall is an unexpected event in which the person comes to rest on the ground, floor or a lower level [10].

The combined effect of falls and low bone mineral density increases the risk of serious injuries such as hip, wrist, humeral, pelvic and vertebral fractures [11]. The latter are the most frequent fragility fractures [12] and, unlike other osteoporotic fractures, might occur without falls and are mostly asymptomatic rarely requiring hospitalisation [13,14].

Fragility fractures, leading to a loss of independence, may dramatically reduce the quality of life of older people and their families, and may also lead to disability and death [15]. Many risk factors can contribute to a higher fall risk. Intrinsic ones are advanced age, previous falls, muscle weakness, gait and balance disorders, poor vision, postural hypotension, chronic conditions (arthritis, stroke, incontinence, diabetes, Parkinson's disease, dementia), and fear of falling. Extrinsic risk factors are poor lighting, an inappropriate home environment

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due to the presence of obstacles, a lack of aids (stair handrails, bathroom grab bars, etc.), slippery or uneven surfaces, and the use of psychoactive medications [16]. In order to reduce fall risk, a multimodal approach may include exercise programmes, education programmes, medication optimisation, environmental modification and assistive devices such as aids and orthoses [17]. Aids are defined as any items, modified or customised, that are useful to improve the functional capabilities of individuals with disabilities. Orthoses are external devices used to limit or assist motion of some part of the body (e.g., insoles, braces, splints) [18]. In clinical practice, these devices are prescribed to improve and/or maintain the physical performance and independence of the patient in performing activities of daily living, such as transfers and walking, as well as to prevent falls [19]. A recent systematic review reported that the use of spinal orthoses in elderly people with osteoporotic vertebral fractures might reduce kyphotic deformity and spinal movements, and might improve muscle strength, postural control and also biomechanical stability of the spine, thus resulting in pain relief and better functional outcomes [20,21]. In this paper we provide an overview of the role of assistive devices in the frail elderly, addressing in particular their use in patients with bone fragility.

## Methods

In this narrative literature review, PubMed and National Library of Medicine databases were searched using combinations of the following keywords: ("Self-Help Devices" [Mesh] OR "Orthotic Devices" [Mesh] OR "Splints" [Mesh] OR "Protective Devices" [Mesh] OR "Canes" [Mesh]) AND "Accidental Falls" [Mesh] AND ("Frail Elderly" [Mesh] OR "Aged" [Mesh]). Additionally, we used "Skeletal Fragility" and "Bone Fragility" to run the search in the previously mentioned databases. We considered studies published up to January 2021.

## Walking aids

Ambulatory aids are devices designed to assist walking and prevent falls in people with gait and balance impairments [22]. The ones most frequently used in clinical practice are crutches, canes, walkers and wheelchairs. The choice of the most appropriate walking aid depends on several factors such as the underlying pathology and its location, the presence of mono or bilateral lower limb involvement, and the possibility of being assisted by a caregiver (Table I). Crutches modify forces applied to the body, transferring the ground reaction forces to the arms, which then bear the individual's body weight during the swing phase of crutch gait [23].

Their use is necessary to improve patients' mobility after surgery or trauma by reducing weight bearing on the affected lower limb [24]. A cane may improve postural stability by providing a stabilising hand reaction force; it also gives a greater centre-of-mass range, enlarging the size of the base of support in order to prevent falls [25]. Many types of cane are available and they each offer specific benefits. Single point canes are useful in patients with early balance problems, which may be caused by visual, auditory and vestibular impairments and peripheral proprioceptive or cerebellar disorders. Canes of this type provide an additional point of contact with the ground to increase the base of support [26]. Quad point canes provide a wider area of support, offering patients a greater weight-bearing capacity and greater stability. They are mainly prescribed for patients with hemiparesis [27]. Seat canes are equipped with a small seat which give the patient the possibility to rest when they are tired from walking [28]. Although canes are useful when one side of the body is affected, a walker is preferable in situations where the patient needs more support for balance control and gait (e.g., after a hip replacement) [24,29]. A fixed-frame walker provides better stability because it guarantees small-step walking, but it is not indicated in elderly patients with muscle weakness of the upper limbs, given that it needs to be lifted off the ground with every step. In individuals with cardiac or respiratory illness, a rollator walker is more appropriate because it reduces the level of energy expenditure and increases endurance [30].

In older people with limited walking ability due to frailty or other conditions that lead to fatigue and muscle weakness (e.g., stroke, amputations, progressive muscular diseases), a wheelchair provides proper postural support, increasing mobility and independence [31]. Self-propelled wheelchairs are designed for people able to walk but for short distances, and who have sufficient upper limb strength. In manual wheelchair use, forward propulsion is a constrained movement due to the fact that, with the patient in a sitting position in which the hands are placed on the hand rim, the upper limbs have a limited range of motion. Reaction forces at the shoulder joints place the rotator cuff muscles under significant strain in stabilising the joints during motion. Furthermore, posterior forces on the glenohumeral joint push the humeral head upward and posteriorly, increasing the risk of impingement syndrome and rotator cuff muscle in-

**Table I** Different types of walking aids for frail elderly.

| | CRUTCHES | CANES | WALKERS | WHEELCHAIRS |
|---|---|---|---|---|
| What conditions require the use of these devices? | Surgery or injury | Early balance problems affecting one side (e.g., due to visual, auditory and vestibular impairments, hemiparesis, knee and/or hip osteoarthritis) | Muscle weakness and loss of balance in both lower limbs (e.g., hip or knee prosthesis) | Limited walking ability due to illnesses, injuries or disabilities |
| How does it work? | They support body weight, avoiding loading of the affected leg or foot | They improve stability by increasing the support base | Increase the base of support and bear the patient's weight | Provide proper postural support, increasing mobility and independence |

jury [32]. In patients with muscle weakness, attendant propelled wheelchairs can be used. These differ from the self-propelled ones, having smaller-diameter posterior wheels to make them easier to transport. Finally, electric wheelchairs are an appropriate choice in the event of caregiver unavailability or for covering long distances [33]. International guidelines suggest that walking devices should be financed when patients have mobility limitations that make it difficult for them to carry out everyday activities at home [34]. Although not risk free, they are among the most widely accepted interventions in older people at risk of falls [35]. Despite the fact that ambulatory aids provide postural stability, a recent study reported that frail elderly individuals using these devices experienced a higher frequency of falls (78.9%) compared with non-users. However, the authors reported that most of the participants were not using walking aids at the time of their fall. This finding suggests that improper use of walking aids might even increase the risk of falls [36]. Since most patients start using their assistive device without recommendations or instructions from a medical professional, clinicians should routinely assess patient's walking devices to verify their proper fit and use [37].

## Mobility aids

Mobility aids are frequently prescribed in the frail elderly, with the aim of reducing the risk of falling during postural changes in daily activities. Assistive mobility devices facilitate transfers and are used to manage functional disabilities in patients with balance and coordination disorders, muscle weakness and impaired respiratory function. Moreover, these devices favour energy conservation, comfort and safety, improving the level of independence in self-care activities in older people [38]. For toilet transfers, patients who have difficulty transitioning from sitting to standing can benefit from a 3-in-1 commode, a raised toilet seat with handles, a drop-arm commode, or a toilet transfer board (for people with severe motor deficits). The 3-in-1 commode is a single device with three functions: it can be used bedside in older patients unable to move to and from the bathroom, in conjunction with the bathroom toilet, or as handrails to help the elderly person get down and up from a sitting position during toilet use [39]. A raised toilet seat provides greater stability when getting up from and sitting down on the toilet, reducing muscular effort. Moreover, the handles help the user to support himself or herself independently [40]. A drop-arm commode is useful to facilitate transitions from toilet to wheelchair in patients unable to walk independently. Toilet transfer boards are suggested for elderly people unable to stand when making the transfer from wheelchair to toilet. They reduce the load on the hands, decreasing the risk of injury to the upper limbs [41]. Recent international guidelines suggest that toileting aids should be prescribed in patients who cannot effectively transfer to the toilet at home.

With regard to bathing, a raised bath board may be prescribed when a standard bath board is not suitable, while a 3-in-1 commode may be prescribed when the older person does not have a mobile shower commode that can be fitted with a pan [42].

Considering that the use of a bathtub becomes progressively more difficult with age, showers should be preferred as they are more practical, albeit not risk free. With the purpose of preventing falls, shower aids can be recommended, such as a shower chair, handheld shower head and/or grab bars. A shower chair with or without a backrest may be necessary in older patients unable to stand when showering in order to reduce the risk of slipping and falling [43]. Handheld shower heads can help elderly people with mobility limitations to wash [44]. Easy to grasp and adjustable in height, they can be used to reach any part of the body. Grab bars are designed to help individuals keep their balance while standing and to reduce fatigue, to support body weight during shower manoeuvres, and to provide support in the event of a slip or fall. Moreover, they reduce the magnitude peak of extension moments at the lower limb joints during stand-to-sit and sit-to-stand transfers [45]. However, poor use of these devices seems to be linked to psychosocial constructs [46]. According to the Americans with Disabilities Act (ADA) Accessibility Guidelines, it is necessary to have handrail or a grab bar to guarantee safety; moreover, the portable seat must be of adequate height so that the elderly person can sit comfortably and safely [47].

Since 25% of falls in the healthcare setting occur from the bed [48], patients who have difficulty getting in and out of bed may benefit from bedrails, a bed trapeze or leg lifters. Bedrails provide a physical barrier, protecting elderly patients from bed falls [49]. A bed trapeze helps with bed mobility, especially in the transition from the supine to the sitting position [50]. Leg lifters help older people who have had a hip injury or hip replacement to lift their legs when they are lying in bed [51]. International guidelines suggest the use of a trapeze to increase bed mobility in patients unable to turn from side to side or to perform positional changes [52]. Similarly, bedrails are recommended in people with a history of bed-related serious injury or episodes of falling out of bed [53].

## Hip protectors

Hip protectors are orthoses consisting of a pair of soft pads or hard shields fitted into specific underwear with pockets. These orthoses are designed to decrease the impact forces generated by a fall on the greater trochanter. Hard shields move the impact force away from the greater trochanter to all the soft tissues surrounding it, whereas soft pads mainly absorb the impact force [54]. Simulated fall studies have shown that hip protectors decreased the impact forces from 7806 N (indicating a severe fall) to less than 3100 N, the average fracture threshold [54]. Hard hip protectors proved able to achieve this reduction under conditions of simulated thick and thin soft tissue surrounding the femur, whereas soft protectors achieved impact force reduction below 3100 N only in the first case. Although hard hip protectors were better than soft ones in reducing the impact force, the soft protectors showed higher compliance. Wearing these devices at the time of a fall can decrease the risk of hip fracture by up to 80%. In terms of absolute effect, it has been reported that hip protectors result in fracture in 11 fewer people per 1000 in nursing and residential settings. On the other hand, hip protectors may slightly increase the risk

of pelvic fracture. It has been demonstrated that use of these devices has an absolute effect of one more person per 1000 having a pelvic fracture. Moreover, some minor adverse events were associated with these devices, such as skin irritation in about 5% of subjects.

Patients report that hip protectors are uncomfortable and time consuming to wear, and they could be a nuisance in those with urinary incontinence. Moreover, the effectiveness of hip protectors is reduced in the event of even only slight displacement of the device, which commonly occurs in daily activities. Therefore, their benefits may be undermined by poor acceptance and adherence, as shown by the wide adherence range (20-92%) [55].

The use of these orthoses has yielded mixed benefits so, to the best of our knowledge, their use is recommended only in residential-care settings in patients with a very high risk of falling [56].

## Spinal orthoses

Spinal orthoses (or braces) are devices intended to support or immobilise a specific vertebral region, such as the cervical, thoracic or lumbar spine, but also junctional regions [57]. Their purpose is to offer stability in the case of fractures, relieving pain, improving early mobility, and avoiding further kyphotic collapse of the fracture site [58]. Spinal orthoses are also designed to improve posture, balance and back muscle strength, ultimately to reduce the risk of falls. Spinal orthoses may be divided into rigid braces, made of stainless steel or titanium, and semirigid braces, made of polymeric or composite rods [59]. With regard to their biomechanical principles, rigid spinal orthoses are based on a three-point pressure system; these aids provide posteriorly directed forces coming from the sternal and suprapubic pads and an anteriorly directed one coming from the thoracolumbar pad [60]. These mechanisms of action may be particularly useful in the acute phase of vertebral fragility fractures, although supporting evidence is poor.

From a biomechanical perspective, the semi-rigid brace works through tactile feedback, inducing muscular activation and reducing kyphotic posture. These braces can be also classified, according to their site of action, as: thoracolumbosacral, thoracolumbar or lumbosacral orthoses. Finally, garment or kypho-orthoses can also be used.

Current evidence on the use of spinal orthoses is poor, however a systematic review supports the use of a semirigid backpack thoracolumbar orthosis in women with vertebral osteoporotic fractures with hyperkyphosis [20]. Furthermore, the use of weighted kypho-orthosis (WKO) may improve balance in non-hyperkyphotic women with osteoporosis. The WKO could achieve this result by creating an extension moment below the scapula and, since it has no pelvic strap, patients must recruit the hip to balance themselves and maintain a correct posture [20].

On the other hand, it has been found that the use of activating spinal orthoses, worn 2 hours a day for 6 months, in osteoporotic patients with or without vertebral fractures produced non-significant improvements in back pain, back extensor strength and kyphotic index [61].

Spinal orthoses are not free from complications, such as decubitus ulcers and soft tissue infections, especially in the elderly [62].

According to international guidelines, rigid braces should be used in the treatment of vertebral collapse and recent osteoporotic vertebral fractures; semirigid braces should be preferred in elderly patients affected by moderate to severe back pain with or without osteoporotic vertebral deformities [63].

## Conclusions

Aids and orthoses are useful in the multidimensional management of elderly individuals, particularly those with osteoporosis. Assistive devices can prevent fragility fractures and improve functional independence in patients with or without osteoporotic fractures, offering additional benefits in terms of reducing the caregiver burden. However, incorrect use of assistive devices may increase the risk of both falls and fall-related injuries, so they must be used appropriately to maximise their beneficial effects and reduce the risk of adverse events.

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