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Evidence-Based Management in the Rehabilitation of Osteoporotic Patients with Fragility Fractures

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1. Introduction

Osteoporosis is a common skeletal disease in older populations, leading to more than a million fractures annually in the United States (Rockville, 2004) and Europe (O'Neil, 1996). Epidemiologic studies show that increased fracture risk in adults begins around the age of 45 years, particularly in women, progressing notably more with each decade of aging (Siris et al., 2010). About half of adult women and one third of adult men will sustain a fracture (Moayyeri, 2008).

Non vertebral fractures represent 75% of osteoporotic fractures seen in clinical practice (Tosteson et al., 2005). The incidence of non-vertebral fractures, especially of the hip, increases rapidly with age (Piscitelli et al., 2010). The progressive aging of the population, observed during recent years, inevitably led to an increase in age-related diseases such as osteoporosis (OP). Patients with fragility fractures need to be prioritized for health and social security concerns. Fractures in older adults are often referred to low trauma or fragility fractures because they tend to occur as the result of a fall from a standing height (or lower) or from a minimally traumatic event that would not necessarily have resulted in a fracture in a younger person, or in the same individual at a younger age. They have also been referred to as osteoporotic fractures, since epidemiologic evidence has shown that low bone mineral density (BMD) is associated with an increased population based risk of fractures (Siris et al., 2006). The risk of fractures seems to be determined by a balance between bone strength and propensity for falls, which in turn are determined by the frailty of the patient (Bergman, 2007). Falls are the most significant risk factor for fractures, with 90% of hip fractures occurring as a direct result of a fall (Jarvinen, 2008). About half of adult women and one third of adult men will sustain a fracture (Moayyeri, 2008). Lifetime risk after the age of 50 years for sustaining hip, distal radius, or proximal humerus fractures is 25% in men and 55% in women (Ahmed, 2009).

Fragility fractures may have important consequences such as hospitalization with long periods of immobility, the need to undergo surgery, increased risk of disability and partial or complete loss of autonomy during ordinary activities of daily life and related economic burden.

After a femoral fragility fracture, only one out of three older people who survive returns to his previous level of independence, 50% require long-term help with routine activities and cannot walk unaided, 25% require full-time nursing home care and 20% die within one year

(Heinrich et al.,2010). Vertebral fractures are the most common osteoporotic fractures, after hip fractures, affecting 25% of the elderly female population. The acute pain after a new vertebral fracture traditionally is managed with rest and analgesic therapy (Rossini et al.,2010). The presence of vertebral fractures is associated with a decrease in the quality of life and with a higher risk of further vertebral and non -vertebral fractures. Once the first vertebral fracture has occurred there is a higher risk (equal to 20%) of further vertebral fractures in the first year (“vertebral fracture cascade”) (Briggs et al.,2007). Clinical studies, in the last years, identified a significant increase in the incidence of ankle fractures in the elderly population, in particular in postmenopausal women and this led the authors to include these among the fragility fractures classification (Eric,2007).Regardless of the type of fragility fracture, the majority of women do not receive any treatment during the year following a trauma. Failure to implement or late implementation of preventive measures, as well as poor treatment compliance, leads to the deterioration of the health economic outcome. In the past decade, there has been an increasing interest in research on exercise for older people recovering from fragility fractures; however, the extent of this literature remains unclear. In the elderly osteoporotic patient, it is necessary to add to these objectives more specific ones: prevention of new fractures, increase of bone mass, maintenance of improved bone quality, improvement of balance to avoid falls, maintenance of effectiveness during the years of treatment. Bone response to mechanical stimuli must also be taken into account. This is different in osteoporotic individuals compared to healthy ones, as well as is the effect of rehabilitation exercises to improve balance and muscle strength. Patients with fragility fractures should be offered a coordinated multidisciplinary rehabilitation program with the specific aim of regaining sufficient function to return to their pre-fracture living arrangements. Many functional benefits are associated with exercise and physical activity participation by older adults, including improved cognitive, cardiovascular functioning, strength and balance, as well as reduced risk for falls and bone density loss (Nelson et al.,2007). However, there is little information on the safety, efficacy, or effectiveness of exercise prescription in older adults after a fracture.

In this chapter we report results of recent studies in the international literature regarding the complex and multifactorial rehabilitation process to be carried out in the osteoporotic elderly patient with a femoral or non-femoral fragility fracture. We wanted to emphasize how the post-operative management in these patients requires a different approach from that of a young patient, with an integration of different aspects such as multidisciplinary approach, specific exercises, educational and social measures and appropriate drug treatment support.

2. Physical activity and rehabilitation in the elderly

Fractures in the elderly—particularly fractures of the appendicular skeleton—result from two processes: a loss of skeletal integrity and an increased risk of falls (Nordstrom et al., 2011).

However, little attention has been given to the targeting of extra-skeletal factors to prevent fractures in selected individuals. In the management of patients at increased risk of fracture because of osteoporosis or extra-skeletal risk factors, measures of musculoskeletal rehabilitation should be considered as a prelude to, or even in conjunction with, pharmacotherapy to optimize musculoskeletal health, improve quality of life, and reduce the risk of fracture and fracture recurrence (Pfeifer et al., 2004).

Rehabilitation is a goal-oriented and time-limited process that focuses on making a functionally impaired person reach an optimal mental, physical and social functional level. The aim is on one hand to restore the functional level of people who sustained a fracture as a consequence of falling; on the other hand, when falling is not combined with fractures, the goal is to avoid the latter by educating the high risk groups.

With aging, a decrease in reaction time is expected, and therefore the ability to respond rapidly and effectively is reduced in older people compared to younger adults. Studies of reaction time in stepping have typically observed a delay in step initiation and execution timing in older people. Co-ordination time has also been linked to upper extremity fracture risk, as elderly people often delay in breaking the fall by outstretching their hand (Dionyssiatis et al., 2008).

Before starting a tailored program for any individual patient, correct medical history and clinical examination must be performed. The following information should be collected: weight/height, menarche/menopause, nutrition, pharmacological therapy (past and present), level of activity, previous fractures, history of falls, risk factors for secondary osteoporosis. The following are considered high risks for secondary osteoporosis: liver and severe chronic kidney pathology, steroid drugs (>7,5 mg for more than 6 months), malabsorption (e.g. Crohn's disease), rheumatoid arthritis, systemic inflammatory syndromes, hyperthyroidism, primary hyperparathyroidism, antiepileptic drugs.

The rehabilitation protocol must be global and specific. The objectives of the general therapeutic exercise are: prevention of fractures in all skeletal sites, increase of bone mass in all districts, maintenance or improvement of bone quality, improvement of balance with reduction of falls, maintenance of effectiveness during the years of treatment (Mangone, 2010). Important potentially modifiable risk factors for falling in community-dwelling older adults are: mental status, psychotropic drugs, multiple drugs, environmental hazards, vision, lower extremity impairments, balance, gait status; for institution-dwelling older adults: mental status, depression, urinary incontinence, hypotension, hearing, balance, gait, lower extremity impairments, low activity level (exercise less than once a week), psychotropic drugs, cardiac drugs, analgesics and use of a mechanical restraint. Non-modifiable risk factors (i.e., hemiplegia, blindness) also exist (Moreland et al., 2003). Interventions to prevent falls may be planned to reduce a single intrinsic or extrinsic risk factor of falling or be broadly focused to reduce multiple risk factors simultaneously.

Single evidence-based interventions include exercise, reassessment of medications and environmental modification. Graded reductions in the risk of hip fracture were found in women who performed moderate-to-vigorous activities for at least 2 h/week or who reported more hours of heavy chores per week. In contrast, the more hours a woman spends sitting per day, the higher the risk is of hip fracture: women who sat for at least 9 h/day had a 43% higher risk than those who sat for 6 h/day. Although the dose-response relation with physical activity was established for hip fractures, it was less apparent for wrist and vertebral fractures.

However, many functional benefits are associated with exercise and physical activity participation by older adults, including improved cognitive, cardiovascular, strength, and balance functioning, as well as reduced risk for falls and bone density loss.

However, there is little information on the safety, efficacy, or effectiveness of exercise prescription in older adults after a fracture (Freehan et al., 2011).

The intervention of “exercise prescription” is broadly defined as physical activity, exercise or active rehabilitation prescribed by a physician, physical therapist or occupational therapist, or other allied health professional. The concept of “exercise prescription” was broadly defined to fit with the concept of exercise prescription as defined by the ACSM position statement (1999) as “the process whereby a person’s recommended regimen of physical activity is designed in a systematic and individual manner.” Physical activity was defined as bodily movement produced by contraction of skeletal muscles that leads to increased energy expenditure, whereas exercise was defined as planned, structured and repetitive movements focused on improving or maintaining physical fitness (Andreoli et al., 2001).

Using the framework of the International Classification of Functioning, Disability and Health (ICF) (WHO, 2001), therapeutic exercise was defined as exercise prescribed by a medical (physician), rehabilitation (physical therapist or occupational therapist), or other allied health professional to address an individual’s structural or functional impairments (e.g., in range of motion, flexibility, strength, balance), limitations in activity (e.g., activities of daily living, dexterity, walking speed/distance, walking up or down stairs), or restrictions in participation in life situations (e.g., work, sport, other life roles). Older people who had recurrent falls should be offered long-term exercise and balance training. Tai Chi is a promising type of balance exercise, although it requires further evaluation before it can be recommended as the preferred method for balance training. Tai Chi, which consists of slow, rhythmic movements emphasizing on the trunk rotation, weight shifting, co-ordination, and a gradual narrowing of the lower extremities’ position, is thought to be an excellent choice of exercise for the elderly. There is experimental evidence from both cross-sectional and longitudinal studies that Tai Chi exercise has beneficial effects on balance control and that postural stability is improved more by Tai Chi than by other types of exercise. However, Tai Chi has not been shown to reduce falls in frailer older people, so cannot be recommended for fall prevention to a group who had hip fractures and are likely to be frail. Those with a history of Colles’ fractures and with only mild deficits of strength and power are more likely to benefit. It is the slow, smooth, 3-D nature of Tai Chi with its transitions of stance that challenge balance that will help reduce a person’s risk of falls; if the person is too frail to lift one foot off the ground and move it forward, then the Tai Chi must be adapted so much that perhaps more static balance work is more appropriate to start with.

A review by Gillespie L.P. et al. (2001) described the results of 13 randomized controlled trials of physical exercise or physical therapy to prevent falls in elderly people. One of the studies reported that participants exposed to Tai Chi intervention had a lower rate of falling than controls (risk ratio, 0.51; 95% CI, 0.36–0.73). Tai Chi exercises were performed on a weekly basis for 15 weeks with supervision by an instructor. In addition, subjects were requested to try Tai Chi exercising for 15 minutes. Pooled data from three studies with a total of 566 community-dwelling 80 years old women using the same individually tailored program of progressive muscle strengthening, balance retraining, and a walking plan, indicated that this intervention reduced the number of individuals sustaining a fall over a 1-year period (pooled relative risk [RR], 0.80; 95% CI, 0.66–0.98).

A trial published by Jensen et al. reported that a multidisciplinary program of both general and resident-specific tailored strategies reduced falls and fall-related injuries in persons 65 years of age living in residential-care facilities. The strategies comprised educating staff, modifying the environment, implementing individual exercise programs, supplying and repairing aids, reviewing drug regimens, providing free hip protectors, and having problem-solving conferences after falls (Jensen et al., 2002). However, as aging is related to

reduced physical functioning, exercise prescription for fall prevention, except balance and strength training, should surely include exercises to increase the functional capabilities in all elderly people (Judex and Rubin, 2010). The suggested solutions are low intensity balance exercises (tandem walking and standing on one's foot) combined with co-ordination exercises. Individuals who are frail, severely kyphotic or suffer from pain or poor balance, may benefit from water exercise (hydrotherapy). The elderly are also advised to undergo strengthening exercises of the quadriceps, hip abductors/extensors, back extensors and the arm muscles. Back strength is also significantly lower in persons with osteoporosis than in healthy ones. As reported by Sinaki et al. (2002), strengthening of the paraspinal muscles can reduce the risk of vertebral fractures. They found that progressive, resistive back strengthening reduced the risk for vertebral fractures in women 58–75 years old. As for fractured patients, although there are trends concerning studies for faster recovery in mobility, functioning and pain reduction (without risk of increased complications) when using early post-surgical motion and/or functional use and/or weight bearing, there is still insufficient or conflicting evidence from randomized trials to be able to recommend any one early mobilization or exercise intervention over another.

2.1 Rehabilitation after hip fractures

Over 98% of hip fractures are associated with falls. A pro-active approach to prevent falls should receive at least as much attention as drug therapy for osteoporosis, in hip fracture patients. However this area of care is often neglected. The concept of frailty has received increasing attention in recent years as neither BMD nor clinical risk factors (i.e. age and weight) can fully quantify the risk of osteoporotic fractures in the elderly. Frailty is a state of poor well being, related to muscle weakness and sarcopenia, poor endurance, a low level of physical activity, easy exhaustion and a slow gait (Fried et al., 2001). Pre-fracture cognitive impairment, functional dependency, and co-morbidities will negatively influence an older adult's ability to regain pre-fracture functioning. Slow functional recovery and increased risk of progressive functional decline within the first year after fracture are most notable after hip fracture, with marked decline in physical, mental, and emotional functioning at 3 months post-fracture and over the next few months. One year after hip fracture, 50–55% of people will have a residual walking disability, with many never returning to pre-fracture or age-matched control functional status. In addition, 15–30% of community-dwelling people will be living in institutional care 1 year after the hip fracture. The potential physical, emotional, and social consequences of any fracture in an older adult are different and wide ranging. Many fractures are managed surgically, with older adults more vulnerable to complications arising from surgery and hospitalization. Successful operative treatment of hip fractures allows optimization of post-injury mobility and functional recovery. Rehabilitation after surgical stabilization of a hip fracture is crucial in order to restore pre-fracture function and decrease the risk of long-term institutionalization, which can be 25% during the first year post-fracture.

Evidence-based clinical practice guidelines suggesting possible treatments and rehabilitation pathways for hip fracture patients, agree that it would be best if they underwent multidisciplinary rehabilitation (Scottish Intercollegiate Guidelines Network, 2002; Chilov et al., 2003). Multidisciplinary rehabilitation can be defined as the combined and coordinated use of medical, social, educational and vocational measures for training or retraining the individual to the highest possible level of function. Physical activity and exercise form, part of the post-hip fracture rehabilitation in the elderly, also serve to increase

muscle mass and strength, improve body function, reduce risk of falls, and contribute to a better quality of life. Immobilization accelerates bone loss and should be avoided as much as possible. Nonetheless the minimal level of physical activity and exercise required to prevent bone loss remains a matter for debate (Moayyeri, 2008).

In hip fracture patients with reduced mobility and poor balance, careful evaluation is required before exercise is prescribed: without adequate balance training the subject may be at higher risk of falls and hence fractures. In post-hip fracture subjects with poor mobility, poor motivation, and easy fatigability, whole-body vibration could be an alternative to conventional exercise. Whole-body vibration can induce strengthening of the muscles as well as improvement of the BMD in postmenopausal women. According to a meta-analysis by Cameron I. et al. (2000), there is no conclusive evidence that coordinated multidisciplinary inpatient rehabilitation is more effective than conventional hospital care (no rehabilitation professionals involved) for older patients with hip fracture. Because many community-living older persons who fracture a hip eventually return home, much of post-fracture rehabilitation occurs at home; thus, little is known about effective ambulatory strategies for the rehabilitation of geriatric patients after hip operation.

In a randomized controlled trial by Tinetti et al. (1999), a home-based systematic multicomponent rehabilitation strategy was no more effective for promoting recovery than usual home-based rehabilitation (Cameron et al., 2000). The Australian guidelines suggest a coordinated rehabilitation program that starts just after admission and provides opportunities for early supported discharge, as long as the patient's mobilization is established (Chilov et al., 2003). Frail patients should follow an inpatient program and are instructed to continue rehabilitation for some time after their discharge. All participants should be nutritionally assessed, so that they receive the recommended protein and energy supplementation. It should be noted that early assisted ambulation should begin 48 hours post-operatively. The majority of studies focus primarily on mobilization introduced within the first 3–4 weeks following fracture, which is consistent with the adverse functional (structural impairment and activity limitation) consequences associated with limb immobilization. The primary clinical concern with early post-fracture mobilization is the possibility of impairing the quality and rate of fracture healing, potentially causing delayed union, non-union or malunion. Hip fracture patients should immediately start breathing exercises so that pulmonary secretions are drained, thus reducing the risk of atelectasies and other complications deriving from the pulmonary system. "Pump like" energetic exercises (ankle pumps) and dorsal/plantar flexion of the foot, knee joint flexion, exercises for the hip and thigh, abduction exercises for the gluteal muscles and exercises for the quadriceps are important. Exercises of the upper extremities and trunk must also be part of the rehabilitation program, so that the patient can move in bed, stand up from a chair and later on be able to mobilize himself by using crutches or a stick. Abdominal and dorsal muscles should also be exercised isometrically and then energetically, in order to minimize the risk of low back pain during weight-bearing exercises. There are some limitations on the range of motion (ROM) after surgery, depending on the surgical procedure (hip fractures stabilized with internal fixation do not require ROM precautions). As soon as the patient who undergoes a prosthetic replacement regains his vigilance, he is instructed to avoid: a) hip flexion greater than 70-90°, b) external rotation of the leg, c) adduction of the leg past midline. Toward this end, the patient must be instructed: a) not to bend forward from the

waist more than 90°, b) not to lift the knee on the side of the surgery higher than the hip, and c) not to cross the legs, neither at the knee, nor the ankle. These precautions should be maintained for approximately 12 weeks. Because dislocations occur usually within the first 30 days more clinical studies are needed to determine the optimum length of time to maintain hip precautions (Kayali et al., 2006). By the third day after surgery, the patient should start training from a sitting position. During transfer from bed to chair, the hip must be abducted. Weight-bearing should start later on, from the 6th to the 10th day when the patient is capable of standing on his feet by himself. Most patients are more likely to start using a walking frame and then progressively move to using crutches.

In the partial weight-bearing stage of rehabilitation, the operated hip is allowed to bear only a load of 20-50% of body weight. Partial weight-bearing should be preserved for 6-12 weeks. Gradually, the patients will be allowed to start walking on crutches for 4-6 weeks. Complete weight-bearing depends on the surgical procedure. Usually, complete weight-bearing is scheduled after a period of 6 weeks following total hip arthroplasty and after 3 months following open reduction and internal fixation (Rucco, 2003).

Physicians should be ready to treat life-threatening medical complications such as cardiopulmonary, deep venous thrombosis and ischemic episodes, but also variable complications such as hip pain, uneven limb length, heterotopic ossification, pressure sores and neurological complications that are likely to occur during hip fracture rehabilitation. Patients are urged to keep on training even after they are discharged and their period of rehabilitation is over. After their strength is regained, they should follow individually tailored and targeted training for dynamic balance, strength, endurance, flexibility, gait and functional skills, training to improve 'righting' or 'correcting' skills to avoid a fall, backward-chaining and functional floor exercises (Skelton et al., 2005).

Hip fracture patients should also have Occupational Therapy (OT) training for skills adaptation and a home visit to get individualized support to improve the ability to perform activities of daily living and to speed up both mental and social recovery. Most studies conducted on training after hip fracture conclude that combined training with task-specific and functionally based exercises may be a sensible way of retraining leg strength, balance and gait ability in elderly people after a hip fracture. The training thus may include a variety of gait exercises, step exercises, stair climbing, and rising from and sitting down on a chair. Most studies of the effectiveness of rehabilitation on functional recovery after hip fracture have involved acute or subacute rehabilitation facilities, targeting patients on wards and in post-discharge settings. In a randomized intervention study by Hauer et al. (2002), a 3-month progressive resistance and functional training program increased strength and functional performance during rehabilitation after hip fracture. Binder et al. (2004) found that six months of extended outpatient rehabilitation including progressive resistance training improves physical functioning, quality of life and reduces disability compared with low intensity home exercise in community dwelling men and women over 65 years. A randomized controlled trial of 49 patients aimed at evaluating the health benefits of an individualized nutrition support program and/or a progressive resistance lower limb training program for older adults admitted to the hospital following a fall-related lower limb fracture. Subjects were randomly allocated to receive a 12-week resistance training intervention using latex-free resistive elastic bands supervised by a physiotherapist. The progressive resistance exercises involved training of the hip and knee extensors, hip

abductors, ankle plantar- and dorsi-flexors. The trial provided evidence that this form of resistance training is well suited to an older, frail lower limb fracture group. Exercise adherence remained high in hospital, in residential care and community settings but it did decline slightly without regular supervision. Progression within the exercise program was steady, with most participants reaching very similar maximal band levels for injured and non-injured sides. This training modality appears to be a suitable alternative for this patient group where traditional methods are limited due to pain, weakness and limited mobility post-hip fracture. It is also an inexpensive option, patients can be educated whilst in hospital and monitored infrequently resulting in reduced travel costs (therapist to home or patient to facility) and resistive bands cost very little. The overall adherence rate was 95%. However it is important to acknowledge that adherence in the study was highest during the supervised period (99.7%; weeks 1–6) compared with the unsupervised period (91.3%; weeks 7–12). This could possibly reflect a decrease in motivation that accompanied a reduction in physiotherapist contact from three times per week initially to only once per week in the final six weeks of the intervention. This reduced supervision may also have had an adverse effect on the social component of regular interaction with the physiotherapists that the program facilitated, which can be an important motivating factor in elderly women. The high adherence rates achieved are also likely a result of the training program being tailored to suit each individual, based on initial strength and pain level of both the injured and non-injured limb (Miller et al., 2008).

Di Monaco et al. (2011) tested the effect of a multidisciplinary program for fall prevention in 95 women with a hip fracture. They received a multidisciplinary intervention during inpatient rehabilitation, which consisted of one to three hours a day for five days a week of physical exercise to improve strength and balance, recommendations and training on the use of assistive devices, training in activities of daily living conducted by physical and occupational therapists. Additionally, 45 women also received a home visit by an occupational therapist at a median of 20 days after discharge. The absolute risk of falling in the population study was significantly lower than that previously reported in hip fracture survivors. Nonetheless, uncorrected environmental and behavioral risk factors and poor adherence to targeted recommendations for fall prevention significantly predicted the risk of falling during a six-month follow-up in community-dwelling women who sustained a fall-related hip fracture. Thus, improving adherence to the recommendations is a major goal to prevent falls.

2.2 Rehabilitation after vertebral fractures

Vertebral fractures have a high impact on the quality of life and their occurrence is related to digestive and respiratory morbidities, anxiety, depression and death. Thereby, the incidence of a vertebral fracture should be followed by a limited period of bed rest, to avoid the hazards of deconditioning, accelerated bone loss, deep venous thrombosis, pneumonia, pressure sores, disorientation and depression. A rehabilitation program is necessary and helps prevent deformity by strengthening anti-gravity muscles and promoting postural retraining. Breathing exercises promote thoracic expansion and improve the heavily degraded pulmonary function found in patients with spinal osteoporotic fractures (Schlaich et al., 1998). Instruction on the proper way of lifting things, as well as how to appropriately use a walker or a cane, could be beneficial and thus is strongly recommended (Bonner et al.,

2003). Patients with fractures should perform low-intensity exercise and gentle strengthening programs (e.g., Tai Chi and hydrotherapy) and are strongly recommended to avoid high impact exercise or movements, to avoid suffering new vertebral fractures. Forward bending of the spine or flexion exercises, especially in combination with twisting, should be avoided.

According to Bassey, this includes several old favourite exercises which are now considered outdated, namely straight-leg toe touches and sit ups (or crunches) for strengthening the abdominal muscles. Sinaki and Mikkelsen reported that the latter are associated with a dramatically increased rate of vertebral fracture in osteoporotic women (89% compared to 16% of those who did extension exercises). As the acute fracture pain subsides, a walking program can begin with gentle strengthening exercises focusing on spinal extensor muscles. A carefully supervised rehabilitation program should be started after 3 to 4 months, to strengthen the spinal extensor and abdominal muscles more aggressively (Sinaki, 1995). Back strengthening exercises can reduce thoracic hyperkyphosis, vertebral fracture, loss of height, and pain of the anterior rib cage, which are the most disfiguring consequences of osteoporosis. Improvement of back strength reduces the kyphotic posture that can occur with osteoporosis and aging. Development of hyperkyphotic posture does not only predispose the patient to postural back pain but can also increase the risk of falls. In subjects with hyperkyphosis, compensatory use of hip strategies rather than ankle strategies occurs during incidents of momentary challenges of balance (Sinaki and Lynn, 2002). In a controlled trial, use of a proprioceptive dynamic posture training (PDPT) program improved balance in osteoporotic subjects with kyphosis. Chronic pain may be caused by vertebral fractures or may be a result of postural deformities, such as hyperkyphotic or scoliotic changes in the spine, with inappropriate stretching of ligaments. Strong back muscles are significantly correlated with a decreased risk of vertebral fractures and kyphosis.)

In patients with severe kyphosis, pressure of the lower part of the rib cage over the pelvic rim causes considerable flank pain and tenderness and compromises breathing. With healthy posture, there is sufficient space between the lower ribs and the iliac crest, so no contact occurs, even on lateral bending of the trunk. In severe osteoporosis with compression fractures, substantial dorsal kyphosis, and loss of height, iliocostal contact occurs. Therefore, helping the patient to decrease kyphotic posturing through recruitment of back extensors for provision of better dynamic-static posturing can reduce pain, increase mobility, reduce depression, and improve the patient's quality of life.

Sacral insufficiency fractures necessitate milder physical therapy, reduction of weight bearing with use of gait aids, and orthoses. Even though there is a lack of specific studies comparing various types of orthoses, it is widely accepted that all spinal orthoses, whether made of cloth, metal, or plastic, or whether rigid or flexible, use a three-point pressure system. Traditionally, spinal orthoses have been used in the management of thoracolumbar injuries treated with or without surgical stabilization. The vast majority of orthoses, however, are used in persons with back pain and spinal deformities.

In the United States alone, 250,000 corsets are prescribed each year. Kaplan et al. (1996) found that rigid bracing is not necessary for managing postural osteoporotic back pain, and indeed, a weighted kypho-orthosis was more effective for patient compliance and pain relief (Kaplan, 1996). Moreover, the use of rigid thoracolumbar braces in osteoporosis is limited by

factors such as short stature (147 cm), atrophy of trunk muscles, hiatal or inguinal hernia, moderate to severe obesity, scoliosis caused by osteoporosis and compression fractures, and restricted respiration, leading to low compliance.

Lantz and Schultz (1986) described increased electrical activity of back muscles when a lumbo-sacral orthosis is worn, supporting the concept of the so-called 'biofeedback' as an underlying principle of efficacy. Stronger back muscles may decrease the angle of kyphosis and thus improve body height. This result may be associated with better posture and a correction of the center of gravity, which then results in less body sway. Given that body sway is a well-documented risk factor for falls and fall-related fractures, this change of the center of gravity may be accompanied by a lower rate of falls and nonvertebral fractures. Given the widespread use of orthoses in various diseases, there is an urgent need for controlled clinical trials to further elucidate functions and applications of these technical devices.

2.3 Rehabilitation after Colles' fracture

Colles' fracture is the most common fracture in women over 40. The reason for prescribing physiotherapy after a fracture of the distal radius is that it serves primary mobilization which is the most important principle of fracture management.. Complications of Colles' fracture may be: rigidity, algodystrophy, or functional limitation. Treatment planning considers the following aspects: type of fracture, stability, presence of possible associated lesions, and type of patient.

Physical therapy after a Colles' fracture consists of muscle strengthening, range of motion exercises, wound healing and scar adhesion. In the rehabilitation pathway consideration is given to the type of surgical intervention. Depending on the type of intervention, we can have different times of limb immobilization: the conservative treatment lasts 5 weeks, osteosynthesis with a plate lasts 2 weeks, external fixing: neutralization for the first 4 weeks, active movements for the successive 3 weeks. The rehabilitation treatment starts during the period of immobilization whatever the treatment (invasive or otherwise). Early reduction of edema is of primary importance in determining hand function. Elevation of the hand above the heart's level and active range of motion exercises are instructed to facilitate the pumping action of hand muscles to decrease swelling. A 15 minute hand-wrap with paraffin should be followed by exercise of equal duration. The hand should be kept in both cold and hot water in order to augment venous return. The articulations not involved in the process must be mobilized actively and passively in order to maintain the integrity of the joint capsule and to prevent tendon thickening and adhesions. The rehabilitation protocol states that at the end of the immobilization period, it is necessary to proceed to active, passive and counter resistance exercises (with or without tutors) under the guidance of the rehabilitation therapist. Exercises must be progressive, but must be initiated early, on the first or second day. Exercise programs consist of transverse scar massage, passive range of motion and progressive resistive exercises, massage and active range of motion exercises, which focus on strengthening both extrinsic and intrinsic muscle groups of the hand.

Global mobilization of the wrist includes: flexion and extension, abduction (ulnarization) and adduction (radialization), longitudinal rotation, pronosupination of the forearm, and mobilization against resistance for regaining of strength. Sessions should be daily for 30

minutes for 2 weeks. Specific exercises aim at producing tension of the periarticular and articular elements. They involve flexion with ulnar inclination (subject standing with forearm in supination, the dorsum of the hand facing the table top and forearm vertically pressing on the table), and extension associated with radial inclination (subject standing, palm of hand on the table and forearm in vertical position, with arm and forearm pronated). Exercises at home are an essential part of the rehabilitation treatment, to be performed at least 4 to 6 times a day for 2 to 3 weeks. Specific exercises are Fingers 'wall walking', bilateral paper ripping, circular 'dusting', simple 'blackboard writing' and drawing tasks, various opposition and pinching are among the most recommended exercises. These activities are graded according to resistance, type of motion and grasp strength. Splinting helps develop the range of motion. Physical therapy should be followed by occupational therapy for 3 weeks (Christensen et al., 2001). Thus in dealing with the rehabilitation treatment of Colles' fracture it is fundamental not to limit ourselves to the specific post-fracture protocol but also to establish a rehabilitation pathway which foresees the global care of the patient with fractures due to fragility fractures.

Clinical practice guidelines for rehabilitation	Objectives of the procedure
Mobilization and early assisted ambulation	<ul style="list-style-type: none">• Avoids immobilization and bone loss• Improves bone healing quality and rate
Breathing exercises	<ul style="list-style-type: none">• Drainage of pulmonary secretions• Reduction of pulmonary complications
Multidisciplinary rehabilitation	<ul style="list-style-type: none">• Increases muscle mass and strength• Improves body function• Early supported discharge• Evaluation of medical complications
Adequate balance training	<ul style="list-style-type: none">• Reduces risk of falls• Reduces risk of a second fracture
Physical activity	<ul style="list-style-type: none">• Reduces risk of falls• Increases muscle mass and strength• Increases BMD
Nutritional statement	<ul style="list-style-type: none">• Adequate protein and energy supplementation
Educational and social measures	<ul style="list-style-type: none">• Better quality of life• Improvement in the ability to perform daily activities• Improves risk awareness• Speeds up mental and social recovery

Table 1. Summary of guidelines and aims of rehabilitation

3. Conclusion

Current osteoporosis practice guidelines recommend that any adult 40 or older who sustains any fracture should be investigated and treated for low BMD, as well as educated about lifestyle and nutritional factors, including exercise and physical activity participation, as a way of potentially modifying their subsequent risk of fractures. In the past decades, there has been increasing interest in research on exercise for older people recovering from fragility fractures; however, the extent of this literature remains unclear. This poses a challenge for determining whether or not there is sufficient evidence to develop practice recommendations, whether or not a systematic review is feasible to conduct and, if there is a gap in knowledge, if that gap exists. Exercise is a complex intervention, and a major challenge to exercise prescription is the identification of the optimal exercise program elements or strategies that contribute to favorable treatment outcomes. Researchers investigating the effects of exercise on BMD have reported increases in BMD in pre-menopausal women participating in low-intensity regular exercise and following the introduction of an exercise regimen. Weight-bearing activities, such as walking or running, have a greater effect than non-weight-bearing activities, such as cycling and swimming, whereas a reduction in mechanical loading, that is, bed rest or space flight, leads to bone loss (Andreoli et al. 2011).

Equally important is the identification of exercise program elements or strategies that do not contribute to more favorable outcomes or are not cost-effective. Although there were trends across all these studies towards more favorable outcomes after specialized, multidisciplinary care programs and more favorable ambulatory and functional outcomes following early mobilization with weight bearing/ambulation, aerobic, balance, and strengthening exercises, there was still insufficient or conflicting evidence from randomized trials to be able to recommend any one mobilization strategy or exercise intervention over another after hip fracture.

There have been few studies that have evaluated resistance training in frail older adults, but in those that have been reported, it appears that high intensity training is more successful than low intensity training in achieving gains in strength. Nevertheless translation of these findings into a clinical setting has been difficult. The provision of therapeutic exercise programs in hospitals to post-operative patients has a poor evidence base and the approach varies from therapist to therapist. There is uncertainty about whether patients recovering from an operation are able to adhere to a resistance strengthening program which commences within a week of fracture when they are often recovering from an operation and dealing with pain and discomfort. There are, however, consistent trends in the literature suggesting: 1) Improved functional outcomes with acute, inpatient, multidisciplinary rehabilitation care programs following hip fracture. 2) Better ambulatory and functional outcomes with early mobilization, weight bearing/ambulation, aerobic, balance, and strengthening exercise interventions following hip fracture. 3) Faster recovery in mobility, functioning and pain without risk of increased complications with early post-surgical motion and/or weight bearing following ankle fractures, and early motion and/or functional use following non-displaced proximal humerus fractures. 4) That supervised or formal therapy may be no more effective in regaining long term mobility and function than unsupervised or home exercise programs following a period of immobilization for distal radius fractures. Prevention of falls and refractures may be even more effective when

multiple risk factors are taken into account simultaneously. Most multifactorial fall prevention programmes have been successful in reducing the incidence of falls and risk factors of falling, especially when prevention has been individually tailored and targeted to populations at high risk of falling.

Multifactorial interventions should include: a) among community-dwelling older persons: (i.e., those living in their own homes) gait training and advice on the appropriate use of assistive devices, review and modification of medication, especially psychotropic medication, exercise programs with balance training as one of the components, treatment of postural hypotension, modification of environmental hazards and treatment of cardiovascular disorders, b) among older persons in long-term care and assisted living settings: staff education programs, gait training and advice on the appropriate use of assistive devices and review and modification of medications, especially psychotropic medications.

Patients with fractures should perform low-intensity exercise and gentle strengthening programs (e.g., Tai Chi and hydrotherapy) and are strongly recommended to avoid high impact exercise or movements, to avoid suffering new vertebral fractures.

Key areas for further research related to exercise prescription following hip fracture included identifying which exercise interventions and/or components of a care program are likely to have long-term, cost-effective and beneficial impacts on functioning and health-related quality of life.

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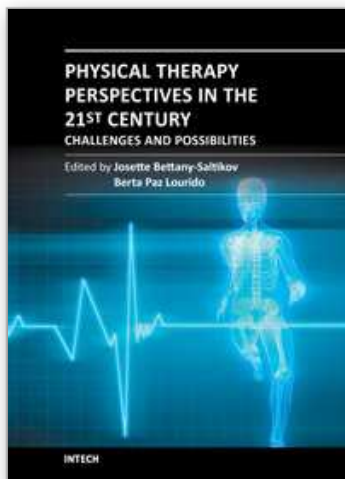
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