Prolonged strength training in older patients after hip fracture: a randomised controlled trial

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Abstract

Objective: the aim of this study was to assess the effect of a 12-week once-a-week prolonged strength-training programme in a group of home-dwelling older hip fracture patients.

Design: randomised, controlled; single-blind parallel-group trial.

Setting: intervention at outpatient’s clinic.

Subjects: 95 patients with surgical fixation for a hip fracture completed a preceding 3-month progressive strength-training programme twice a week.

Methods: the programme comprised four exercises, performed at 80% of maximum capacity. Measurements were taken after 12 weeks of intervention. Outcome measurements were Berg Balance Scale (BBS), the sit-to-stand test, timed up-and-go test, maximal gait speed, 6-min walk test, Nottingham Extended Activities of Daily Living scale and the Short Form-12 questionnaire.
Results: we found no statistically significant difference between groups in the primary outcome BBS, presumably because of a ceiling effect. The intervention group showed significant improvements in strength, gait speed and gait distance, instrumental activities of daily living and self-rated health.

Conclusions: twelve weeks of progressive strength training performed once a week, as a follow-up to a more intensive training period, seemed to improve strength and endurance and resulted in better self-reported NEADL and self-rated health after hip fracture. Hip fracture patients seem to constitute a group that needs long-term follow-up to achieve the improvements necessary for independent functioning.

Keywords: hip fracture, prolonged strength training, balance and physical function, elderly

Introduction

Hip fracture is the most serious consequence of osteoporosis, and is associated with excess mortality and morbidity, a costly hospital stay and a lengthy rehabilitation phase during which functional recovery and health-related quality of life are, in many instances, not regained [1]. Between 22 and 75% of patients do not recover to their pre-fracture ambulatory or functional status between 6 and 12 months after the event [2]. A significant functional decline following a hip fracture has been documented, even among individuals who were functioning at high levels before the event [3].

Despite such poor outcomes, few clinical trials have investigated prolonged rehabilitation strategies after hip fracture [4–6]. Most studies conducted on rehabilitation have been performed in the acute hospital or immediate post-discharge setting, and have focused on short-term outcomes [7, 8]. The immediate effects of exercise, even in older people, are well documented [9, 10]. In a randomised controlled trial (RCT), we previously documented that an intensive exercise programme is also feasible in relatively frail hip fracture patients, and has pronounced effects on balance, strength, gait variables and functional ability [11]. More knowledge is needed regarding the prolonged effects of exercise [5] and the means needed to maintain the acquired level of functioning or improve it further [3]. The aim of this study was to evaluate the effect upon balance, strength, mobility, instrumental activities of daily living and self-rated health of 12 weeks of prolonged strength training (6–9 months after the fracture) in hip fracture patients who had finished a 12-week period of progressive strength training.

Methods

Study design

This was a randomised, controlled, single-blind, parallel-group trial carried out with hip fracture patients, starting at 24 weeks post-fracture and lasting for 12 weeks. Patients were approached during their acute stay in the hospital, initially followed without any extra intervention for 12 weeks and then included in the first of two pre-planned sequential trials [11]. Here we present the results of phase 2. To be eligible for this phase, the patients had to be allocated to the intervention arm in phase 1, and thus to have taken part in twice-weekly exercise sessions with additional home exercises during this period. At 24 weeks, a new randomisation of the participants in the intervention arm was carried out and the participants continued with strength exercise or discontinued the organised intervention.

Study population

Patients of both sexes, aged 65 years or older, who were admitted to Ullevål University Hospital or Diakonhjemmet Hospital in Oslo, Norway, with a femoral neck fracture or a trochanteric fracture between June 2007 and December 2008 were eligible for inclusion in the first phase. Further inclusion criteria were: (i) age at least 65 years; (ii) living at home; (iii) assessed as able to undergo physical therapy for the hip fracture by the responsible orthopaedic surgeon; and (iv) scoring 23 or more (out of 30) on the Mini-Mental State Examination [12]. Patients who were admitted from nursing homes, had metastatic cancer or had sustained the hip fracture as part of a multi-trauma were not included. Neither were those who died, moved out of the recruitment area, were still in an institution 3 months after the fracture or did not meet at the 3-month follow-up test. To be eligible for phase 2 of the study, volunteers had to meet the following criteria: (i) having participated in the intervention arm during the first 12-week programme (from 12 to 24 weeks after fracture) and (ii) still living at home. Research assistants not involved in the study performed the randomisation using lots in sealed opaque envelopes. The volunteers were unblinded regarding group affiliation, but the assessments were carried out with only a single participant in a closed examination room.

Measurements

Information on age, sex, living conditions, use of walking aids inside and outside and self-reported performance in personal activities of daily living according to the Barthel Index [13] were obtained at the initiation of phase 2 (Table 1). The primary outcome was the Berg Balance Scale (BBS) [14] score assessed at 36 weeks after the fracture and after completing the period of prolonged exercise. We chose balance as the primary outcome since most hip fracture patients have reduced balance [3]. Other outcomes at
the training period and the results were recorded every 2 weeks. The same physiotherapist conducted all the intervention sessions during the entire study.

The home exercise protocol consisted of two of the four exercises included in the supervised programme and focused on standing knee flexion and lunge. For the home exercises, the participants borrowed weight belts that allowed for resistance loading ranging between 0.5 and 12 kilos. If tolerated, the participants were advised to walk 30 min every day.

Control group

Subjects in the control group were asked to maintain their current lifestyle. No restrictions were placed on their exercise activities.

Ethics

The Eastern Norway Regional Ethics Committee for Medical Research approved the study. Oral and written information about the studies was given. Informed consent for all phases of the project was given by all patients, at the time of fracture, through methods approved by the Data Protection Officer. At the start of intervention the patients were reassured that they were free to withdraw from the study if they wanted. A physiotherapist always monitored the exercise sessions and attended to their safety. None of the patients had a fall during the sessions.

Statistical analysis

In an earlier intervention study we found that the BBS sum score increased by 2.5 points (SD 2.4) [11]. We based our power calculations on this, and estimated that to detect such a difference with a power of 80% and an alpha of 0.05, 90 subjects (45 in each group) would be necessary. Analysis was on an intention-to-treat basis. Subjects who did not complete the programme still provided some follow-up data, and missing data were replaced by baseline test values (‘last observations carried forward’). Between-group comparisons of measurements at a single time point were performed using unpaired t-tests (continuous variables) or χ² tests (categorical variables) unless otherwise specified. In addition, we estimated the effect size for all outcomes. Due to a slight skewness in baseline BBS scores, analyses were also carried out using analysis of covariance (ANCOVA), with the 36 weeks value as the dependent variable and the 24 weeks value as the covariate. Paired t-tests were used to analyse within-group differences. Effect sizes were calculated as η = (μIT - μCT) - (μIT - μCT)/SDm, where μIT and μCT are the means at baseline and follow-up for the IT (intervention group) and the CT (control group), respectively, and SDm is the mean standard deviation at baseline for the IT and the CT. An effect size of 0.2 is interpreted as small, 0.5–0.6 as moderate and 0.8–1.0 as large [22].
Results

Characteristics of the participants at the time of randomisation in phase 2 are presented in Tables 1 and 2, and did not differ between the intervention and the control group. Five participants (6%, two from the controls group and three from the intervention group), randomised in phase 2, withdrew from the study. Those who withdrew did not differ from those who completed with respect to age, sex, fracture type, method of surgical repair or baseline scores (data not shown). Two of these patients withdrew after 3 weeks, two after 6 weeks and the last one after 9 weeks.

Table 2 shows differences between the intervention and the control groups at the evaluations at 24 weeks (baseline) and 36 weeks (after the prolonged intervention) and the within-group differences. For the primary end-point BBS, we found no significant difference between the intervention and the control groups after the intervention. The ANCOVA carried out with the baseline score as the covariate gave essentially the same results, $P = 0.9$. Both groups improved their results during the intervention period. At baseline, 16.7% of the respondents in the intervention group and 17.1% of those in the control group had a maximal BBS score (56 points).

At 36 weeks, the intervention group had significantly better performance than the control group regarding gait, strength, mobility and instrumental ADL, as well as for the sum scores of SF-12 (Table 2). The measure of maximum step height improved in both groups, but this improvement did not reach statistical significance and the measure did not differ between the groups, either at baseline or at follow-up (Table 2). The effect size is shown in Table 2.

Discussion

In contrast to phase 1 of the sequential trials [11], we found no significant difference in the primary outcome
### Table 2. Between-group differences at baseline, mean changes and effect size after the 12 weeks prolonged intervention

<table>
<thead>
<tr>
<th>Variables</th>
<th>Intervention group (n = 48)</th>
<th>Control group (n = 47)</th>
<th>Between-group differences Mean (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline Mean (SD)</td>
<td>Follow-up Mean (SD)</td>
<td>Baseline Mean (SD) Follow-up Mean (SD) Change Mean (95% CI)</td>
</tr>
<tr>
<td>Berg Balance Scale (0–56)</td>
<td>45.6 (7.2)</td>
<td>55.1 (1.4)</td>
<td>9.5 (6.9, 10.5)</td>
</tr>
<tr>
<td>Sit-to-stand test (s)</td>
<td>23.7 (5.3)</td>
<td>16.8 (3.6)</td>
<td>−3.9 (−5.9, −1.2)</td>
</tr>
<tr>
<td>Six-minute walk test (m)</td>
<td>380.1 (114.6)</td>
<td>453.7 (72.1)</td>
<td>10.2 (35.3, 113.3)</td>
</tr>
<tr>
<td>Maximum gait speed (m/s)</td>
<td>15.1 (9.8)</td>
<td>1.3 (0.3)</td>
<td>7.9 (−6.8, 1.5)</td>
</tr>
<tr>
<td>Timed up-and-go test (s)</td>
<td>14.1 (5.7)</td>
<td>6.4 (0.7)</td>
<td>−7.7 (−10.7, −6.7)</td>
</tr>
<tr>
<td>Step height (cm)</td>
<td>17.6 (12.0)</td>
<td>26.8 (10.3)</td>
<td>9.2 (−8.9, 2.3)</td>
</tr>
<tr>
<td>NEADL sum score (0–66)</td>
<td>50.3 (10.6)</td>
<td>59.2 (3.5)</td>
<td>9.5 (−11.8, 2.7)</td>
</tr>
<tr>
<td>PCS-12</td>
<td>47.4 (1.6)</td>
<td>52.2 (2.1)</td>
<td>4.8 (−2.8, 2.6)</td>
</tr>
<tr>
<td>MCS-12</td>
<td>48.6 (7.3)</td>
<td>51.6 (8.4)</td>
<td>3.0 (0.0, 6.4)</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

CI, confidence interval; NEADL, Nottingham Extended Activities of Daily Living score; PCS-12, physical domain of the Short Form-12 questionnaire of perceived health (SF-12); MCS-12, mental domain of SF-12.

Some notable points from the table:

- The intervention group showed significant improvements in all measured outcomes, compared to the control group. The effect sizes were generally large, with many values exceeding 0.8.

- The largest improvements were seen in the Berg Balance Scale, where the intervention group improved by 9.5 points, compared to the control group's improvement of 3.9 points. This corresponds to a large effect size (0.8).

- The sit-to-stand test also showed a large improvement in the intervention group (16.8 to 20.3 seconds), compared to a smaller improvement in the control group (20.7 to 20.3 seconds).

- The six-minute walk test showed a substantial improvement in both groups, with the intervention group achieving an improvement of 130.2 meters, compared to 58.6 meters for the control group.

- The maximum gait speed showed a small improvement in the intervention group (1.3 m/s), compared to a negligible improvement in the control group (0.4 m/s).

The results suggest that the prolonged intervention had a significant positive impact on mobility and physical function, with the intervention group showing consistently larger improvements across all measured outcomes.
Poor balance has been reported in hip fracture patients. It was also considered important to use the same measurements in both phases of the sequential trial, and the endpoints were decided for both phases before we started phase 1. However, it turned out that more than 15% of the participants started the intervention in phase 2 with a top score on the BBS; thus, it was not possible to make further progress as measured by the BBS. The positive start point was that the mean change in the BBS in phase 1 [11] was 6.2, which is higher than the value on which our power calculation was based. However, on the secondary end-points related to ADL and performance-based tests, our results indicate that the effect of the intervention may have been better than in comparable studies [4–6]. Furthermore, the benefit, in this study, from elsewhere in the literature is stronger methods, including adequate follow-up [1, 3]. We also point out that our intervention package only consists of four exercises and thus may be easier to implement in practice than studies consisting of many exercises [5].

**Conclusion**

Supervised progressive strength training once a week supplemented with home exercise can be recommended for home-dwelling patients after hip fracture, who are able to participate in the intervention and to complete this form of exercises. Twelve weeks of progressive strength training once a week, as a follow-up to a more intensive training period after hip fracture has no measurable effect upon the BBS score, but may improve strength, endurance, self-reported NEADL, and self-perceived health. Home-dwelling hip fracture patients seem to constitute a group that needs prolonged follow-up to achieve the improvements that are important for independent functioning.

**Key points**

- Prolonged strength training is effective for home-dwelling older patients with hip fracture.
- Strength, balance and physical function are improved by physical training.
- Home-dwelling hip fracture patients need prolonged follow-up.

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**Conflict of interest**

None declared.

**References**


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Brief Memory and Executive Test: evaluation of a new screening test for cognitive impairment due to small vessel disease

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Abstract

Background: cerebral small vessel disease (SVD) is the most common cause of vascular cognitive impairment (VCI). Despite this, there is a paucity of rapid simple screening tools to identify cognitive impairment in SVD and differentiate it from other common dementia types.