Predictive factors associated with the clinical outcome of intertrochanteric hip fracture in high-risk elderly patients treated with total hip arthroplasty versus percutaneous external fixation

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Background: Little is known regarding the survival and functional recovery of elderly intertrochanteric hip fracture (IHF) patients after total hip arthroplasty (THA) versus percutaneous external fixation (PEF). This study aims to analyze the prognostic factors of THA and PEF in elderly IHF patients.

Methods: A total of 155 consecutive elderly patients (mean age of 80 years) diagnosed with IHF were retrospectively reviewed from our database between January 1, 2010, and December 31, 2018. The preoperative, intraoperative and postoperative covariates were analyzed by two independent surgical cohorts: THA and PEF. The main outcomes included the hip function score, all-cause mortality within 1 year after surgery, and overall survival. Covariables and their influence on independent outcomes were analyzed using multivariate regression models.

Results: The median follow-up period was 5.1 years, and 6 patients were lost to follow-up. At the endpoint, 70 of 85 patients treated with THA and 37 of 70 patients treated with PEF survived, exhibiting mean Harris hip scores of 84.4 and 69.0, respectively. The Kaplan-Meier curves and log-rank tests showed no significant difference in overall survival. After adjusting for the covariates, the surgical mode was a unique prognostic factor affecting hip function recovery, and two prognostic factors (leukocyte count and D-dimer) were correlated with 1-year all-cause mortality. Age at admission, fracture classification, D-dimer level and surgical mode were identified as prognostic factors affecting overall survival. After adjusting for the former three covariates, THA reduced the risk of death by 67.20% compared with PEF (HR 0.328, 95% CI, 0.121–0.890).

Conclusions: Despite the nonsignificant difference in 1-year all-cause mortality, THA demonstrated superior midterm survival and hip function recovery in elderly IHF patients compared with PEF. Predictive factors, including age at admission, fracture classification, D-dimer level and surgical mode, are associated with the overall survival of IHF in high-risk elderly patients.

Keywords: Intertrochanteric hip fractures (IHFs); elderly; arthroplasty; external fixation; survival; functional recovery; early mortality

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Introduction

The incidence of hip fracture and associated mortality, medical expenses and social burden in elderly patients has increased considerably in the last decade. An epidemiological investigation showed that 1.6 million cases occur annually worldwide, with a predicted occurrence of 6.3 million by 2050 (1-3). The prognosis is usually poor due to a mortality rate of 10% at 1 month and 30% at 1 year (4,5). A total of 38–50% of hip fractures occur in the intertrochanteric region (6). Although there is much similarity in the pathology of intertrochanteric hip fracture (IHF) and femoral neck fracture, the different treatment modes could be used (7). There is a strong consensus regarding the treatment of femoral neck fracture by hip arthroplasty, which has been proven to be superior in terms of quality of life and long-term survival (8,9).

However, there are notable controversies regarding the roles of repair strategies, such as fracture fixation, other than reconstructive approaches, such as arthroplasty, in patients diagnosed with IHF (10-13). Classical internal fixation (dynamic hip screw, proximal femoral nail and locking plate) has been recommended as another choice for elderly IHF patients due to the high failure rate (range, 4.7–16.5%) and poor general condition of this population, preventing anesthesia for an invasive intervention (14-17). Hip arthroplasty, either hemiarthroplasty (HA) or total hip arthroplasty (THA), is indicated in unstable IHF, patients with preexisting disorders (such as osteoarthritis), patients suffering from bedridden complications (bedsore, respiratory and urinary infection, etc.) and patient asking for immediate weight-bearing activities (18). However, a high frequency of complications, such as dislocation, implant loosening and abductor insufficiency, is the subject of many complaints (19-21). Arthroplasty is mostly recommended in elderly patients with unstable osteoporotic fractures or as a salvage procedure in cases of fixation failure (22,23). Another choice is closed reduction and percutaneous external fixation (PEF), which can be applied under local anesthesia with sedation and has been reported to be appropriate for high-risk patients (24-27). Many studies have documented that PEF could be cost-effective in delaying surgery and reducing the operative duration, blood loss and surgical trauma (25,26,28). However, little is known regarding its long-term outcome in elderly patients.

Many studies have compared the clinical outcomes between internal fixation and hip arthroplasty, and the results remain controversial (7,9-11,13,15,20,22). We undertook a retrospective cohort study to compare the therapeutic effect of two mainstay treatment modes, PEF and THA, in elderly patients between July 1, 2010, and December 31, 2018. Our study aimed to answer two questions: first, is there any clinical difference in terms of functional independence and survival rate; and second, which are the prognostic factors affecting the main outcomes, including hip function recovery, all-cause mortality within one year after surgery, and endpoint survival? We present the following article in accordance with the STROBE reporting checklist (available at http://dx.doi.org/10.21037/atm-20-8037).

Methods

Data sources and study design

The cohort comprised all consecutive patients diagnosed with IHF who underwent PEF or THA at our institution from January 1, 2010, through December 31, 2018. All of the data were retrieved by a picture archiving and communication system (PACS) station (version 10.0) using ICD-11-CM diagnosis codes for IHF with approval from the institutional review board. The search was further defined by the following inclusion criteria: (I) age over 75 years old at admission; (II) unilateral and closed IHF within 3 weeks of injury; and (III) IHF confirmed according to the Evan classification system (29). The exclusion criteria were as follows: (I) elderly IHF patients with coexisting hip disorders, such as osteoarthritis and femoral head avascular necrosis; (II) preinjury nonambulatory status; (III) contralateral hip fracture during follow-up; and (IV) treatment with HA. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the institutional committee of Xinqiao Hospital (No.: 2019027), and individual consent for this retrospective analysis was waived.

Two groups of patients treated by surgical modes of PEF and THA were set as the comparative cohorts. The choice of the surgical mode was made by the patient and his/her family member after a risk-benefit assessment and therapeutic advice were proposed by a multidisciplinary team. All surgical procedures were performed by three senior surgeons (X.Z., M.W., and Y.Z.). The PEF was accomplished by fracture reduction by axial traction and internal rotation of the injured limb in a tractable system under fluoroscopy monitoring, followed by fixing the fracture with two 4.5 mm cancellous Schanz screw

transfracture lines percutaneously and two 4.5 mm cortical Schanz screws on the femoral shaft. THA was performed via minimally invasive Moore's approach in a lateral decubitus position, with sequential procedures consisting of repositioning and temporary fixation of the fragments of the trochanter, preparation of the acetabulum and femoral canal, implantation of cementless and fully coated porous components, and repair of the short external rotators.

Covariates

Baseline characteristics and preoperative assessment
Patient age, sex, operational side, body mass index (BMI), cause of injury, fracture classification and anesthesia type were collected from PACS files. Validated algorithms identified patients with four types of preexisting disorders, including cardiovascular disease (coronary and cerebral vascular disease, hypertension, etc.), respiratory disease (chronic obstructive pulmonary disease, hypostatic pneumonia, etc.), metabolic disease (diabetes, hyperthyroidism, etc.), and neurological disease (Parkinson's disease, Alzheimer's disease, etc.). The preoperative risk ratings, including bone quality, American Society of Anesthesia (ASA) score, nutritional risk screening (NRS2002), Caprini score of venous thromboembolism, bedsore risk rating (Braden score), self-care and independent ability (ADL-Barthel score), and mental status (Nu-DESC score), were retrieved (30-33).

Intraoperative and postoperative data
The intraoperative descriptive variables included in-hospital length of stay, corrected medical expenses (subtracting the implant expense due to the significant difference in expense of the external fixator and arthroplasty prosthesis), operative duration, blood loss, and transfusion volume and rate. The one-day postoperative descriptive variables included leukocyte count, neutrophil percentage, albumin and D-dimer levels, blood oxygen pressure and oxygen saturation rate. Adverse events were defined by complications related to hip surgery within three months postoperatively and the causes of unexpected death within the first year postoperatively.

Follow-up variables
All patients were followed up by clinical and radiological evaluation annually, and the endpoint of the follow-up period was set as the start of the statistical analysis of this study (December 31, 2019). The variables employed for evaluating functional outcomes and quality of life were the Harris Hip Score (HHS) and Short Form 12 Health Survey (SF-12) score. Radiological analysis was employed to determine functional bone healing and the occurrence of implant failure, including bone nonunion, mechanical loosening, loss of fracture reduction, implant loosening, cutting-out, and subsidence.

Outcome metrics
The primary outcome was overall survival at the final follow-up. The secondary outcomes included hip function recovery indicated by the HHS and all-cause mortality within 1 year after surgery.

Statistical analysis

Statistical analyses were performed using SAS Version 9.4 (SAS Institute, Cary, NC). Continuous variables are described as the mean and standard deviation (SD), and nonnormally distributed data are described as the median and interquartile range. Two-sided tests were performed for all statistical analyses. Cochran-Mantel-Haenszel χ^2 tests or Fisher's exact tests were used to compare categorical data. Continuous data were analyzed by Student's *t*-test or Wilcoxon rank test. P values of 0.05 were considered to indicate statistical significance.

Kaplan-Meier survival curves and a log-rank test were used to compare survival between the two groups. The specific prognostic factors with clinical outcomes were determined by three different regression models: (I) a multiple linear regression model for associated prognostic factors of hip functional recovery (HHS); (II) a logistic regression model for associated prognostic factors of all-cause mortality within one year after surgery; and (III) a multivariate Cox proportional hazards model for associated prognostic factors of general survival.

Results

Data sources and patient characteristics

A total of 252 patients were identified in the database according to our inclusion criteria, and 78 cases were excluded as follows: 32 cases of combined femoral head necrosis and hip osteoarthritis, 17 cases of contralateral hip fracture after hip surgery, and 29 cases of nonambulatory preinjury status. The complete medical documents of the remaining 155 patients were reviewed from January 1, 2010 through December 31, 2018. The median follow-up period

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Table 1 Baseline characteristics and preoperative risk assessment of the patients in this study

Indicator	THA (n=85)	PEF (n=70)	P
Gender (male/female), case	31/54	32/38	0.245
Age at admission [mean (SD)], year	80.0 (7.1)	83.6 (7.1)	0.963
Operational side (left/right), case	41/44	38/32	0.455
Body mass index, [mean (SD)]	20.9 (3.2)	21.6 (3.8)	0.460
Bone quality (I/II/III/IV)*, case	0/25/26/34	0/13/19/38	0.407
Cause of injury (I/II/III)*, case	82/0/3	63/4/3	0.098
Fracture classification (I/II/III/IV/V/R)*, case	2/13/11/18/40/1	0/8/13/18/27/4	0.318
Time from injury to surgery*, day	3.5/7/10.5	3/4/7	0.001
Preoperative comorbidities, case	49/58/29/17	43/52/26/28	0.235
Anesthesia type (local/general/spine), case	0/11/74	18/7/45	0.002
Anesthesia risk (ASA score), mean (SD)	3.3 (0.8)	3.6 (0.8)	0.001
Pain score (NRS), mean (SD)	2.0 (1.7)	1.6 (1.4)	0.215
Nutrition risk (NRS2002), mean (SD)	2.7 (0.9)	2.6 (0.8)	0.498
VTE risk (Carprini score)*, mean (SD)	14/16/24/31	13/10/12/35	0.364
Bedsore risk (Braden score), mean (SD)	14.1 (1.7)	14.4 (2.2)	0.407
Self-care ability (ADL-Barthel)*, mean (SD)	25.6 (3.2)	26.7 (9.7)	0.769
Mental status (Nu-DESC)*, mean (SD)	1.7 (0.4)	1.9 (0.6)	0.127

*, bone quality: I, normal (T>−1.0); II, osteopenia (−2.5<T<−1.0); III, osteoporosis (T<−2.5); IV, severe osteoporosis (T<−2.5, combined with osteoporotic fracture). Cause of injury: I, fall while walking; II, fall from height; III, road traffic accident. Fracture classification: I/II/III/IV/V/R of EVANS' system. Time from injury to surgery: lower quartile/median/upper quartile. Preoperative comorbidities: cardio-vascular/respiratory/metabolic/neurological. ADL-Barthel score: I, normal [100]; II, mild [61–99]; III, moderate [41–60]; IV, severe [<40]. VTE risk score: I, low risk; II, moderate risk; III, high risk; IV, extremely high risk. SD, standard deviation; THA, total hip arthroplasty; PEF, percutaneous external fixation; ASA, American Society of Anesthesiologists; NRS, Numerical Rating Scale; NRS2002, nutrition risk screening of 2002; VTE, venous thrombus embolism; ADL, activities of daily living; Nu-DESC, Nursing Delirium Screening Scale.

was 5.1 years (range, 1.5–9.5 years).

Continuous variables presented, including age at admission and BMI, were similar in the two groups. There was no significant difference in categorical variables, including sex, operational side, bone quality, cause of injury, and fracture classification. The quantitative analysis of surgical-related risks, including pain, nutrition, venous thromboembolism, bedsore, self-care ability and mental status risks, also demonstrated no significant difference. We did notice a significant difference in three variables, including the ASA score, anesthesia type and time from injury to surgery (TFIS) (*Table 1*).

Intraoperative and postoperative variables

In terms of intraoperative variables, the operative duration (from incision to closure) and estimated blood loss were significantly lower in PEF than in THA (P<0.05). Although the general transfusion rate was much lower in PEF, the difference in transfusion volume in the two groups remained nonsignificant, and it was calculated from the total blood volume given to the number of patients who received transfusions (13 in PEF versus 60 in THA). The medical expenses and length of in-hospital stay were similar in the two groups (P=0.296). Blood tests on postoperative day 1 showed significantly higher leukocyte counts and D-dimer levels in THA patients than in PEF patients (P<0.05), while other hematological variables, including the neutrophil percentage, albumin level, oxygen saturation and blood oxygen pressure, were identical (P>0.05). The total postoperative complication rate was 22.3% in THA versus 26.6% in PEF (P=0.552). In particular, postoperative dislocation was exclusively found in THA, with a significant

difference (P=0.017, *Table 2*).

Association of covariates and hip function recovery

At the endpoint of the study, the HHS was 84.4 and 69.0 in the THA and PEF groups, respectively (P<0.001), and the percentage of patients whose hip function reached a grade of excellent and fine was significantly higher in the THA group (P<0.01). In terms of overall quality of life, the SF-12 physical component score increased by 16.2 versus 14.1 points in THA and PEF, respectively (P<0.001), and no significance was observed in the mental component. We then determined prognostic factors affecting the HHS using a specific regression model. We found that the surgical mode had a significant influence on the final hip function score using a linear regression model (P=0.002). Moreover, we assumed that the HHS at the final follow-up was likely to be associated with relevant prognostic factors. The results showed that the surgical mode was a unique prognostic factor affecting the final hip function score after adjusting for covariates using a multiple regression model (P=0.04, *Table 3*).

Association of covariates and all-cause mortality within 1 year after surgery

Our primary investigation demonstrated that the rate of all-cause mortality within 1 year after THA was 5.9% (5/85), and the four most common causes were respiratory failure (50%), cardiac failure (12.5%), pulmonary embolism (12.5%) and sepsis (12.5%). In contrast, the rate of all-cause mortality within 1 year after PEF was 11.4% (8/70), and the three most common causes were respiratory failure (40%), cancer (20%), and pulmonary embolism (20%). There was no significant difference in the 1-year mortality rate (P=0.261). In addition, we preliminarily identified that the surgical mode had no significant impact on this mortality rate through logistic regression analysis (P=0.228).

However, when we introduced associated factors, including the ASA score, TFIS, leukocyte count, hemoglobin, albumin and D-dimer levels at 1 day after surgery, and coexisting comorbidities into the logistic regression model, the results showed that the leukocyte count and D-dimer level were prognostic factors affecting all-cause mortality within 1 year after surgery (P<0.001, *Table 4*).

Association of covariates and overall survival

Seventy of 85 (82.3%) patients in the THA group survived,

with 15 cases of death, while 37 of 70 (52.9%) patients in the PEF group survived, with 27 cases of death and 6 patients lost to follow-up at the median period of 5.1 years. A log-rank test without adjusting for covariates was used to evaluate the overall survival in the two groups. There was no significant difference in overall survival between the two groups (P=0.0669, *Figure 1*). Patients treated with PEF had a median overall survival of 7.1 years [95% confidence interval (CI), 5.4–10.2], while patients treated with THA had a median survival time of more than 9.5 years (95% CI, 7.9–13.2).

Four variables, including age at admission, fracture classification, D-dimer level and surgical mode, had a significant prognostic influence on overall survival (*Table 5*). After adjusting for the former three variables, the results suggested a significant risk ratio for THA versus PEF (HR 0.328, 95% CI, 0.121–0.890), revealing that THA has a mortality 67.2% less than that of PEF.

Discussion

The treatment of elderly IHF patients is challenging in terms of both decision-making and perioperative management (34,35). There are still massive debates on the topics of surgical mode, implant selection, intervention time, and perioperative management (36,37). This study highlights the value of the surgical mode in this high-risk population.

There have been very few studies on the mid- to long-term clinical outcomes in high-risk patients treated with THA versus PEF. Polat *et al.* observed the short-term outcome of PEF versus HA in 42 elderly unstable IHF patients. They found PEF to be an advantageous choice compared with HA in terms of a superior surgical time, hospital stay, and intensive care unit stay. The one-year mortality rates were 55.0% and 40.9% in the PEF and HA groups, respectively. Both the survival rate and functional results were not different at the last follow-up visit (38). In our study, we enrolled all consecutive patients diagnosed with IHF and surgically treated with THA and PEF at our center from 2010 to 2018, illustrated the clinical outcome of the two surgical modes and further unveiled the definite prognostic factors related to the outcome.

The first significant finding that we identified is a difference in the midterm outcome of elderly IHF patients treated with THA and PEF. We proved that the overall survival rate at the 5.1-year follow-up in the THA group was significantly higher than that in the PEF group, with an estimated difference of 30.5% in our retrospective series.

Table 2 Intra- and post-operative variables, follow-up records, and complication of this study

Indicator	Variables	THA (n=85)	PEF (n=70)	P
Intraoperative & in-hospital record	Surgery duration (min)	92.5±60.2	67.1±28.3	0.002
	Blood loss (mL)	290.0±182.5	35.5±25.0	0.000
	Transfusion rate (%)	78.20	21.80	0.000
	Transfusion volume (mL)	602.9±275.9	600.0±256.0	0.927
	Corrected expense ($)*	4,624.6±2,479.2	2,636.9±2,072.8	0.296
	Hospital stay (day)	13.8±10.3	14.8±9.6	0.917
Blood test at postoperative day 1	Leukocyte count (×10^9)	9.4±2.9	8.2±2.9	0.002
	Neutrophil percentage	81.8±10.7	78.9±7.3	0.061
	Albumin (g/L)	37.9±3.9	33.4±3.0	0.312
	D-dimer	0.84±0.31	0.26±0.22	0.005
	Blood oxygen pressure (mmHg)	81.4±24.4	78.7±14.9	0.468
	Blood oxygen saturation (%)	93.8±5.7	96.2±2.6	0.154
Follow-up record at end-point of study	Harris Hip Score	84.4±15.1	69.0±21.6	0.000
	Hip function with excellent and fine (%)	75.9	42.9	0.000
	Mortality rate within 1 year postop. (%)	5.9	11.4	0.261
	SF-12 (PCS)	16.2±0.98	14.1±2.2	0.000
	SF-12 (MCS)	15.0±0.9	14.9±0.8	0.454
Complication occurrence	Total occurrence (%)	22.3	26.6	0.552
	Pulmonary infection	4/85	5/70	0.764
	Respiratory failure	4/85	2/70	0.861
	Cardiac failure	2/85	1/70	1.000
	Cerebral infarction	2/85	2/70	1.000
	DVT	3/85	5/70	0.518
	PE	2/85	1/70	1.000
	Hematoma	2/85	0/70	1.000
	Surgical site infection	3/85	6/70	0.322
	Joint dislocation	7/85	0/70	0.017
	Bone non-union	1/85	6/70	0.069
	Implant failure	2/85	1/70	1.000
	Revision surgery	5/85	1/70	0.311
	Proximal femur mal-alignment	3/85	7/70	0.192
	Limb discrepancy (shortening or lengthening >10 mm)	2/85	5/70	0.298
	Hip stiffness	1/85	3/70	0.205

*, medical expense after subtracting the implant expense from total expense. THA, total hip arthroplasty; PEF, percutaneous external fixation; SF-12, 12-item short form health survey; PCS, physical component score; MCS, mental component score; DVT, deep venous thrombosis; PE, pulmonary embolism.

Table 3 Association of prognostic factors with Harris Hip Score

Variates	III type SS	MS	F value	P
ASA score	98.497	98.497	0.41	0.521
Fracture classification	656.074	131.215	0.55	0.736
Anesthesia type	189.911	189.911	0.80	0.374
Respiratory disorder	0.961	0.961	0.00	0.949
Metabolic disorder	44.365	44.365	0.19	0.667
Cardio-vascular disorder	0.0482	0.048	0.00	0.989
Neurological diseases	128.154	128.154	0.54	0.465
Surgical mode	1,016.164	1,016.164	4.28	0.041

ASA, American Society of Anesthesiologists; SS, sums of squares; MS, mean squared.

Table 4 Association of prognostic factors and mortality from any reason within 1 year after surgery

Variates	B value	SE	Wald	P
Intercept	29.006	10.088	8.267	0.004
ASA score	−1.997	1.156	2.984	0.084
TFIS	−0.264	0.581	0.207	0.649
Leukocyte count	−1.423	0.517	7.588	0.006
D-dimer	−8.953	3.446	6.751	0.009
Hemoglobin	−0.199	0.194	1.057	0.304
Albumin	−0.231	0.330	0.488	0.485
Metabolic disorder	2.565	1.972	1.692	0.193
Cardio-vascular disorder	0.047	1.405	0.001	0.974
Respiratory disorder	3.362	2.270	1.162	0.551
Neurological disorder	11.1176	610.8	0.0003	0.9855
Surgical mode	−4.1710	2.6647	2.4501	0.1175

SE, standard error; ASA, American Society of Anesthesiologists; TFIS, time from injury to surgery.

We further estimated that THA would have a 5.1-year mortality rate after surgery 67.2% less than that of PEF using a Cox proportional hazards model.

This finding is typically contradictory to the traditional viewpoint of the role of PEF in elderly IHF patients. Although many studies have recommended PEF as an optimal choice for these patients because of economic and comorbidity-related considerations (38,39), their conclusions were inclusive because the findings were obtained in the acute phase (perioperative period) or after short-term observation. To our knowledge, we are the first to illustrate in this retrospective study that PEF in elderly IHF patients has inferior midterm outcomes compared with THA.

The second significant finding is that we screened extensive covariates related to the surgical mode and identified definite prognostic factors affecting overall survival and hip functional recovery at the last follow-up as well as all-cause mortality within 1 year after surgery. The factors were included in our regression analysis based on the study objectives, clinical judgment and literature review. These factors included the following: baseline patient factors, preoperative risk assessment results and comorbidities, intraoperative and postoperative variables, and incidence of complications. To our knowledge, this
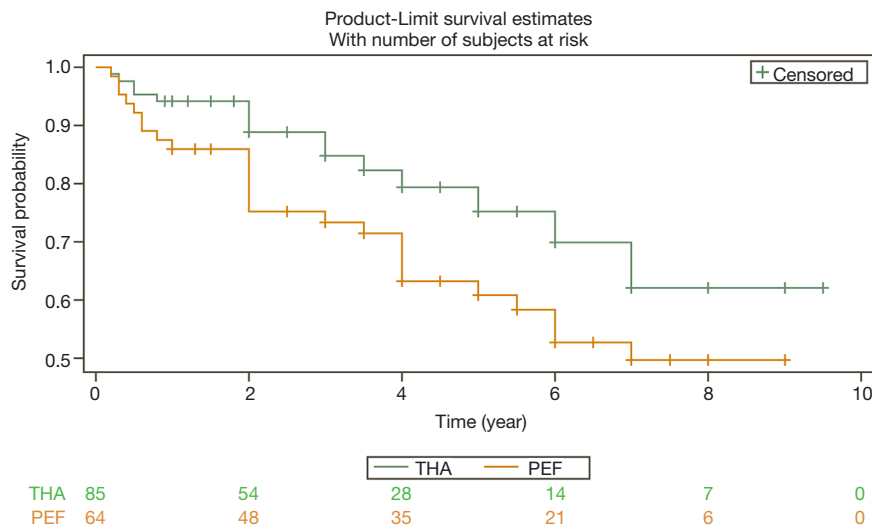
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Figure 1 Overall survival of the patients treated with THA and PEF according to the Kaplan-Meier analysis. Data at the bottom represent the number of surviving patients at each time point (Censored data =6). THA, total hip arthroplasty; PEF, percutaneous external fixation.

Table 5 Association of prognostic factors and overall survival

Variates	B value	SE	P	HR	95% CI
Age at admission	0.089	0.032	0.005	1.094	1.027–1.166
ASA score	0.348	0.302	0.249	1.417	0.783–2.565
Anesthesia type	0.479	0.381	0.172	1.819	0.922–2.174
Fracture classification					
R	1.175	0.877	0.180	3.241	0.580–18.111
I	10.534	1384.000	0.993	0.000	0.000–0.000
II	0.510	0.482	0.290	1.666	0.647–4.289
III	0.717	0.487	0.140	2.050	0.789–5.329
IV	1.206	0.489	0.013	3.342	1.280–8.726
TFIS	−0.067	0.097	0.486	0.935	0.772–1.131
Leukocyte count	17.248	9.237	0.621	1.375	0.819–2.001
D-dimer	6.087	0.798	0.000	440.233	92.105–2,104.179
Surgical mode	−1.114	0.509	0.028	0.328	0.121–0.890
Cardio-vascular disorder	0.194	0.423	0.645	1.215	0.530–2.783
Respiratory disorder	0.339	0.581	0.092	1.661	0.670–4.226
Metabolic disorder	0.588	0.344	0.087	1.800	0.917–3.533
Neurological disorder	−0.022	0.854	0.979	0.978	0.183–5.219

SE, standard error; HR, hazard ratio; CI, confidence interval; ASA, American Society of Anesthesiologists; TFIS, time from injury to surgery.

is one of the most thorough studies on the subject, with abundant covariates related to the clinical outcome.

Among all of the covariates, the surgical mode was identified to be a pivotal prognostic factor influencing both hip function recovery and overall survival, and the D-dimer level was found to be a crucial prognostic factor influencing 1-year mortality and overall survival. In addition, the leukocyte count was a factor affecting 1-year mortality. Overall survival was also influenced by age at admission and fracture classification, suggesting that the general preoperative functional indicators age and fracture type, not comorbidities, were independent predictors of midterm survival. Although the incidence of comorbidities in elderly IHF patients (pulmonary, cardiac and neurological diseases, hypertension, diabetes, etc.) can reach 80–95% (3,4,11,38), (40,41), some studies have reported that, regardless of the surgical treatment selected, pneumonia and heart failure cause significantly high rates of mortality (14,35,42). The results of our study suggest that four types of common comorbidities have a negligible prognostic influence on the survival rate, 1-year all-cause mortality rate, and hip function recovery at the last follow-up. This unexpected finding is not consistent with previous results (43-45).

Our study also presents valuable evidence on the timing of surgical intervention in elderly IHF patients. It is well believed that surgery should be performed as soon as the patient's medical condition allows if appropriate staff and facilities are available (46,47). Some studies have suggested that TFIS is closely related to the occurrence of complications and the clinical outcome (34,35,41,48). In this study, we further analyzed the impact of TFIS on overall survival in a Cox regression model, and the results showed no significant prognostic influence (P=0.69). Similarly, no significant influence on the 1-year mortality rate was found using a logistic regression model (P=0.59). These results suggest that TFIS is not a dominant factor in the survival rate, as some other studies have concluded (42,49).

The strengths of the study are that this standard retrospective cohort study was carefully designed and performed. In addition, the mean follow-up period of 5.1 years could be considered to represent mid- to long-term clinical outcomes in elderly patients over 80 years old. In addition, the covariates of the large number of consecutive patients were comprehensively recorded and analyzed using different regression models, ensuring the validity and robustness of the results of this study. There are two limitations in this study. The first is the intraclass heterogeneity resulting from classifying the preoperative

comorbidities into four main disorders, which might increase the bias. The second is that the patients in the PEF cohort demonstrated worse physical condition than those in the THA cohort preoperatively, and the difference in ASA score had a definitive influence on the decision-making of anesthesia type and surgical mode. This heterogeneity seemed to be related to the general clinical outcome, as discovered in this work. However, a multivariate Cox proportional hazards model was employed to adjust these preoperative differences, and specific prognostic factors were identified.

Conclusions

Despite the nonsignificant difference in 1-year all-cause mortality, THA demonstrated superior midterm survival and hip function recovery in elderly IHF patients compared with PEF. Predictive factors, including age at admission, fracture classification, D-dimer level and surgical mode, are associated with the overall survival of IHF in high-risk, elderly patients.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at http://dx.doi.org/10.21037/atm-20-8037

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Conflicts of Interest: All authors have completed the ICMJE

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uniform disclosure form (available at http://dx.doi.org/10.21037/atm-20-8037). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the institutional committee of our centers (No. 2019027), and individual consent for this retrospective analysis was waived.

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