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Intensive physical training in geriatric patients after severe falls and hip surgery

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Abstract

Background: intensive exercise training can lead to improvement in strength and functional performance in older people living at home and nursing home residents. There is little information whether intensive physical exercise may be applicable and effective in elderly patients suffering from the acute sequelae of injurious falls or hip surgery.
Objective: to assess the feasibility, safety and efficacy of intensive, progressive physical training in rehabilitation after hip surgery.
Design: prospective, randomised, placebo-controlled intervention study of a 3-months training intervention and a 3-months' follow-up.
Setting: physical training 6–8 weeks after hip surgery.
Subjects: twenty-eight (15 intervention, 13 control) elderly patients with a history of injurious falls admitted to acute care or inpatient rehabilitation because of acute fall-related hip fracture or elective hip replacement.
Methods: progressive resistance and functional training to improve strength and functional performance.
Results: no training-related medical problems occurred in the study group. Twenty-four patients (86%) completed all assessments during the intervention and follow-up period. Adherence was excellent in both groups (intervention: 93, 0 ± 13, 5% *versus* control: 96, 7 ± 6, 2%). Training significantly increased strength, functional motor performance and balance and reduced fall-related behavioural and emotional problems. Some improvements in strength persisted during 3-months follow-up while other strength variables and functional performances were lost after cessation of training. Patients in the control group showed no change in strength, functional performance and emotional state during intervention and follow-up.
Conclusions: progressive resistance training and progressive functional training are safe and effective methods to increase strength and functional performance during rehabilitation in patients after hip surgery and a history of injurious falls. Because part of the training improvements were lost after stopping the training, a continuing training regime should be established.

Keywords: *geriatric rehabilitation, hip-surgery, physical training, randomised controlled trial*

Introduction

Patients with a history of injurious falls have a high fall-related morbidity and mortality and high prevalence of dependency that cause substantial public health costs [1–3]. Standard care has a limited effect on the rehabilitation of hip-fracture patients. Many of these patients do not regain their pre-traumatic walking ability or levels of self care [4–7].

Little is known about effective ambulatory strategies for the rehabilitation of geriatric patients after hip surgery. Studies published on rehabilitation of hip-fracture have chosen patients on wards and post-discharge settings. The methodology used in these studies differed considerably in aims, interventions and outcomes, producing inconsistent and conflicting results [8–13].

Motor performance may be a main target for rehabilitation as mobility is important for independence, autonomy and quality of life. Active exercise is associated with a reduced risk of hip fracture [14, 15]; intervention studies using various forms of intensive exercise reduce the risk of falling [16–18].

Insignificant effects to prevent falls in some intervention studies using physical training might be due to inappropriately low exercise intensity and methodological shortcomings [19, 20]. Earlier studies have shown that intensive physical training is effective in improving strength and functional performance in older people and frail nursing home residents [21–23].

Despite these positive results, intensive exercise training is not used in rehabilitation of geriatric patients after hip surgery and injurious falls because of the potential risk of training-induced musculo-skeletal, cardiac and circulatory problems. In the few published studies physical training has so far been organised as individual, home-based training. Results were inconclusive as the studies were uncontrolled [24], used a training intervention that was uni-dimensional including patients no longer in acute rehabilitation [25] or did not achieve significance [26]. Insignificant training effects might have been caused by insufficient training intensity and training adherence in these groups of old patients when training alone at home.

We hypothesised that an intensive, supervised group training of strength, co-ordination and functional performance would be motivating, safe and effective in acute rehabilitation of geriatric patients after surgical repair of the hip and a history of injurious falls.

Methods

Study design

The study was designed as a randomised, placebo-controlled, 12-week ambulant clinical trial in which patients were assigned to receive lower extremity progressive resistance training, progressive functional and balance training or a placebo motor activity. Patients were followed-up for 3 months after cessation of intervention.

Study population

A subgroup of participants of a larger intervention study for rehabilitation and secondary fall prevention in patients with a history of injurious falls (but not necessarily hip surgery or fractures [27]). Patients were recruited consecutively and randomly assigned to either control or intervention group after baseline testing in the last week of in-patient rehabilitation. The training intervention started immediately after discharge from hospital. Inclusion criteria were: hip surgery, recent history of injurious falls, age over 75 years, female sex, consent of the orthopaedic surgeon, and patient willingness to participate in the study. Patients were excluded if they had acute neurological impairment, severe cardio-vascular disease, unstable chronic or terminal illness, major depression, severe cognitive impairment or severe musculo-skeletal impairment.

Intervention

The patients underwent a regime of high-intensity progressive resistance training of functionally relevant muscle groups and a progressive functional training for 3 days a week for 12 weeks. Intensity of strength training was adjusted to 70–90% of the individual maximal workload. Basic functions such as walking, stepping or balancing were trained progressively with increasing complexity, as described previously [27].

Placebo activities

All patients assigned to the control group met 3 times a week for 1 hour for motor placebo activities. Typical placebo motor activities, which were not supposed to be relevant for the study purpose, were calisthenics, games and memory tasks whilst seated [27].

Physiotherapy

Because of acute orthopaedic problems following the fall and orthopaedic surgery, both groups received identical physiotherapy two times a week for 25 minutes. Strength and balance training were excluded during physiotherapy and control group sessions. Physiotherapy consisted of massage, stretching and application of heat or ice.

Measurements

Baseline measurements were performed before randomisation 3–4 weeks after admission to the rehabilitation hospital (T1), at the end of the training period (T2) and after an additional 3 months-follow-up (T3). Main outcome variables were documented by a person blinded to the patients' group assignment.

Clinical characteristics

We recorded medical status, comorbidity, medication, and functional status, using the Barthel/Mahoney Activities of Daily Living Index (ADL) [28], the Lawton/Brody Instrumental Activities of Daily Living Index (IADL) [29] and cognitive status, using the Mini-Mental-State Examination (MMSE) [30].

Muscle strength

We documented maximal dynamic and isometric muscle strength for relevant muscle groups by a strength-measuring unit (Diagnos 40®, Schnell, Peutenhausen) and as the One-Repetition-Maximum in a training device (leg-press, Kaphingst, Lahntal). We measured handgrip strength by a dynamometer (Vigorimeter®, Kaphingst, Lahntal). Strength of limbs that were affected by the fall were only measured to workloads that the orthopaedically stable patients would individually accept. Combined measurements of both legs were measured on both limbs acting simultaneously for isometric measurements. Only for maximal strength (leg-press) the results of either side were summed.

Functional performance

Maximal gait speed [31, 32], stair climbing performance [33], chair stand [32, 34], step height [32], the timed-up-and-go-Test [35], Tinetti's Performance Oriented Mobility Assessment [36] and a modified balance test [31, 37] were performed.

Training events, training adherence and overall physical activity

Training-related symptoms were evaluated by a geriatrician and a physiotherapist. If necessary, modifications of training were arranged. Training adherence was documented in training lists. Overall physical activity with sub-scores for activities in the home, leisure time activity and sports activities (including walking) was evaluated by a physical activity questionnaire for elderly people [38].

Emotional status

The emotional status was administered by the Geriatric Depression Scale (GDS) [39] and the Philadelphia Geriatric Morale Scale (PGMS) [40]. Post-traumatic emotional state was documented by patients' subjective rating of walking steadiness, subjective rating of fear of falling [31, 41] and the Falls Handicap Inventory [42].

Statistical analysis

Statistical procedures were performed on SPSS 7.5 for Windows software using a complete case analysis [43]. Descriptive data ($\pm$) are given as SD. We used unpaired *t*-Test and Mann–Whitney *U* test to compare baseline values between groups. We evaluated the effect of intervention (T2) and follow-up (T3) by using analysis of co-variance with the baseline measurement of age and baseline values of the dependent variable as co-variates.

Ethical approval

The study was approved by the ethics committee of the University of Heidelberg in accordance with the Helsinki declaration in its revised form and written informed consent was obtained from each participant.

Results

Enrolment

Of 696 female patients screened for participation in the previously published larger study [27], 526 were excluded in a first screening process based on pre-defined exclusion criteria. A total of 72.2% did not participate in the study because of age below 75 years (35.3%), residence not at study location (6.9%) or history of neurological disease (36.0%). These exclusion criteria were study specific as most of these patients would have been able to take part in the training regime. Other patients were excluded because of serious medical conditions, such as severe heart failure, terminal illness or other disorders (22.8%). After screening, 170 patients were considered potentially eligible to participate in the study. Fifty- seven of these patients (33.5%) consented to take part in the study. In the 113 patients that did not take part in the study, lack of motivation or social commitment (e.g. caring for spouse) were the most common reasons for not consenting to the study (57%). One third (35%) of the patients were excluded because of predominantly medical reasons (such as severe heart disease, cognitive impairment, major depression or new acute disease) that were not evaluated correctly in the first screening process, or were lost to follow up (7%). 28 of the 57 patients, who consented to take part in the larger study, had hip surgery and thus formed the study group of this paper.

Patient characteristics

Baseline characteristics of the patients did not differ significantly between groups and are summarised in Table 1. All patients had suffered injurious falls and hip surgery within the last 3 months. Of all hip fractures, 17 were medial, 7 pertrochanteric, and 1 lateral fractures of the neck of the femur. Three patients (1 control, 2 intervention) were admitted to hospital predominantly because of elective hip surgery but had documented recent injurious falls. The hip surgery performed was total hip replacement ($n=14$), hemiarthroplasty ($n=4$) and various forms of osteosynthesis ($n=10$). Mean length of inpatient rehabilitation was 23 ± 5 days. Duration of care in the surgical unit was 9 ± 2 days. For all patients, we obtained the consent of the orthopaedic surgeon to take part in the intervention.

Following the predefined exclusion criteria patients did not have severe psychological, cognitive or other severe medical disorders that would exclude training participation. Most patients had a preserved ability for activities of daily living (Barthel's ADL: 89.3 ± 7.7; Lawton's IADL: 6.2 ± 1.7). Nonetheless, all the geriatric patients were multi-morbid (number of diagnosis: 8.3 ± 3.0), old (age: 81.3 ± 3.9 years) and had a poor functional capacity (Tinetti's POMA: 19.5 ± 4.2;

Timed-up-and-go: 28.0 ± 11.5; walking velocity: 0.52 ± 0.2 m/sec).

Adherence to training and adverse events

Group adherence was 96.7 ± 6.1% (median 100, range 83–100%) in the control and 93.1 ± 13.5% (median 99, range 55–100%) in the intervention for those who started group sessions. Two patients in the intervention and 1 patient of control group did not start with the group sessions after randomisation and one patient of the intervention group dropped out of training because of motivational reasons. The training intervention more than doubled total physical activity in the intervention group, leading to a significant difference between groups at the end of the intervention period. Physical activity level almost returned to baseline levels after training ceased. The total physical activity level did not change in the control group over time (Table 3). No major health problems occurred during training or testing. Minor problems included aching muscles after initial training sessions, cramps, tenderness, knee pain and wound/scar aching. All these problems were resolved by adjustment of training and physiotherapy.

Strength (Table 2)

Strength increased significantly in the intervention group. Improvements could be achieved both in the

Table 1. Baseline patient characteristics

Characteristic	Intervention ($n=15$)	Control ($n=13$)
Age (years)	81.7 ± 7.6	80.8 ± 7.0
Height (cm)	157.3 ± 9.2	158.4 ± 6.7
Weight (kg)	56.9 ± 11.4	62.2 ± 8.6
Body-mass-index (kg/m^2)	23.1 ± 3.6	24.8 ± 3.5
Mini Mental State Examination (MMSE)	28.6 ± 2.1	27.0 ± 3.7
	29 (23–30)	29 (20–30)
Geriatric Depression Scale (GDS)	3.2 ± 2.7	2.7 ± 2.3
	2 (0–10)	2 (0–7)
Medication (No.)	3.4 ± 1.6	2.8 ± 1.8
Activities of Daily Living (ADL)	89.6 ± 7.7	89.1 ± 7.0
	90 (75−100)	90 (75−100)
Instrumental Activities of Daily Living (IADL)	6.2 ± 1.6	6.1 ± 1.7
Tinetti's Performance Oriented Motor Assessment (POMA)	20.1 ± 3.9	18.8 ± 4.4
Timed-up-and-go (sec)	28.7 ± 12.3	28.3 ± 9.3
Leg press (one repetition maximum/kg)	86.8 ± 32.3	96.0 ± 28.5

Presented are means ± SD measured initially. For skewed data also the median and range is given. No significant differences were observed between groups. Leg press represents the sum of both legs measured.

Table 2. Comparison of strength between groups

	Intervention ($n=12$)			Control ($n=12$)			*P*-Values	
Strength test	T1	T2	T3	T1	T2	T3	*P*-value T2	*P*-value T3
Leg-press, both legs 1RM (kg)	87 ± 32	161 ± 75	158 ± 71	96 ± 29	107 ± 40	116 ± 30	$P=0.011$	$P=0.036$
Leg-press, affected side 1RM (kg)	32 ± 16	71 ± 6	71 ± 35	40 ± 13	42 ± 19	50 ± 21	$P=0.002$	$P=0.021$
Leg-press, non affected side 1RM (kg)	55 ± 19	90 ± 42	88 ± 39	59 ± 17	64 ± 24	67 ± 17	$P=0.011$	$P=0.018$
Leg-extensor, both legs (N)	98 ± 26	133 ± 26	128 ± 24	91 ± 33	95 ± 39	101 ± 40	$P=0.005$	$P=0.069$
Leg extensor, affected side (N)	41 ± 15	66 ± 11	68 ± 13	42 ± 14	47 ± 19	51 ± 22	$P<0.001$	$P=0.011$
Leg extensor, non-affected side (N)	65 ± 17	78 ± 13	80 ± 11	60 ± 18	56 ± 19	60 ± 20	$P=0.001$	$P=0.006$
Leg flexor, both legs (N)	46 ± 18	62 ± 18	57 ± 15	55 ± 24	54 ± 23	55 ± 23	$P=0.027$	$P=0.152$
Leg flexor, affected side (N)	25 ± 11	36 ± 9	37 ± 7	29 ± 15	31 ± 14	34 ± 13	$P=0.027$	$P=0.036$
Leg flexor, non-affected side (N)	30 ± 15	39 ± 13	39 ± 11	34 ± 15	36 ± 12	37 ± 12	$P=0.113$	$P=0.119$
Ankle plantar flexion, both legs (N)	126 ± 50	165 ± 57	160 ± 50	97 ± 38	101 ± 51	115 ± 58	$P=0.043$	$P=0.738$
Ankle plantar flexion, affected side (N)	68 ± 30	90 ± 29	88 ± 30	50 ± 20	58 ± 29	65 ± 33	$P=0.251$	$P=0.944$
Ankle plantar flexion, non-affected side (N)	80 ± 32	99 ± 34	98 ± 32	66 ± 22	67 ± 24	78 ± 32	$P=0.028$	$P=0.968$
Hand grip strength, both hands (KPa)	118 ± 39	117 ± 30	121 ± 29	113 ± 20	106 ± 21	108 ± 28	$P=0.09$	$P=0.270$

Results are given as mean ± SD for baseline values T1, values at the end of training period T2, or the end of follow-up. No strength variables were significantly different at baseline. Results of analysis of variance are adjusted for age. Values obtained at T2 and T3 are also adjusted for baseline strength. Handgrip strength represents a non-trained muscle group.
1RM, one repetition maximum; N, Newton; KPa, Kilopascal.

side that was affected by fracture and surgery as well as in the non-affected side in most of the muscles groups tested. Handgrip strength, that represents a muscle group not targeted in the intervention, did not change. Differences between groups were partly lost in the follow-up period. Control patients did not significantly change their strength performance during the measuring period.

Functional performance (Table 3)

In the intervention group motor key functions such as walking, stepping, getting-up, climbing stairs, and keeping postural control increased significantly in most performances tested. Significant differences between groups were lost in the follow-up period. Patients of the control group did not change their motor performance during the study period.

Emotional status (Table 4)

Fall-related emotional status was partly improved by the study intervention. When we analysed changes within groups, a significant improvement could be documented in the intervention group for the results of the Falls Handicap Inventory ($P=0.016$) and the subjective perception of walking steadiness ($P=0.008$), but not for fear of falling ($P=0.260$) and depression ($P=0.270$). No

Table 3. Comparison of functional performance between groups

	Intervention ($n=12$)			Control ($n=12$)			*P*-values	
Tests	T1	T2	T3	T1	T2	T3	*P*-value T2	*P*-value T3
Tinetti's POMA	20.1 ± 3.9	25.6 ± 2.4	23.5 ± 4.5	18.8 ± 4.3	20.7 ± 4.3	20.5 ± 4.0	$P=0.004$	$P=0.505$
POMA Part 1	11.1 ± 2.4	13.8 ± 1.4	12.7 ± 2.2	10.0 ± 2.4	11.1 ± 2.5	11.4 ± 2.4	$P=0.025$	$P=0.747$
POMA Part 2	9.0 ± 2.5	11.7 ± 1.5	10.8 ± 2.5	8.8 ± 2.5	9.5 ± 2.1	9.1 ± 2.1	$P=0.021$	$P=0.249$
Box step, both legs (cm)	54.3 ± 14.7	73.6 ± 14.3	73.0 ± 12.7	55.9 ± 16.7	61.0 ± 9.9	65.0 ± 14.8	$P=0.07$	$P=0.401$
Box step, affected leg (cm)	23.2 ± 8.2	34.5 ± 8.2	34.5 ± 6.4	24.1 ± 10.7	28.5 ± 6.2	30.6 ± 9.8	$P=0.164$	$P=0.482$
Box step, non-affected leg (cm)	31.1 ± 7.9	39.1 ± 7.0	38.5 ± 7.8	31.8 ± 8.4	32.5 ± 4.2	34.4 ± 5.8	$P=0.03$	$P=0.420$
Balance score	12.1 ± 2.7	14.0 ± 1.5	13.4 ± 1.2	12.6 ± 1.3	12.3 ± 2.5	12.2 ± 2.7	$P=0.05$	$P=0.203$
Functional reach (cm)	15.4 ± 4.8	18.7 ± 6.2	18.2 ± 6.5	16.1 ± 4.4	14.5 ± 5.5	17.1 ± 8.7	$P=0.198$	$P=0.586$
Walking velocity (m/sec)	0.54 ± 0.21	0.73 ± 0.21	0.72 ± 0.28	0.50 ± 0.18	0.44 ± 0.20	0.49 ± 0.15	$P=0.008$	$P=0.121$
Timed-up-and-go (sec)	27.7 ± 12.3	18.8 ± 4.5	26.1 ± 17.8	28.3 ± 9.3	34.3 ± 14.4	26.9 ± 9.8	$P=0.007$	$P=0.731$
Chair rise (sec)	17.2 ± 7.9	12.9 ± 3.4	16.9 ± 5.7	17.6 ± 5.6	20.5 ± 6.3	18.7 ± 6.3	$P=0.008$	$P=0.589$
Stair rise (sec)	25.9 ± 18.5	15.0 ± 5.1	16.9 ± 6.2	32.3 ± 16.9	29.3 ± 15.4	24.7 ± 11.4	$P=0.019$	$P=0.124$
Barthel's ADL	89.6 ± 7.8	94.5 ± 5.5	93.0 ± 8.2	89.1 ± 7.0	94.5 ± 8.6	96.1 ± 8.2	$P=0.938$	$P=0.636$
Lawton's IADL	6.2 ± 1.6	7.2 ± 1.0	7.3 ± 1.4	6.1 ± 1.7	6.7 ± 1.6	6.9 ± 1.3	$P=0.293$	$P=0.416$
Total activity	9.9 ± 4.8	20.2 ± 3.5	11.0 ± 6.5	6.5 ± 2.3	7.9 ± 3.5	6.5 ± 3.2	$P<0.001$	$P=0.294$
'Sports' activities	6.5 ± 3.6	18.8 ± 3.0	7.8 ± 4.5	4.6 ± 1.9	6.5 ± 3.2	4.9 ± 3.0	$P>0.001$	$P=0.147$
Household activities	1.7 ± 0.7	1.4 ± 0.9	1.7 ± 0.8	1.5 ± 0.6	1.3 ± 0.8	1.6 ± 0.6	$P=0.987$	$P=0.604$

Data are given as means ± SD. No functional variables were significantly different at baseline. Results of analysis of variance are adjusted for age. Values obtained at T2 and T3 are also adjusted for baseline results at T1.
POMA, Performance Oriented Motor Assessment; m/sec, meters per second; ADL, Activities of Daily Living; IADL, Instrumental Activities of Daily Living.

Table 4. Comparison of emotional state between groups

	Intervention ($n=12$)			Control ($n=12$)			*P*-value	
Test	T1	T2	T3	T1	T2	T3	*P* -value T2	*P*-value T3
GDS	3.2 ± 2.8	2.4 ± 2.5	3.0 ± 2.4	2.7 ± 2.3	3.7 ± 2.8	3.8 ± 2.8	$P=0.052$	$P=0.254$
PGCMS	6.2 ± 2.7	5.6 ± 2.7	6.0 ± 3.9	5.1 ± 3.7	6.2 ± 3.5	6.0 ± 3.7	$P=0.253$	$P=0.302$
FHI	26.4 ± 16.8	15.8 ± 15.3	12.0 ± 13.5	33.6 ± 16.3	29.3 ± 16.3	28.0 ± 14.7	$P=0.158$	$P=0.042$
Fear of falling	1.50 ± 0.71 1 (1–3)	0.78 ± 0.83 0 (0–2)	1.00 ± 0.92 0 (0–2)	1.67 ± 1.0 1 (0–3)	1.55 ± 0.88 2 (0–3)	1.78 ± 0.67 2 (1–3)	$P=0.179$	$P=0.351$
Walking steadiness	2.00 ± 0.0 2 (2–2)	1.44 ± 0.73 1 (1–3)	1.50 ± 0.53 1 (1–2)	2.1 ± 0.8 2 (1–3)	2.1 ± 0.60 2 (1–3)	2.00 ± 0.50 2 (1–3)	$P=0.068$	$P=0.190$

Data are given as means ± SD. For non-continuous data, the modal and range are also given. No emotional variables were different at baseline. Results of analysis of variance are adjusted for age. Values obtained at T2 and T3 are also adjusted for baseline emotional status.
GDS, Geriatric Depression Scale; PGCMS, Philadelphia Geriatric Center Morale Scale; FHI, Fall Handicap Inventory.

significant changes within the control group occurred in the tested variables for emotional state. Differences between groups were significant for the results of the Fall Handicap Inventory at the end of the follow-up period.

Discussion

In this randomised, placebo-controlled study a regime of intensive physical training significantly improved strength, functional performances and partly fall-related emotional state. However, training gains were partly lost in the 3-months follow-up period. While training adherence was excellent, proving the high acceptance in these high-risk geriatric patients, no training-related adverse clinical events occurred.

Strength

Strength increased significantly in the intervention group in most of the muscle groups tested, as they had in a group of frail nursing home residents [21]. In other training studies including patients with hip-surgery, significant improvements in strength either could not be achieved [26], were achieved in an uncontrolled study by methods hard to standardise [24], or were achieved in an uni-dimensional training in patients 7 months after hip-fracture, and therefore no longer during acute rehabilitation [25]. In the present study, both the operated and the non-operated side improved. In both sides a different but adequate training load was fixed for each leg at the beginning of the training and was increased according to the training progress. Progress in strength was strictly training-related, as the non-trained handgrip strength did not improve.

Functional performance

Motor functions such as walking, stepping, getting up, climbing stairs, and keeping postural control significantly improved in the intervention group. Previous reports have shown that frail older people show a linear- to curvi-linear correlation between strength and functional performances [44–47]. Lack of strength and balance are powerful predictors of severe walking disability [48]. When strength falls below a minimum threshold, functional performances deteriorate progressively [49]. Older women often have insufficient muscular strength [50] which is further compromised by bed-rest following an injurious fall and orthopaedic surgery [51, 52]. In the present study, the improved strength induced by the progressive resistance training along with the functional training produced the significant increase in functional performance. The 35% increase in walking speed as achieved in the intervention group represented a marked improvement for the patients. Patients were still handicapped in motor performances after in-patient rehabilitation as they were initially not able to achieve half the walking speed necessary to cross a street during normal traffic light sequences [50] or a third of the walking speed of comparable healthy older women [53]. The improvement in speed in ascending stairs by 42% and the improved ability to step 50% higher with the affected leg is crucial in every-day performance such as ascending stairs or getting onto a bus.

The performances improved significantly in all those motor tasks which correlate significantly with the risk of functional disability, dependence, or falls, such as stair climbing [49] chair-rise [37, 55–57], timed-up-and-go [58], walking performance [37, 55, 57], balance/sway [37, 54, 55, 57, 59], Tinetti's Motor Assessment Test [60]. As reported in previous studies [61] gains in strength and functional performance were partly lost in the follow-up period after training cessation, suggesting that habitual physical activity is insufficient to maintain functional performance achieved after intensive physical training.

Emotional state

Fall-related emotional state as expressed in the fear of falling or restriction in every-day activities such as walking are common among geriatric patients with a history of injurious falls [56, 60–63]. In previous studies, an effect of motor training on emotional state was documented [27, 64, 65]. Increased self-confidence and a growing sense of self-efficacy [66], that might be fostered by the obvious gains in motor performance, may be the cause of the growing improvement in fall-related emotional state [65, 67]. In this study, the significant improvement of motor performance in the intervention group may have improved emotional state documented in the perceived walking steadiness and the results of the falls handicap inventory.

Conclusion

After injurious falls leading to hip surgery most patients do not regain their pre-traumatic performance when treated with usual ward care with no or scant ambulatory rehabilitation. Frail, elderly hip fracture patients are part of the growing number of multi-morbid patients, who require intensive and continuing medical care. Intensified ambulant rehabilitation extends the period of treatment and starts when patients are less handicapped by acute post-traumatic and post-surgical medical problems. When rehabilitation is organised in training groups in public health clubs (as established now in the study location) costs are comparatively low. They may be counterbalanced by potential reduction of public health costs in care and treatment and enormous individual benefits. Rehabilitation may help certain patients to return to pre-traumatic or even higher levels of functional state and mobility, and therefore to prevent further falls or dependency. However, only selected patients with at least partly preserved functional ability may be able to take part in the described training regime.

Key points

- Progressive functional and resistance training is safe and effective in geriatric rehabilitation after hip surgery.
- Strength, functional performance and fall-related emotional state are improved by physical training.
- Training should be long-term because of detraining effects.
- Patients with partly preserved functional ability should be included in suggested exercise programs.

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