

Are bed exercises necessary following hip arthroplasty?

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This study investigated whether a program of bed exercises increased the effectiveness of a mobility regimen during the acute period of hospitalisation, for patients who had undergone primary hip arthroplasty. Forty-two patients were randomly allocated, using a concealed allocation procedure, to one of two groups. Patients in the control group were mobilised according to a standard post-operative protocol. Patients in the exercise group were also mobilised using this protocol but in addition received a program of bed exercises. Severity of pain, range of active hip flexion and hip abduction, and a functional assessment were measured by a blinded assessor on the third or fourth post-operative day and again on the seventh or eighth post-operative day. Significant improvements were found in all outcome measures from the third or fourth post-operative day to the seventh or eighth post-operative day. No significant differences were seen between groups for any outcome measures at either measurement time. Bed exercises do not appear to be of additional benefit to a mobility regimen during the period of acute hospitalisation after primary hip arthroplasty. [Jesudason C and Stiller K: Are bed exercises necessary following hip arthroplasty? (2002): *Australian Journal of Physiotherapy* 48: 73-81]

Key words: Arthroplasty; Hip Joint; Outcome Assessment (Health Care); Randomized Controlled Trials

Introduction

In most hospitals, patients routinely receive physiotherapy following hip arthroplasty to help them regain hip range of movement and function (Enloe et al 1996, Fagerson 1998). It is generally recommended that the physiotherapy treatment comprises a program of exercises performed while in bed, and daily mobilisation, during the period of acute hospitalisation (Enloe et al 1996). Although this combined regimen appears to be effective in helping patients to regain lower limb mobility and function, the necessity for the components of this treatment approach is unknown. No previous studies examining this issue were identified from a literature search of the databases MEDLINE and CINAHL. While it seems logical to expect that some form of mobilisation is required post-operatively, it is possible that routine bed exercises are of no additional benefit. If bed exercises were found to be an unnecessary component of the post-operative physiotherapy regimen, and a mobility program alone was found to be equally effective, this may have the potential to reduce the cost of service provision or allow more time to be spent on patients' mobility.

Therefore, the aim of this study was to assess whether bed exercises provided additional benefit, in terms of hip pain, range and function, to a program of mobilisation during the period of acute hospitalisation following primary hip arthroplasty.

Method

All patients admitted to the Royal Adelaide Hospital (RAH) for elective primary hip arthroplasty, and who gave informed written consent, were eligible for inclusion in this prospective study. Exclusion criteria were: unwillingness to participate, inability to understand written or spoken English, inability to co-operate with the assessment and treatment procedures, inability to walk prior to admission and partial weight bearing status post-operatively.

From February 2000 to May 2001, 42 patients were included in the study and randomly allocated, using a concealed allocation procedure, to one of two groups by means of a random numbers table (Portney and Watkins 1993). Patients in the control group were mobilised according to the standard RAH protocol following hip arthroplasty. This involved sitting/perching on the edge of the bed, attempted standing and walking (using appropriate mobility aids) commencing on the first post-operative day. This mobilisation regimen was performed twice per day for the first four post-operative days and once per day thereafter for the duration of hospital stay. Mobility was progressed (in terms of the distance walked, speed of walking, degree of assistance required and mobility aids) as deemed clinically appropriate for individual patients by the treating physiotherapist. Patients were assisted in this activity by at least one physiotherapist, with the help of another physiotherapist or physiotherapy assistant as

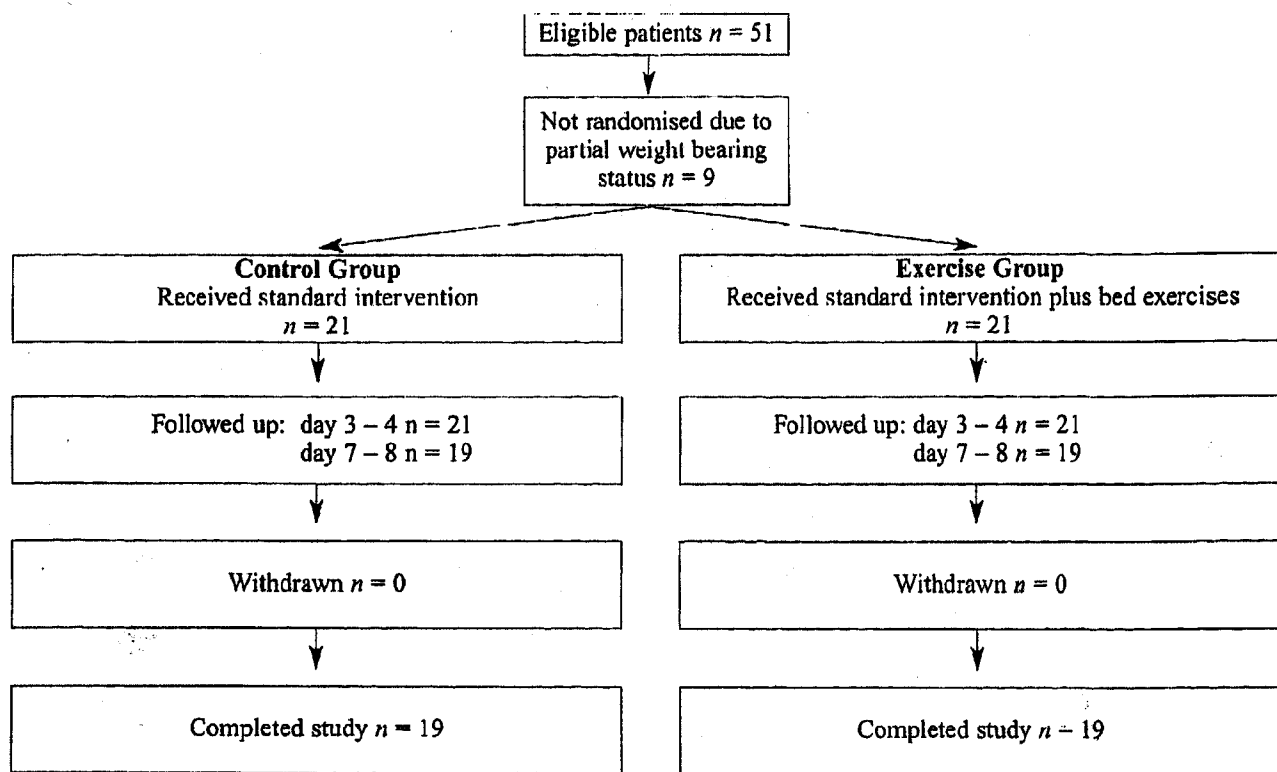


Figure 1. Progress of patients throughout the study period.

required by the patient's condition. Additionally, from the second post-operative day, patients were mobilised by nursing staff for the purposes of showering and toileting, as is normal protocol at the RAH.

Patients in the exercise group received a program of bed exercises in addition to the mobility protocol as described for the control group. These bed exercises were aimed at increasing range of movement and/or strength of the hip, knee and ankle. Specifically, these exercises, performed in supine, comprised: hip and knee flexion; hip and knee extension to neutral; hip abduction; hip adduction to neutral; ankle dorsiflexion and plantarflexion; static quadriceps contraction; and inner range quadriceps exercises over a rolled up towel. Patients were instructed to do each exercise five times initially, building up to 10 repetitions as tolerated, two to three times per day. Patients were instructed in these exercises by a physiotherapist on the first post-operative day and supervised once per day by a physiotherapist for the duration of hospital stay. Patients in the exercise group also received a handout explaining the purpose of the exercises, how to do them and how often they should be independently performed.

All physiotherapists who provided treatment for patients participating in the study were carefully instructed in the management protocols for the two groups, to ensure that interventions were as standardised as possible.

Each patient's gender, age, pre-existing medical conditions, operative procedure and major post-operative complications were recorded from the case notes. In addition, an independent experienced orthopaedic physiotherapist specifically questioned all patients and recorded the following: history of previous lower limb injury or pain on the involved side; previous general joint problems and any medications required for these; and pre-admission level of mobility.

The outcome measurements recorded for the purpose of the study were: severity of pain; range of hip flexion and hip abduction; and a functional assessment. Severity of resting pain was rated by each patient marking their current level of pain on a 10cm visual analogue scale (VAS), where 0 represented no pain and 10 was the worst pain imaginable. Each patient's active (unassisted) range of hip flexion and hip abduction was measured to the nearest 5 degrees, using a goniometer with the patient in the supine position. To ensure goniometric measurements were performed in a standardised fashion, anatomical reference points were marked on each patient according to the guidelines for measuring hip range as described by the American Academy of Orthopaedic Surgeons (1965). After reviewing a range of possible functional outcome measures, as will be outlined further in the Discussion, functional status was assessed using the Iowa Level of Assistance (ILOA) Scale described by Shields et al (1995; see Appendix). This test

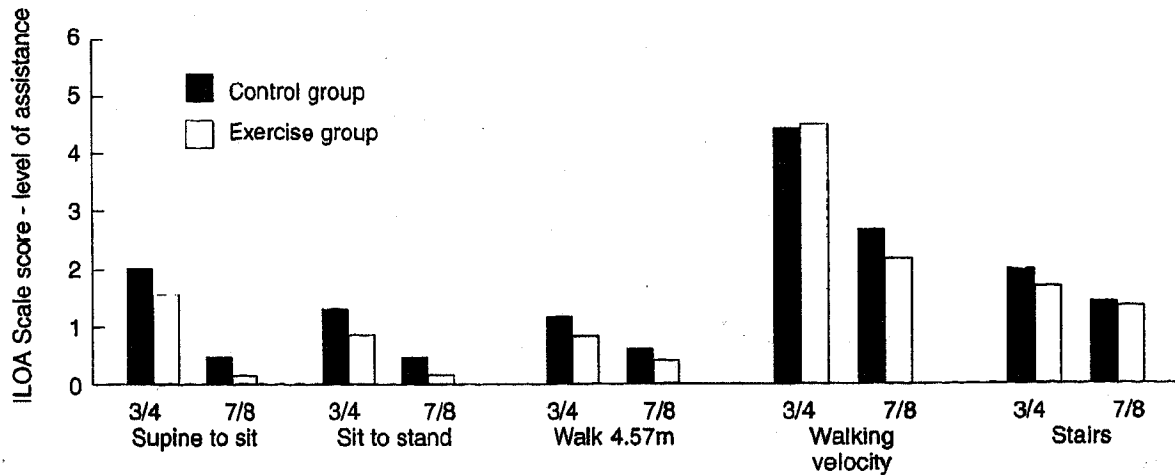


Figure 2. Mean level of assistance scores from the IOWA Level of Assistance Scale according to group.

assesses the patient's ability to perform four functional activities, namely, supine to sitting on the edge of the bed, sitting on the edge of the bed to standing, walking 4.57 metres and climbing up and down three stairs. In addition, as described by Shields et al (1995), walking speed over a 13.4m distance is recorded and ranked using an ordinal scale. Each task is graded (using the ordinal scales outlined in the Appendix), according to the level of assistance and the assistive device required. For testing purposes, the assessor strives to provide the least amount of assistance possible to maximise the capability of the patient, whilst ensuring patient safety. A score is then obtained for each task and an overall total score is calculated (scores range from 0 = no assistive device required and independent in all tasks to 50 = using a frame as an assistive device but unable to attempt test due to safety reasons – see Appendix for further explanation). These outcome measurements were performed by the same physiotherapist who was blinded to patients' allocated groups, on the third or fourth post-operative day and repeated on the seventh or eighth post-operative day.

Statistical analyses Analyses were performed using the SPSS statistical software package. Nominal data from the patient profiles were analysed with the Chi-square test. Interval data from the patient profiles were analysed using the *t*-test. A paired samples *t*-test was used to assess whether significant improvements were found in outcome measures from the third or fourth post-operative day to the seventh or eighth post-operative day. Probabilities of less than 0.05 were considered significant.

An independent samples *t*-test was used to compare groups at each measurement time. In addition, for the ordinal ranked outcomes (ie scores for the VAS and ILOA Scale), the Mann-Whitney U test was used to compare groups at each measurement time. To avoid an increased chance of Type 1 errors from repeated measures with multiple comparisons, a more stringent level of significance

($p < 0.01$) was used in these analyses.

A sample size of 20 subjects per group was calculated (Minitab Version 12) as being required, based on a Type I error of 0.05, statistical power of 87%, a standard deviation of 6.9 on the ILOA Scale (Shields et al 1995) and considering a difference of 7.0 (Shields et al 1995) to be clinically significant.

Intra-rater reliability study Prior to commencement of the study, the physiotherapist involved in the measurement procedures completed an assessment of 10 patients recovering from hip surgery. This assessment was performed within the third to eighth post-operative days to make the timing of measurements comparable with that used in the main study. These assessments were repeated later on the same day, in a different order, with the examiner unable to refer to the original results. For the assessment of hip flexion range, the intra-class correlation coefficient (ICC [1,1]) was 0.47 and for hip abduction 0.58. These indicate moderate intra-rater reliability. For the ILOA Scale, the same grade was achieved for the tasks of supine to sitting on the edge of the bed and walking 4.57 metres for all 10 patients on both occasions. For sitting on the edge of the bed to standing and climbing three stairs, the same grade was achieved for nine patients and was within one grade for the tenth patient. Walking speed was scored the same for five patients, within one grade for four patients and within three grades for the final patient. Total ILOA score was the same for four patients, within one grade for four patients, within two grades for one patient and within three grades for one patient. The ICC (1,1) for the total ILOA Scale score was 0.98, which indicates good intra-rater reliability. Similarly, the Kappa or ICC (1,1) values for the individual scores which comprise the total ILOA Scale scores were all above 0.85, indicating good intra-rater reliability (Kappa for supine to sit = 1.00, sit to stand = 0.86, walk 4.57 metres = 1.00, stairs = 0.86; ICC (1,1) for walking velocity = 0.90).

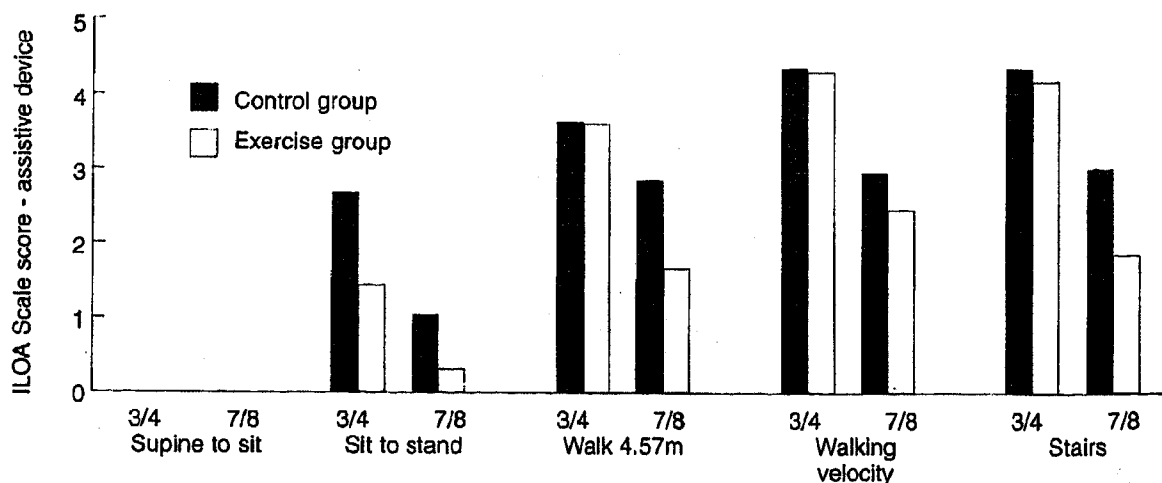


Figure 3. Mean assistive device scores from the ILOA Scale according to group.

Results

Of the 51 patients who were eligible to be included in the study, nine were not randomised as their mobility status was limited to partial weight bearing (see Figure 1). Thus 42 patients entered the study, 21 in each of the control and exercise groups. Four patients (two per group) did not have data collected at the second time period (ie seventh or eighth post-operative day) because they were discharged from hospital on the fifth post-operative day. The initial data from these patients have been included in the analyses.

The profiles of the 42 patients who entered the study are shown in Table 1 and indicate that the process of randomisation was successful in achieving homogeneity between the groups. The main presenting complaint necessitating hip arthroplasty was pain. Prior to surgery, a total of 30 patients (71.4%) required a walking aid for mobilisation and, in all but one case, the walking aid was required because of the hip problem. Despite most patients requiring a walking aid pre-operatively, the majority were able to get out of bed, move from sitting to standing, climb three steps and walk 4.57 metres without assistance. Six patients (14.3%) developed major post-operative complications (four in the control group, two in the exercise group; $p = 0.38$). These complications were as follows: deep vein thrombosis (one patient); wound dehiscence/ooze (two patients); cardiac event (two patients); and an exacerbation of pre-existing gout (one patient). Although mean length of hospital stay was increased for these six patients (12.5 days), the protocol of treatment as per group allocation was adhered to for all but one patient whose mobilisation program was delayed due to a myocardial infarction. The data from all six patients were included in the analyses.

Range of hip flexion and hip abduction significantly increased from the first to second measurement occasion ($p < 0.001$). As can be seen from Table 2, no significant differences were found between groups at the third or fourth post-operative day, or at the seventh or eighth post-operative day. The 95% CIs for the differences between groups at day seven or eight post-operatively involved values that ranged over less than 10 degrees for abduction but over 20 degrees for flexion. The width of the confidence interval for hip flexion may be related to the moderate intra-rater reliability achieved for that measurement.

The mean (and SD) VAS scores for pain are shown in Table 3. Analysis of these data demonstrated a significant decrease in these scores (ie a decrease in pain) from the third or fourth post-operative day to the seventh or eighth post-operative day ($p = 0.01$). No significant difference was found between groups at either measurement time (Table 3). Similarly, no significant differences were detected between groups for the VAS scores at either of the measurement times using the Mann-Whitney U test ($p > 0.69$).

The total and individual scores which comprise the ILOA Scale also showed significant improvement over time ($p < 0.001$). There were no significant differences between groups at either measurement time for the ILOA Scale data using the t-test or the Mann-Whitney U test (Table 3; $p \geq 0.03$). To enable the reader to gain an appreciation of the level of assistance and assistive devices required during the functional testing, Figures 2 and 3 depict the mean scores obtained using the ILOA Scale, with Figure 2 showing the level of assistance and Figure 3 the assistive device required. The assistive device used during the four tasks which involved standing or mobilising was most

Table 1. Profiles of the 42 patients entering the study according to group.

	Control group (n = 21)	Exercise group (n = 21)		
Sex: female/male (n)	12/9	9/12	$\chi^2 = 0.86$	$p = 0.36$
Age (years) (mean [SD])	69.3 [7.9]	69.1 [7.9]	$t_{(40)} = 0.08$	$p = 0.94$
<i>Musculoskeletal history</i>				
Main problem with hip: decreased function/pain/stiffness (n)	2/17/2	0/21/0	$\chi^2 = 4.42$	$p = 0.11$
Previous injury to operated leg (n)	7	6	$\chi^2 = 0.11$	$p = 0.74$
Other problem with operated leg (n)	5	2	$\chi^2 = 1.54$	$p = 0.21$
General joint problems (n)	12	13	$\chi^2 = 0.10$	$p = 0.75$
Medication for joint problems (n)	8	9	$\chi^2 = 0.10$	$p = 0.75$
<i>Previous mobility status</i>				
Walking aid (n)	13	17	$\chi^2 = 1.87$	$p = 0.17$
Assistance required to get out of bed (n)	4	1	$\chi^2 = 2.04$	$p = 0.15$
Assistance required for sit to stand (n)	4	2	$\chi^2 = 0.78$	$p = 0.38$
Able to climb 3 steps (n)	18	17	$\chi^2 = 0.17$	$p = 0.68$
Able to walk 4.57m (n)	20	21	$\chi^2 = 1.02$	$p = 0.31$
Operative approach: lateral/posterior (n)	11/10	7/14	$\chi^2 = 1.56$	$p = 0.21$
Post-operative complications (n)	4	2	$\chi^2 = 0.78$	$p = 0.38$

Table 2. Mean (SD) hip range of motion according to group.

	Control group	Exercise group	Differences (95% CI)*		
<i>Flexion</i>					
Day 3-4	28.8 (15.8)	32.9 (15.2)	-4.1	(-13.9 to 5.7)	$t_{(39)} = -0.85, p = 0.40$
Day 7-8	43.1 (18.9)	52.9 (17.2)	-9.8	(-21.9 to 2.2)	$t_{(35)} = -1.66, p = 0.11$
<i>Abduction</i>					
Day 3-4	8.0 (7.0)	8.1 (4.9)	-0.1	(-3.9 to 3.7)	$t_{(39)} = -0.05, p = 0.96$
Day 7-8	11.7 (7.1)	11.8 (6.5)	-0.2	(-4.7 to 4.4)	$t_{(35)} = -0.08, p = 0.94$

* Negative differences indicate greater range of motion in the exercise group.

commonly a frame (ie score of 5) or one to two sticks (ie score of 1 or 2 respectively). Thus, although the mean assistive device scores seen in Figure 3 most often corresponded to two elbow or axillary crutches (ie score of 3 or 4), this score actually reflects the mix of patients using a frame or one to two sticks.

Data obtained from the walking speed component of the ILOA test were also transformed into m/s. Walking speed on the third or fourth day was not significantly different between the control and exercise groups (mean [SD] control group = 0.28 [0.19] m/s; exercise group = 0.23 [0.21] m/s, $t_{(35)} = 0.64, p = 0.53$; mean difference [95% CI]

= 0.04 [-0.09 to 0.18]). Similarly, there was no significant difference between groups in walking speed on the seventh or eighth post-operative day (mean [SD] control group = 0.42 [0.23] m/s; exercise group = 0.41 [0.22] m/s, $t_{(34)} = 0.15, p = 0.88$; mean difference [95% CI] = 0.01 [-0.14 to 0.17]).

Mean length of stay was not significantly different between the groups (mean [SD] control group = 8.43 [3.57] days; exercise group = 7.95 [2.12] days; $t_{(40)} = 0.52, p = 0.61$; mean difference [95% CI] = 0.48 [-1.37 to 2.32]).

Table 3. Mean (SD) Visual Analogue Scale and IOWA Level of Assistance Scale scores according to group.

	Control group		Exercise Group		Differences (95% CI)*		
<i>VAS scores</i>							
Day 3-4	3.2	(2.6)	2.6	(1.8)	0.5	(-0.9 to 1.9)	$t_{(39)} = 0.76, p = 0.45$
Day 7-8	1.8	(2.0)	2.0	(1.9)	-0.2	(-1.5 to 1.1)	$t_{(35)} = -0.31, p = 0.76$
<i>ILOA scale scores</i>							
Total							
Day 3-4	26.0	(11.6)	22.9	(9.0)	3.1	(-3.4 to 9.5)	$t_{(40)} = 0.95, p = 0.35$
Day 7-8	15.6	(10.2)	10.6	(5.5)	5.0	(-0.4 to 10.4)	$t_{(36)} = 1.88, p = 0.07$
Supine to sit							
Day 3-4	2.0	(1.9)	1.6	(1.5)	0.4	(-0.7 to 1.5)	$t_{(40)} = 0.80, p = 0.43$
Day 7-8	0.5	(1.5)	0.1	(0.5)	0.4	(-0.3 to 1.1)	$t_{(36)} = 1.19, p = 0.24$
Sit to stand							
Day 3-4	4.0	(3.6)	2.3	(3.0)	1.7	(-0.3 to 3.8)	$t_{(40)} = 1.69, p = 0.10$
Day 7-8	1.5	(3.0)	0.4	(1.2)	1.1	(-0.4 to 2.6)	$t_{(36)} = 1.47, p = 0.15$
Walk 15 feet							
Day 3-4	4.8	(2.6)	4.4	(1.4)	0.4	(-0.9 to 1.7)	$t_{(40)} = 0.67, p = 0.51$
Day 7-8	3.5	(2.3)	2.2	(1.0)	1.3	(0.2 to 2.5)	$t_{(36)} = 2.31, p = 0.03$
Walking velocity							
Day 3-4	8.8	(3.5)	8.8	(3.2)	0.0	(-2.1 to 2.1)	$t_{(40)} = 0.00, p = 1.00$
Day 7-8	5.6	(2.9)	4.7	(3.1)	0.9	(-1.0 to 2.9)	$t_{(36)} = 0.99, p = 0.33$
Stairs							
Day 3-4	6.3	(2.4)	5.9	(1.6)	0.5	(-0.8 to 1.7)	$t_{(40)} = 0.76, p = 0.45$
Day 7-8	4.4	(2.0)	3.2	(1.3)	1.2	(0.01 to 2.3)	$t_{(36)} = 2.20, p = 0.04$

* Positive differences indicate less pain or lower levels of assistance in the exercise group.

Discussion

This original research showed that hip range, pain and function significantly improved over the study period after primary elective hip arthroplasty for patients who received a mobilisation regimen, with or without the addition of bed exercises. No significant differences were found between patients who did or did not receive the bed exercises for any of the outcomes measured at any time point. Thus, for this sample of patients, the addition of bed exercises to a program of mobilisation did not appear to improve hip pain, range or function during the period of initial hospitalisation.

The sample of patients included in the study were typical of those who undergo primary hip arthroplasty and no attempt was made to select patients who were likely to have a better outcome. However, prior to commencement of the study it was decided to exclude patients who were only allowed to partially weight bear post-operatively, as this would have made a higher level of assistive device (eg frame or crutches) mandatory and thus would have affected the

ILOA Scale score. Physiotherapists involved in providing the treatments were confident that group protocols were followed, except in those instances already outlined. No attempt was made to measure the compliance of patients in the exercise group with the instructions to perform unsupervised bed exercises. However, the daily supervision of bed exercises for patients in the exercise group by their physiotherapist should have provided a regular reminder for these patients to perform their exercise program.

With respect to the outcome measures used, we believed it was important to measure a combination of a patient reported symptom (ie pain), as well as range and function. Hip strength was not used as an outcome measure as it seemed unlikely that the study period would be sufficient to allow a training effect to occur. Furthermore, the functional assessment used in the study is likely to at least partially reflect underlying hip strength. Prior to commencement of the study, a number of functional tests were considered for use (eg the Functional Independence Measure and Barthel's Index). However, as has been noted by other authors, some of the tests which comprise these

outcome measures (eg cognitive function, sphincter control) seem more suited to patients undergoing long term rehabilitation, rather than patients in the acute care setting (Shields et al 1995, Zavadak et al 1995). In contrast, the ILOA Scale assesses a range of functional activities that are representative of typical discharge criteria for this patient group (ie ability to independently sit from lying, stand from sitting, walk and climb stairs). Furthermore, all components of the test are well described and a specific training manual for its use is available. Shields et al (1995) investigated the reliability, validity and responsiveness of the ILOA Scale for 86 patients who had undergone total hip or knee replacement, assessing patients over the second to sixth post-operative days (approximately). They found that the ILOA Scale was reliable (both intra-examiner and inter-examiner reliability), valid (when compared with the Harris Hip Rating Scale) and sensitive to change over the study period, with a mean change of seven points for the total ILOA Scale score found for their patient sample from the second to sixth post-operative day. Thus, the ILOA Scale was chosen as the main outcome measurement for this study and, in our experience, was simple to use, reliable and sensitive to change over the study period.

As far as the timing of the outcome measurements was concerned, the initial measurement time (ie third or fourth post-operative day) was chosen as it was believed this would allow sufficient time from the operative procedure for most patients to be able to attempt the functional tasks involved in the ILOA Scale. The second measurement time (ie seventh or eighth post-operative day) was selected as it would allow a reasonable period of time for outcomes to improve and thus a treatment effect to be noted. Additionally, this second measurement could not be further delayed as many patients are discharged from hospital shortly thereafter. Thus, the time scale over which outcome measurements were performed in the present study was similar to that used by Shields et al (1995). Longer term follow up of patients was considered (eg three and six weeks post-operatively), however, it was felt that confounding variables that would be impossible to control adequately may have affected outcomes at these times. For example, patients' levels of motivation to regain function on return home would have been variable and it is likely that this would have affected longer term follow up responses, whereas during the relatively short inpatient stay it was possible for the physiotherapist to supervise and motivate patients to perform the mobility protocol and exercise program. Similarly, the amount of support available at home would differ from patient to patient, be very difficult to control (compared with the initial period of hospitalisation), and could impact on longer term outcomes.

The bed exercises that were used in this study are similar to those described for comparable groups of patients (Aarons et al 1996, Enloe et al 1996, Hughes et al 1993, Zavadak et al 1995). The inability of these exercises to significantly improve range of hip movement in this study (in addition to a mobilisation program) may be because the mobilisation

program achieved a greater range of movement than the patient was able to achieve doing bed exercises independently. However the moderate intra-rater examiner reliability that was achieved for hip range of movement, may have increased measurement error and thus affected the accuracy of these measurements. The inability of bed exercises to significantly improve functional outcome (when added to a mobilisation program) was not altogether unexpected, and may reflect that, in contrast with the mobilisation program, the bed exercises were not based on functional tasks. The program of bed exercises used in this study was not predominantly aimed at increasing strength, nor was strength chosen as an outcome measure, for the reasons outlined previously. While hip arthroplasty patients may demonstrate decreased strength around the affected hip due to their long-standing hip problem (Shih et al 1994), it is likely that muscle strengthening exercises for these patients will be most effective if the training is specific to the exact movements for which the increased strength is desired (Astrand and Rodahl 1986, Bowers and Foss 1988, McArdle et al 1996). Thus, the ability of a program of bed exercises to increase strength for patient groups similar to those included in this study is debatable, although this has not yet been investigated. Although no attempt was made to formally screen all patients for the development of deep vein thrombosis, only one patient (control group) was diagnosed with this clinically. In view of this low incidence, it is not possible to draw any conclusion regarding the effect that a lack of bed exercises may have had on the incidence of clinically important deep vein thrombosis.

Further research should be undertaken with similar patient groups to confirm the findings of this study. While the results of this study should not be extrapolated to other patient groups where bed exercises are used, it nevertheless raises the question of their effectiveness, except perhaps for the most debilitated patients who are unable to attempt range of movement and strengthening exercises in a functional manner. However, it is possible that an alternative program of bed exercises may have been more effective, that partially weight bearing patients or sub-groups of fully weight bearing patients do benefit from bed exercises, or that they may be more effective after the acute post-operative period.

Conclusion

This study found that bed exercises did not add to the effectiveness of a mobility program for patients following elective primary hip arthroplasty during the initial post-operative period, in terms of hip pain, range and function. The results of this study suggest that physiotherapists should continue to provide mobility programs for patients after primary hip arthroplasty, but the routine use of bed exercises during the initial period of hospitalisation is not supported.

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