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Hip fracture patients at St. Olavs University Hospital in Trondheim – The perioperative pathway and evaluation of impact on mobility four months after surgery

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Abstract

Background: Hip fracture patients are characterized by old age and multiple comorbidites. Despite the relatively simple surgery needed for treatment, the patient group is a challenge for the anesthesist and the orthopaedic surgeon. We have described the perioperative pathway after a hip fracture at St. Olav University Hospital in Norway, and investigated how various perioperative factors affect mobility four months after surgery, namely time from fracture to surgery, intraoperative hypotension and blood transfusion therapy during the hospital stay.

Methods: This observational study is based on data from the Trondheim Hip Fracture Trial. Home-dwelling hip fracture patients of 70 years or older and able to walk 10 meters prefracture, were included from April 2008 to December 2010. Data from pre-, peri- and postoperative monitoring was collected from hospital records. The primary outcome was mobility measued by Short Physical Performance Battery (SPPB). To conduct this study, a modification of the original approval (REK4.2008.335) to the Regional Committe of Ethics in Medical Research was made (2009/648_19/REKmidt).

Results: In total, 1077 hip fracture patients were assessed for eligibility, and 397 were included in the trial. Two hundred and nine patients (52.6 %) received blood transfusions during the hospital stay, and 135 patients (34.0 %) experienced a hypotensive episode during surgery. A total of 343 patients (86.4 %) had surgery within 48 hours after admission, as compared to 47 patients (11.8 %) who had surgery more than 48 hours after admission.We found an association between blood transfusion therapy and reduction in SPPB score four months after surgery (p = 0.000), while time from fracture to surgery and presence of intraoperative hypotension did not affect the outcome.

Discussion/conclusion: The decrease in SPPB score after four months in patients receiving blood transfusions during the hospital stay is most likely due to a combination of factors, such as the extent of anemia, fracture type and possibly the blood transfusions themselves. Intraoperative hypotension among hip fracture patients is common. Further research on the effect of the intraoperative hypotension is needed.

Background

About 9000 patients undergo hip fracture surgery each year in Norway (1). Hip fractures represent a challenge for the health care system and the community, due to high complication rate and high mortality. One-year mortality ranges between 18 to 33 % (2). Many patients who survive hip fractures experience loss of function and mobility afterwards. It is reported that patients suffering a hip fracture experience a functional decline three times larger than non-hip-fracture patients (2). A review of long-term disability after hip fracture estimates that 42 % of the surviving patients fail to return to their prefracture mobility, 35 % are incapable of walking independently, 29 % experience lifelong disability and approximately 20 % move to a long term care facility (3). Due to these factors, among others, hip fractures are considered as the most expensive fractures (4).

Hip fracture patients are characterized by old age and multiple comorbidities. The mean age is above 80 years, and about three out of four are women (5). The risk of complications is shown to increase with increasing age, increasing number of comorbidities and male sex (6, 7). Common comorbidities include congestive heart failure, chronic pulmonary disease, chronic renal failure and diabetes (6). In addition, many hip fracture patients suffer from cognitive impairment or dementia. A study from 2011 estimates that 42 % of hip fracture patients suffer from cognitive impairment, whereas 19 % have dementia (8). As a result of these factors, the patient group represents a challenge for the anaesthetist and the orthopaedic surgeon, despite the relatively simple surgery needed for treatment.

Several perioperative factors are shown to affect outcome after a hip fracture (9). Important perioperative factors include time from fracture to surgery, adequate pain control, type of surgical treatment, use of general versus spinal anesthesia, presence of intraoperative hypotension and management of anemia (10-12).

Previous studies have shown increased risk of mortality and postoperative complications when surgery is delayed more than 48 hours (13-17). However, it is necessary to acknowledge that there is a balance between early surgery and optimization of medical disturbances. Theoretical benefits of surgical delay are physiological stabilization of the fracture, more careful assessment of the patient and correction of fluid imbalances. Kenzora et al (18) conducted a retrospective study to identify significant and nonsignificant risk factors that influence morbidity and mortality after hip fracture. The study revealed no increase in mortality with a surgical delay of less than a week. The authors concluded that severe medical conditions should be stabilized for at least 24 hours before scheduling surgery. Nevertheless, most studies reveal an association between operative delay above 24-48 hours and higher 1-year mortality rate.

There are three main types of hip fractures: Femoral neck fractures, pertrochanteric fractures and subtrochanteric fractures. Femoral neck fractures are classified as intracapsular, while pertrochanteric and subtrochanteric fractures are classified as extracapsular. The mortality is higher in extracapsular fractures (19-21). Possible explanations are that patients with extracapsular fractures are shown to be slightly older and have more comorbidities (22, 23), and that extracapsular fractures tend to bleed more (24). This is due to two factors: The blood supply is better in the pertrochanteric and subtrochanteric region, and the surgery in extracapsular fractures is more traumatizing. The surgical treatment thus differs between the fracture types. Non-dislocated femoral neck fractures (Garden 1-2) are commonly treated with a two-screw fixation, while dislocated femoral neck fractures (Garden 3-4) are treated with hemiarthroplasty (25-27). Pertrochanteric fractures are commonly repaired with a sliding hip screw fixation or intramedullary nailing (28, 29). Subtrochanteric fractures are normally repaired using an intramedullary device (30, 31). Differences in outcome between the fracture types can be due to both fracture site and different surgical treatment.

During surgery, the majority of hip fracture patients experience a drop in blood pressure. Wood et al (32) found a prevalence of relative intraoperative hypotension of 79.8 % (fall in systolic blood pressure above 20 % from baseline blood pressure) and a prevalence of absolute intraoperative hypotension of 37.9 % (systolic blood pressure below 90 mmHg). Hypotension causes tissue hypoperfusion, which in turn might result in organ damage or even death. Intraoperative hypotension is most likely to occur during initiation of anesthesia, or during cementation in patients receiving arthroplasty (33, 34). The condition is associated with adverse outcomes, such as perioperative stroke or myocardial infarction, and increased mortality (35, 36). In addition, fluctuations in blood pressure during surgery are associated with increased risk of early postoperative delirium after non-cardiac surgery (37). The ability to tolerate episodes of hypotension depends on several factors, such as age and comorbidities (38). Therefore, one would assume that hip fracture patients are particularly vulnerable to hypotensive episodes.

Many hip fracture patients experience blood loss (39), which may affect the outcome. Anemia in hip fracture patients results in decreased physical performance and thereby impede postoperative rehabilitation (40), and is also associated with an increase in postoperative morbidity and mortality (41, 42). As a result of this, many hip fracture patients are in need of blood transfusion therapy. Researchers have been discussing whether the patients should follow a restrictive (Hb < 8 g/dL) or liberal (Hb < 10 g/dL) transfusion strategy. A clinical trial from 2011 randomly assigned hip fracture patients to a liberal or a restrictive transfusion strategy. They found that a liberal transfusion strategy as compared to a restrictive transfusion therapy did not reduce rates of death or inability to walk independently on 60-day follow-up (43). Findings from Foss et al (44) support this. Furthermore, several studies have found that blood transfusions can be harmful, due to increased risk of postoperative infections (45, 46).

The aims of this study are twofolded: Firstly, the article will describe the perioperative pathway after a hip fracture at St. Olav University Hospital in Trondheim, Norway. Secondly, we will investigate whether delay of surgery, intraoperative hypotension and transfusion therapy affect postoperative mobility 4 months after surgery.

Patients and methods

Study design

This is a prospective observational study based on data from the Trondheim Hip Fracture Trial (47). The trial investigated if orthogeriatric care (intervention group) was beneficial as compared traditional orthopaedic care (control group) after admission to hospital for a hip fracture. Patients were included from April 2008 to December 2010. In the present study the whole dataset of this trial is used irrespective of the randomisation allocation.

Patients

All patients admitted to the hospital with hip fractures were screened for eligibility. To be included the patients had to be older than 70 years, living at home prefracture and able to walk 10 meters before the fracture. Patients with pathological fractures, multitrauma, living permanently in nursing homes or with short life expectancy were excluded. In total, 397 patients were included: 199 patients to the intervention group and 198 patients to the control group. The inclusion criteria are described in more detail in the protocol of the Trondheim Hip Fracture Trial (48).

Procedures

An orthopaedic resident performed a general clinical examination on the patients in the Emergency Room, with additional blood samples, measurement of blood pressure, temperature, pulse, oxygenation, electrocardiogram and X-ray (49). The hip fracture diagnosis was made by an orthopaedic surgeon, who also decided which surgical treatment the patient should receive. Femoral neck fractures were classified according to the Garden classification system (27). The standard surgical procedure is shown in table 1. For baseline registration of prefracture comorbidity the Charlson Comorbidity Index was used (50). The score ranges from 0 to 30, in which higher score indicates more comorbidity. High score is associated with increased 30-day mortality after hip fracture (51, 52).

Table 1: Standard surgical treatment

Standard surgical treatment	Spinal anesthesia Femoral neck fractures: • Non-dislocated: Two-screw fixation • Dislocated: Hemi-arthroplasty Trochanteric and sub-trochanteric fractures: • Sliding hip screw system • Some sub-trochanteric fractures fixed with ante-grade intramedullary nailing.

Before surgery, all patients received intravenous saline or Ringer´s acetate. Low molecular heparin was given as thromboembolic prophylaxis. As analgesia, most patients received a femoral nerve blockade. In addition, paracetamol (1 g every 6 hours) was given routinely, while opioids were given on demand. Cephalotin was given as prophylactic antibiotics in connection to surgery to most patients.

All patients were assessed by an anaesthesist prior to surgery. The American Society of Anaesthesiologists (ASA) score was used to determine predictors of operative risk (53). The score ranges from 1 to 5, where 1 means normal and 5 means moribund. The operability was decided by the anaesthesist in cooperation with an orthopaedic surgeon. In the intervention group, most patients were assessed by a geriatrician or a resident within internal medicine before surgery. In patients with severe medical disorders, such as unstable cardiac problems, severe infection or pulmonary embolism, surgery was delayed until the patient was stable. Healthy patients and patients with minor medical disturbances were scheduled for surgery within 48 hours after admission.

The majority of patients received spinal anesthesia, established by an anaesthesist and a nurse anaesthesist. During surgery the nurse anaesthesist monitored the patient, while the anaesthesist was available on demand. Routinely one orthopaedic surgeon performed the surgery. On occasion there were two surgeons when performing arthroplasty or antegrade intramedullary nailing.

After surgery the patients were observed in a recovery ward until they were stabilized and able to move both legs, and then transferred back to the allocated ward. Most patients, regardless of fracture type and surgical treatment, were allowed full weight bearing postoperatively.

Study outcomes and assessment tools

The primary outcome was mobility at four months after surgery measured by the Short Physical Performance Battery (SPPB) (54). SPPB is a screening test evaluating physical performance in the elderly. The test evaluates standing balance, walking speed and ability to rise from a chair. The total score ranges from 0 to 12, in which higher score indicates better mobility. A score below 10 points indicates increased risk of loss of function, while a score below 8 points indicates incipient failure of activities of daily living (ADL) (55). The test was performed at the hospital by the same assessors for both treatment groups. The assessors were not associated with patient care.

Assessment tools applied to describe baseline characteristics of the patient group were personal activities of daily living (p-ADL) as measured by Barthel Index, instrumental activities of daily living (i-ADL) as measured by the Nottingham Extended ADL scale, and cognition as measured by Clinical Dementia Rating Scale (56-58). The Barthel Index score ranges from 0 to 30, with higher scores indicating greater independence. The Nottingham Extended ADL score ranges from 0 to 66, with higher score indicating greater independence. The Clinical Dementia Rating Scale ranges from 0 to 18 points. Lower score indicates better cognition.

Blood pressure during surgery was measured continuously using an arterial line. The database from the Trondheim Hip Fracture Trial contains measurements of baseline blood pressure before surgery and the nadir of blood pressure during the operative period. To define intraoperative hypotension, the following criteria were used: Mean arterial blood pressure (MAP) during surgery below 50 mmHg (absolute hypotension) or a 35 % decrease in the mean arterial blood pressure from the baseline registration (relative hypotension). These criteria are based on previous studies on intraoperative hypotension (36, 37, 59).

The data used in this study was registered in the electronic database of the Trondheim Hip Fracture Trial. Background information on living conditions, physical function prefracture and medical information was collected from the participant or next-of-kin during the hospital stay or by telephone. Supplements were collected from hospital records. Hospital records were also used to obtain data related to pre-, peri- and postoperative monitoring.

Statistics

We used linear regression with SPPB at four months as dependent variable, and intraoperative hypotension, transfusion therapy and time from fracture to surgery as covariates, one at a time. All analyses were adjusted for randomisation group, gender and age. The normality of residuals was checked by visual inspection of Q-Q plots. Two-sided p-values < 0.05 were considered statistically significant. Ninety-five percent confidence intervals (CI) are reported where relevant. Statistical analyses were performed using SPSS Inc. (IBM SPSS statistics 21).

Ethics

Trondheim Hip Fracture Trial was approved by the Regional Committee of Ethics in Medical Research (REK4.2008.335), the Norwegian Social Science Data Services (NSD19109), and the Norwegian Directorate of Health (08/5814). To conduct this study, a modification of the original application to the Regional Committe of Ethics in Medical Research was made (2009/648_19/REKmidt). Patients or their next-of-kin gave informed written consent to be included in the study before participation.

Results

Baseline characteristics

In total, 1077 hip fracture patients were screened in the Emergency Department and 397 patients were included in the trial. The baseline characteristics of the participants are shown in table 2. The mean age was 83.4 years (SD 6.1), 293 (73.8 %) were women and 239 (60 %) lived alone before the fracture. Mean prefracture Barthel Index score was 18.3 (SD 2.5), while mean prefracture Nottingham Extended ADL score was 42.2 (SD 17.6). Two hundred and forty six patients (62.0 %) were diagnosed with a femoral neck fracture, 124 patients (31.2 %) were diagnosed with a trochanteric fracture and 27 patients (6.8 %) were diagnosed with a subtrochanteric fracture.

Table 2: Baseline characteristics

Age (years) –mean (SD)	83.8	6.1
Female –n (%)	293	73.8 %
Sheltered housing –n (%)	46	11.6 %
Living alone –n (%)	239	60.2 %
Barthel Index (0-20) –mean (SD)	18.3	2.5
Nottingham Extended ADL scale (0-66) –mean (SD)	42.2	17.6
Clinical Dementia Rating Scale (0-18) –mean (SD)	2.7	3.9
Charlson comorbidity index (0-30) – mean (SD)	2.7	2.3
Previous diagnoses –n (%)		
Heart disease	186	46.9 %
Stroke	106	26.7 %
Diabetes	51	12.8 %
Dementia	53	13.4 %
Cancer	96	24.2 %
Kidney disease	27	6.8 %
Hemoglobin value (g/dL)		
Mean (SD)	12.8	1.6
< 8 g/dL –n (%)	1	0.3 %
8-10 g/dL –n (%)	16	4.0 %
> 10 g/dL –n (%)	378	95.2 %
Fracture type –n (%)		
Femoral neck	246	62.0 %
Trochanteric	124	31.2 %
Subtrochanteric	27	6.8 %
ASA score –n (%)		
1 Normal	30	7.6 %
2 Mild systemic disease	141	35.5 %
3 Severe systemic disease	209	52.6 %
4 Systemic life threatening disease	16	4.0 %
5 Moribund not expected to survive	1	0.3 %

Perioperative pathway at St Olavs University Hospital

As preoperative analgesia, 328 patients (82.6 %) received a femoral nerve blockade, 388 patients (97.7 %) received paracetamol and 390 patients (98.2 %) received opioids. This is demonstrated in table 3. Prophylaxis against deep venous thrombosis (DVT) was given to 391 patients (98.5 %) and antibiotics were given to 357 patients (89.9 %).

Table 3: The perioperative pathway

Preoperative analgesia		
Femoral nerve blockade –n (%)	328	82.6 %
Paracetamol –n (%)	388	97.7 %
Opioids –n (%)	390	98.2 %
DVT prophylaxis –n (%)	391	98.5 %
Antibiotic prophylaxis –n (%)	357	89.9 %
Delay to surgery		
Mean, hours (SD)	29.0	23.5
< 24 hours after admission –n(%)	203	51.1 %
24-48 hours after admission –n(%)	140	35.3 %
> 48 hours after admission –n(%)	47	11.8 %
Not known –n (%)	7	1.8 %
Type of anesthesia –n (%)		
Regional	379	95.5 %
General	9	2.3 %
Missing	9	2.3 %
Surgical treatment –n (%)		
Hemiarthroplasty	155	39.0 %
Total arthroplasty	10	2.5 %
Screws	75	18.9 %
Bone plates and screws	135	34.0 %
Other	18	4.5 %
Died before surgery	4	1.0 %
Theater time (min) – mean (SD)	157.8	46.6
Hemiarthroplasty – mean (SD)	154.2	46.2
Total arthroplasty – mean (SD)	160.8	49.5
Screws – mean (SD)	161.2	52.7
Bone plates and screws – mean (SD)	161.4	43.6
Other – mean (SD)	147.4	44.9

Mean time from admission to surgery was 29.0 hours (SD 23.5). Surgery was delayed in 67 patients (16.9 %), for which there was a medical reason in 17 patients (25.4 %). Regional anesthesia was given to 379 patients (95.5 %), while 9 patients (2.3 %) had general anesthesia. There were nine missing cases. Among these, four patients died before surgery and two patients were transferred to a different hospital due to lack of available operating theatre. A total of 155 patients were treated with hemiarthroplasty, 10 patients were treated with total arthroplasty, 75 patients were treated with screws and 135 patients were treated with bone plates and screws. The distribution between fracture type and surgical treatment is shown in figure 1.

Figure 1: Surgical treatment and fracture type

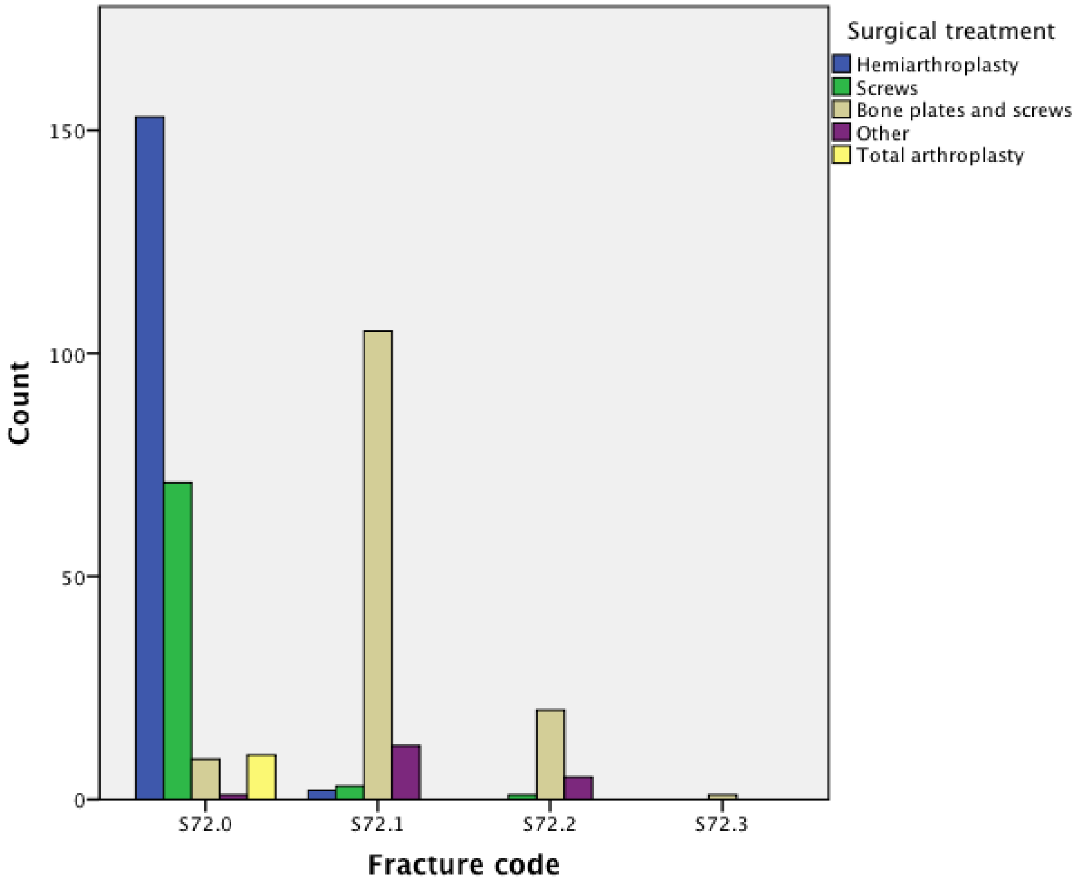

Figure 1: S72.0: Femoral neck fracture, S72.1: Pertrochanteric fracture, S72.2: Subtrochanteric fracture, S72.3: Femoral shaft fracture

Mean preoperative MAP was 103.9 mmHg (SD 17.2) and mean intraoperative MAP was 73.8 mmHg (SD 15.0) (table 4). A total of 135 patients (34.0 %) experienced intraoperative hypotension during surgery, defined as either MAP below 50 mmHg or a 35 % reduction from preoperative MAP. During surgery, 198 patients (49.9 %) received some sort of vasopressor treatment.

Table 4: Intraoperative hypotension

Preoperative MAP, –mean (SD)	103.9 mmHg	17.2
Intraoperative MAP, –mean (SD)	73.8 mmHg	15.0
Postoperative MAP, –mean (SD)	88.2 mmHg	15.4
Intraoperative hypotension,		
Intraoperative MAP < 50 mmHg, –n (%)	11	2.8 %
35 % reduction from preoperative MAP, –n (%)	133	33.5 %
Total, –n (%)	135	34.0 %
Vasopressor treatment		
Dobutamine	1	0.3 %
Ephedrine	51	12.8 %
Phenylephrine	190	47.9 %
Norepinephrine	14	3.5 %
Missing cases	9	2.3 %
Total*	198	49.9 %

* Patients who received one or more drugs in treatment of intraoperative hypotension.

Blood transfusions were given to 18 patients (4.5 %) preoperatively, 41 patients (10.3 %) intraoperatively and 190 patients (47.9 %) postoperatively (table 5). A total of 209 patients (52.6 %) received one or more blood transfusions during the hospital stay. Most transfusions were given on ward postoperatively. Patients with extracapsular fractures received more units of blood than patients with intracapsular fractures.

Table 5: Blood transfusions during the hospital stay

Prevalence of blood transfusions		
Preoperative, –n (%)	18	4.5 %
Intraoperative, –n (%)	41	10.3 %
Postoperative, –n (%)	190	47.9 %
Total, –n (%)	209	52.6 %
Units of blood per patients		
Total, –mean (SD)	1.52	1.91
Preoperative, –mean (SD)	0.08	0.37
Intraoperative, –mean (SD)	0.18	0.61
Postoperative, –mean (SD)	1.26	1.72
Intracapsular fractures, –mean (SD)	1.03	1.55
Extracapsular fractures, –mean (SD)	2.30	2.18
Comprehensive Orthogeriatric Care, –mean (SD)	1.91	2.03
Traditional Orthopaedic Care, –mean (SD)	1.12	1.70

Analyses

Preoperative waiting time

A univariate analysis (analysis of covariance, ANCOVA) was run to determine the effect of preoperative waiting time before surgery on SPPB four months after surgery. Preoperative waiting time was a categorical variable, with the following categories: 0-23 hours, 24-48 hours and > 48 hours. The univariate analysis demonstrated an association between SPPB score four months after surgery and randomisation group ($p = 0.019$) and age ($p < 0.001$). There was no association between SPPB score and preoperative waiting time ($p = 0.803$) or gender ($p = 0.826$).

Table 6: Summary of univariate analysis on preoperative waiting time

Variable	*B*	SE_B	*p* value	95 % CI	
				Lower bound	Upper bound
Intercept	21.373	2.376	0.000	16.701	26.045
Age	-0.190	0.027	0.000	-0.243	-0.137
Randomisation group	-0.788	0.334	0.019	-1.444	-0.132
Gender	-0.083	0.378	0.826	-0.826	0.660
Preoperative waiting time					
0-23 hours	0*				
24-48 hours	0.225	0.357	0.530	-0.478	0.927
> 48 hours	0.203	0.539	0.707	-0.858	1.264

* The 0-23 hours category was set to zero because it was redundant.

Intraoperative hypotension

A multiple regression was conducted to predict SPPB total score after 4 months from gender, age, randomisation group and presence of intraoperative hypotension, defined as 35 % reduction from preoperative MAP or MAP below 50 mmHg during surgery. The assumptions of linearity, independence of errors, homoscedasticity, unusual points and normality of residuals were met. The variables statistically significantly predicted SPPB total score after 4 months, $F(4,349) = 13.911$, $p < 0.0005$, adj. $R^2 = 0.128$. Age and randomisation group added statistically significantly to the prediction, $p < 0.05$, whereas gender and presence of intraoperative hypotension did not make a significant unique contribution to the prediction.

Table 7: Summary of multiple regression analysis on intraoperative hypotension

Variable	*B*	SE_B	*ß*	*p* value
Intercept	21.401	2.371		0.000
Age	-0.190	0.027	-0.351	0.000
Randomisation group	-0.883	0.331	-0.133	0.008
Gender	-0.007	0.376	-0.001	0.986
Intraoperative hypotension	0.372	0.351	0.053	0.290

Blood transfusions

A multiple regression was conducted to predict SPPB total score after 4 months from gender, age, randomisation group and blood transfusions. The assumptions of linearity, independence of errors, homoscedasticity, unusual points and normality of residuals were met. The variables statistically significantly predicted SPPB total score after 4 months, $F(4,358) = 18.452$, $p < 0.0005$, adj. $R^2 = 0.162$. Age, randomisation group and blood transfusions added statistically significantly to the prediction, $p < 0.05$, whereas gender did not make a significant unique contribution to the prediction.

Total SPPB score in patients who received one or more units of blood during the hospital stay was 3.65 (SD 3.07), while the total SPPB score in patients who did not receive blood transfusions was 4.95 (SD 3.54).

Table 8: Summary of multiple regression analysis on transfusion therapy

Variable	*B*	SE_B	*ß*	*p* value
Intercept	21.664	2.312		0.000
Age	-0.179	0.026	-0.328	0.000
Randomisation group	-1.106	0.332	-0.165	0.001
Gender	-0.059	0.368	-0.008	0.873
Transfusion therapy	-1.288	0.335	-0.192	0.000

Discussion

In the present descriptive study of 397 home-dwelling, elderly hip fracture patients, we have investigated the perioperative pathway after a hip fracture at St. Olav University Hospital in Trondheim, Norway. Secondly, we have investigated whether delay from admission to surgery, presence of intraoperative hypotension and blood transfusion therapy affected mobility four months after surgery, as measured by SPPB (54). We found that 47 patients (11.8 %) had surgery more than 48 hours after admission, as compared to the 203 (51.1 %) and 140 (35.3 %) patients who had surgery before 24 and between 24 and 48 hours, respectively. Delay from admission to surgery had no effect on the SPPB score. A total of 135 patients (34.0 %) experienced intraoperative hypotension and 198 patients (49.9 %) were treated with at least one vasopressor drug during surgery. Presence of intraoperative hypotension had no effect on the SPPB score. We found that patients receiving blood transfusions during the hospital stay (52.6 %) had poorer mobility four months after surgery, as compared to those who did not get blood transfusion (46.9 %).

There was no effect of surgical delay on the SPPB score four months after surgery. This is not in agreement with earlier research on the topic, as most studies reveal an association between operative delay (above 48 hours) and increased one-year mortality and complication rate (13-17). When surgery is delayed the patient is confined to bed rest, which in turn is associated with several complications, such as deep vein thrombosis, pressure sores and infections. These complications may in turn affect ambulation and rehabilitation. In our study, most patients were scheduled for surgery within 48 hours after admission. Only 47 patients (11.8 %) had surgery more than 48 hours after admission, as compared to the 344 patients (86.4 %) who were scheduled for surgery before 48 hours. This imbalance between the groups is a possible explanation of our findings. In addition, most studies on surgical delay have been focusing on different outcomes, such as mortality, pressure sores, pneumonia, deep vein thrombosis and pulmonary embolism (17, 60).

We found no effect of intraoperative hypotension on the SPPB score. As mentioned earlier, intraoperative hypotension and blood pressure fluctuations are associated with increased risk of mortality, perioperative stroke, myocardial infarction and early postoperative delirium (35-37). However, there is no general consensus for the definition of intraoperative hypotension. Bijker et al (59) found in their systematic literature search and cohort study that the incidence of intraoperative hypotension varies between 5 to 99 %, depending on the criteria used to define the condition. In our study, we did not include duration of the hypotensive episode in the definition. By including the duration, we would have found a more accurate definition and thereby be able to identify the patients with intraoperative hypotension more precisely. We found more patients (N = 198) receiving vasopressor treatment than patients registered with intraoperative hypotension (N = 135). This suggests that our definition of intraoperative hypotension have underestimated the true prevalence. In addition, it suggests that the management of intraoperative hypotension was fairly good. Adequate management of intraoperative hypotension might also explain the lack of findings.

The mean SPPB score in patients who received one or more blood transfusions during the hospital stay was 1.30 points lower than in patients who did not receive blood transfusions. Our multiple regression analysis revealed a statistically significantly correlation between blood transfusions and poorer SPPB score four months after surgery. Blood transfusions are immunosuppressive (45) and might result in increased tendency of bacterial infections (44, 46). However, the difference in mobility between the patients who received blood transfusions and those who did not receive blood transfusions is more likely to have different explanations. As anemia is associated with adverse outcomes after a hip fracture (40-42), the difference in mobility could be due to anemia. Patients with extracapsular fractures had a higher prevalence of blood transfusions than patients with intracapsular fractures. This is in accordance with previous studies on fracture type showing that extracapsular fractures tend to bleed more (24). The observed difference in mobility between the transfusion groups can partly be explained by different fracture type. Nevertheless, previous studies have found blood transfusions to be an independent risk factor of adverse outcomes (46, 61, 62).

In conclusion, we found no effect of surgical delay or intraoperative hypotension on the SPPB score four months after surgery. A substantial number of hip fracture patients experience hypotensive episodes. As the patient group is frail and comorbid, the consequences of these episodes should be further investigated. We found an association between the need of blood transfusion during the hospital stay and a decrease in SPPB score four months after surgery. This decrease is most likely due to a combination of factors, such as the extent of anemia, fracture type and possibly the blood transfusions themselves. In accordance with previous studies, it is still reasonable to follow a restrictive transfusion strategy (Hb < 8 g/dL) as compared to a liberal transfusion strategy (Hb < 10 g/dL).

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