Cohort Study

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Factors associated with postoperative quality of life in patients with intertrochanteric fracture

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Introduction: Intertrochanteric fractures, which make up the majority of hip fractures, are a common and serious injury that can greatly impact quality of life. Treatment of such fractures comprises nearly half of the costs contributed to hip fractures. Identifying the factors affecting the functional outcomes of patients after intertrochanteric fracture can help to reduce burden of disease for the patient and healthcare system. The present study investigated the factors underlying the worsening of short form-36 score (SF-36) scores for intertrochanteric fracture patients.

Materials and methods: This retrospective cohort study was designed based on data from our clinic. All consecutive patients with intertrochanteric fractures from November 2016 to September 2020 were reviewed. The exclusion criteria included patients having a second injury or having had previous surgery related to the hip and those with incomplete data. Baseline characteristics of patients were extracted from annotated records. The lab data were acquired from the electronic hospital system. The outcomes were SF-36 scores obtained by phone contact with patients or their families. Statistical analysis was conducted in SPSS.

Results: A total of 310 patients were included in the current study. The female gender, advanced age, history of diabetes, thyroid malfunction, cancer, osteoporosis, anticoagulant use and blood transfusion were identified as risk factors for lower SF-36 scores. Low levels of haemoglobin before surgery, blood urea nitrogen (BUN), BUN/Creatinine, and white blood count values correlated with lower SF-36 scores.

Conclusion: Numerous contextual variables affected the functional outcomes of the patients. Consideration of these factors could be helpful in reducing costs and improving the quality of life for intertrochanteric fracture patients.

Keywords: elderly, functional outcomes, hip fracture, intertrochanteric fracture, SF-36'

Introduction

Intertrochanteric fracture is the most common type of extracapsular fracture of the proximal femur which occurs between the greater and the lesser trochanters[1]. These devastating injuries account for approximately half of the hip fractures in the elderly population and, in most cases, are related to osteoporosis[2]. It has been projected that the number of yearly hip fractures will reach 6.3 million by 2050[3]. The cost associated with these fractures is staggering, amounting to a whopping $2.63 billion in the US annually. This type of hip fracture is responsible for 44% of all hip fracture costs[1].

As the average life expectancy increases, the population is also aging. This has led to an increased incidence of fractures in geriatric population. Despite the notable improvements in treatment methods, intertrochanteric hip fracture has led to an increased mortality, morbidity and poor outcomes[4]. It also puts a significant social and economic burden on patients and healthcare systems[1]. In the geriatric population, intertrochanteric fractures

HIGHLIGHTS

- As intertrochanteric fractures are amongst the most common cases of hip fracture, identifying and controlling the factors affecting the functional outcomes of patients with intertrochanteric fracture can help to reduce burden of disease for the patient and healthcare system.
- As the population is aging, increasing our knowledge about the risk factors for intertrochanteric fracture and its association with negative consequences among the geriatric population, becomes a greater subject of matter.
- Factors such as delayed surgery, anaemia, BUN, BUN/Cr ratio, compromised immune system, advanced age and longer exposure time to anaesthesia, female gender, advanced age, history of diabetes, thyroid malfunction, cancer, osteoporosis, anticoagulant use seemed to be associated with lower short form-36 score scores.

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are usually the result of low-energy trauma such as a fall from standing height[5].

With an abundant blood supply, intertrochanteric (IT) fractures have a higher union rate and less osteonecrosis compared to femoral neck fracture[6]. Additionally, avascular necrosis and nonunion as a result of these fractures is uncommon[7]. Intertrochanteric fractures are classified as either stable or unstable. A determination of stability is important, as it helps determine the type of fixation required for stability. The posteromedial cortex is intact in stable fractures and reduction would make it resistant to compressive loads. Our decision for surgical treatment is based on the fracture pattern and its inherent stability, as the failure rate is highly correlated with the choice of implant and fracture pattern[8]. Fractures with involvement of the lateral femoral wall, displaced lesser trochanter fractures, subtrochanteric extension of the fracture and reverse obliquity fractures are considered to be indications for intramedullary nailing and would not be treated with a sliding hip screw[9–13].

The global number of hip fractures is expected to increase[14] and, despite the extensive body of literature regarding fixation of IT fractures, patient functional outcomes remain far from what should be expected. Poor functional outcomes of IT fractures could decrease the quality of life of a patent[15–17].

Our knowledge about the risk factors for intertrochanteric fracture and its association with negative consequences among the geriatric population remains a subject of debate. The purpose of this study was to evaluate and compare the following variables in patients having radiographically confirmed intertrochanteric fracture: demographic data, general condition, type of fracture and treatment of two unstable intertrochanteric femur fracture groups comprising geriatric patients.

Material and methods

After acquiring the approval of the institutional ethics committee, we conducted a retrospective study using previously collected data from patients sustaining intertrochanteric fractures. All consecutive patients from November 2016 to September 2020 at our clinic with radiographically confirmed IT fractures were retrospectively included in the study. Patients with a second injury, pathological fractures, bilateral involvement, periprosthetic fractures, those having had previous surgery related to the hip and those with incomplete demographic data or outcome information were excluded. We obtained informed consent from all the participants.

Patient lab data from before and after surgery on post-operation day 1 (POD-1), demographic data, past medical history and information pertaining to the surgery and type of fracture were documented. Lab data before surgery was obtained from the last blood test recorded in the online system when the patient's general condition remained stable from that moment until the time of surgery. The Δ variables have been defined as: Δ variables = $\text{variable}_{\text{on POD-1}} - \text{variable}_{\text{before surgery}}$.

The red cell distribution width (RDW) and blood sugar baseline were recorded from the first blood test before surgery. An expert orthopaedic hip surgeon (SHS) determined the type of fracture according to AO/OTA classifications. The study endpoint was defined as the short form-36 score (SF-36) after at least five months of follow-up. SF-36 measurement was carried out by an orthopaedic surgeon by phone contact with patients or their families.

And the study has been reported in line with the STROCSS criteria[18].

Statistical analysis

Statistical analysis carried out using SPSS, version 23, for Windows (IBM). Continuous data have been presented as mean ± standard deviation. The categorical variables, such as sex, fracture type, surgical technique and smoking history have been summarized as frequencies and percentages. Statistical comparison, when relevant, was performed using a Fisher exact test for the categorical data. Continuous variables were compared using ANOVA, the *t*-test or Mann–Whitney test whenever the data did not appear to have a normal distribution or when the assumption of equal variance was violated across the study groups. An analysis of the multivariable regression modelling was conducted to determine if the baseline parameters were effective for predicting outcomes with confounders present. Multivariate analysis was considered significant at P less than 0.05 and univariate analysis at P less than 0.1. The statistical analysis was carried out in consultation with a statistician.

Results

A total of 310 patients were enroled in the study. Information and data were not available for 137 patients due to mortality or having been lost to follow-up. The follow-up duration ranged from 5 to 69.4 months with a mean of 30.65 ± 13.96 months.

Demographic variables

The mean age was 69.62 ± 14.27 years at the time of surgery and 45.1% of the patients were female. The baseline parameters of the patients are presented in Table 1. Stable fractures comprised 104 cases and unstable fractures comprised 40 cases.

SF-36 scores

The SF-36 scores of patients are summarized in Table 2. The correlations between the quantitative variables and SF-36 are shown in Table 3. Being female ($P = 0.062$), having diabetes ($P = 0.055$), thyroid malfunction ($P = 0.003$), blood transfusion ($P = 0.017$), prophylactic anticoagulant use ($P = 0.064$), active cancer ($P = 0.010$) were risk factors for lower physical functioning (PF).

The social functioning (SF) score was lower in patients with thyroid malfunctions ($P = 0.021$) and those requiring blood transfusions ($P = 0.037$). Patients with osteoporosis ($P = 0.076$) and requiring blood transfusions ($P = 0.003$) had lower scores for body pain (BP). The physical component summary (PCS) was lower in patients having had blood transfusions ($P = 0.088$) and patients with active cancer ($P = 0.010$). The mean score of general health (GH) in those requiring general anaesthesia ($P = 0.013$) and those requiring spinal anaesthesia ($P = 0.088$) was higher than those requiring both general and spinal anaesthesia simultaneously. The mean score for GH in those with spinal anaesthesia was 3.85 ± 1.49 points lower than those requiring general anaesthesia ($P = 0.029$). Patients requiring prophylactic anticoagulants ($P = 0.078$) and those with active cancer ($P = 0.010$) had lower GH scores. The mean score of vitality in those

Table 1

Demographic characteristics

Characteristics (*n* = missing)	No. patients, *n* (%)
Female sex (*n* = 0)	78 (45.1)
Age (year; n = 0)[a]	69.62 ± 14.27
AO/OTA (*n* = 2 5)	
31A1.2	73 (42.2)
31A1.3	31 (17.9)
31A2.2	19 (11.0)
31A2.3	5(2.9)
31A3.1	4 (2.3)
31A3.2	2 (1.2)
31A3.3	10 (6.9)
Smoking (n = 4)	55 (31.8)
Height (cm) (*n* = 24)[a]	166.08 ± 9.60
Weight (kg) (*n* = 23)[a]	68.75 ± 11.17
BMI (kg/m^2) (*n* = 18)[a]	24.937 ± 3.85
Duration of admission to surgery (day) (*n* = 0)[a]	5.20 ± 3.41
Anticoagulant use (*n* = 4)	59 (34.1)
Past medical history	
HTN (*n* = 0)	72 (41.6)
IHD (*n* = 0)	37 (21.4)
DM (*n* = 0)	41 (23.7)
Thyroid malfunction (*n* = 0)	12 (6.9)
Cancer (*n* = 34)	6 (3.5)
Osteoporosis (*n* = 34)	25 (14.5)
Lab data	
Haemoglobin before surgery (mg/dl) (*n* = 4)[a]	11.97 ± 1.86
δ haemoglobin (mg/dl) (*n* = 61)[a]	− 1.51 ± 1.95
Blood sugar before surgery (mg/dl) (*n* = 31)[a]	143.73 ± 52.68
δ blood sugar (mg/dl) (*n* = 96)[a]	− 6.04 ± 67.70
White blood cell before surgery (*n* = 7)[a]	9.30 ± 2.88
δ white blood cell (*n* = 70)[a]	1.68 ± 4.05
Platelet before surgery (*n* = 6)[a]	238.94 ± 89.10
δ platelet (*n* = 70)[a]	26.16 ± 66.68
Neutrophil before surgery (%: *n* = 9)[a]	74.56 ± 9.48
δ neutrophil (%: *n* = 75)[a]	3.54 ± 10.44
Lymphocyte before surgery (%: *n* = 5)[a]	16.30 ± 7.60
Δ lymphocyte (%: *n* = 71)[a]	− 4.02 ± 7.60
Cr before surgery (mg/dl; *n* = 15)[a]	1.15 ± .52
Δ Cr (mg/dl; *n* = 91)[a]	− 0.03 ± 0.29
BUN before surgery (mg/dl; *n* = 15)[a]	46.72 ± 21.82
Δ BUN (mg/dl; *n* = 99)[a]	3.07 ± 20.74
Na before surgery (mg/dl; *n* = 29)[a]	137.61 ± 9.27
Δ Na (mg/dl) (*n* = 103)[a]	− 0.36 ± 5.42
K before surgery (mg/dl) (*n* = 28)[a]	4.18 ± 0.44
Δ K (mg/dl; *n* = 103)[a]	0.36 ± 0.58
Neutrophil/platelet before surgery (*n* = 11)[a]	0.034230 ± 0.0161073
δ neutrophil/platelet (*n* = 75)[a]	0.0034660344 ± 0.01617468533
Neutrophil/lymphocyte before surgery (*n* = 9)[a]	5.93 ± 3.42
δ neutrophil/lymphocyte (*n* = 76)[a]	2.22 ± 4.99
No. neutrophil before surgery (*n* = 11)[a]	7.10 ± 2.77
δ number of neutrophils (*n* = 75)[a]	1.64 ± 4.00
No. lymphocytes before surgery (*n* = 7)[a]	1.43 ± 0.63
δ number of lymphocytes (*n* = 72)[a]	− 0.19 ± 0.62
RDW (*n* = 3)[a]	14.00 ± 1.87
Blood sugar baseline (mg/d dl; *n* = 35)[a]	155.92 ± 73.50
Surgical factors	
Length of surgery (min; *n* = 20)[a]	181.16 ± 54.00
Length of time under anaesthesia (min; *n* = 1)[a]	191.72 ± 53.73
Anaesthesia type (*n* = 1)	
Spinal anaesthesia use	128 (74.0)
General anaesthesia use	41 (23.7)
Spinal + general anaesthesia	3 (1.7)
Surgical technique (*n* = 6)	
DHS	143 (82.7)
Arthroplasty	4 (2.3)
Nail	16 (9.2)
DCS	4 (2.3)
Blood transfusion (*n* = 1)	49 (28.3)

BUN, blood urea nitrogen; DCS, dynamic condylar screw; DHS, dynamic hip screw; DM, diabetes mellitus; HTN, hypertension; IHD, ischaemic heart disease; RDW, red cell distribution width.
[a]Given as mean ± standard deviation.

requiring spinal anaesthesia was 8.88 ± 4.29 points lower than those requiring both general and spinal anaesthesia simultaneously ($P = 0.099$). The PF was 32.41 ± 20.57 in patients who actively smoked compared to 25.93 ± 14.49 in those who did not smoke ($P = 0.064$).

Role limitations due to physical health was 34.85 ± 41.90 in patients with medical histories of ischaemic heart disease (IHD) compared to 22.84 ± 32.06 in those without IHD ($P = 0.069$). BP in those with AO/OTA 31A1.2 was 17.40 ± 5.31 points higher than for those with AO/OTA 31A1.3 ($P = 0.022$). GH in those with AO/OTA 31A1.2 was 5.87 ± 1.68 points higher than for those with AO/OTA 31A1.3 ($P = 0.011$). GH in those with AO/OTA 31A1.2 was 11.75 ± 3.96 points higher than for those with AO/OTA 31A3.1 ($P = 0.011$). GH in those with AO/OTA 31A2.2 was 11.91 ± 4.24 points higher than for those with AO/OTA 31A3.1 ($P = 0.081$).

The mental component summary (MCS) for those with AO/OTA 31A1.2 was 22.99 ± 7.58 points lower than for those with AO/OTA 31A3.2 ($P = 0.046$). The MCS in those with AO/OTA 31A1.3 is 21.81 ± 7.73 points lower than for those with AO/OTA 31A3.2 ($P = 0.080$). MCS in those with AO/OTA 31A2.3 was 27.25 ± 8.83 points lower than for those with AO/OTA 31A3.2 ($P = 0.039$).

Duration of admission to surgery, Δ blood sugar, Δ K, number of lymphocytes before surgery, age, haemoglobin (Hgb) level before surgery, length of time requiring anaesthesia, blood urea nitrogen (BUN) before surgery, white blood count (WBC) before surgery, blood transfusion and cancer were included in the final multivariable regression to predict PCS. The value of R^2 was 0.356. (Table 4). The R^2 value in the multivariable predictive model of MCS was too low and has been omitted.

Table 2

SF-36 of patients at medium of 30.65 months follow-up

SF-36 (*n* = missing)	Mean (Sd)
Physical functioning (9)	28.29 (17.04)
Role limitations due to physical health (23)	25.17 (34.69)
BP (8)	45.03 (25.18)
General health (9)	40.07 (8.49)
Vitality (8)	55.12 (7.41)
Role limitations due to emotional health (20)	21.78 (40.88)
Mental health (8)	50.59 (7.85)
Social functioning (8)	60.65 (17.20)
PCS (33)	33.83 (7.87)
MCS (33)	20.07 (10.24)

BP, body pain; MCS, mental component summary; PCS, physical component summary; SF-36, short form-36 score.

Table 3

Correlation of SF-36 and quantitative variables

	PF	Role limit due to PH	Body pain	GH	Vital.	SF	Role limit due to emot. health	MH	PCS	MCS
Duration of admission to surgery										
Pearson cor.	– 0.105	– 0.11	– 0.105	– 0.091	– 0.085	– 0.066	– 0.062	0.094	– 0.216	– 0.001
P value	0.181	0.18	0.178	0.247	0.275	0.401	0.45	0.229	0.01	0.986
Δ Hgb										
Pearson cor.	– 0.123	0.071	**– 0.192**	0.041	– 0.149	– 0.082	– 0.003	0.056	– 0.092	0.027
P value	0.207	0.481	**0.046**	0.672	0.124	0.399	0.973	0.567	0.373	0.796
Δ blood sugar										
Pearson cor.	0.067	0.019	0.173	0.126	0.069	– 0.051	– 0.074	– 0.144	**0.218**	– 0.148
P value	0.583	0.883	0.152	0.304	0.568	0.678	0.557	0.233	**0.088**	0.252
Δ WBC										
Pearson cor.	**– 0.169**	– 0.071	– 0.142	– 0.157	– 0.045	– 0.066	– 0.078	0.027	– 0.146	– 0.084
P value	**0.094**	0.502	0.158	0.12	0.657	0.515	0.451	0.788	0.174	0.435
Δ neutrophil (%)										
Pearson cor.	**– 0.248**	0.03	– 0.108	**– 0.201**	– 0.062	0.062	– 0.097	0.061	– 0.14	– 0.067
P value	**0.016**	0.781	0.297	**0.052**	0.554	0.55	0.361	0.56	0.208	0.546
Δ platelet										
Pearson cor.	– 0.036	0.044	0.043	– 0.044	– 0.043	0.019	0.098	0.09	– 0.036	0.064
P value	0.726	0.674	0.669	0.669	0.673	0.849	0.347	0.371	0.737	0.551
Δ Cr										
Pearson cor.	**– 0.198**	0.141	0.038	**0.349**	– 0.149	– 0.118	0.189	– 0.01	– 0.013	0.145
P value	**0.091**	0.254	0.75	**0.002**	0.207	0.315	0.119	0.932	0.92	0.244
Δ Na										
Pearson cor.	– 0.106	0.052	0.048	0.102	– 0.004	0.046	**0.259**	0.054	– 0.089	**0.239**
P value	0.383	0.686	0.692	0.404	0.976	0.708	**0.036**	0.655	0.487	**0.059**
Δ K										
Pearson cor.	– 0.112	– 0.002	– 0.189	– 0.121	**– 0.221**	– 0.128	0.135	– 0.01	**– 0.256**	0.166
P value	0.356	0.99	0.116	0.322	**0.065**	0.291	0.28	0.937	**0.043**	0.193
Δ BUN										
Pearson cor.	**– 0.228**	0.014	0.015	0.154	– 0.004	– 0.077	0.009	0.006	– 0.039	0.035
P value	**0.05**	0.91	0.899	0.193	0.971	0.512	0.938	0.957	0.755	0.78
Δ lymph. (%)										
Pearson cor.	**0.25**	– 0.066	0.086	**0.253**	– 0.029	– 0.096	0.037	– 0.018	0.102	0.029
P value	**0.013**	0.532	0.395	**0.012**	0.779	0.343	0.721	0.858	0.346	0.788
Neutrophil/platelet before surgery										
Pearson cor.	**0.209**	– 0.026	– 0.013	0.064	0.02	**– 0.158**	0.086	– 0.079	0.052	0.059
P value	**0.009**	0.757	0.872	0.432	0.806	**0.049**	0.309	0.325	0.553	0.499
Neutrophil/lymphocyte before surgery										
Pearson cor.	0.034	– 0.097	– 0.014	**0.169**	– 0.077	– 0.072	– 0.08	0.036	– 0.008	– 0.078
P value	0.669	0.253	0.858	**0.034**	0.337	0.369	0.341	0.658	0.931	0.371
δ neutrophil/platelet										
Pearson cor.	– 0.119	– 0.026	– 0.131	– 0.137	0.035	– 0.109	– 0.066	– 0.101	– 0.078	– 0.095
P value	0.254	0.808	0.206	0.187	0.735	0.292	0.538	0.33	0.481	0.395
δ neutrophil/lymph.										
Pearson cor.	– 0.15	– 0.004	– 0.136	– 0.161	0.001	– 0.138	– 0.111	– 0.062	– 0.058	– 0.143
P value	0.152	0.973	0.193	0.124	0.989	0.185	0.297	0.556	0.601	0.197
No neutrophil before surgery										

Pearson cor.	0.12	− 0.06	**0.133**	**0.222**	0.042	− 0.035	− 0.003	− 0.081	0.131	− 0.028
P value	0.138	0.48	**0.098**	**0.006**	0.602	0.664	0.969	0.318	0.134	0.747
No. lymphocyte before surgery										
Pearson cor.	0.094	0.119	**0.166**	− 0.035	**0.173**	**0.189**	0.124	− 0.025	**0.147**	0.126
P value	0.243	0.155	**0.036**	0.661	**0.029**	**0.017**	0.136	0.751	**0.09**	0.146
δ no. neutrophil										
Pearson cor.	**− 0.182**	− 0.032	− 0.143	**− 0.188**	− 0.028	− 0.053	− 0.066	0.024	− 0.14	− 0.074
P value	**0.08**	0.77	0.166	**0.069**	0.787	0.61	0.536	0.818	0.208	0.508
δ no. lymphocyte										
Pearson cor.	0.063	− 0.109	0.034	0.158	− 0.088	− 0.056	− 0.042	0.031	0.011	− 0.048
P value	0.539	0.302	0.741	0.123	0.388	0.584	0.686	0.763	0.921	0.659
Age										
Pearson cor.	**− 0.418**	− 0.114	**− 0.542**	**− 0.381**	**− 0.3**	**− 0.27**	− 0.009	**0.13**	**− 0.548**	0.062
P value	**0**	0.164	**0**	**0**	**0**	**0**	0.913	**0.096**	**0**	0.47
Hgb before surgery										
Pearson cor.	**0.216**	− 0.086	**0.245**	**0.142**	0.114	**0.137**	− 0.028	− 0.047	**0.182**	− 0.082
P value	**0.006**	0.299	**0.002**	**0.072**	0.15	**0.083**	0.737	0.551	**0.034**	0.342
Blood sugar baseline										
Pearson cor.	− 0.071	− 0.093	− 0.057	0.096	− 0.112	0.003	− 0.067	0.136	− 0.092	0.036
P value	0.425	0.322	0.521	0.278	0.203	0.972	0.466	0.122	0.348	0.711
Blood sugar before surgery										
Pearson cor.	− 0.067	− 0.038	− 0.031	0.06	− 0.035	− 0.071	0.005	0.073	− 0.089	0.071
P value	0.445	0.681	0.719	0.49	0.684	0.414	0.953	0.401	0.352	0.454
Anaesthesia time										
Pearson cor.	**− 0.153**	**− 0.164**	− 0.005	− 0.031	0.009	0.074	− 0.07	0.059	**− 0.158**	0.007
P value	**0.051**	**0.045**	0.947	0.694	0.906	0.349	0.395	0.454	**0.063**	0.932
Operation time										
Pearson cor.	− 0.113	− 0.082	0.02	− 0.088	0.058	0.088	− 0.043	0.056	− 0.07	0.034
P value	0.177	0.353	0.815	0.297	0.486	0.295	0.62	0.505	0.443	0.708
Height										
Pearson cor.	**0.155**	0.073	0.095	**0.145**	0.01	0.05	0.105	0.037	0.114	0.099
P value	**0.064**	0.407	0.258	**0.085**	0.904	0.555	0.229	0.663	0.211	0.277
Weight										
Pearson cor.	0.128	0.027	0.049	− 0.087	− 0.054	0.055	0.006	0.1	0.068	0.031
P value	0.126	0.755	0.559	0.302	0.518	0.509	0.944	0.235	0.455	0.736
BMI										
Pearson cor.	0.009	− 0.037	− 0.033	**− 0.177**	− 0.092	− 0.001	− 0.093	0.078	− 0.021	− 0.056
P value	0.917	0.673	0.691	**0.031**	0.267	0.987	0.279	0.342	0.818	0.536
Platelet before surgery										
Pearson cor.	− 0.073	− 0.047	**0.167**	0.111	0.028	**0.152**	− 0.093	0.016	0.089	− 0.102
P value	0.366	0.575	**0.036**	0.164	0.731	**0.056**	0.262	0.837	0.305	0.238
Neutrophil before surgery (%)										
Pearson cor.	0.011	− 0.097	− 0.045	**0.175**	− 0.059	**− 0.188**	− 0.068	− 0.079	0.001	− 0.099
P value	0.891	0.253	0.572	**0.029**	0.46	**0.018**	0.419	0.322	0.992	0.254
Lymphocyte before surgery (%)										
Pearson cor.	0.008	0.134	0.073	− 0.101	0.093	**0.17**	0.084	0.01	0.057	0.087
P value	0.92	0.107	0.355	0.206	0.241	**0.031**	0.308	0.901	0.506	0.313
Cr before surgery										
Pearson cor.	− 0.117	0.094	0.002	0.024	− 0.031	0.014	0.113	0.119	− 0.014	**0.167**
P value	0.155	0.278	0.981	0.771	0.706	0.864	0.186	0.147	0.874	**0.061**

Table 3

(Continued)

	PF	Role limit due to PH	Body pain	GH	Vital.	SF	Role limit due to emot. health	MH	PCS	MCS
BUN before surgery										
Pearson cor.	**−0.206**	−0.005	**−0.212**	−0.096	**−0.222**	−0.053	0.078	**0.225**	**−0.187**	0.107
P value	**0.012**	0.951	**0.009**	0.242	**0.006**	0.515	0.363	**0.006**	**0.036**	0.231
Na before surgery										
Pearson cor.	0.081	−0.012	−0.067	−0.105	−0.037	−0.106	0.05	−0.064	−0.054	0.025
P value	0.348	0.897	0.432	0.223	0.666	0.216	0.58	0.457	0.568	0.792
K before surgery										
Pearson cor.	−0.034	0.146	0.025	0.006	−0.04	**−0.145**	0.102	0.021	0.096	0.057
P value	0.694	0.108	0.774	0.944	0.643	**0.088**	0.255	0.81	0.308	0.543
RDW										
Pearson cor.	**−0.133**	**0.165**	−0.071	−0.097	−0.067	−0.022	**0.154**	0.064	−0.066	**0.145**
P value	**0.094**	**0.046**	0.369	0.223	0.394	0.781	**0.059**	0.418	0.443	**0.091**
WBC before surgery										
Pearson cor.	**0.151**	−0.034	0.17	**0.182**	**0.083**	0.022	0.021	−0.066	**0.16**	0.01
P value	**0.06**	0.687	0.032	**0.022**	**0.295**	0.779	0.797	0.409	**0.065**	0.91

BP, body pain; BUN, blood urea nitrogen; GH, general health; Hgb, haemoglobin; MCS, mental component summary; MH, mental health; PCS, physical component summary; PF, physical functioning; RDW, red cell distribution width; SF, social functioning; WBC, white blood count.
Bold values are in statistically significant $P < 0.1$.

Discussion

With the rapid aging of the population, a trend toward an increase in the incidence of hip fractures, including intertrochanteric fractures, is being observed. There are different opinions about the factors affecting functional outcomes, especially in elderly patients. This study investigated the correlations between postoperative variables, their changes and functional outcomes after surgery.

The results of previous studies have indicated that factors such as the age, pre-fracture function of the patient, comorbidities, fracture type, anaemia, dementia, muscle strength and early mobilization can influence functional outcomes after a hip fracture[19,20]. A negative correlation between the duration of admission to surgery and PCS was found in our study. Previous studies have suggested that a delay in surgery is associated with worse functional outcomes[21,22]. Previous studies indicated that patients who underwent surgery earlier, recovered weight-bearing capacity and self-care ability faster than those who had delayed surgery[23,24].

Prescribing anticoagulants for patients with a hip fracture can impose a delay in surgical fixation[25]. However, our results revealed that patients given prophylactic anticoagulants had lower GH and PF scores than patients who did not receive anticoagulants. IT fracture itself appears to be an independent risk factor for poorer hip function[26]. Hypertension and anaemia are also among the most common comorbidities in patients with hip fracture[27].

Our results demonstrated that a higher Hgb level before surgery is associated with better PCS, PF, BP, GH and SF scores. One meta-analysis reported that anaemia upon admission was found to be associated with poor functional outcomes and that people with low Hgb levels upon admission were more likely to be frail and have less muscle strength than those without anaemia[28]. Atthakomol *et al.*[29]. reported that the Hgb level upon admission was a prognostic factor for functional outcomes and mortality in patients with hip fracture.

In contrast with the results of a previous study[30], postoperative Hgb levels failed to show any correlation with SF-36, although a change in Hgb seemed to worsen body pain. It has been shown that perioperative blood loss is correlated with an increased risk of mortality, infection, deep vein thrombosis and poorer functional outcomes[31,32]. However, blood loss did not correlate with SF-36 scores in our study, although transfused patients had lower scores for PF, BP, PCS and SF.

In both diabetic and non-diabetic patients, the glucose levels before and after surgery had no correlation with SF-36, although SF seemed to have a weak correlation with glucose level before surgery in non-diabetic patients. However, the mean SF-36 scores for diabetic and non-diabetic patients were similar and no association was found between being diabetic and SF-36 scores except that PF scores tended to be lower in diabetic patients. Some studies have indicated that diabetic patients have poorer rehabilitation and functional outcomes than non-diabetic patients[33,34], but other studies have concluded that functional outcomes after hip fracture was not affected by diabetes[35].

Our results also showed a correlation between the BUN levels before surgery and SF-36 for PF, BP, vitality, mental health (MH) and PCS. BUN/Cr before surgery also showed a correlation with BP, vitality, MH and PCS. We found a positive correlation between WBC before surgery and SF scores for PF, BP, GH and

Table 4

Regression model of PCS

Model		Unstand. coefficients B	Unstand. coefficients Std. error	Stand. coefficients Beta	*t*	*P*	95.0% CI for B Lower bound	95.0% CI for B Upper bound
	(Constant)	43.996	19.182		2.294	0.029	4.764	83.227
	Duration of admission to surgery	– 0.642	0.36	– 0.335	– 1.784	0.085	– 1.378	0.094
	Δ Blood sugar	0.03	0.023	0.219	1.297	0.205	-0.017	0.077
	Δ K	– 2.172	2.146	– 0.17	– 1.012	0.32	– 6.562	2.217
	No lymphocyte before surgery	1.735	1.624	0.178	1.068	0.294	– 1.587	5.058
	Age	– 0.101	0.118	– 0.15	– 0.849	0.403	– 0.343	0.142
	Hgb before surgery	0.321	0.869	0.087	0.37	0.714	-1.455	2.098
	Anaesthesia time	0.002	0.021	0.016	0.093	0.927	– 0.042	0.046
	BUN before surgery	0.026	0.074	0.068	0.354	0.726	– 0.125	0.177
	WBC before surgery	– 0.706	0.495	– 0.299	– 1.427	0.164	– 1.717	0.306
	Blood transfusion	– 0.533	2.903	– 0.04	– 0.184	0.856	– 6.47	5.403
	Cancer	– 3.929	3.527	– 0.173	– 1.114	0.274	– 11.142	3.285
Model summary								
Model	R	R^2	Adj. R^2	Std. error of estimate				
1	0.597[a]	0.356	0.112	6.42612				

(Constant): cancer, Δ K, Δ blood sugar, no. of lymphocyte before surgery, age, duration of admission to surgery, anaesthesia time, BUN before surgery, WBC before surgery, blood transfusion, Hgb before surgery.

BUN, blood urea nitrogen; Hgb, haemoglobin; PCS, physical component summary; WBC, white blood count.

PCS. The immune response being known in order to limit infection might influence functional outcomes[36]. The number of platelets also correlated with better BP and vitality scores. The current study identified lower levels of neutrophil and neutrophil/ lymphocyte as being associated with lower GH scores. The lymphocyte count before surgery also correlated with BP, vitality, SF and PCS.

Previous health, functional status and social circumstances have been shown to be associated with functional outcomes in elderly patients with hip fractures[37,38]. Establishing a proper communication, even through the phone, with the patient might benefit them, such as better self-care and well-being[39–41]. In line with previous studies[42], we found that advanced age correlated strongly with lower scores for PF, BP, GH, vitality, SF and PCS. However, a weak correlation was found between advanced age and better MH scores. No clear cutoff value for age has been determined.

The mean PF scores was higher for males than for females in our study. This is in contrast with previous studies which indicated that males generally tended to have worse outcomes[43–46]. Our results support results from previous studies that indicate that a previous health history of thyroid malfunction (PF and SF), cancer (PF, GH and PCS), osteoporosis (BP) and smoking (PF) worsened SF-36 scores. Although no association was found between the length of the surgery and SF-36 scores, but regarding anaesthetic time, lower anaesthetic time was correlated with better PF, role limitations due to physical health and PCS scores.

Some studies found differences in postoperative cognitive dysfunction between general and spinal anaesthesia in elderly patients[47–49], while other studies indicated no differences in the effect of anaesthesia type on postoperative cognitive dysfunction[43,50–52]. We found that the GH score was higher after general anaesthesia alone compared to spinal alone and combined use of spinal and general anaesthesia.

Among the variables investigated in this study, lab data and demographic characteristics including higher WBC before surgery, BUN before surgery, Cr before surgery, Δ Number of Neutrophiles, lower Haemoglobin levels before surgery, K before surgery, being female, older age, history of IHD, having diabetes mellitus, longer duration of admission to surgery and blood transfusion have been identified as key factors in predicting in-hospital or long-term mortality rates in another study[53].

In our study, AO/OTA classification was not associated with any SF-36 sub-scores. A study by Chehade *et al.*[54]. showed that unstable fractures according to AO/OTA were accompanied by early device failure that required reoperation and mortality after trochanteric hip fractures. It should also be considered that the surgical method employed and its proper execution affects the subsequent outcomes[55]. Several studies comparing the gamma nail and DHS have indicated that DHS seems to be a better method for treatment of trochanteric fractures[56,57]. Other studies have found no noteworthy differences, including functional outcomes, between these two methods[58–60].

Strengths and limitations

One strength of our study was that it was one of only a few to clarify the association between pre-operative factors and SF-36 scores in elderly patients with IT fractures. One limitation of the study was the retrospective collection of baseline characteristics of patients, which make it susceptible to several types of bias. Also, because of the lack of randomization, we cannot infer causal effects. Additionally, we did not have a standardized method of assessing the presence of comorbid conditions. For example, determination of the presence of diabetes or osteoporosis were based on the self-reported symptoms. Also, as older patients are more prone to cognitive dysfunction and lack of recall, some information could be lacking. Finally, only one surgeon computed the SF-36 scores, which could have affected their accuracy. Telephone interviews also might have been influenced by interviewer bias.

Conclusion

In summary, delayed surgery, anaemia, BUN, BUN/Cr ratio, compromised immune system, advanced age and longer exposure time to anaesthesia were associated with lower SF-36 scores. The factors of female gender, advanced age, history of diabetes, thyroid malfunction, cancer, osteoporosis, prophylactic anticoagulant use, combined use of general and spinal anaesthesia and blood transfusions also were found to correlate with reduced SF-36 scores. It is evident that patient-related factors and perioperative factors should be considered carefully when treating IT fractures. Considering these findings, we suggest that individual treatment should be applied for each patient based on fracture type and any other underlying risk factors to mitigate the interference of modifiable factors.

Further large-scale, well-designed, sufficiently powered randomized controlled trials would be needed to validate our findings.

Ethical approval

The present study design was approved by the Research Ethics Committees of Sina Hospital, Tehran University of Medical Sciences (Code: IR.TUMS.SINAHOSPITAL.REC.1400.084) on 26 October 2021.

Consent

No personal information or images of the patients have been used in this study. Written informed consent was obtained from the patients for publication and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Author contribution

S.H.S.: conceptualization and review. A.R.: writing the manuscript and analysing data. M.B.: data gathering and writing the manuscript. A.G.R.: editing the manuscript. M.G.: analysing data.

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Guarantor

Dr seyyed Hossein shafiei as the corresponding author accepts full responsibility for this work.

Data availability statement

All the data are available with the corresponding author.

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