

PHYSICAL THERAPY UPDATE

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SEQUOIA PHYSICAL THERAPY



Reducing Falls and Fall Injuries

We believe Sequoia PT has one of the finest fall prevention programs available and we recently published a White Paper on Evidence-based Fall Prevention. If you have not read it, please request it. This issue of Physical Therapy Update is dedicated to some of the literature which drives our approach to fall prevention.

An important issue is identifying patients who need and can benefit from fall prevention therapy. “Fall Prevention for People who Call an Ambulance After a Fall” summarizes research on a patient population hurt severely enough to call an ambulance but are not taken to hospital. Traditional therapy reduced fall rates by 55% in this population. “Jumping Exercise Program Reduce Fall Risk of Elderly People” looks at seniors residing in a residential care facility and shows elderly people with significant deficits respond well to strenuous exercise programs.

Fall Prevention for People Who Call an Ambulance After a Fall

One of the most important factors of a fall prevention program is how patients are selected for the program. The objective of this study was to determine if a fall prevention intervention would reduce the rate of falls in people who call an emergency ambulance when they fall but are not taken to the hospital. In the United States and United Kingdom, between 30-50% of people who call an ambulance are not taken to the hospital. It is not currently

“Deficient Limb Support Major Contributor to Falls” looks into actual mechanisms of falling and finds deficient limb support, specifically lack of neuromuscular control and speed of force development, is the major cause of falls among seniors. A contributing factor is the short protective step often used by seniors.

Two articles—“A Sideways Fall and Hip Fracture” and “Effect of Whole Body Vibration on BMD: A Systematic Review” look at hip fractures from falls. The sideways fall is the most common cause of hip fracture so it is important to protect against those falls. Also, a review of literature on whole body vibration shows vibration to be very promising in slowing the loss of bone mineral density (BMD). Since Sequoia PT uses vibration in our strength and balance training for seniors, it is nice to know the vibration may also have a very beneficial side effect of increasing BMD in the hip.

routine for these patients to be referred to a fall prevention program.

A total of 204 patients were recruited for the study, 102 in the study group and 102 in the control group. The intervention sessions in the home included six strength and balance training sessions provided by physiotherapists, an assessment of and modifications to hazards in the home, practice getting up from the floor by

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occupational therapists, and a nurse provided a review of drugs and blood pressure readings. In addition, patients also attended up to 12 group sessions on fall prevention, twice weekly over six weeks, in local community centers. Each session included one hour of strength and balance training led by a physiotherapist and one hour of education and functional activities led by an occupational therapist. Participants received a median of eight muscle strengthening sessions, 7.5 balance training sessions, 13.5 on functional activities and reduction of hazards.

The primary outcome measure was the rate of falls over 12 months, as recorded using a diary mailed to participants each month. Participants were asked to record every time they had a slip or trip in which they lost their balance and came to rest on

“The intervention resulted in a 55% reduction in the rate of falls over the subsequent year.”

the floor, ground or lower level. The secondary outcome measure was the time to a first fall after completion of the program. Other secondary outcomes included the number of hospital admissions, number of days in the hospital, any fall-related fracture, Barthel activities of daily living index, Nottingham extended activities of daily living scale, and the falls efficacy scale.

A total of 956 falls were reported in the follow-up period, 649 in the control group and 307 in the intervention group. In the intervention group, 83% reported one or more falls over the 12 months and 97% of the control group reported one or more falls. The median time to the first fall during follow-up was 166 days in the intervention group and 21 days in the control group. The intervention resulted in a 55%

reduction in the rate of falls over the subsequent year. The effect was larger than expected.

People who have fallen and called an ambulance but are not taken to the hospital are at high risk of falling again. The authors conclude “Immediate referral of such people to a falls prevention rehabilitation service may reduce the number of further falls and improve other factors of indicators of health.”

Philippa A Logan, C A C Coupland, J R F Gladman, O Sahota, V Stoner-Hobbs, K Robertson, V Tomlinson, M Ward, T Sach, and A J Avery Community falls prevention for people who call an emergency ambulance after a fall: randomised controlled trial. *BMJ* 2010;340:c2102, doi: 10.1136/bmj.c2102 (Published 11 May 2010)

Implications: The greatest reduction in falls is achieved by targeting repeat fallers and painful fallers. Elderly patients who have called an ambulance but not been taken to the hospital are easily overlooked.

Deficient Limb Support Major Contributor to Falls

Researchers Michael Pavol (Oregon State University) and Yi-Chung Pai (University of Illinois at Chicago) noted that increased fall risk has been attributed to a variety of sensory, motor, cognitive, environmental and medical factors, but the actual mechanisms involved when older adults fall have been little investigated. Authors found a loss of postural balance will often lead to a fall unless stability is reestablished by a change in the base of support, typically through protective stepping.

Investigators enrolled 41 older adults (65-85) with a mean age of 73 (21 women and 20 men) and 60 healthy young adults under age 30 (44 women and 16 men). Subjects were told slips would be induced at some point during sit-to-stand movements. Subjects wore a safety harness and a load cell measured the force exerted on the ropes. Feet were positioned on top of force plates. The kinematics of 26 markers attached to arms, legs and torso were recorded by a motion capture system at 60Hz. After four normal sit-to-stand tri-

als, a slip was induced without warning. The slip produced an instability requiring a backward step to recover.

Protective step initiation could be seen in the simultaneous change in vertical force beneath the feet, the stepping foot decreasing force and the support foot increasing force. Step lift off and touch-down were determined precisely from the vertical force on the underlying force plates.

76% of older adults fell compared to 30% of younger subjects. All but one recovery

included a protective step, but 30% of fallers did not attempt a step. 28% of older adults failed to step, versus only 6% of young adults. Authors conclude the no-step fallers were predicting a protective step would fail and were attempting to land safely instead. Also, fallers of all ages took a shorter backward step placing their foot less posterior to their center of mass than those who recovered. The older adults who recovered were more likely to use a second backward step for successful recovery. Fallers experienced greater collapse of the support limb, as evidenced by

Slip Outcome	Backward Steps	Young (n=56)	Older (n=41)
Recover	0	1	0
	1	22	1
	2 or more	12	8
	Total	35	9
Fall	0	3	11
	1	9	14
	2 or more	3	4
	Total	15	29
Harness affected		6	3

greater and faster hip descent, while stepping. Hip height was the primary determinant of slip outcome, meaning in both young and old, falls were most strongly related to deficient limb support. As long as hip height was high enough, subjects could take a second protective step. The need for a second protective step has been observed to be more common among seniors than young adults.

Researchers concluded older adults were 2.5 times more likely to fall than young adults for three reasons: One, the hips of

“Improving proactive and reactive limb support should therefore be a focus of fall prevention efforts.”

older adults were lower and rising more slowly at slip onset. Two, older adults were less likely to respond with the forceful knee and/or hip extensor movements needed. Three, older adults did not step as far backward as younger adults and often required a second step. Deficient limb support could reflect lack of muscle strength, lack of neuromuscular control or both. Authors observed the incidence of falls “decreased by a factor of three with each repeated exposure to the slipping perturbation, even though their strength almost certainly remained the same” (p. 6) and suggest lack of strength is not the primary reason for the fall. Au-

thors conclude “Improving proactive and reactive limb support should therefore be a focus of fall prevention efforts.”

Michael J. Pavol, Yi-Chung Pai. Deficient limb support is a major contributor to age differences in falling. *Journal of Biomechanics* - 2007 (Vol. 40, Issue 6, Pages 1318-1325, DOI: 0.1016/j.jbiomech.2006.05.016)

Implications for Sequoia PT: Because of this study, Sequoia has adapted its fall prevention exercise program in ways to help seniors improve neuromuscular control and speed of force development in the legs using vibration training. Sequoia also uses the safety treadmill to help seniors increase their stride length forwards, backwards and laterally.

Jumping Exercise Programs Reduce Fall Risk of Elderly People

Researchers led by E. Cakar of Department of Physical Medicine and Rehabilitation at Haydarpasa Training Hospital in Istanbul, Turkey investigated whether an exercise program which included jumping would be more beneficial than the exercise program without jumping in older people living in a residential care facility. While balance improved and fall risk was reduced in both groups, the improvements in the jumping group were statistically better than the non-jumping exercise group.

Fall rates and fall injuries are three times higher in residential care facilities as compared to seniors living in community. Long-term care facility residents probably have increased frailty compared to those living in community.

Jumping has become a component of combined exercise programs for the elderly because it is commonly seen as an exercise which maximizes osteogenic responses in lower extremity to prevent osteoporosis and bone fractures.

“Fall rates and fall injuries are three times higher in residential care facilities as compared to seniors living in community.”

A study of two experimental groups was performed and a total of 66 participants completed the study. The inclusion criteria were willingness to participate, over 65, no contraindications to exercise and no uncorrected vision problems. Exclusion criteria included cognitive impairment, unregulated cardiac failure, functional limb failure and usage of an assistive device. The exercise groups met three times a week for six weeks. Each group had a warm-up of 5-7 minutes, 20-30 minutes of exercise and 5-7 minutes of cool down. Total exercising time was not more than 45 minutes and was done under the supervision of a sport teacher and physiotherapist.

One group had exercises which combined stretching, strengthening and aerobics (fast walking, sideways walking with accelerations and decelerations, ball throwing and catching, squatting down and standing up, sitting down and standing up from an armless chair, stretching the extremities and the spine, hip abduction and extension and calf raise).

The second group did the above exercises but also had an additional 10 minutes of self-paced jumping. Jumping was not limited in frequency or intensity. Participants were encouraged to maintain a high level of effort and care was given by research assistants to avoid falls.

Outcome assessments were Berg balance test, Biodex Balance System, SF36 for health-related QOL and Geriatric Depression Scale (GDS) for depression status. While subjects dropped out of both study groups, twice as many dropped from the non-jumping group (8 vs 4). None of the subjects were injured.

Improvement was seen in both groups regarding balance and fall risk but the jumping group experienced “markedly additional positive effects on balance and fall risk.”

Cakar E, Dincer U, Kiralp MZ, Cakar DB, Durmus O, Kilac H, Soydan FC, Sevinc S, Alper C. Jumping combined exercise programs reduce fall risk and improve balance and life quality of elderly people who live in a long-term care facility. *Eur J Phys Rehabil Med*. 2009 Nov 10

Implications for Sequoia PT: This study gives evidence that jumping provides improved balance and reduced fall risk in addition to known osteogenic adaptations.

A Sideways Fall and Hip Fracture

Hip fractures of older adults are a major public health problem. Pekka Kannus of the Accident and Trauma Research Center at UKK Institute for Health Promotion Research in Finland, and co-researchers, conducted a retrospective survey of young adults aged 15 to 49 years old who had suffered a hip fracture to determine cause.

Of the 26 healthy young adults who suffered a hip fracture, 15 were men and 11 were women with a mean age of 39 years. In 12 patients, the fall was caused by a slip, in 7 it was caused by a trip, four patients were pushed and three patients suf-

fered dizziness or fainting. In 21 patients, the fracture type was femoral neck fracture. In 4 patients, it was a trochanteric fracture with a subtrochanteric fracture in the remaining patient.

In 18 of the 26 patients, it is clear the fall was a sideways fall directly onto the hip. This investigation gives evidence that a fall directly onto the hip is a high-impact injury possessing the energy to fracture the hip even in healthy young men. It should be better recognized that sideways falls are dangerous. It is estimated that 1-2% of all falls leads to a hip fracture while

the risk of hip fracture is 20 times greater with sideways falls onto the hip.

Pekka Kannus, Petri Leiponenb, Jari Parkkaric, Mika Palvanena, Markku Järvinen A sideways fall and hip fracture. *Journal of Bone and Mineral Research* 2006. Volume 39, Issue 2, Pages 383-384 (August 2006)

Implication: Sequoia's Fall Prevention program includes walking forward, backward and laterally on a safety treadmill with overhead cabling system to provide functional rehabilitation and strengthening of muscles used in accelerating and decelerating during sideways motion.

Effect of Whole Body Vibration on BMD: A Systematic Review

Whole body vibration (WBV) has a number of effects on the body. This study is focused on changes to bone mineral density (BMD). Animal experiments report anabolic bone changes in response to WBV and randomized human trials also look promising. While summaries of clinical evidence exist, no systematic review of human studies has been published.

Lubomira Slatkovska of Osteoporosis Program at Mount Sinai Hospital in Toronto, Canada led a systematic review and meta-analysis of randomized controlled trials examining whole body vibration on BMD in humans. They found significant but small improvements in BMD in postmenopausal women and children and adolescents, but not in young adults.

Researchers followed the procedures defined by the Cochrane Collaboration on conducting systematic reviews and the QUORUM statement on reporting guidelines. The studies selected were randomized and quasi-randomized trials investigating the effects of WBV on BMD in humans with a minimum follow-up period of

six months, as it takes six or more months for BMD to show a significant response. Acceptable controls included no treatment, sham vibration (audible sound with no mechanical vibration) and exercise interventions.

WBV involves a person standing on a vibrating platform. The intensity of WBV is defined by frequency (number of vibrations per second or hertz) and amplitude or vertical displacement (millimeters). One hypothesis is that WBV exerts its anabolic effects on the bones through activation of the musculature. Another hypothesis is that WBV signals become amplified within bone tissue by stress-generated fluid flow, activating bone cells which act as mechanosensors. In spite of plausible mechanisms, exact effects are uncertain.

Many different WBV platforms are available in the North America and Europe. Eight randomized controlled trials (RCTs) were deemed eligible. A large number of studies were excluded because they were not randomized, did not measure BMD or the study duration was too short. Five of

the trials studied postmenopausal women, four using high-magnitude WBV and one low-magnitude WBV. Most participants did not take bone medication, except for one RCT in which 50 osteoporotic Japanese women received the same alendronate treatment in both the WBV and control arms of the study.

Researchers wrote: "In conclusion, this is the first systematic review and meta-analysis of the effect of WBV on BMD in humans. We found statistically significant but clinically small effects in postmenopausal women, and moderate effects in children and adolescents, but not in young adults. We also found WBV to be well tolerated and safe."

L. Slatkovska, et al. Effect of whole-body vibration on BMD: a systematic review and meta-analysis. *Osteoporosis Int.* 2010. 10.1007/s00198-010-1228-z

Implications: Sequoia PT uses WBV in our fall prevention program to improve strength and balance in seniors. It is good to know WBV may be providing a significant side-effect by improving BMD.

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