Orthostatic hypotension in elderly patients.
Hartog, Laura

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2017

Link to publication in University of Groningen/UMCG research database

Citation for published version (APA):

Copyright
Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

Take-down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): http://www.rug.nl/research/portal. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Download date: 02-11-2019
CHAPTER 7

The association between orthostatic hypotension and handgrip strength with successful rehabilitation in elderly hip fracture patients

Accepted for publication as:
Hartog LC, Winters AM, Roijen H, Kamper AM, Inia H, Kleefstra N, Bilo HJG, Van Hateren KJJ. The association between Orthostatic Hypotension and Handgrip Strength with Successful Rehabilitation in elderly hip fracture patients. Archives of Physical medicine and Rehabilitation.
Chapter 7

ABSTRACT

Objective: Our objectives were to investigate the relationship between orthostatic hypotension (OH) and muscle strength versus time to successful rehabilitation within elderly hip fracture patients.

Design: A prospective observational cohort study. Handgrip strength was measured at the day of admission and OH as soon as possible after surgery. Cox proportional hazard modelling was used to investigate the relation between OH, or handgrip strength (kg) and time to successful rehabilitation, expressed as hazard ratios (HR). OH was defined as a drop in systolic blood pressure of > 20 mmHg or diastolic blood pressure of > 10 mmHg after postural change (dichotomous). Handgrip strength was measured with a hand dynamometer (continuous). The study was registered on trialregister.nl (NTR4940).

Setting: General hospital

Participants: Patients of ≥ 70 years with a hip fracture were recruited at the day of hospital admission. A total of 116 patients was included.

Main outcome measures: Primary outcome was time to successful rehabilitation, which was defined as discharge to patients’ own homes.

Results: During a median follow-up period of 36 days (IQR 9-57), 103 (89%) patients were successfully rehabilitated. No statistically significant relationships were found between OH and time to successful rehabilitation; HR 1.05 (95% confidence interval (CI) 0.67-1.66). Also handgrip strength and successful rehabilitation were not statistically significantly related; HR 1.03 (95% CI 0.99-1.06).

Conclusions: OH measured during the first days of hospitalization is not related to time to successful rehabilitation in operated hip fracture patients. Although no significant relationship was seen in the present study, the width of the confidence intervals does not exclude a relevant relationship between handgrip strength and time to successful rehabilitation.
INTRODUCTION

Hip fractures are a common cause of hospitalization and rehabilitation in elderly patients [1, 2]. The main purpose of rehabilitation in these patients is to regain their prefracture health status as much as possible [3, 4]. Dependence on medical care, decline in functional outcome, or admission to a nursing home may be the consequence when rehabilitation fails. The outcome of rehabilitation reflects the condition of the elderly patient and is a summation of many factors, including both physical and mental parameters [3-11]. The definition of successful rehabilitation or recovery varied widely; from regaining prior functional and/or mobility status, to functional independence leading to discharge to patients own home [4, 7, 9, 10, 12].

Examples of the numerous factors that negatively influence the response to rehabilitation are high age, presence of cognitive impairment or coexisting diseases, and high fear of falling (FOF) [3-5, 9, 13].

Also, orthostatic hypotension (OH) and muscle strength are amongst the factors that have been found to influence rehabilitation in elderly patients [7] [8, 10]. As the prevalence of OH and impaired muscle strength is high in elderly patients and are considered as important risk factors for falling and frailty, these variables are likely to negatively influence successful rehabilitation [14-20].

A previous study observed the counterintuitive finding that patients with OH were found to have a higher risk of successful rehabilitation compared to patients without OH [7]. Another study found no difference in functional outcome between stroke patients with and without OH [21]. Muscle strength is considered to be a strong positive predictor for functional outcome after rehabilitation in elderly hip fracture patients [8, 10]. OH and muscle strength separately influence outcome, but it is likely that these factors are also interrelated. Several causes of OH, such as the use of different medications, hypovolemic disorders, and bed rest, are potentially related to muscle strength [22-25].

As muscle strength and OH are both related to successful rehabilitation, and possibly also interrelated, these factors should be combined (and adjusted for) in analysing the association with rehabilitation. As far as we are aware, no previous studies investigated these combined associations. Therefore, we performed a study in which we aimed to investigate the relation between OH and muscle strength with time to successful rehabilitation within elderly hip fracture patients. We hypothesized that the presence of OH or low muscle strength would negatively influence the time to successful rehabilitation. Furthermore, we hypothesized that the relationship between OH and time to successful rehabilitation would be influenced by muscle strength.
Chapter 7

METHODS

Study population
This prospective observational cohort study was performed in a general hospital (the Isala hospital, Zwolle, the Netherlands). All patients of 70 years of age or older, admitted to the hospital with a hip fracture and treated by surgery, were recruited. Recruitment and all study procedures took place between November 2014 and December 2015. Exclusion criteria were a life expectancy of less than 3 months, unable to mobilize before hospitalization, and being institutionalized in a nursing home facility before hospitalization. By performing a prospective study in a general hospital we tried to minimize the chance of selection bias.

Data collection
Baseline data involved demographic characteristics, a full medical history including a history of cardiovascular disease (CVD), diabetes mellitus (DM), hypertension, FOF, and medication use. Patients were considered to have cardiovascular disease when they had a history of angina pectoris, myocardial infarction, percutaneous transluminal coronary angioplasty, coronary artery bypass grafting, stroke or transient ischaemic attack. Blood pressure was measured following a standardized protocol, using an automated sphygmomanometer (A&D UA-767 Plus) [26]. If the automated sphygmomanometer displayed an error message, blood pressure was manually measured with a Heine Gamma XXL-T sphygmomanometer [27]. Blood pressure was measured two times in supine position after 5 minutes of rest, and two times each at 1 and 3 minutes after postural change. The forearm of the patient was supported at heart level during the measurements in upright position [28]. The postural change was from supine to standing position, or from supine to sitting position for patients who were unable to stand. Blood pressure was measured as soon as possible after surgery. OH was defined as a drop in systolic blood pressure (SBP) of \( > 20 \) mmHg or diastolic blood pressure (DBP) of \( > 10 \) mmHg after postural change compared to the mean value of the baseline measurements in supine position [29]. Characteristic symptoms of OH like light-headedness, syncope, or dizziness after postural change were questioned and the combination of OH and orthostatic complaints was described as symptomatic OH.
Handgrip strength was measured with a Jamar hand dynamometer [30] in kilogram (kg) within 2 days of hospital admission, preferably at the day of admission. When a patient was operated on the day of admission, the handgrip strength was measured postoperatively but always within two days after admission. Testing was performed with the participant in a comfortable sitting position in the hospital bed. The forearms were resting with the elbow flexed at \( 90^\circ \), the forearm in neutral
position, and thumbs facing up. Both dominant and non-dominant hand was tested, both 3 times. The best of 6 attempts of maximal voluntary contraction was used for statistical analysis [30]. OH was expressed as dichotomous (OH vs no OH) and handgrip strength as a continuous variable.

To measure FOF, a numeric scale (1-10) was used, with 1 representing no FOF and with 10 representing an extreme FOF [31]. The FOF was measured at the day of admission.

Activities of daily living were measured with the Barthel-20 index at the day of admission [32] to evaluate prefracture status.

Body mass index was calculated by measuring body weight and height.

All tests were part of usual clinical care. Four trained medical staff members performed all tests to reduce the change on inter-observer disagreement. It was intended to measure all variables per patient by the same medical staff member. Primary outcome was time to successful rehabilitation, which was defined as discharge to patients' own homes, where they functioned self-reliant and lived by themselves. Time to successful rehabilitation started on the day of OH blood pressure measurements, which were performed as soon as possible after surgery. Patients were considered as self-reliant if a patient regained his or her prefracture health status. As a consequence, patients with an already highly adapted home environment (e.g. stairlift, homecare, meal service) may be sent home earlier than others.

In the trial register, successful rehabilitation was predefined as having the same functional status compared to the prefracture status, evaluated by using the mobility component of the Barthel index. Because all patients reached the prefracture mobility score on the Barthel index in a few days after surgery (despite the fact they were not discharged home, but had to be admitted to a rehabilitation facility), we evaluated this definition and decided to change it into the current clinically more relevant definition.

**Statistical analyses**

Continuous variables are presented as mean and standard deviation for normally distributed variables, or as median and interquartile range for non-normally distributed variables. Cox proportional hazard modelling was used to investigate the relation between OH, orthostatic complaints, symptomatic OH, or handgrip strength and time to successful rehabilitation. Two separate cox proportional hazard analyses were performed; one regarding the relationship between OH and successful rehabilitation and one between muscle strength and successful rehabilitation. We used three different models. In model 1, unadjusted analyses were performed. In model 2, only age and gender were taken into account as possible confounders. In model 3, regarding the relationship between OH and rehabilitation, we additionally adjusted for the following variables: body mass index (BMI), a history of diabetes mellitus, the score on the Barthel index, previous macrovascular complications, mean systolic blood pressure, the use of antihypertensive medication, and...
baseline handgrip strength. For the analyses regarding the relationship between handgrip strength and rehabilitation, we adjusted for age, gender, BMI, the score of the Barthel index, previous macrovascular complications, and OH. These confounders were chosen based on clinical grounds, since all confounders were likely to be related to successful rehabilitation and OH or handgrip strength. By adjusting for potential confounding factors the risk of confounding bias was reduced.

The confounding effect of FOF on the relationship between OH, handgrip strength and successful rehabilitation was explored by adding FOF to model 3 in both analyses. FOF was added separately because of missing values (n=8). There were missing values of FOF (n=8), BMI (n=6), and Barthel index (n=2). The hazard ratios (HRs) regarding systolic blood pressure refer to a pressure increase in steps of 10 mmHg.

The Schoenfeld residual plots were inspected for each predictor variable to check the assumption of proportional hazards. P-values less than 0.05 were considered statistically significant. Collinearity diagnostics were tested for each confounder; co-variables are considered to be highly correlated with a variance inflation factor (VIF) of 10 or more [33, 34]. When necessary, interaction was tested between different variables. Interaction was considered to be significant, with a p value less than 0.05.

All statistical analyses were performed using SPSS software (version 22). The ‘Strengthening the Reporting of Observational studies in Epidemiology’ (STROBE) statement was used to describe this observational cohort study [35]. The study was registered on trialregister.nl (NTR4940).

**Ethical approval and Clinical Trial registration**

This study was performed in accordance with the Declaration of Helsinki. According to Dutch guidelines this study did not fall under the scope of the Medical Research Involving Human Subjects Act, and therefore this study did not need a formal approval of an accredited medical ethics committee. Written informed consent was obtained for all patients by the participating medical doctor or nurse. All data were analysed anonymously. The study was registered on Trialregister.nl (NTR4940).

**RESULTS**

A total of 116 patients was included in this cohort. The baseline characteristics are presented in table 1. Median age of the total study population was 82 (IQR (interquartile range) 76-86) years. Various surgical techniques were used to treat the hip fractures; 37% intramedullary nail, 50% hemi- or total hip arthroplasty, 13% (sliding) hip screws. 39 patients (34%) were
discharged to their own homes and 77 patients (66%) to a nursing home facility for further rehabilitation. During a median follow-up period of 36 days (IQR 9-57), 103 (89%) patients were successfully rehabilitated. Three patients died during rehabilitation. Ten patients could not return home and stayed at a long-term nursing home facility. Patients who did not successfully rehabilitate were found to have a higher prevalence of macrovascular disease and hypertension compared to patients who were successfully rehabilitated.

Table 1. Baseline characteristics total population.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total Baseline N=116</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>82 (76-86)</td>
</tr>
<tr>
<td>Female gender</td>
<td>86 (74)</td>
</tr>
<tr>
<td>Mean body mass index (kg/m²)</td>
<td>25 (23-28)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>77 (66)</td>
</tr>
<tr>
<td>History of CVD</td>
<td>27 (23)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>23 (20)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>17 (15)</td>
</tr>
<tr>
<td><strong>Measurements</strong></td>
<td></td>
</tr>
<tr>
<td>Consumption meal or drinka</td>
<td>113 (97)</td>
</tr>
<tr>
<td>No. Days between operation and BPM</td>
<td>2 (1-3)</td>
</tr>
<tr>
<td>Mean SBP lying (mmHg)</td>
<td>130 (22)</td>
</tr>
<tr>
<td>Mean DBP lying (mmHg)</td>
<td>65 (11)</td>
</tr>
<tr>
<td>Mean pulse frequency (beats/min)</td>
<td>81 (18)</td>
</tr>
<tr>
<td>Orthostatic hypotension</td>
<td>39 (34)</td>
</tr>
<tr>
<td>Orthostatic complaints</td>
<td>22 (19)</td>
</tr>
<tr>
<td>Symptomatic hypotension</td>
<td>16 (14)</td>
</tr>
<tr>
<td>Percentage postoperative handgrip strength measurement</td>
<td>21 (18)</td>
</tr>
<tr>
<td>Handgrip Strength (kg)</td>
<td>20 (15-26)</td>
</tr>
<tr>
<td>Score Barthel index</td>
<td>19 (17-20)</td>
</tr>
<tr>
<td>Fear of Fallingb</td>
<td>1 (1-4)</td>
</tr>
<tr>
<td><strong>Medication during admission</strong></td>
<td></td>
</tr>
<tr>
<td>Mean number of agents</td>
<td>6 (3-9)</td>
</tr>
<tr>
<td>Anthypertensive medication</td>
<td>70 (60)</td>
</tr>
<tr>
<td>- Diuretics</td>
<td>40 (35)</td>
</tr>
<tr>
<td>- Beta blockers</td>
<td>31 (27)</td>
</tr>
<tr>
<td>- Calcium channel blockers</td>
<td>17 (15)</td>
</tr>
<tr>
<td>- ACE inhibitors</td>
<td>44 (38)</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>22 (19)</td>
</tr>
<tr>
<td>Antipsychotics</td>
<td>3 (3)</td>
</tr>
<tr>
<td>Antidepressants</td>
<td>12 (10)</td>
</tr>
</tbody>
</table>

Data are means (± SD), medians (interquartile range) or n (%). BPM = blood pressure measurement. MSM = muscle strength measurement. SBP = systolic blood pressure. DBP = diastolic blood pressure. a Meal < 2 hours or drink < 1 hour prior to the measurements. b Missing values in 8 patients.
Chapter 7

**OH and Successful rehabilitation**

OH was present in 39 out of 116 patients, resulting in a prevalence of 34% (95% confidence interval (CI) 25-43%). The postural change was performed mostly from lying to sitting (n=114 (98%)) due to decreased mobility; only 2% of the tested population could perform postural change from lying to standing position. Blood pressure measurement took place with a median of 2 (IQR 1-3) days after surgery.

Table 2 presents the results of the Cox regression analyses regarding the relationship between OH and successful rehabilitation. In the present study no statistically significant relationships were seen between OH (HR 1.05 (95%CI 0.67-1.66)) and time to rehabilitation. The confounders systolic blood pressure (HR 1.01 (95%CI 1.00-1.03)), diabetes mellitus (HR 0.47 (95%CI 0.26-0.85)), and handgrip strength (HR 1.05 (95%CI 1.01-1.08)) were statistically significantly related to time to successful rehabilitation. Adding FOF to the multivariate model did not change the association between OH and time to rehabilitation. The hazard ratio of FOF was 0.87 (95%CI 0.79-0.97). Orthostatic complaints (HR 1.15 (95%CI 0.62-2.13)) and symptomatic OH (HR 1.15 (95%CI 0.62-2.13)) were also not related to time to successful rehabilitation in the multivariate analyses.

Table 2. Hazard ratios of OH for successful rehabilitation (n=116).

<table>
<thead>
<tr>
<th></th>
<th>Model 1 HR (95% CI)</th>
<th>Model 2 HR (95% CI)</th>
<th>Model 3 HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OH</td>
<td>1.35 (0.90-2.05)</td>
<td>1.28 (0.85-1.94)</td>
<td>1.05 (0.67-1.66)</td>
</tr>
<tr>
<td>Age</td>
<td>-</td>
<td>0.96 (0.93-0.99) (p=0.02)</td>
<td>0.99 (0.96-1.03)</td>
</tr>
<tr>
<td>Gender, female vs male</td>
<td>-</td>
<td>0.99 (0.63-1.54)</td>
<td>0.61 (0.31-1.18)</td>
</tr>
<tr>
<td>BMI</td>
<td>-</td>
<td>-</td>
<td>0.99 (0.95-1.05)</td>
</tr>
<tr>
<td>Score Barthel Index</td>
<td>-</td>
<td>-</td>
<td>1.05 (0.94-1.18)</td>
</tr>
<tr>
<td>Antihypertensive medication</td>
<td>-</td>
<td>-</td>
<td>0.90 (0.58-1.40)</td>
</tr>
<tr>
<td>History of CVD disease</td>
<td>-</td>
<td>-</td>
<td>0.64 (0.37-1.11)</td>
</tr>
<tr>
<td>DM, DM vs control</td>
<td>-</td>
<td>-</td>
<td>0.47 (0.26-0.85) (p=0.01)</td>
</tr>
<tr>
<td>Mean SBP lying a</td>
<td>-</td>
<td>-</td>
<td>1.01 (1.00-1.03) (p=0.01)</td>
</tr>
<tr>
<td>Handgrip Strength</td>
<td>-</td>
<td>-</td>
<td>1.05 (1.01-1.08) (p&lt;0.01)</td>
</tr>
</tbody>
</table>

Hazard ratios for successful rehabilitation. Model 1 unadjusted. Model 2 adjusted for age and gender. Model 3 adjusted for age, gender, BMI, score Barthel index, the number of antihypertensive medications, previous macro vascular complications, diabetes mellitus, mean SBP lying, and Handgrip Strength. OH = orthostatic hypotension. BMI = Body mass index. CVD = Cardio vascular disease. DM = Diabetes Mellitus. SBP = systolic blood pressure. a The hazard ratio refers to a pressure increase of 10 mmHg.

As blood pressure may be a marker of frailty in old age [36], we performed analyses in which we tested for interaction between systolic blood pressure and OH. No statistically significant interaction was seen.

The plots of the Schoenfeld residuals showed that the assumptions of proportional hazards were met. Collinearity was tested and no serious multicollinearity was seen, because the mean VIF value was 1.37 (range 1.01-2.22).
Handgrip strength and Successful rehabilitation

Median handgrip strength of the dominant arm was 20 kilograms (IQR 15-26). All handgrip strength measurements were performed within 2 days of admission. For the majority (82%) of the patients the handgrip strength measurements were performed preoperatively.

Table 3 present the results of the Cox regression analyses regarding the relationship between muscle strength and time to successful rehabilitation. None of the models showed a significant relationship between handgrip strength and time to successful rehabilitation. The confounder CVD was related to time to successful rehabilitation (HR 0.57 (95%CI 0.33-0.99)).

Adding FOF to the multivariate model did not change the association of handgrip strength with rehabilitation (HR 1.03 (95%CI 0.99-1.06)). As a confounder, FOF was significantly related to time to successful rehabilitation (HR 0.87 (95%CI 0.78-0.97)).

Table 3. Hazard ratios of handgrip strength for successful rehabilitation (n=116).

<table>
<thead>
<tr>
<th></th>
<th>Model 1 HR (95% CI)</th>
<th>Model 2 HR (95% CI)</th>
<th>Model 3 HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handgrip strength</td>
<td>1.02 (1.00-1.04)*</td>
<td>1.02 (0.99-1.05)</td>
<td>1.03 (0.99-1.06)</td>
</tr>
<tr>
<td>Age</td>
<td>-</td>
<td>0.97 (0.94-1.00)</td>
<td>0.99 (0.95-1.02)</td>
</tr>
<tr>
<td>Gender, female vs male</td>
<td>-</td>
<td>0.72 (0.39-1.33)</td>
<td>0.83 (0.44-1.57)</td>
</tr>
<tr>
<td>BMI</td>
<td>-</td>
<td>-</td>
<td>0.97 (0.93-1.02)</td>
</tr>
<tr>
<td>Score Barthel Index</td>
<td>-</td>
<td>-</td>
<td>1.09 (0.98-1.21)</td>
</tr>
<tr>
<td>History of CVD disease</td>
<td>-</td>
<td>-</td>
<td>0.57 (0.33-0.99)</td>
</tr>
<tr>
<td>OH</td>
<td>-</td>
<td>-</td>
<td>1.09 (0.71-1.68)</td>
</tr>
</tbody>
</table>


DISCUSSION

OH, measured in the immediate postoperative phase, was not related to time to successful rehabilitation in hospitalized elderly with a hip fracture. Although increased muscle strength was not significantly related to time to successful rehabilitation in the present study, the width of the confidence interval does not exclude a relevant relationship between handgrip strength and time to successful rehabilitation. Besides, muscle strength as a confounder, in the model with OH as the variable of interest, was significantly related to time to successful rehabilitation.
Chapter 7

OH and successful rehabilitation

In contrast to the current study, a previous study performed by the same authors showed that patients with OH were found to have a higher hazard of successful rehabilitation compared to patients without OH [7]. Although our previous study reported a positive relation between OH and time to successful rehabilitation, we hypothesized prior to the present study that the presence of OH would negatively influence the time to successful rehabilitation. The prevalence of OH and successful rehabilitation was similar in both studies. When comparing both study populations, patients of the present study seemed to have less comorbidity, used less medication, and baseline blood pressure was lower, which reflects the setting of the previous study (nursing home).

The high prevalence of OH in the present study could be partially caused by hip fracture or hospital admission-related factors like bed rest, surgery, effects of anaesthesia, inadequate water intake, and blood loss. In these circumstances, OH may very well be a temporarily phenomenon and therefore not a predictor for an outcome such as time to successful rehabilitation [23]. In the study of Weiss et al., the impact of OH in hospitalized patients on mortality was described, and they advised to divide patients in 2 groups; patients with episodic OH, as is seen during hospitalization, and established OH (repeated measurements) [22]. Measuring OH in the first week of rehabilitation within a nursing home might possibly be a more accurate predictor for successful rehabilitation.

Analogous to the association with mortality, as assessed in the study by Weiss et al., one may hypothesize that episodic and sustained OH have different associations with rehabilitation. Episodic OH may have no consequences for chances of rehabilitation, whereas sustained OH may be much more relevant.

The confounders DM, SBP, handgrip strength and FOF were significantly related to time to successful rehabilitation. The hazard of successful rehabilitation in patients with DM was lower than patients without DM, as was also seen in the previous (mentioned) study [7]. The hazard of successful rehabilitation increased by 15% (95% CI 3-28%) for every 10 mmHg increase in SBP. In a previous study, higher blood pressure in frail patients was related to lower all-cause mortality while the opposite relationship was seen in non-frail patients [37]. Therefore, it was not unexpected that higher SBP is associated with a higher hazard of successful rehabilitation.

Poor muscle strength and FOF are frequently seen in elderly patients, and these factors are also related with the level of frailty [14-16]. Successful rehabilitation increased by 5% (95% CI 1-8) for every 1 kg increase in handgrip strength measurement. The relationship between handgrip strength and rehabilitation will be discussed in 4.2.

Time to successful rehabilitation decreased by 13% (95% CI 3-22%) for every 1-point increase on the VAS-FOF scale. These results support previous studies regarding the impact of FOF on functional outcome [11, 38], which describes an association between FOF with negative
Orthostatic hypotension, handgrip strength, and rehabilitation in elderly

outcomes as falling and functional impairment (e.g. IADL). In the study by Oude Voshaar et al. FOF seems to be an important predictor for functional recovery after hip fracture surgery [9]. Previous studies described that fear after falling may restrict physical activity, which causes immobility and further loss of functional independence and risk of falling [39, 40]. FOF can be divided into three components; physiological, behavioural, and cognitive [11]. Prevention and treatment of FOF by intervening all of those three components is an important clinical treatment goal.

Handgrip strength and successful rehabilitation

Although increased muscle strength was not significantly related to time to successful rehabilitation in the present study, a relationship cannot be excluded based on the width of the confidence interval. In the model with OH as the variable of interest, a statistically significant association was observed. Previous studies also observed positive relationships between handgrip strength and rehabilitation [8] [41]. Di Monaco et al. described a significant relationship between handgrip strength and functional outcome in hip fracture patients [8]. Another study showed a relationship between handgrip strength during hospital admission and walking independently [41]. An important difference between the study of Di Monaco and the present study is the timing of the handgrip strength measurement; at the rehabilitation division after discharge from the hospital versus preoperatively in the present study. Measuring handgrip strength preoperatively reflects the baseline condition of a patient and is a predictor for complications or length of stay [42, 43]. Therefore, handgrip strength measurement can be used to identify those patients who are frailer and need a different approach during hospital admission [42].

Study Strengths and Limitations

As the present study took place in a general hospital, and only a few exclusion criteria were used, our study population is a representative group of elderly patients with a hip fracture. The timing of inclusion and the homogenous study population of the present study were major strengths compared to our previous study [7]. Recruitment and testing took place within 2 days after admission to the hospital, preferably at the day of admission. The current study has also some limitations. The main limitation was that 18% of the handgrip strength measurements were not measured preoperatively. However, we performed the same analyses in the group of patients with preoperatively measured handgrip strength, and the results did not relevantly change (data not shown). Although OH should be measured from lying to standing, this was not possible in 98% of patients. It is very likely that the actual number of patients with OH was higher. Furthermore, OH was only measured once during the follow-up period, which probably biased the results. By repeated OH measurements not only episodic OH but also established OH would have been diagnosed. Future studies are needed to evaluate the clinical implications of sustained OH on rehabilitation.
Another limitation is the definition of successful rehabilitation; in our study, this was defined as discharge to patients’ own homes. Patients with a worse outcome after rehabilitation but with a highly adapted home environment may be sent home earlier than others.

CONCLUSIONS

In conclusion, this study showed that orthostatic hypotension measured during the first days of hospitalization was not related to time to successful rehabilitation. Although no significant relationship was seen in the present study, the width of the confidence interval does not exclude a relevant relationship between handgrip strength and time to successful rehabilitation.
REFERENCES


114


