A randomised trial of weight-bearing versus non-weight-bearing exercise for improving physical ability in inpatients after hip fracture

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The purpose of this study was to assess the effects of weight-bearing and non-weight-bearing exercise on strength, balance, gait and functional performance among older inpatients following hip fracture. Eighty people (mean age 81 years, SD 8) undergoing inpatient rehabilitation after fall-related hip fracture were randomised to receive two-week programs of either weight-bearing or non-weight-bearing exercise prescribed by a physiotherapist. Both groups improved markedly (in the order of 50%) on measures of physical ability. Overall there was little difference between groups in the extent of improvement, however post hoc testing identified some additional strength benefits for the non-weight-bearing group - non-affected leg hip flexion mean difference in extent of improvement was 9.3 N (95% CI 3.7 to 15.0), non-affected leg hip abduction mean difference in extent of improvement was 6.5 N (95% CI 0.1 to 12.9). There were also additional functional benefits for the weight-bearing group - improved ability to complete a lateral step-up on the affected leg with nil or one hand supports (OR 3.4, 95% CI 1.1 to 12.3) and the need for less supportive walking aids (p = 0.045). Weight-bearing and non-weight-bearing exercise programs produce similar effects on strength, balance, gait and functional performance among inpatients soon after hip fracture. **[Sherrington C, Lord SR and Herbert RD (2003): A randomised trial of weight-bearing versus non-weight-bearing exercise for improving physical ability in inpatients after hip fracture. *Australian Journal of Physiotherapy* 49: 15-22]**

Key words: Exercise Therapy; Hip Fracture; Rehabilitation; Weight-Bearing

Introduction

Hip fractures are an important public health issue. By the age of 90, 32% of women and 17% of men have suffered a hip fracture (Gallagher et al 1980). By the year 2050 there will be about 2.3 million annual hip fractures globally (Gullberg et al 1997). Unfortunately, outcomes after hip fracture are often poor (Marottoli et al 1992). If more effective rehabilitation strategies could be developed for the immediate post-fracture period, longer term outcomes may also be improved.

Several studies have investigated different models for intensity and organisation of early post-fracture care (Cameron et al 2001). While no clinical trials to date have directly compared different types of exercises in this population, a few have investigated the effects of various exercise or training programs. These studies found that treadmill training enhanced mobility outcomes (Baker et al 1991), high-intensity quadriceps strength training improved leg extensor power and reduced disability (Mitchell et al 2001) and a program of progressive resistance training and progressive functional training enhanced strength and functional performance (Hauer et al 2002).

Commonly prescribed exercise programs after hip fracture involve non-weight-bearing exercise conducted on a bed or chair. These exercises aim to work targeted muscles in an isolated manner (Cifu 1995, Karumo 1977, Rush 1996). However, there may be more benefits from exercises conducted in weight-bearing postures more relevant to tasks of daily living which are primarily conducted in standing. The use and efficacy of weight-bearing exercise has now been described in a number of patient groups (Bynum et al 1995, Callaghan et al 1995, Carr and Shepherd 1987, Nugent et al 1994, Palmitier et al 1991, Sherrington and Lord 1997).

The present study sought to compare the effects of weight-bearing and non-weight-bearing exercises on strength, balance, gait and functional performance among inpatients undergoing rehabilitation after a hip fracture.

Methods

Subjects This study involved 80 eligible older people admitted to the Bankstown-Lidcombe Hospital (Sydney, Australia) inpatient rehabilitation wards following recent fall-related hip fractures. The sample had an average age of 81 years (range 64-98, SD 8) and 68% were women.

Patients were excluded if they were aged less than 60 years or were unable to complete the assessments and exercise program due to one or more of the following: a) cognitive impairment (as determined on the basis of the first author's observations); b) major medical conditions; c) complications from the fracture (if directed to be non-weight-bearing or touch-weight-bearing due to problems with the fixation of the fracture). Only four subjects did not meet these inclusion criteria (Figure 1).

Patients were randomised into one of two exercise groups using a random number table and randomisation in blocks of six (Pocock 1983). After eligibility was ascertained by the first author in conjunction with a senior physiotherapist, subjects were assigned to groups using a concealed randomisation method. The physiotherapist treating that subject then conducted a routine physiotherapy assessment and commenced the allocated study intervention. The first author sought the subject's written consent to participate in the study and conducted the initial assessment for the study. Ethical approval for the study was granted by the South Western Sydney Area Health Service Research Ethics Committee.

Assessment procedure All assessments were conducted by the first author, a registered physiotherapist. The final assessment was undertaken two weeks after the initial assessment. The assessor was not blinded to group allocation. If the subject had been discharged from the hospital by this time (21 subjects), this assessment was completed at home. Each assessment took between 45 and 60 minutes and consisted of an examiner-administered questionnaire and a physical assessment. Footwear was standardised across the two measurement sessions.

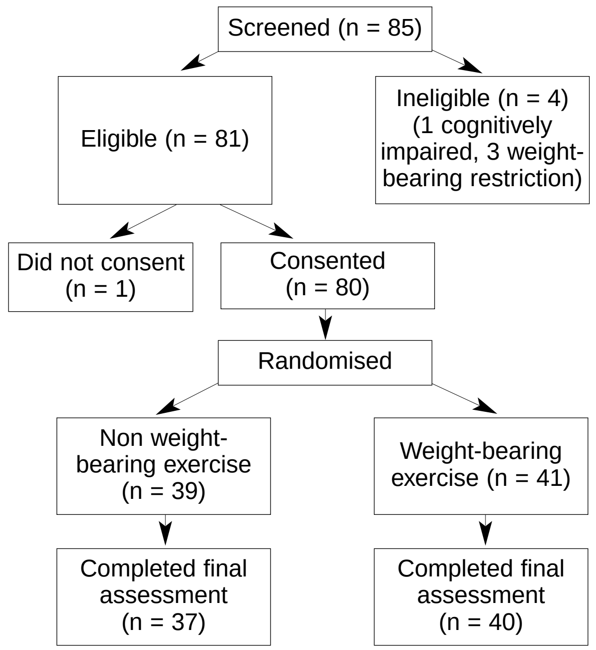
Measurement tools A questionnaire was used to obtain demographic details and details about subjects' health and functional abilities. In addition, a physical assessment was conducted. The physical assessment measured strength, balance, gait and functional abilities.

Strength measures a) A spring balance was used to measure isometric force generation of the knee extensor muscles in kilograms (Lord et al 1991) with the subject seated and knee flexed to 90 degrees. Two attempts were performed on each leg and the higher value for each leg used. Force was measured 5 cm proximal to the malleoli.

b) A hand-held dynamometer (Bohannon 1986) was used to measure isometric force generation of the hip abductor and hip muscles. Subjects lay supine on a plinth with the hips in the anatomical position. Again, two attempts were performed for each test and the higher value used, and force was measured 5 cm proximal to the malleoli.

c) Lateral step-up ability was measured with the subject standing. With both feet adjacent, the subject placed one foot on a 10 cm block and attempted to lift the other leg off the ground. The subject's need for support was documented on a five-point scale (unable, required assistance from the examiner, required two hand supports, required one hand support, required no hand support).

Figure 1. Flow of subjects through the study.



Balance measures a) Postural sway was measured with the subject standing on the floor and on a 7 cm medium density foam rubber mat, using a portable swaymeter[a] (Lord et al 1991) and a force plate as described elsewhere (Ekdahl et al 1989). An AMTI[b] force plate was used. While the subject attempted to stand still for 30 seconds, the total distance swayed (ie sway path) was recorded. This was measured in millimetres by the force platform software and from the graph paper on which the swaymeter traces the sway path.

b) Functional reach (Duncan et al 1990), the distance a subject is able to reach forward without moving the feet, was measured in centimetres using a retractable tape measure. Two attempts were completed and the better effort recorded.

c) Step test (Hill et al 1996), the number of times that a subject could step up onto a 7.5 cm block without hand support in 15 seconds was assessed for each leg. For this test, the subject stood in front of the block and placed the whole of one foot up onto and then down off the block repeatedly.

Gait measures a) A number of measures were taken while the subject walked six metres at a fast pace with the least supportive aid that the examiner judged to be safe. Time taken was recorded using a stopwatch. Walking aid used and the number of steps taken were recorded. Step length was recorded using marker pens positioned vertically and attached to the subject's heels with sports tape (Cerny 1983).

b) The maximal vertical force during stepping was measured for each leg using an AMTI[b] force plate and expressed as a proportion of body weight. The foot of the limb being measured remained stationary on the force plate while the subject stepped forwards and backwards several times with the other leg. One or two hand supports were used as necessary.

Functional performance measures The Physical Performance and Mobility Examination (PPME; Winograd et al 1994) involves measures of bed mobility, transfer skills, multiple stands from a chair, standing balance, step-up ability and ambulation. Assistance and time taken for each category are quantified, and each is scored on a three level scale ("high pass" (2), "low pass" (1) and "fail" (0)). The maximum possible score is 12. The time taken to stand up from and sit down on a 55 cm chair five times and the time taken to move from lying to sitting over the side of a bed or plinth were also recorded.

Intervention One intervention group undertook a weight-bearing exercise program, while the other undertook a non-weight-bearing program. The programs were established by the treating physiotherapist and supervised by the treating physiotherapist in conjunction with a physiotherapy assistant. The program commenced while the subject was on the rehabilitation ward and was carried out each weekday in the rehabilitation gymnasium. The subject was advised to continue the program at home if discharged before the final assessment. All subjects also received the usual physiotherapy intervention. This involved practice of walking, progression of walking aids and assessment of tasks needed for discharge (bed mobility, sit-to-stand and stair climbing). All subjects also received all the usual interventions from other health professionals such as occupational therapists, social workers, medical and nursing staff.

The non-weight-bearing exercise group (NWBE) carried out all exercises in a non-weight-bearing (supine) position as commonly prescribed after hip fracture (Cifu 1995, Rush 1996). These exercises were: hip abduction (sliding the straight leg out to the side), hip flexion (lifting the straight leg), hip/knee flexion/extension (sliding the heel towards the buttock by bending the hip and knee), end of range knee extension (straightening the bent knee over a wedge) and ankle dorsiflexion/plantarflexion. A doughnut-shaped piece of foam was used under the heel to prevent excessive friction and damage to the skin while doing the first three exercises. These exercises were modified by the use of isometric muscle contractions in the direction of movement if the subject was unable to move the limb. The exercises were progressed by increasing the number of repetitions undertaken.

The weight-bearing exercise group (WBE) carried out exercises in weight-bearing positions. This program has been implemented in several Sydney hospitals where it has been modified from programs used for rehabilitation following stroke (Carr and Shepherd 1998, Nugent et al 1994). The exercises were sit-to-stand (repeated stands from a chair or adjustable-height exercise plinth), lateral step-up (as described in the testing procedure), forward step-up-and-over (stepping onto a block with both legs and down off it again), forward foot taps (tapping one foot up onto a block while supporting the weight on the other leg) and a stepping grid (stepping in different directions as guided by marks on the floor). These exercises were initially conducted with the support of a walking frame or one or two portable adjustable-height tables. If this was too difficult, the subject exercised while supported on a tilt-table. These exercises were progressed by increasing the number of repetitions, lessening the hand support, increasing the height of the blocks, decreasing the height of the surface from which the subject was standing up, or increasing the angle of the tilt-table.

For both groups, the treating physiotherapist chose several initial exercises, then added extra exercises in keeping with the subject's capability. The number of repetitions was established on the basis of the subject's initial performance, and ranged from five to 30 for a single exercise. All subjects were encouraged to take prescribed pain relief before exercising.

Statistical analysis Data were analysed with multivariate general linear models. Each model assessed the effects of intervention on the differences between pre- and post-intervention performance on one of the four multivariate physical domains (strength, balance, gait or functional performance). Univariate analyses from the general linear model are also reported. Between-group comparisons were conducted for pre-intervention means and post-intervention measures not covered by the multivariable analyses using factorial (group x time) ANOVA for continuous measures, the Mann-Whitney U test for ordinal measures, and chi squared tests for dichotomous variables. For the physical variables, differences between the groups in the extent of change between the initial and final assessments were also compared using these tests. All available data were analysed by initial group assignment (ie an intention-to-treat approach). The analyses were performed with SPSS Version 10.0 for Windows[c] (SPSS 1993).

In addition, data from subjects in both groups were analysed together to assess the extent of improvement between the initial and final assessments. This was done using paired *t*-tests for continuous data, Wilcoxon matched-pairs signed-rank tests for ordinal data and McNemar test for dichotomous data.

If continuous data were found to be skewed (skewness statistic > 1), logs of the scores were taken and statistical testing was carried out on these more normally distributed variables. For a number of variables, data were unobtainable due to impaired subject performance. Most of these variables were transformed to a form where a low score reflected poor performance (eg the time taken to stand up five times was expressed as stands per second) and zero was allocated to those subjects who were unable to perform the test. This was not done for sway and step

Table 1. Pre-intervention between-group comparisons.

	Non-weight-bearing exercise n = 39		*Weight-bearing exercise n = 41*	
Age – mean (SD)	81.1	(8.3)	81.0	(7.0)
Sex: female – n (%)	27	(69)	27	(66)
Days since fracture – mean (SD)	17.4	(8.5)	19.2	(22.8)
Side of fracture: left – n (%)	26	(67)	24	(59)
Type of fracture: intracapsular – n (%)	16	(41)	12	(29)
Fixation: screws, pin and plate – n (%)	27	(69)	28	(68)
Number of medications taken – mean (SD)	6.4	(2.6)	6.1	(2.8)
Number of illnesses reported – mean (SD)	3.9	(1.7)	3.4	(1.9)
Falls in past 12 months – mean (SD)	1.7	(1.0)	1.8	(1.8)
Pre-fracture accommodation: community – n (%)	34	(87)	36	(88)
Health: excellent or very good – n (%)	8	(21)	13	(32)
Balance: always steady – n (%)	10	(26)	6	(15)
Fall risk: low – n (%)	14	(36)	13	(32)
Sleep quality: good/very good – n (%)	14	(36)	21	(52)
Pre-fracture walking: no aid – n (%)	28	(72)	28	(68)
Mental status: intact [a] – n (%)	21	(54)	22	(54)
Current pain: moderate or less [b] – n (%)	12	(31)	14	(33)

[a] Pfeiffer (1975). [b] Pynsent et al (1993).

length as it was not considered meaningful for these variables. For the sway variables, those who were unable to do the tests due to poor performance were allocated the mean plus three standard deviations (this figure approximated the worst performance). Because data were missing from the initial assessment and from the follow-up tests which could not be conducted in the home (weight-bearing ability on the force platform and step length), multivariate analyses on the gait and balance domains were performed both with and without these variables. Inclusion of these variables did not have an important effect on the statistical significance of the results.

Results

Pre-intervention: subject characteristics Subject characteristics are summarised in Table 1. There were no clinically important or statistically significant differences between the two exercise groups prior to the intervention.

Post-intervention: dropouts, discharge details, dosage and participants' experience of exercise Three subjects did not complete the final assessment, giving a drop-out rate of 4% (Figure 1). One subject in the WBE withdrew consent and one subject from the NWBE had complications with fracture fixation, which necessitated further surgery. Another subject from the NWBE had suspected problems with fracture fixation and was put on bed rest while awaiting an orthopaedic review. Some data were available for these three subjects.

The period of time between the first and second assessment was the same for both groups (mean (SD) of 14.5 (1.0) days for NWBE and 14.4 (1.3) days for WBE). There was no difference between the groups in the length of time spent in the inpatient rehabilitation ward (25.2 (12.1) days for NWBE and 24.1 (12.4) days for WBE), or in the total time spent in hospital (38.5 (16.3) days for NWBE and 36.2 (13.6) days for WBE).

The NWBE carried out significantly more repetitions than the WBE (an average (SD) of 3,082 (2,159) for the NWBE and 1,369 (1,250) for the WBE ($t_{(73)} = 4.22$, $p < 0.001$). There were no differences between the groups on participants' perceptions of the exercise program they received. The groups reported experiencing similar levels of difficulty (32% of NWBE and 35% of WBE found the exercises difficult or very difficult) and similar amounts of pain while carrying out the exercises (49% of NWBE and 43% of WBE reported moderate or marked pain), and had similar perceptions about the usefulness of the exercises (81% of NWBE and 70% of WBE reported moderate or marked usefulness).

Post-intervention: self-report At the end of the trial, subjects in the WBE reported having significantly better balance (27% reported always feeling steady compared with 13% in the NWBE, $z = -2.5$, $p = 0.01$) and there was a trend towards this group reporting better general health ($z = -1.8$, $p = 0.08$). However, there were no differences between the groups for self-rated fall risk ($z = -1.1$,

Table 2. Pre- and post-intervention between-group comparison: continuous variables.

	Pre-test mean (SD)		Post-test mean (SD)	
	NWBE	WBE	NWBE	WBE
Strength (Newtons)				
Hip abduction affected leg [a]	15.5 (7.2)	17.8 (11.4)	22.5 (10.0)	24.6 (17.6)
Hip abduction non-affected leg [a]	32.4 (14.5)	40.0 (22.9)	41.0 (17.0)	42.6 (21.2) *
Hip flexion affected leg [a]	11.3 (6.7)	11.9 (6.5)	17.2 (11.6)	17.7 (9.4)
Hip flexion non-affected leg [a]	27.2 (13.8)	38.0 (24.2)	35.8 (19.5)	37.9 (21.9) *
Knee extension affected leg [a]	45.7 (24.3)	46.1 (30.4)	67.9 (36.0)	65.5 (30.1)
Knee extension non-affected leg [a]	94.9 (44.1)	112.0 (63.1)	109.1 (50.8)	118.7 (61.7)
Balance				
Step test affected leg (reps) [a]	0.1 (0.6)	0.0 (0.2)	0.5 (1.4)	1.3 (3.1)
Step test non-affected leg (reps) [a]	0.5 (1.3)	1.3 (3.0)	2.1 (2.8)	3.7 (4.3)
Functional reach distance (cm) [a]	5.9 (7.5)	5.9 (7.1)	9.4 (7.5)	11.5 (9.2)
Sway (swaymeter) floor (mm) [b]	126 (88)	126 (67)	108 (64)	114 (55)
Sway (swaymeter) foam (mm) [c]	137 (43)	207 (126)	135 (49)	154 (74)
Sway (force plate) floor (mm) [d]	547 (356)	728 (515)	519 (272)	608 (346)
Sway (force plate) foam (mm) [e]	699 (336)	1143 (1013)	727 (301)	912 (533)
Gait				
Velocity (m/sec) [a]	0.09 (0.09)	0.12 (0.10)	0.19 (0.20)	0.25 (0.22)
Steps per second [a]	0.47 (0.33)	0.60 (0.38)	0.71 (0.42)	0.91 (0.58)
Step length affected leg (cm) [f]	16.3 (15.2)	20.0 (16.3)	23.1 (15.0)	25.8 (15.9)
Step length non-affected leg (cm) [f]	7.9 (9.3)	8.3 (10.1)	13.8 (12.8)	13.2 (11.4)
Force plate weight bearing aff. leg [g]	0.30 (0.36)	0.42 (0.37)	0.48 (0.39)	0.45 (0.40)
Force plate wt. bearing non-aff. leg [g]	0.39 (0.45)	0.53 (0.45)	0.58 (0.45)	0.55 (0.47)
Functional performance				
Stand/sec [a]	0.09 (0.07)	0.14 (0.10)	0.16 (0.09)	0.21 (0.12)
Sit up/sec [a]	0.04 (0.07)	0.06 (0.06)	0.10 (0.09)	0.13 (0.13)
PPME total score [a, h]	4.5 (2.5)	5.4 (3.0)	6.8 (2.8)	7.5 (2.7)

* $p < 0.05$ Univariate tests of between-group differences in the change between pre- and post-test performance.
[a] Pre-test n NWBE = 39, WBE = 41, Post-test NWBE = 37, WBE = 40.
[b] Pre-test n NWBE = 20, WBE = 21, Post-test NWBE = 27, WBE = 28.
[c] Pre-test n NWBE = 8, WBE = 14, Post-test NWBE = 17, WBE = 23.
[d] Pre-test n NWBE = 18, WBE = 22, Post-test NWBE = 17, WBE = 17.
[e] Pre-test n NWBE = 8, WBE = 15, Post-test NWBE = 13, WBE = 15.
[f] Pre-test n NWBE = 18, WBE = 22, Post-test NWBE = 22, WBE = 19.
[g] Pre-test n NWBE = 39, WBE = 41, Post-test NWBE = 27, WBE = 29.
[h] Physical Performance and Mobility Examination score.

$p = 0.26$), quality of night-time sleep ($z = -0.5$, $p = 0.65$) or pain ($z = -1.0$, $p = 0.34$).

Post-intervention: physical assessment No differences were found between groups in the change from initial to final test performance for the domains of strength ($F_{(6,70)} = 1.67$, $p = 0.14$), balance ($F_{(3,73)} = 1.21$, $p = 0.31$), gait ($F_{(2,74)} = 0.37$, $p = 0.69$) or functional performance ($F_{(3,73)} = 0.42$, $p = 0.74$).

Tables 2 and 3 summarise the results of the post-intervention physical assessment. As the tables show, there were no clinically important or statistically significant differences between the groups for the majority of variables. In post hoc univariate analysis, the NWBE improved to a greater extent on two of the strength measures. On the non-affected leg, the mean difference in the extent of improvement was 9.3 N (95% CI 3.7 to 15.0) for hip flexion and 6.5 N (95% CI 0.1 to 12.9) for hip abduction. The extent of hand support needed to complete a lateral step-up (ie extend the hip and knee of the leg resting on a block while standing, so as to lift the

Table 3. Pre- and post-intervention between-group comparison: ordinal and nominal variables. Data are counts (percentages in brackets).

	Pre-test		Post-	
	NWBE	WBE	NWBE	WBE
Strength [a]				
Lateral step-up non-affected leg: 0-1 hand support	10 (26)	16 (39)	21 (57)	26 (66)
Became able to do lateral step-up non-affected leg with 0-1 hand			15 (41)	13 (33)
Lateral step-up affected leg: 0-1 hand	3 (8)	6 (15)	7 (19)	22 (55) *
Became able to do lateral step-up affected leg with 0-1 hand			6 (16)	16 (40) *
Gait [b]				
Walking ability (6 metres)				
Unable	12 (31)	9 (22)	7 (18)	4 (10)
Frame	27 (69)	31 (76)	23 (59)	20 (49)
Two sticks	0 (0)	1 (2)	7 (18)	9 (22)
One stick or no aid	0 (0)	0 (0)	2 (5)	8 (20) *
Became able to walk with one stick or no aid			2 (5)	8 (20) +

* $p < 0.05$. + $p = 0.09$.

[a] Pre-test n NWBE = 39, WBE = 41, Post-test NWBE = 37, WBE = 40.

[b] Pre-test n NWBE = 39, WBE = 41, Post-test NWBE = 39, WBE = 41.

contralateral leg from the ground) was used as a functional strength measure. The WBE showed a greater improvement in this measure. More people in the WBE who were initially unable to complete a lateral step-up on the affected leg with nil or one hand supports became able to do so at the final assessment (OR 3.4, 95% CI 1.1 to 12.3, $p = 0.02$). More subjects in the WBE required a less supportive walking aid at the final assessment ($z = -2.0$, $p = 0.045$).

When all subjects were considered together, there were statistically significant differences between initial and final test performance for all variables. The extent of this improvement was in the order of 50% of initial values.

Discussion

Overall, this study found few additional benefits of one program over the other. The greater improvement in two of the six isometric strength measures among the NWBE indicates some additional benefit from non-weight-bearing exercise in this population. Yet the extent of these differences was small (in the order of 7-9 N). The fact that the WBE showed greater improvements in lateral step-up ability and use of less supportive walking aids indicates some additional benefits from that program. These findings are consistent with the concept of specificity of training (Dean and Shepherd 1997, Rutherford 1988) ie that performance improves more in tasks which have been practised.

Conversely, the finding that few between-group differences were evident in measures of balance, gait and functional performance seems to be inconsistent with the concept of specificity of training. However, as the patients were exercising soon after hip fracture (an average of 18 days) they generally needed to use at least one hand support to carry out the exercises safely and to minimise pain from weight bearing on recently-operated joints. This may have limited the difference between the groups in the extent of challenge to the postural control system and thus reduced potential benefits from these exercises on balance, gait and functional performance.

The finding that only a small proportion of people became able to walk with one stick or no walking aid (5% in the NBWE and 20% in the WBE) suggests that few individuals have the potential to reach this level of mobility soon after their surgery.

Improvements between initial and final assessments when all subjects were considered together were in the order of 50% of initial test performance for most variables. As the measurements were carried out relatively soon after fracture and surgical repair, it is likely that pain, anxiety and general health may have had a substantial impact on the person's ability to perform the baseline tests. The overall improvements noted may therefore have been a result of an improvement in these factors rather than, or in addition to, changes in the neuromuscular system. This improvement may be also be partially explained by a learning effect on the measurement instruments.

The results of this study can be broadly applied, as the subjects were representative of older people with fractured hips. A wide age range (64 to 98 years) was included and there were few exclusion criteria (only 5% of potential subjects were excluded). Treating physiotherapists carried out the study intervention, meaning that it was feasible for this to be done under existing workloads. Although appearing more aggressive, the weight-bearing exercise program is not contraindicated according to the common recommendations for activity after hip fracture (Cifu 1995, McAndrew 1996). In fact, there is evidence that greater forces are experienced about the hip joint during non-weight-bearing exercise than during walking (Strickland et al 1992). The weight-bearing exercises cannot be done effectively if the person has weight-bearing restrictions imposed by the surgical team, but these are no longer routinely recommended after uncomplicated fracture and surgery (Koval et al 1996).

A limitation of the design of this study is that the outcome assessor was not masked to subject group allocation. In an attempt to minimise the bias associated with the lack of blinding, most assessments were made using objective measurement devices and all were made without reference to previous assessment values. In addition, the short-term nature of this study means it cannot address the question of the maintenance of between-group differences over time.

Power calculations were conducted before beginning this trial, based on the means and standard deviations data from a reliability study. Sample size was determined as adequate to establish a 20% between-group difference for the majority of outcome variables (power = 0.8, alpha = 0.05). The actual study data were more variable than the reliability study data, thus decreasing the power of the trial. Although a larger sample size may have detected a greater number of statistically significant between-group differences, it could also be argued that a between-group difference of substantially less than 20% would be of limited clinical significance.

It is concluded that weight-bearing and non-weight-bearing exercise programs produce similar effects on strength, balance, gait and functional performance among inpatients soon after hip fracture. As some additional benefits were evident among those who carried out each exercise intervention, it may be appropriate for inpatients soon after hip fracture to complete a combination of both types of exercise.

Footnotes [a]Balance Systems Inc, PO Box 915, Caringbah NSW 1495, Australia. [b]AMTI, 176 Waltham St, Watertown MA02472, USA. [c]SPSS Inc, 233 S. Wacker Drive, Chicago, Illinois 60606, USA.

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