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Effects of an Emergency-Based FASE Strategy on Treating Geriatric Patients with Femoral Neck Fracture: A Retrospective Propensity Score-Matched Study

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Introduction: This study aims to assess the impacts of the Fast Access to Surgery in Emergency (FASE) strategy on (1) the workflow of multidisciplinary team (MDT) during hospitalization; (2) the clinical outcomes of geriatric femoral neck fracture (FNF) patients.
Methods: A retrospective study was conducted in a single trauma center to evaluate the clinical data of geriatric FNF patients admitted through emergency from July 2017 to June 2022. The FASE strategy was implemented since Jan 1st 2020, and patients were categorized into the FASE group or the control group according to the time of admission (before/after the initiation timepoint of FASE strategy). Propensity score matching (PSM) was utilized to limit confounding bias between the two groups.
Results: Finally, 344 patients were included after a one-to-one matching. The FASE strategy resulted in a slightly prolonged duration in emergency (6.02±5.99 h vs 2.72±4.22 h, p<0.001) but was meanwhile associated with significant decreases in time to surgery (61.16 ±38.74 h vs 92.02±82.80 h, p<0.001), actual surgery delay (67.18±39.04 h vs. 94.25±84.41 h, p<0.001) and total length of hospital stay (10.57±4.93 h vs 12.50±4.73 h, p <0.001). Besides, despite the consistency of transfusion rate between the two groups, improved blood management was achieved in the FASE group, as evidenced by a smaller drop in hemoglobin levels (−20.49±17.02 g/L vs −25.28±16.33 g/L, p = 0.013) in patients without preoperative or intraoperative transfusion. However, no significant differences were observed regarding the overall clinical outcomes such as mortality or postoperative complications.
Conclusion: The Fast Access to Surgery in Emergency (FASE) for geriatric FNF patients effectively optimized the preoperative evaluation workflow, which significantly shortened time to surgery and length of hospital stay, and reduced perioperative blood loss. FASE strategy improved the surgical workflows and turnover efficiency of geriatric FNF patients, therefore could play an important role in the optimal MDT co-management for geriatric FNF patients.
Keywords: femoral neck fracture, geriatric, emergency optimization, multidisciplinary management, early surgery

Introduction

Femoral neck fracture (FNF) represents a significant healthcare challenge to geriatric patients, characterized by high incidence, significant disability rate, and elevated mortality rate.[1–3] Along with the ongoing trend of population aging, femoral neck fractures in the elderly have posed an indispensable burden on public health and the socio-economic system.[4,5]

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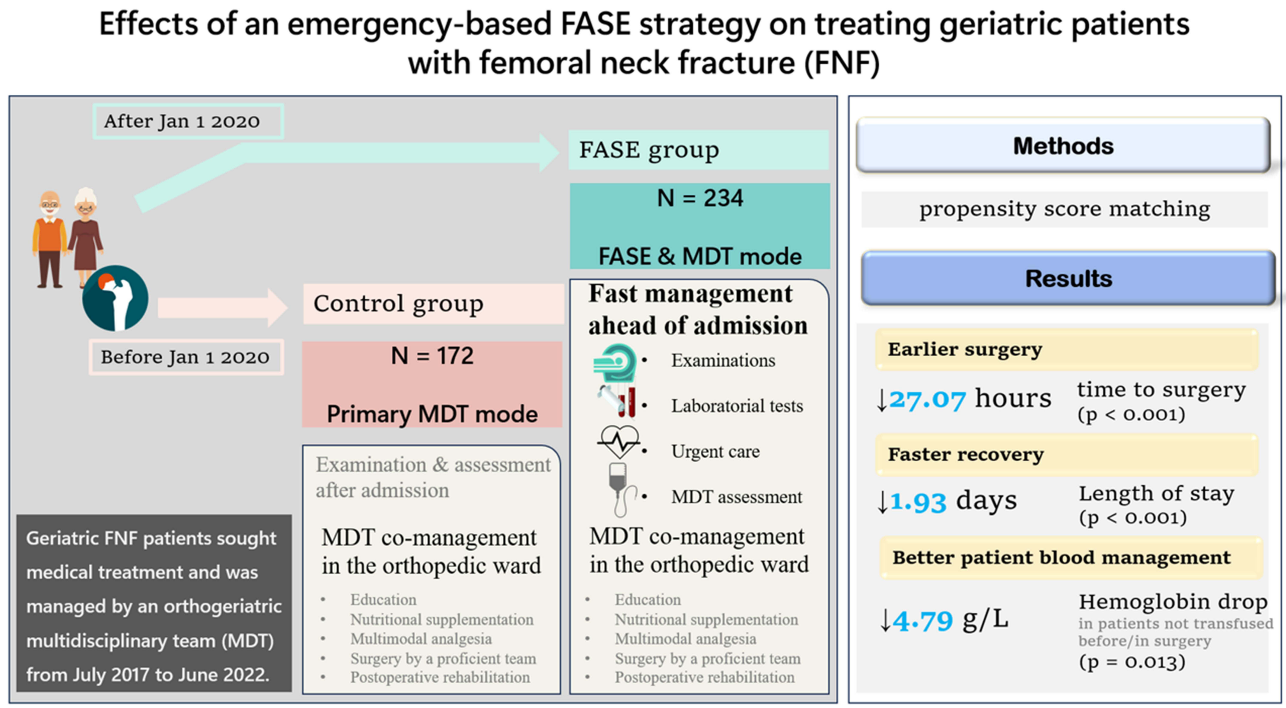
Graphical Abstract



Given the high prevalence and associated morbidity and mortality rates, the concept termed Enhanced Recovery After Surgery (ERAS) was proposed to mitigate these risks and achieve better outcomes by employing evidence-based perioperative protocols.[6] In line with the ERAS concept, methods aimed to shorten time to surgery for geriatric FNF patients has raised more and more concern in recent years.[6–11]

As a core component of ERAS, early surgery based on multidisciplinary assessment and optimization is increasingly advocated by orthogeriatric practitioners.[1,12,13] The co-management of an orthogeriatric multidisciplinary team (MDT) involves collaboration among different healthcare professionals. Prior to surgical intervention, a thorough assessment by MDT is essential to evaluate the patients' overall status.

The preoperative optimization necessitates comprehensive examinations to reveal and address the complex physiological conditions of geriatric individuals with FNF. The traditional hospitalization procedure features with a discontinuous examination process which requires repeated transfers between orthopedic ward and certain examination rooms (such as computed tomography room). Such process is inefficient for early assessment in the MDT context, and may subsequently prelong time to surgery and restrict the turnover efficiency. Besides, frequent carrying between ward bed and transfer board is also responsible for greater patient discomfort during transfer. Considering the waiting time before handling the admission formalities, utilizing this period in emergency for examination or interventions seems to be a better choice to facilitate early surgery.

Early examination and intervention during the emergency period could play an important role in reducing time to surgery and optimizing turnover efficiency of geriatric FNF patients.[14] Since Jan 1st 2020, a new strategy (Fast Access to Surgery in Emergency, FASE) has been implemented in our center to involve emergency department and laboratorial/radiological department as new participants in the MDT co-management. The FASE strategy introduced a different perspective of improving MDT co-management by providing opportunities for early examination and further promoting early surgery.

This study aimed to assess what role does the FASE strategy plays in the co-management of geriatric FNF patients. The primary outcomes included (1) time to surgery; (2) early surgery rate; (3) total length of hospital stay; and (4) mortality rate at 30-day, 90-day, 1-year. The secondary outcomes included: (1) duration in ED; (2) actual surgery delay; (3) postoperative length of hospital stay; (4) total hospitalization cost; (5) postoperative complications within 30 days after surgery; (6) transfusion rate and level of perioperative hemoglobin drop, (7) surgical features (type of surgery and operation time).

Method

Patient Selection and Grouping Criteria

This retrospective cohort study scrutinized clinical data of geriatric patients with femoral neck fracture who sought medical treatment and underwent surgical procedures in a single orthopedic trauma center from July 2017 to June 2022 (see in Figure 1).

The inclusion criteria were as follows: ① Age ≥65 years; ② Low-energy femoral neck fracture within 1 week; ③ Admitted through emergency; ④ Consent to complete necessary examinations or receive interventions at emergency; The exclusion criteria were as follows: ① Polytrauma or fractures due to high-energy injuries; ② Pathological fractures

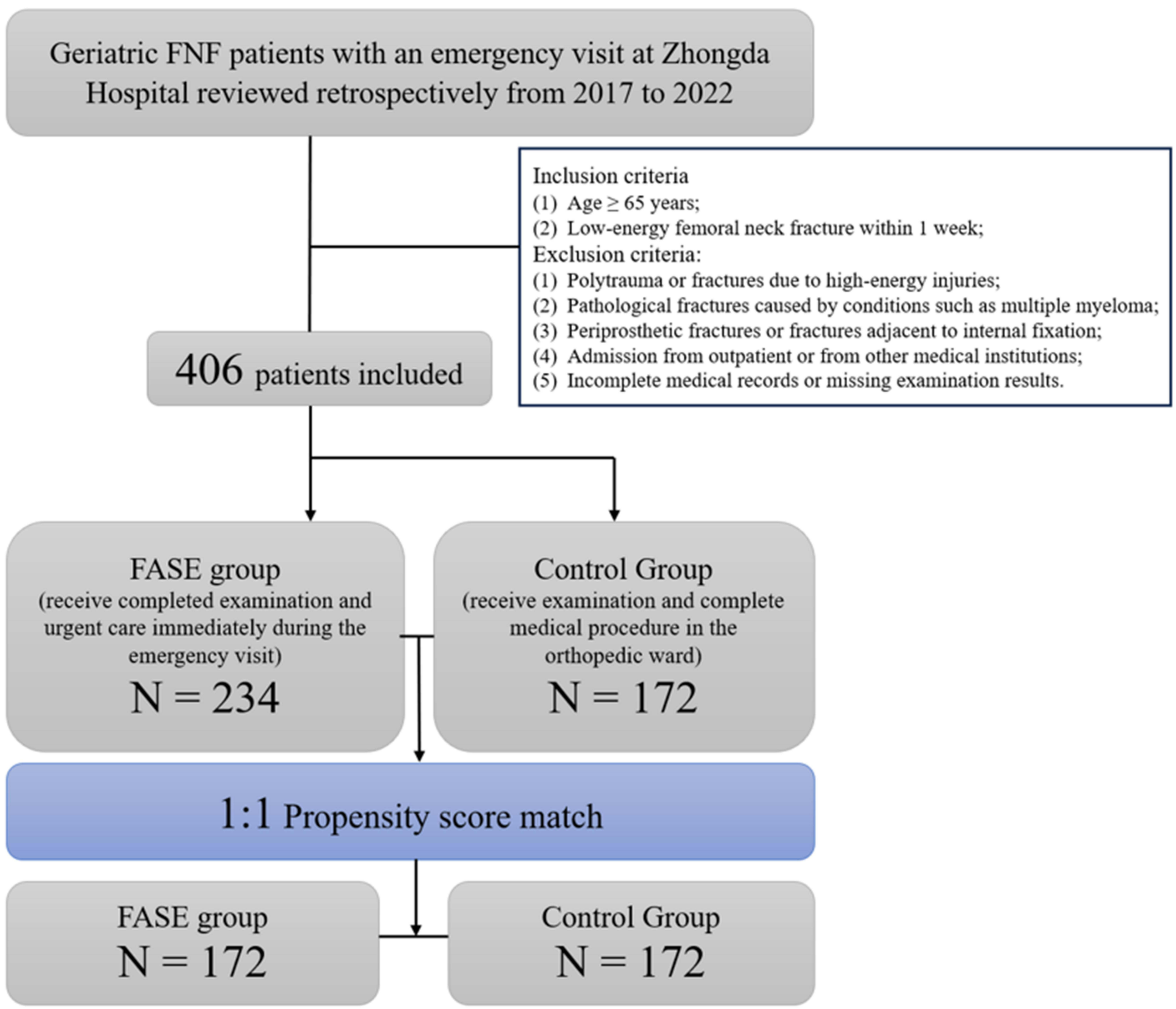


Figure 1 Schematic of patient selection, grouping and matching.

caused by conditions such as multiple myeloma; ③ Periprosthetic fractures or fractures adjacent to internal fixation; ④ Not admitted through emergency; ⑤ Incomplete medical records or examination results.

The grouping criteria this retrospective study are shown as follows. Since Jan 1st 2020, an emergency-based FASE strategy for geriatric FNF patients has been implemented in our trauma center to accelerate the preoperative optimization and promote early surgery. Patients admitted before Jan 1st 2020 were grouped to control group, who underwent routine emergency diagnosis procedure (transferred to orthopedic ward once diagnosed with a femoral neck fracture, n=172). Patients admitted after Jan 1st, 2020 were classified into FASE group, respectively, and underwent the FASE procedure (complete additional examinations upon arrival and voluntarily cooperating with doctors for necessary treatment, n=234) in emergency.

Patient Management

Emergency Phase

FASE Group

Patients in the FASE group underwent an optimized procedure in the emergency department (ED), which mainly encompassed early triage, examinations, multidisciplinary assessment and swift interventions ahead of admission.

Based on the collaboration between emergency department, orthopedic department, and other departments in an orthogeriatric multidisciplinary team (MDT), FASE strategy was proposed to improve the optimization procedures and shorten time to surgery, and was implemented since Jan 1st, 2020. At the commencement phase of the FASE project, a targeted training program was implemented to promote the standardization of emergency management protocols for geriatric femoral neck fractures (FNF) among emergency practitioners. Meanwhile, laboratorial and radiological departments were involved in the FASE project to give priority to FNF patients for early examination.

The FASE strategy focused on earlier examination based on the close communication between emergency department and laboratorial/radiological department. Geriatric patients suspected of a hip fracture were triaged by emergency practitioners, and completed diagnostic imaging of hip joints. They were then transferred to the emergency observation area, monitored for vital signs, receiving quick oral analgesics and await for further assessment. A series of standardized laboratorial tests (including complete blood count, biochemistry analysis, arterial blood gas analysis, etc.) were performed in ED for early assessment. Additionally, patients underwent computed tomography (CT) scans of chest and brain, and Doppler echocardiography ahead of admission to assess baseline status and physiological reserves. Optimization of the above examination process avoided the repeated transfers and movement caused by discontinuous examinations after admission, thereby was beneficial to alleviating patient pain and trauma stress.[15]

Simultaneously, the Orthogeriatric Multidisciplinary Team (MDT) initiated a comprehensive assessment procedure upon the diagnosis of FNF. Swift assessment and interventions were provided by MDT focusing on early oxygen therapy, correction of electrolyte imbalances, fluid resuscitation, multimodal analgesia and anticoagulation. Low-flow nasal oxygen was routinely applied, and non-invasive ventilation was given as necessary once detecting persistent low oxygen saturation ($SpO_2 < 90\%$). Fluid balance was comprehensively assessed by geriatricians, and adequate fluid resuscitation was provided to avoid dehydration or fluid overload. Simultaneously, correction of electrolyte imbalances was administered according to the laboratorial examination. Tranexamic acid would be administered by geriatric physicians based on physical status and bleeding risk. Regarding the patients' pain scores, graded multimodal analgesia was provided by anesthesiologists, combining oral analgesics, intravenous analgesics, and iliac fascia blockade to achieve satisfactory pain relief. Low molecular weight heparin (LMWH) was routinely administered for thrombosis prophylaxis during the emergency period. Following the emergency stage, patients were managed by an orthogeriatric multidisciplinary team during hospitalization, and surgical procedures were conducted by the same team.

Control Group

The control group featured with a routine examination procedure after admission. Patients were assessed by emergency practitioners and received only basic radiological examinations (such as X-ray or CT) in the ED. Upon the diagnosis of a femoral neck fracture, the patient would be admitted to orthopedic ward and further completed necessary laboratorial tests and radiological examinations. Patients were managed by the same team as FASE group in an MDT form during hospitalization.

Hospitalization Phase

Patients in both groups of this study were managed by an orthogeriatric MDT during hospitalization. The co-management of MDT involves collaboration among various healthcare professionals, including orthopedic surgeons, geriatricians, anesthesiologists, physiotherapists, occupational therapists, nurses, psychiatrists, nutritionists, and intensive care unit (ICU) physicians. A multidisciplinary assessment was carried out to identify and address modifiable risk factors. Optimization strategies focused on nutritional supplementation, correction of electrolyte imbalances, optimization of chronic medical conditions (including functional status and cognitive function), multimodal analgesia and anticoagulation.

The operation staff were informed and prepared for the hip repair surgery as soon as the modifiable risk factors of patients were addressed. In case of any hemodynamic instability or severe blood loss during surgery, erythrocytes and plasma were routinely reserved before operation for all geriatric FNF patients in our center. Anesthesiologists contribute expertise in perioperative pain management and anesthesia method, considering the patient's physical status. Routine prophylactic antibiotic administration was performed 30 minutes before surgery. Orthopedic surgeons perform the surgical repair, employing techniques such as internal fixation or arthroplasty according to fracture type, patient characteristics, and functional status. When considered as high-risk individuals after surgery, geriatric FNF patients would receive enhanced monitoring and postoperative care in ICU overnight.

Blood transfusion was administered for geriatric FNF patients as needed. The criteria for transfusion were as follows: (1) Hb <80g/L; (2) Hb <100 g/L with symptoms of hypoxemia or poor cardiopulmonary function reserves; (3) Clinical indicators of inadequate tissue oxygenation, such as tachycardia, hypotension, and decreased urine output, unresponsive to fluid resuscitation; (4) estimated blood loss volume greater than 300mL during operation.

Following surgery, nurses in orthopedic ward or ICU provided skilled nursing care, monitor for postoperative complications, and assist with wound care and prevention of pressure sore. Standardized postoperative rehabilitation and discharge guidelines for the patients is administered by physiotherapists and occupational therapists. Patients exhibiting persistent or new-onset psychiatric symptoms (such as delirium) received specialized intervention from psychiatrists. Once postoperative complications were observed, specialists from different departments would organize an MDT discussion to ensure optimal medication use, dosage adjustments, and to avoid potentially harmful drug interactions. After discharge, comprehensive education was provided for early rehabilitation training and care.

Data Collection

Patient demographic data, laboratorial tests, and hospitalization information were collected from the electronic medical record system. Mortality data were obtained through follow-up statistics. Patient characteristics included age, gender, body mass index (BMI), American Society of Anesthesiologists classification (ASA), comorbidity-related medical conditions (including a history of pulmonary diseases, hypertension, diabetes, coronary artery disease, Parkinson's disease, dementia, and history of cerebrovascular diseases), as well as laboratorial tests at admission. Outcome indicators were designated as duration in ED, time to surgery, actual surgery delay, length of hospital stay, length of postoperative hospital stay, hospitalization costs, early surgery rate, surgical method, operation time, transfusion characteristics during hospitalization, complications within one month after surgery, and mortality at 1 month, 3 months, and 1 year postoperatively.

Outcomes of This Study

The primary outcomes included (1) time to surgery; (2) early surgery rate; (3) total length of hospital stay; and (4) mortality rate at 30-day, 90-day, 1-year. The secondary outcomes included: (1) duration in ED; (2) actual surgery delay; (3) postoperative length of hospital stay; (4) total hospitalization cost; (5) postoperative complications within 30 days after surgery; (6) transfusion rate and level of perioperative hemoglobin drop, (7) surgical features (type of surgery and operation time).

Definition of Outcomes

The time to surgery was defined as the interval between admission and the operation. The early surgery rate referred to proportion of patients with a TTS from admission less than 48 hours. Total length of hospital stay was defined as the interval between admission and the discharge.

The duration in ED was defined as the interval between hospital arrival and admission. Actual surgery delay referred to the interval between hospital arrival and surgery. Postoperative complications within 30 days after surgery were recorded, including: postoperative pneumonia, gastrointestinal-complications, urinary tract infection, cardiovascular complications, electrolyte imbalance/nutrition disorders, wound complications. GI-complications referred to gastrointestinal complications including postoperative ileus (POI), gastrointestinal bleeding (GIB), and infection with Clostridium difficile. Cardiovascular complications refer to postoperative arrhythmia, shock (or significant hypotension), acute heart failure, and myocardial infarction. Electrolyte imbalance/nutrition disorders refer to severe hypokalemia (K^+ < 3.0mmol/L) or hyperkalemia (K^+ > 5.5mmol/L), hyponatremia (Na^+ < 120 mmol/L), hypoalbuminemia (albumin < 25 g/L). Wound complications were defined as any adverse events related to the surgical site that occurred within the postoperative period, including: (1) Infection: presence of purulent discharge, redness, swelling, or positive bacterial cultures. (2) Dehiscence: partial or complete separation of the wound edges. (3) Hematoma: Accumulation of blood within the tissue.

In this study, transfusion specifically referred to allogenic erythrocyte transfusions. Transfusion rates were assessed before, during, and after surgery. Patients were categorized based on their transfusion status into different groups: "No trans" indicating no blood transfusion during hospitalization, "Minor trans" indicating blood transfusion of less than 400mL, and "Major trans" indicating blood transfusion exceeding 400mL during the same period, respectively.

Hemoglobin (Hb) drop was analyzed by comparing Hb levels on the first day after surgery with the levels at admission. Considering the influence of transfusion on Hb levels, subgroup analysis explored the differences in Hb drop between the FASE group and the control group within both the transfused and non-transfused subgroups.

Statistical Methods

Propensity score matching (PSM) is utilized in this study to minimize the bias. PSM is a statistical technique commonly used in retrospective studies to estimate causal treatment effects and limit bias.[16] The propensity score, defined as the estimated probability of receiving treatment based on observed characteristics, serves as the basis for matching individuals across interested groups and control groups. By ensuring balance on measured covariates, PSM aims to mitigate confounding effects, thus allowing a clearer comparison between the groups compared.[16,17]

Continuous data were compared using Student's *t*-test; the results are presented as mean plus/minus standard deviation, and categorical data were compared using chi-square tests (or Fisher exact tests to analyze categorical data if more than 20% of cells had expected counts less than 5); the results are presented as frequency (percentage). All data were analyzed using R software (version: 4.2.2, http://www.r-project.org/).

Result

Baseline Characteristics and Propensity Score Matching

Data were analyzed for a total of 406 participants, of which 234 were classified as FASE group and 172 as control group. The comparison of the demographic and clinical characteristics for geriatric FNF patients before/after PSM is shown in Table 1.

Statistically significant differences ($P < 0.05$) were observed in baseline data for several variables between the two groups (number of comorbidities, respiratory diseases/hypoxemia, cognitive impairment). Based on these parameters, one-to-one nearest neighbor matching was applied using logistic regression-based propensity scores, matching patients between the two groups. Acknowledging the heterogeneity of variables such as "Age" and "ASA classification" after primary PSM, adjustments were made for "Age" and "ASA classification" to further improve the balance between

Table 1 Comparison of Raw Demographic and Clinical Characteristics of Patients Between FASE Group and Control Group Before/After Propensity Score Matching (PSM)

	Before PSM			After PSM		
Group	**FASE**	**Control**	**p**	**FASE**	**Control**	**p**
n	234	172		172	172	
Age (mean±SD)	80.05 (8.30)	78.44 (9.68)	0.073	78.81±8.27)	78.44±9.68	0.697
Sex (Male, (%))	73 (31.20)	57 (33.14)	0.759	52 (30.23)	57 (33.14)	0.643
BMI (mean±SD)	22.54 (3.41)	22.78 (3.46)	0.519	22.61±3.38)	22.78±3.46	0.651
ASA classification (%)			0.387			0.234
I	8 (3.42)	2 (1.16)		8 (4.65)	2 (1.16)	
II	113 (48.29)	93 (54.07)		93 (54.07)	93 (54.07)	
III	111 (47.44)	76 (44.19)		69 (40.12)	76 (44.19)	
IV	2 (0.85)	1 (0.58)		2 (1.16)	1 (0.58)	
Number of comorbidities (mean±SD)	3.75 ±2.33	3.27±2.04	0.033	3.42±2.26)	3.27±2.04	0.532
Pulmonary disease/hypoxemia (%)	71 (30.34)	12 (6.98)	<0.001	13 (7.56)	12 (6.98)	1
Hypertension (%)	128 (54.70)	92 (53.49)	0.887	91 (52.91)	92 (53.49)	1
Diabetes mellitus (%)	55 (23.50)	35 (20.35)	0.525	41 (23.84)	35 (20.35)	0.516
Heart disease (%)	31 (13.25)	20 (11.63)	0.738	24 (13.95)	20 (11.63)	0.628
Parkinson's disease (%)	10 (4.27)	5 (2.91)	0.649	7 (4.07)	5 (2.91)	0.769
Cognitive impairment (%)	14 (5.98)	2 (1.16)	0.027	4 (2.33)	2 (1.16)	0.68
Cerebrovascular disease (%)	73 (31.20)	55 (31.98)	0.953	51 (29.65)	55 (31.98)	0.726
Preoperative laboratorial tests						
RBC ($*10^{12}$/L, mean±SD)	4.02±0.62	4.08±0.56	0.289	4.09±0.58)	4.08±0.56	0.91
WBC ($*10^{9}$/L, mean±SD)	9.34±3.34	9.29±3.19	0.889	9.24±3.23)	9.29±3.19	0.869
Hb (g/L, mean±SD)	125.19±18.27	125.42±16.54	0.896	127.27±17.15	125.42±16.54	0.308
ALB (g/L, mean±SD)	39.35±4.35	39.71±4.46	0.416	39.91±4.19	39.71±4.46	0.662
BUN (mmol/L, mean±SD)	6.98±3.37	6.75±4.23	0.552	6.79±3.21	6.75±4.23	0.929
Na (mmol/L, mean±SD)	137.79±4.65	138.27±3.94	0.269	137.99±4.99	138.27±3.94	0.559
Level of Potassium (%)			0.271			0.44
<3.5 mmol/L	75 (32.05)	46 (26.74)		53 (30.81)	46 (26.74)	
3.5~5.5 mmol/L	159 (67.95)	125 (72.67)		119 (69.19)	125 (72.67)	
>5.5 mmol/L	0 (0.00)	1 (0.58)		0 (0.00)	1 (0.58)	
Level of BNP (%)			0.306			0.937
<100 ng/L	119 (50.85)	100 (58.14)		98 (56.98)	100 (58.14)	
100 ~ 400 ng/L	84 (35.90)	55 (31.98)		58 (33.72)	55 (31.98)	
>400 ng/L	31 (13.25)	17 (9.88)		16 (9.30)	17 (9.88)	

Notes: A P value<0.05 indicates statistical significance. Pulmonary diseases was defined to include abnormal conditions such as COPD, asthma, and a history of lung surgery, hypoxemia was defined as SaO_2 <90% or PaO2 < 80 mmHg, according to the ABG (Arterial blood gas) analysis at emergency. Heart disease included history of arrhythmia, heart failure, coronary diseases and a history of heart surgery.
Abbreviations: SD, Standard deviation; RBC, Red blood cell; WBC, White blood cell; HB, Hemoglobin; TP, Total protein; ALB, Albumin; Na, Sodium; BUN, Blood urea nitrogen; BNP, Brain natriuretic peptide.

groups. Finally, 344 patients were included after a one-to-one matching. Baseline characteristics between the two groups were well balanced, with no statistically significant differences observed ($p < 0.05$) (see in Table 1).

Outcomes

Primary Outcomes

The time to surgery (TTS) was significantly shorter in the FASE group compared to the control group (61.16±38.74 h vs 92.02±82.80 h, p<0.001) (see in Table 2). Additionally, the total length of hospital stay (tLOS) was reduced in the FASE group (10.57±4.93 d) than in the control group (12.50±4.73 d) ($p < 0.001$). After 1-year follow-up period, fewer deceased individuals were observed in the FASE group compared to the control group. However, there were no significant differences detected in 1-month mortality (FASE: 2/172 (1.16%) vs control: 3/172 (1.74%), p = 1), 3-month mortality

Table 2 Clinical Outcomes Between FASE Group and Control Group

	FASE (n=172)	Control (n=172)	p
Primary outcomes			
Time to surgery (h, mean±SD)	61.16±38.74	92.02±82.80	<0.001
Early surgery rate (%)	86 (50.00)	59 (34.30)	0.005
tLOS (d, mean±SD)	10.57±4.93	12.50±4.73	<0.001
Mortality rate			
1-month mortality (%)**	2 (1.16)	3 (1.74)	1
3-month mortality (%)**	3 (1.74)	7 (4.07)	0.336
1-year mortality (%)	8 (4.65)	12 (6.98)	0.489
Secondary outcomes			
Duration in ED (h, mean±SD)	6.02±5.99	2.72±4.22	<0.001
Actual surgery delay (h, mean±SD)	67.18±39.04	94.25±84.41	<0.001
postLOS (d, mean±SD)	8.03±4.42	8.66±3.15	0.126
Hospitalization costs ($, mean±SD)	8139±3355	8683±2851	0.106
Postoperative complications			
Postoperative pneumonia (%)	11 (6.40)	15 (8.72)	0.541
GI-complications (%)**	2 (1.16)	2 (1.16)	1
Urinary tract infection (%)**	3 (1.74)	4 (2.33)	1
Cardiovascular complications (%)**	2 (1.16)	7 (4.07)	0.174
Electrolyte imbalance / nutrition disorders (%)	11 (6.40)	13 (7.56)	0.832
Wound complications (%)	2 (1.16)	11 (6.40)	0.024
Total transfusion grade (%)			0.798
No trans	143 (83.14)	140 (81.40)	
Minor trans	4 (2.33)	6 (3.49)	
Major trans	25 (14.53)	26 (15.12)	
Hb drop (g/L, mean±SD)	−20.30±16.82	−23.63±17.06	0.069
Surgical features			
Type of surgery (%)			0.008
Total hip arthroplasty	89 (51.74)	62 (36.05)	
Hip hemiarthroplasty	66 (38.37)	94 (54.65)	
Multiple cannulated screw fixation	17 (9.88)	16 (9.30)	
Operation time (min, mean±SD)	108.56±25.36	98.5±30.75	0.001

Note: Fisher's exact test was applied to compare data with**.
Abbreviations: SD, Standard deviation; ED, Emergency department; TTS, Time to surgery; postLOS, Postoperative length of hospital stay; tLOS, total length of hospitalization stay.

(FASE: 3/172 (1.74%) vs control: 7/172 (4.07%), p = 0.336), or 1-year mortality (FASE: 8/172 (4.65%) vs control: 12/172 (6.98%), p = 0.489).

Secondary Outcomes

Despite the increase of the duration in ED (6.02±5.99 h vs 2.72±4.22 h, p<0.001), the FASE strategy was still associated with a shorter actual surgery delay compared with control group (67.18±39.04 h vs 94.25±84.41 h, p<0.001). No statistically significant difference was observed in length of postoperative stay (postLOS) (8.03±4.42 d vs 8.66±3.15 d, p = 0.126). Likewise, the FASE group exhibited a decreasing trend in overall hospitalization costs, but no statistically significant difference was detected between the FASE and Control groups (8139±3355 dollars vs $ 8683±2851 dollars, p = 0.106).

Investigation into postoperative complications demonstrated a similarity between the groups regarding the occurrence of postoperative pneumonia (11/172 (6.40%) vs 15/172 (8.72%), p = 0.541), GI-complications (2/172 (1.16%) vs 2/172 (1.16%), p = 1.000), urinary tract infections (3/172 (1.74%) vs 4/172 (2.33%), p = 1), cardiovascular complications (2/

Table 3 Comparison of Transfusion Features and Blood Loss Features Between FASE Group and Control Group

	FASE Group (n = 172)	Control Group (n = 172)	p
Transfusion features			
Total transfusion (%)			0.798
No trans	143 (83.14)	140 (81.40)	
Minor trans	4 (2.33)	6 (3.49)	
Major trans	25 (14.53)	26 (15.12)	
Preoperative transfusion (%)			1
No trans	170 (98.84)	171 (99.42)	
Major trans	2 (1.16)	1 (0.58)	
Intraoperative transfusion (%)			0.098
No trans	159 (92.44)	149 (86.63)	
Minor trans	4 (2.33)	3 (1.74)	
Major trans	9 (5.23)	20 (11.63)	
Postoperative transfusion (%)			0.981
No trans	155 (90.12)	154 (89.53)	
Minor trans	3 (1.74)	3 (1.74)	
Major trans	14 (8.14)	15 (8.72)	
Blood loss features			
Hb drop (g/L, mean±SD)	−20.30±16.82	−23.63±17.06	0.069

Notes: A P value<0.05 indicates statistical significance. "No trans" means the patient did not receive blood transfusion during hospitalization. "Minor trans" means the patient received a small amount of blood transfusion (< 400mL) during hospitalization. "Major trans" means the patient received a large amount of blood transfusion (≥400mL) during hospitalization. Hb drop refers to the difference in hemoglobin levels between the first postoperative day and the first day of emergency visit.

172 (1.16%) vs 7/172 (4.07%), p = 0.174), electrolyte imbalance/nutrition disorders (11/172 (6.4%) vs 13/172 (7.56%), p = 0.832), whereas wound complications were less common in the FASE group than in the control group (2/172 (1.16%) vs 11/172 (6.4%), p = 0.024).

The majority of patients in both groups did not receive blood transfusion in both groups (FASE: 83.14%, Control: 81.40%) (see in Table 3). No statistically significant differences were observed between the FASE group and the control group in terms of total transfusion grade (p = 0.798), preoperative transfusion grade (p = 1), intraoperative transfusion grade (p = 0.098), and postoperative transfusion grade (p = 0.981). The groups were not significantly different regarding the overall Hb drop (−20.30±16.82 g/L vs −23.63±17.06 g/L, p = 0.069), a subgroup analysis indicated fewer blood loss in the FASE group, as evidenced by a significantly lower Hb drop (−20.49±17.02 g/L vs −25.28±16.33 g/L, p = 0.013) in the non-transfused subgroup (see in Table 4 and Figure 2).

Table 4 Comparison of Hemoglobin Drop Between FASE Group and Control Group When Stratified into "Transfusion Before/in Operation" and "Non-Transfusion Before/in Operation"

	FASE Group (n = 172)	Control Group (n = 172)	p
Hb drop (g/L, mean±SD)			
Trans	−18.33±14.88	−13.00±18.17	0.330
Non-trans	−20.49±17.02	−25.28±16.33	0.013

Notes: Trans refers to patients who received transfusion before/in operation; Non-Trans refers to patients who did not receive transfusion before/in operation.

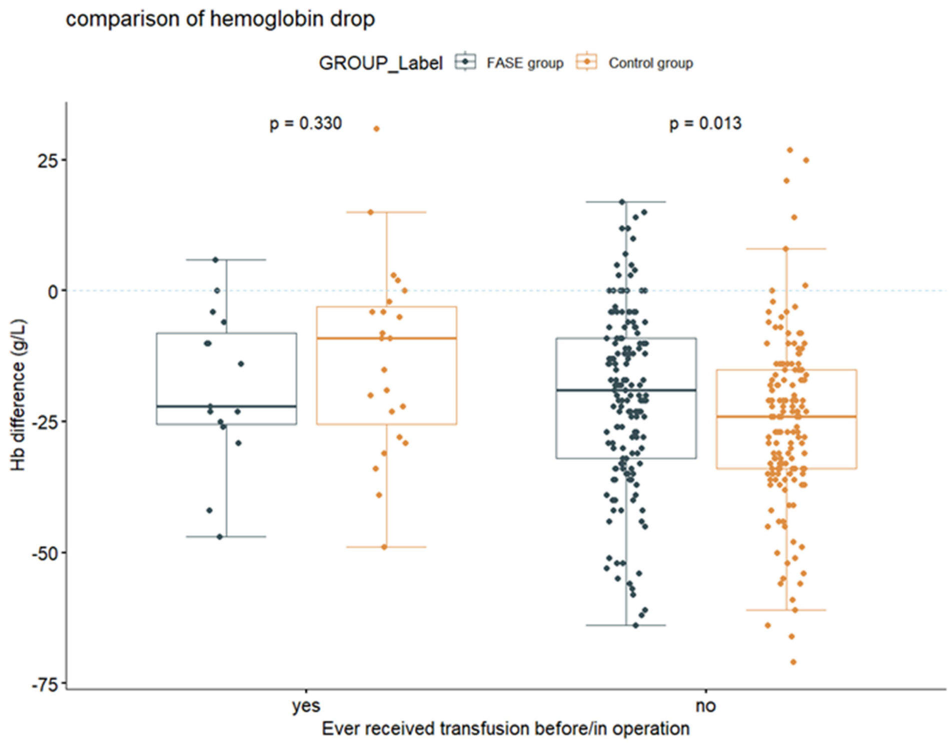


Figure 2 Comparison of hemoglobin drop between FASE group and control group.
Notes: Analysis of Hb drop was stratified into "Transfusion before/in operation" and "Non-Transfusion before/in operation".

An alter in type of surgery (p = 0.008) was observed (see in Table 2), with the FASE group comprising a higher proportion of total hip arthroplasty cases (51.74%) compared to the control group (36.05%). Furthermore, the FASE group demonstrated a prolonged mean operation time (108.56±25.36 min) compared to the control group (98.35 ±30.75 min) (p = 0.001).

Discussion

This study aims to assess the impacts of an emergency-based strategy (FASE) on (1) the workflow of MDT during hospitalization; (2) the clinical outcomes of geriatric FNF patients in a certain trauma center. The FASE strategy demonstrated significant advantages in shortening TTS and LOS and reducing perioperative blood loss.

Previous studies have focused on the impact of emergency interventions on improving the hospitalization process, complications, and mortality rate of hip fractures,[7] thereby supporting the development of an integral emergency examination and management procedure for geriatric FNF patients. Due to the prolonged waiting time for a hospital bed in certain situations (especially when the hospital is at maximum capacity and resources are stretched), we established an emergency observation zone to promptly identify and address modifiable risk factors ahead of admission. This initiative aims to minimize preoperative delays, reduce perioperative risks, and therefore improve the overall prognosis. In this retrospective study, we observed that the implementation of the FASE strategy for geriatric FNF patients resulted in a prolonged waiting time before admission, which was due to the integrated examination and management procedures in the ED. On the contrary, the TTS and tLOS was significantly reduced after this slightly prolonged waiting period in the ED. It was assumed that the integrated management procedures enabled the early detection and interventions for modifiable risk factors, thereby accelerated the MDT management and prompted the recovery of these patients.

Nevertheless, it is essential to consider the potential negative effects of prolonged ED stays. Prolonged ED stays may result in discomfort and lower patient satisfaction, which may directly impact patients' adherence to treatment. Enhancing comfort measures and providing clear communication about wait times can improve the overall patient experience. Besides, strengthening coordination between ED and MDT members may facilitate timely transfers and improve overall patient flow, therefore mitigate the negative effects of prolonged ED stays.

The timing of surgery for geriatric FNF patients remains a critical issue in orthogeriatric care. Hip fractures typically trigger an acute phase characterized by inflammatory responses, a hypercoagulable state, and catabolic and stress reactions.[18–20] Although the feasibility of ultra-early surgery for hip fractures has been investigated,[21] it is more prudent to conduct necessary examination and optimization for patients unfit for immediate surgery because of their poor health status or severe comorbidities.[22] Current evidence advocates for surgical treatment within 48 hours of hospital admission, to reduce the exposure to harmful stress and promote early recovery,[13,23] so as to reduce mortality and improve postoperative outcomes.[24] The association between FASE strategy and shorter TTS may support its generalization as a better clinical practice in the context of MDT co-management.

Geriatric FNF patients are prone to experience various postoperative complications, such as cognitive and neurological alterations, cardiopulmonary affections, venous thromboembolism, GI-complications, urinary tract complications, perioperative anemia, electrolyte and metabolic disorders, and pressure sores.[25] Postoperative mortality following a hip fracture is well acknowledged to be associated with multiple factors, including advanced age, male sex, clinical comorbidities, cognitive impairment, time-to-surgery.[26,27] Despite the shorter time to surgery and length of hospital stay in the FASE group, no significant differences were observed regarding overall postoperative complications and mortality between FASE and control group. The following factors may contribute to the lack of significant differences regarding mortality rate. (1) the underlying health status and comorbidities of the patient population may have a more profound impact on mortality. (2) the sample size of this study may be insufficient to detect differences in mortality rates, although a statistically insignificant decreasing trend in mortality was associated with FASE group. (3) the COVID-19 pandemic may have adversely influenced patient outcomes, including access to care, treatment protocols, and overall health status, which could confound survival outcomes.

The FASE strategy was associated with fewer wound complications in this study (2/172 (1.16%) vs 11/172 (6.40%), $p = 0.024$). The earlier surgery and reduced Hb drop may contribute to lower occurrence of wound complications of FASE group. Prompt surgical management minimizes the inflammatory response in hip fractures.[28,29] A prolonged inflammatory phase can exacerbate tissue damage and increase the risk of infection or wound dehiscence. Besides, lower hemoglobin levels may indicate compromised blood supply, which can result in potential tissue hypoperfusion and hypoxia, and consequently worse wound healing.[30] However, it should be noted that the overall occurrence of wound complications was low, and other factors including nutrition status and postoperative care could play an important role in the process of wound healing, so this finding should be interpreted more prudently.

Given that the FASE strategy did not significantly improve survival outcomes for geriatric patients with femoral neck fractures (FNF), it is essential to focus on the optimization of its workflow. By identifying the primary causes of death, we can better understand of the factors contributing to mortality in this population, thereby enhancing the effectiveness of the FASE strategy. Previous studies have highlighted several causes of mortality in geriatric FNF patients, including pulmonary and cardiovascular complications,[31] underscoring the need for early monitoring and tailored management in the emergency department. Future improvement measures for FASE strategy should focus on optimizing cardiovascular and pulmonary function.

The FASE strategy was associated with an insignificantly decreasing trend compared with control group in lowering rates of intraoperative major transfusion ($p = 0.098$) and in reducing perioperative Hb drop ($p = 0.069$). The Hb drop was chosen as an objective indicator of blood loss rather than estimated intraoperative blood loss in this study. Considering the imbalance of Hb levels between patients transfused and patients not transfused, a subgroup analysis was further performed, which demonstrated a greater advantage of FASE strategy in attenuating perioperative Hb drop ($p = 0.013$) in individuals who were not transfused either preoperatively or intraoperatively. Acute blood loss following hip fractures mainly attributes to the injury and surgery. The FASE strategy provided more opportunities for ultra-early hemostatic interventions such as administration of tranexamic acid (TXA) in patients sustaining acute blood loss, which had the potential to reduce injury-related blood loss. Additionally, the FASE strategy facilitated a reduction in time to surgery through more efficient preoperative preparation, which in turn shortened the bleeding period following femoral neck fracture, further mitigating the Hb drop levels. Considering the uncertain availability of blood products when resources are stretched, strategies to minimize the risk of blood loss and transfusion may be of great significance. Besides, it was suggested that reduced blood transfusion was also associated with lower risk of DVT in patients with hip fractures,[32] and further emphasized the importance of optimizing blood management.

Regarding the surgical methods, the FASE strategy was associated with a relatively higher proportion of total hip arthroplasty (THA) and a prolonged mean operation time. The decision to opt for THA primarily depends on the patient's activity level and overall health, as well as other factors such as patient expectations and affordability.[33–35] In this study, the matched baseline characteristics may indicate a balanced overall health status between the FASE group and the control group, so the alter in surgical choice is potentially associated with a higher patients' expectations of functional outcomes. It is well acknowledged that THA exhibits superiority in terms of reducing the length of hospital stay, enhancing long-term functional status and recovery, and lowering revision surgery rates compared to hemiarthroplasty.[35–38] In the other hand, THA is inherently more complex than HHA, involving additional steps such as acetabular preparation, acetabular cup implantation and a prolonged operation time. This complexity necessitates comprehensive preoperative adjustment and better tolerance to surgical stress, which may benefit from the early examination of FASE strategy.

Resource constraints in emergency and disadvantaged socioeconomic backgrounds of some patients (such as limited health insurance coverage) were the major barriers in the implementation of FASE strategy. Evaluation and treatment of FNF may be delayed due to the presence of other patients with life-threatening conditions. We expedited the patients' examination process and advocated for the MDT co-management in emergency settings to address complex conditions, and this was considered to alleviate the emergency workload and improve the turnover efficiency when resources were stretched. Besides, despite the cost concerns that costs could not be fully covered by insurance in emergency, only few patients declined to complete examinations in emergency, which provided evidence for the practical use of FASE strategy.

Strengths and Limitations

The strengths of the present study included the following. This study highlights the early examination and management procedures for geriatric FNF patients in emergency, which serves as an initial trigger of promoting early surgery in the MDT context. The FASE strategy offers a simple and feasible approach for emergency department in different medical institutions to carry out, which is of significant importance for optimizing the workflow of MDT, especially when resources were scarce. Propensity score matching (PSM) was employed to mitigate bias between the FASE group and control group, therefore ensuring comparability. Additionally, this study focused on the differences of perioperative transfusion and Hb drop between the FASE group and the control group based on subgroup analysis, further supporting the benefits of earlier blood management of the FASE mode for geriatric FNF patients.

The most notable limitation of this study is its restriction to a single-center retrospective study, characterized by a limited sample size and a lower level of evidence. The matching strategy to control bias further lowered the sample size. The evaluation of dependency and function status and other unknown or unmeasured factors may be missing, which were potentially relevant to prognosis for a patient with femoral neck fracture, hence the results should be interpreted with caution. Besides, the overall mortality and complications did not show significant differences. These factors may limit the conclusions. Further studies are warranted to enhance the generalizability of the results. Multi-center studies and prospective studies would help capture a more diverse patient population and account for variations in practice patterns and patient demographics across different settings. Additionally, long-term follow-up studies could provide insights into the sustained impact of the FASE strategy on patient outcomes. Comparative effectiveness researches that compare the FASE strategy with other standard care practices would provide additional information regarding its effectiveness and generalizability.

Conclusion

To sum up, the Fast Access to Surgery in Emergency (FASE) for geriatric FNF patients effectively optimized the preoperative evaluation workflow, which significantly shortened time to surgery and length of hospital stay, and reduced perioperative blood loss. FASE strategy improved the surgical workflows and turnover efficiency of geriatric FNF patients, therefore could play an important role in the optimal MDT co-management for geriatric FNF patients. Further studies involving a greater cohort are warranted for validating the impact and feasibility of this emergency-based strategy.

Ethical Statement

This study received approval from the institutional board review of Zhongda Hospital, affiliated to Southeast University (2022ZDSYLL183-P01). According to national legislation and institutional guidelines, written informed consent for participation was not required. The waiver for informed consent was granted by the institutional review board on the basis that it would not adversely affect the rights or welfare of the participants. Our research utilizes anonymized data, ensuring that individual participants cannot be identified. Furthermore, all patient data has been managed with the utmost confidentiality, in compliance with the Declaration of Helsinki. The waiver for informed consent is also supported by the "Notice on Issuing the Ethical Review Measures for Life Sciences and Medical Research Involving Human Beings" (National Health Science and Education Development [2023] No. 4), Chapter 3, Section 32. This legislation allows for the waiver of informed consent when utilizing anonymized data.

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Disclosure

The authors state that there was no conflict of interests relating to this manuscript.

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