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Minimally invasive surgery and conservative treatment achieve similar clinical outcomes in patients with type II fragility fractures of the pelvis

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Abstract

Objective To compare clinical efficacy and quality of life (QoL) outcomes between minimally invasive surgery and conservative treatment for type II fragility fractures of the pelvis (FFP II).

Methods A total of 150 patients with FFP II, treated at our hospital from January 2019 to December 2022, were included in this study. The mean follow-up period was 22 ± 5 months. Patients were divided into two groups: 68 were assigned to the minimally invasive surgery group and 82 to the conservative treatment group. Clinical outcomes were assessed using the Majeed questionnaire and the self-reported Short Musculoskeletal Function Assessment. Health-related quality of life was evaluated with the Short-Form 36 Health Survey and World Health Organization Quality of Life Brief Version questionnaires.

Results There were no significant differences in basic information (gender/cause of injury/comorbidities/Rommens classification/osteoporosis status) or clinical outcomes between the two groups on the basis of the Majeed and Short Musculoskeletal Function Assessment questionnaire scores at the final follow-up. However, the minimally invasive surgery group showed a significant improvement in QoL compared with the conservative treatment group (including on the Short-Form 36 Health Survey and World Health Organization Quality of Life Brief Version; $P < 0.01$).

Conclusion Minimally invasive surgery and conservative treatment achieve similar clinical outcomes in patients with FFP II fractures. However, minimally invasive surgery significantly enhances the health-related QoL of these patients.

Keywords Fragility fractures of the pelvis, Minimally invasive surgery, Conservative treatment, Clinical efficacy, Quality of life

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Introduction

With the aging of the population, fragility fractures of the pelvic ring (FFP) are becoming increasingly common. By this year the overall increase in all osteoporotic fractures is expected to rise by 20%, where pelvic fragility fractures are expected to disproportionately rise by 56% in the United States [1]. Loggers et al. [2] retrospectively investigated 117 elderly patients with FFPs and showed that 49% lost their independent mobility status, 40% failure to return to pre-injury functional status, and the 1-year mortality rate was 23%. FFPs result in considerable morbidity and mortality and as well as massive financial burden on the already strained health systems throughout the world. FFP is typically caused by low-energy trauma, such as falls in those without a significant history of trauma and occurs in older patients with osteoporosis. Symptoms include moderate-to-severe pain in the pubic, groin, and sacrococcygeal regions, which significantly impacts daily life but rarely causes hemodynamic instability. Because of the characteristics of FFP, the traditional Tile and Young–Burgess classification systems are not applicable. Consequently, Rommens et al. proposed an alternative classification system for FFP in 2013 [3], which has been increasingly recognized and applied in clinical practice. Typically, type I cases are considered for conservative treatment, whereas types III and IV cases are considered for surgical treatment. FFP type II (FFP II) is the most common type of FFP (accounting for > 50% of cases), yet its treatment remains controversial [4]. The main goals of treatment are to stabilize the fracture ends, relieve pain, and promote early mobilization, whereas anatomical reduction of the fracture and restoration of pelvic symmetry are relatively secondary concerns. Osteoporotic fractures include those of the spine, pelvis, hip (femoral neck and intertrochanteric fractures), proximal humerus, and distal radius, with early surgical treatment of hip fractures being widely accepted. FFP shares many similarities with intertrochanteric femoral fractures, such as being caused by low-energy trauma and leading to bed rest in older patients, as well as to subsequent complications (e.g., pneumonia, pressure sores, urinary tract infections, and deep vein thrombosis). However, the optimal treatment strategy for FFP and its impact on outcomes remain unclear. Historically, FFP was often managed conservatively, but the functional impairment and reduced quality of life (QoL) associated with conservative treatment are frequently underestimated [5].

In recent years, more and more surgeons have performed surgical treatment of FFP and achieved significant clinical results. Tolosano et al. studied [6] of 48 patients with FFP showed that surgical treatment can significantly relieve pain and preserve the patient's independence. On the basis of a study of 42 patients with FFP, Yoshida et al. [7] suggested that surgery contributes to early mobilization. Heiman et al. [8], in their latest review, suggested that operative fixation should focus on minimally invasive stabilization of the pelvic ring to facilitate early mobilization and avoid the complications that can arise from comorbidities associated with immobility. Further high-quality comparative literature is needed before treatment criteria can be optimized and standardized.

Rollmann et al. [9] reported a significant increase in the proportion of older patients with FFP undergoing surgical treatment over the past 22 years. With the advent of robot-assisted surgery and 3D printing technology, many studies [5, 10, 11] have reported good progress in the surgical treatment of older patients with FFP, with minimally invasive surgery gaining increasing acceptance among doctors and patients. Despite the increasing application of minimally invasive surgery for FFP, there are few reports comparing its clinical outcomes and postoperative QoL with those of conservative treatment. Therefore, this study aims to compare clinical outcomes and QoL improvements between minimally invasive surgery and conservative treatment for type II FFP.

Materials and methods

Study design

A retrospective cohort study was conducted to compare outcomes of minimally invasive surgery versus conservative treatment in patients with type II fragility fractures of the pelvis (FFP). The study included patients treated at Tianjin Medical University Baodi Hospital between January 2019 and December 2022. Ethical approval was obtained from the Ethics Committee of Tianjin Medical University. Participants were divided into two groups based on treatment modality: surgical ($n = 68$) and conservative ($n = 82$). Outcomes were assessed using validated questionnaires and imaging at three time points: pre-treatment, pre-discharge, and final follow-up (mean follow-up: 22 ± 5 months).

Setting

The study was conducted at Tianjin Medical University Baodi Hospital, a tertiary care facility. Data were collected from electronic medical records, imaging archives, and patient-reported outcome measures.

Participants

Inclusion Criteria: Age ≥ 65 years. Diagnosis of type II FFP confirmed via imaging (X-ray, CT, MRI). Completed follow-up ≥ 1 year. Exclusion Criteria: Age < 65 years. High-energy trauma, open fractures, or infection. Incomplete survey responses, revision surgeries, or refusal to participate. Cohort: 150 patients met inclusion criteria (Fig. 1). Informed consent was obtained from all

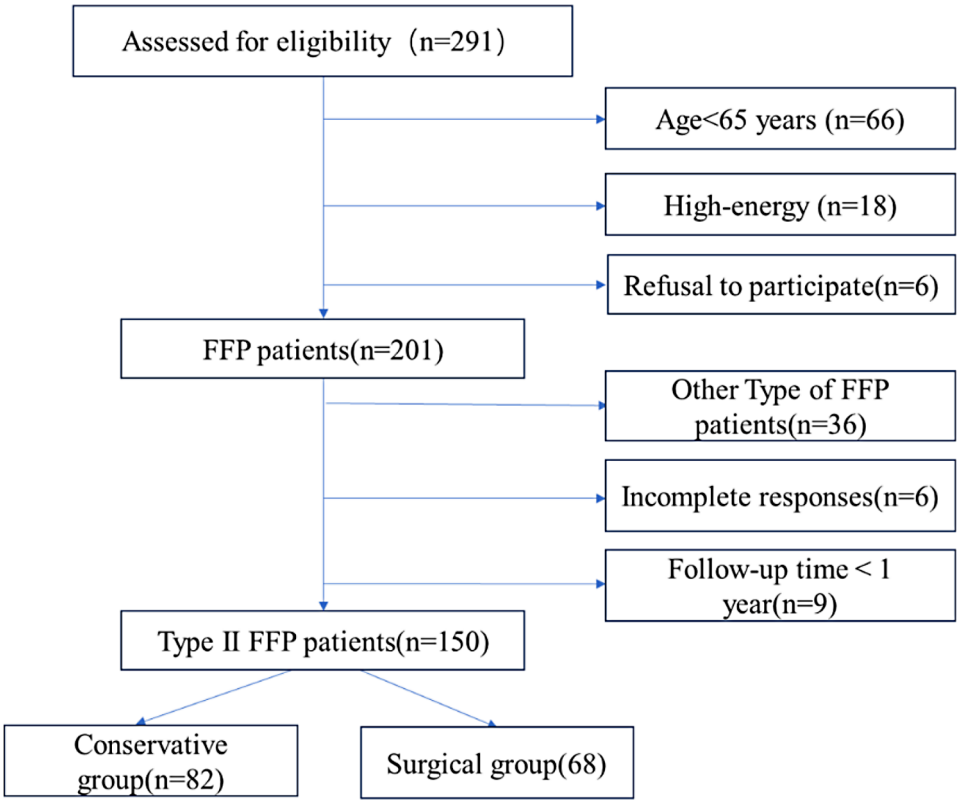

Fig. 1 Flowchart of participants

participants after providing them with detailed information about the study purpose, procedures, and potential risks and benefits. Consent was documented by having the participants sign a consent form.

Variables

Primary outcomes

Clinical function: Majeed score [12] (0–100; higher = better pelvic function) and Short Musculoskeletal Function Assessment (SMFA) questionnaire [13] (0–46; higher = poorer function/distress). Quality of life (QoL): Short-Form 36 Health Survey (SF-36) [14] (0–100; higher = better QoL) and World Health Organization Quality of Life Brief Version (WHOQOL-BREF) questionnaire [15] (physical, psychological, social, environmental domains).

The Majeed score is a tool used to evaluate pelvic function. It mainly assesses Pain, Standing, Sitting, Sexual intercourse and Work. The score ranges from 0 to 100, with a higher score indicating better pelvic function. It offers a comprehensive and standardized way to measure pelvic function. The SMFA consists of two sections, with a total of 46 items: 34 questions assess clinical function, and 12 questions evaluate the level of distress caused by symptoms. This questionnaire assesses treatment outcomes for musculoskeletal diseases/injuries and can reliably and effectively evaluate the patient's health status, with higher scores indicating poorer function or greater distress. The SF-36 is a well-known and widely used health questionnaire composed of eight sections, with higher scores indicating better QoL and health status. The WHOQOL-BREF assesses patients in terms of physical, psychological, social, and environmental aspects and is a reliable and effective method for evaluating health-related QoL.

Secondary variables

Demographic data (age, sex). Fracture classification (Rommens system Table 1). Treatment type (surgical vs. conservative). Imaging findings (displacement, healing).

Data sources/measurement

Imaging: All patients underwent standardized X-ray, CT, and MRI examinations. Fractures were classified using the Rommens system [10, 16]. Questionnaires Administered at three time points: before treatment, before discharge, and at the final follow-up. Majeed Score: Assesses pain, standing, sitting, sexual intercourse, and work. SMFA: 34 items for clinical function, 12 for symptom-related distress. SF-36: Eight domains (e.g., physical function, mental health). WHOQOL-BREF: Evaluates physical, psychological, social, and environmental QoL.

Table 1 Patient demographics

	Conservative group (*N* = 82)	Minimally invasive surgery group (*N* = 68)	*P*
Gender (male, %)	18(21.95%)	13(19.12%)	0.08
Age (years, mean ± SD)	73.2 ± 15.36	75.61 ± 12.60	0.17
Injury cause			
Fall	71(86.59%)	61(89.71%)	0.06
Bed Fall	8(9.76%)	5(7.35%)	0.60
Others	3(3.66%)	2(2.94%)	0.78
Comorbidities			
Diabetes, Miletus	11(13.41%)	7(10.29%)	0.71
Hypertension	17(20.73%)	11(16.18%)	0.16
Coronary Heart Disease	8(9.76%)	7(10.29%)	0.19
Cerebrovascular Accident	5(6.10%)	3(4.41%)	0.08
Rommens Classification			
FFPIIa	20(24.39%)	16(23.53%)	0.18
FFPIIb	44(53.66%)	37(54.41%)	0.17
FFPIIc	18(21.95%)	15(22.06%)	0.09
Osteoporosis status	61(73.30%)	53(77.94)	0.15

Bias

Selection Bias: Minimized by strict inclusion/exclusion criteria and standardized treatment protocols. Measurement Bias: Reduced via validated tools (Majeed, SMFA, SF-36, WHOQOL-BREF) and blinded imaging analysis. Attrition Bias: Addressed by excluding patients with follow-up < 1 year.

Confounding: Controlled by matching baseline characteristics (e.g., age, fracture severity) between groups.

Sample size

The final cohort included 150 patients (surgical: 68; conservative: 82), determined by the availability of eligible patients during the study period. Post-hoc power analysis confirmed adequate power ($\beta \geq 0.8$) to detect clinically meaningful differences in primary outcomes.

Quantitative variables

Continuous: Age, follow-up duration, and questionnaire scores (mean ± SD). Categorical: Treatment type, fracture classification, and demographic variables (frequency/percentage).

Statistical methods

Software: SPSS v23.0 (Chicago, IL). Normality: Assessed via Shapiro–Wilk test. Group Comparisons: Parametric data: Independent t-test (continuous) and chi-square (categorical). Non-parametric data: Mann–Whitney U (independent samples) and Wilcoxon test (related samples). Significance Threshold: $p < 0.05$.

Treatment protocols

Conservative Group: Received pain management and anti-osteoporosis therapy. Continued if pain improved and imaging showed no displacement after 1 week, or if patients declined surgery despite worsening symptoms (Fig. 2). Surgical Group: Underwent minimally invasive surgery if pain persisted or imaging revealed displacement after 1 week (Fig. 3).

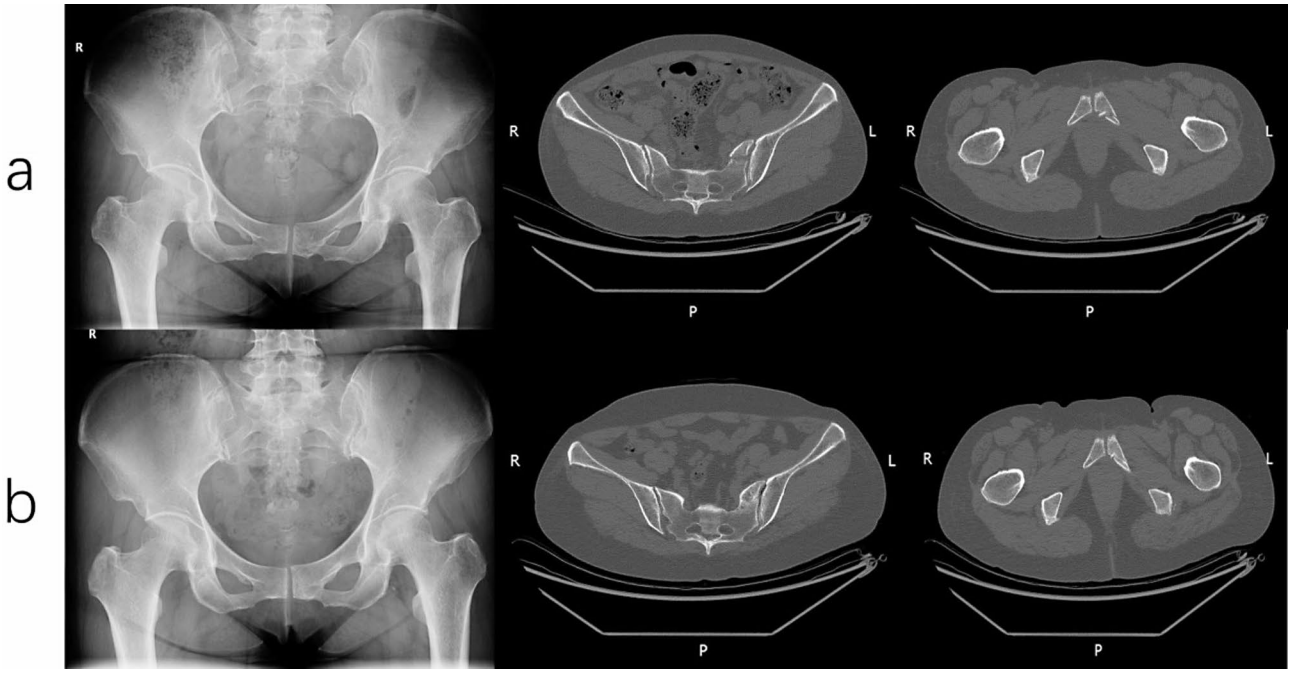

Fig. 2 Conservative treatment patient, female, 66 years old. (**a**): X-ray and CT images before treatment; (**b**): X-ray and CT images after 1 year of treatment

Fig. 3 Surgical treatment patient, female, 68 years old. (**c**): Preoperative X-ray and CT images; (**d**): Postoperative X-ray and CT images

Table 2 Clinical effectiveness assessment

	Majeed score (mean ± SD)			SMFA score (mean ± SD)		
	Conservative	Minimally invasive	*P*	Conservative	Minimally invasive	*P*
Admission	45.36 ± 15.33	38.05 ± 28.56	0.060	161.58 ± 20.67	168.35 ± 25.88	0.128
Final Follow-up	85.51 ± 23.74	88.12 ± 16.38	0.481	60.05 ± 8.65	56.45 ± 12.04	0.400
P_1	<0.01	<0.01		<0.01	<0.01	

P: comparison between groups at admission and final follow-up. P_1: intragroup

Results

Comparison of basic information

A total of 150 type II FFP patients were included in the study: 82 patients in the conservative treatment group (18 men, 64 women; average age, 78 ± 12.3 years) and 68 patients in the minimally invasive surgery group (13 men, 55 women; average age, 77 ± 11.6 years). Among the conservative treatment group, there were 20 cases of FFP IIa, 44 cases of FFP IIb, and 18 cases of FFP IIc. Among the surgical group, there were 16 cases of FFP IIa, 37 cases of FFP IIb, and 15 cases of FFP IIc. There were no statistically significant differences in basic information between the two groups (Table 1). In the conservative group, there was one case of bedsores, one case of urinary tract infection, and three cases of deep vein thrombosis. There was one case of urinary tract infection, two cases of deep vein thrombosis, and two cases of mild incision infection in the surgical group. None of the complications had serious adverse consequences.

Clinical effectiveness assessment

There were no significant differences in the Majeed or SMFA questionnaire scores between the conservative treatment group and the minimally invasive surgery group at admission (45.36 ± 15.33 vs. 38.05 ± 28.56, $P = 0.060$; and 161.58 ± 20.67 vs. 168.35 ± 25.88, $P = 0.128$, respectively) or the final follow-up (85.51 ± 23.74 vs. 88.12 ± 16.38, $P = 0.481$; and 60.05 ± 8.65 vs. 56.45 ± 12.04, $P = 0.400$, respectively). The results indicate that conservative treatment and minimally invasive surgery achieve similar clinical outcomes in patients with type II FFP pelvic fractures (Table 2). Significant functional improvements were observed before and after treatment (Table 2, $P_1 < 0.01$).

QoL assessment

There were no statistically significant differences in QoL between the conservative treatment group and the minimally invasive surgery group at admission, as assessed by the SF-36 and WHOQOL-BREF questionnaire (P_1, Tables 3 and 4). At the final follow-up, both groups showed significant improvements in QoL compared with

Table 3 SF-36 score (mean ± SD)

	Conservative		Minimally invasive		P_1	P_2	P_3	P_4
	Admission	Final follow-up	Admission	Final follow-up				
Physical functioning (PF)	11.31 ± 9.03	32.25 ± 14.95	14.07 ± 10.36	47.07 ± 16.90	0.38	<0.01	<0.01	0.02
Role limitations due to physical health problems (RP)	17.70 ± 11.35	45.00 ± 23.54	20.52 ± 14.46	75.58 ± 32.21	0.30	<0.01	<0.01	0.02
Bodily pain (BP)	39.65 ± 15.32	65.22 ± 13.03	36.07 ± 16.34	58.54 ± 28.70	0.56	<0.01	<0.01	0.13
General health perceptions (GH)	48.55 ± 25.30	51.75 ± 10.05	50.01 ± 18.38	52.80 ± 13.12	0.82	<0.01	<0.01	0.40
Vitality (VT)	38.22 ± 15.03	57.25 ± 13.79	40.05 ± 18.00	70.50 ± 12.84	0.55	<0.01	<0.01	0.03
Social functioning (SF)	28.35 ± 18.68	57.41 ± 18.74	25.05 ± 12.84	74.09 ± 28.25	0.70	<0.01	<0.01	0.01
Role limitations due to emotional problems (RE)	38.17 ± 20.92	89.66 ± 28.80	30.8 ± 18.46	90.81 ± 25.71	0.08	<0.01	<0.01	0.01
General mental health (MH)	36.84 ± 27.81	66.36 ± 13.92	40.10 ± 17.28	56.87 ± 18.90	0.13	<0.01	<0.01	0.04

P_i: comparison between the two groups before treatment. P_2: comparison within the conservative treatment group before and after treatment. P_3: comparison within the minimally invasive surgery group before and after treatment. P_4: comparison between the two groups after treatment

Table 4 WHOQOL-BREF score (mean ± SD)

	Conservative		Minimally Invasive		P_1	P_2	P_3	P_4
	Admission	Final follow-up	Admission	Final follow-up				
Physics (PHYS)	15.02 ± 8.14	68.05 ± 17,11	18.23 ± 9.02	88.76 ± 10.75	0.78	<0.01	<0.01	0.01
Psychological (PSYCH)	25.07 ± 12.58	75.36 ± 28,39	23.78 ± 15,38	79.30 ± 21.58	0.60	<0.01	<0.01	0.28
Social (SOCIL)	28.77 ± 15,80	70.03 ± 15,50	31.72 ± 13.86	89.02 ± 22.36	0.65	<0.01	<0.01	0.01
Environment (ENVIR)	34.76 ± 18.32	78.81 ± 25.34	36.05 ± 22.13	87.36 ± 24.43	0.25	<0.01	<0.01	0.01

P_i: comparison between the two groups before treatment. P_2: comparison within the conservative treatment group before and after treatment. P_3: comparison within the minimally invasive surgery group before and after treatment. P_4: comparison between the two groups after treatment

that before treatment (conservative treatment group, $P_2 < 0.01$; minimally invasive surgery group, $P_3 < 0.01$, Tables 3 and 4). However, at the final follow-up, except for the SF-36 scores in the general health and bodily pain domains, and the WHOQOL-BREF questionnaire scores in the psychological domain, all SF-36 domain scores (physical functioning, role physical, vitality, social functioning, role emotional, mental health) and WHOQOL-BREF domain scores (physical, social, and environment) showed significantly greater improvements in the minimally invasive surgery group compared with the conservative treatment group (P_4, Tables 3 and 4).

Discussion

In our study, the conservative treatment group had significantly lower QoL scores compared with the minimally invasive surgery group, including SF-36 physical functioning, role physical, vitality, social functioning, role emotional, and mental health domain scores as well as WHOQOL-BREF physical, social, and environment domain scores. This finding suggests that minimally invasive surgery offers a significant advantage in terms of improving QoL. Yang et al. [17] conducted a retrospective analysis of 135 patients with pelvic fragility fractures and found that the minimally invasive surgery group had significantly better Majeed and VAS scores compared with the conservative group. Additionally, the surgery group had shorter bed rest and fracture healing times, leading to the conclusion that minimally invasive surgery significantly enhances the QoL of older patients with pelvic fragility fractures. Conversely, Thiesen et al. [4] performed a randomized, prospective, non-blinded study of 39 pelvic fracture patients, using the Barthel index, VAS pain score, QoL on the EuroQol five-dimension three-level questionnaire, and Tinetti gait test for assessment, and found no significant benefits of surgical treatment over conservative treatment in terms of QoL, mortality, or pain level. This discrepancy with our results highlights the need for further research to determine the best management approach for FFP. Our findings can serve as a reference for future randomized controlled trials.

Our study found no significant difference in clinical outcomes between the conservative treatment and minimally invasive surgery groups, on the basis of clinical and QoL scores. However, both treatment methods resulted in significant improvements in clinical outcomes and QoL from pre-treatment to follow-up; this indicates that both conservative and surgical treatments are beneficial for patients with osteoporotic pelvic fractures, which aligns with the findings of Schramm, Yoo, and Yoshimura [18–20]. Schramm et al. assessed 46 patients with pelvic fractures using the Barthel Index, Tinetti mobility test, and timed up and go test, confirming that conservative treatment improved the meeting of care needs, independent mobility, and fall risk. Yoo et al. evaluated 41 patients treated conservatively on the basis of visual analog scale (VAS) pain scores and time to mobilization, demonstrating that teriparatide treatment could achieve early pain relief and mobilization, reducing fracture healing time. Yoshimura et al. found that minimally invasive surgery for six sacral fractures allowed early use of

assistive devices and improved walking ability, even with in situ pelvic ring fixation.

Pelvic fractures are considered severe injuries, and individuals with pelvic fractures experience a reduced QoL compared with the general population. Age and surgery are independent predictors of decreased QoL following pelvic ring fractures [21]. However, it remains unclear whether patient age influences the decision for surgical treatment of pelvic ring fractures and whether the indications for surgery in older patients have changed over the past two decades. Osteoporotic pelvic fractures in older adults are becoming increasingly common, yet there is no consensus on whether to treat most of these patients conservatively or surgically, especially those with FFP II-type fractures [4]. Although osteoporosis can be prevented and treated with medications and dietary interventions, such as vitamin D, calcium, bisphosphonates, and recombinant human parathyroid hormone, the optimal treatment approach for these patients remains a topic of ongoing discussion between clinicians and patients. The primary aim of this study was to evaluate and compare clinical outcomes and QoL between conservative treatment and surgical intervention, to assist in selecting the best treatment approach.

Osteoporotic pelvic fractures in older patients often involve minimal or no displacement and may not require anatomical reduction, making minimally invasive reduction and fixation techniques more suitable for older patients with FFP. Functional reduction and minimally invasive fixation are fundamental for early pain-free functional exercise. Preoperative assessment should consider factors such as age, thromboembolism risk, albumin levels, anemia, cardiovascular and respiratory diseases, smoking, body mass index, Parkinson's disease, and osteoporosis to prevent, control, and manage related risk factors, adopting similar treatment models and strategies to those used in older patients with hip fractures. A fast-track system should also be established. Compared with conservative treatment, surgery significantly improves patients' QoL, restores independence, and reduces the burden on families and society. Minimally invasive fixation techniques include external fixators, nail-rod systems, minimally invasive plating, and percutaneous screw fixation. Surgical goals include functional reduction, pelvic stability, pain relief, and reduced bed rest [22]. However, minimally invasive surgery faces challenges, such as the need for precise placement of various sacroiliac screws, where planning entry points and screw paths on the basis of imaging data is crucial. Imaging technology, 3D printing, navigation, robotic-assisted surgery, and minimally invasive pelvic fracture reduction techniques continue to evolve [10]. A prospective study [23] indicated that navigated percutaneous sacral iliac screw placement improved screw positioning in deformed sacra but came at the cost of longer surgery times and increased radiation exposure. Other researchers [24] proposed that robotic navigation technology could address these issues, with robotic and 3D-printed assistance reducing surgery time and radiation exposure, and improving safety and accuracy. Wu et al. [25] used patient-specific locking navigation templates to treat pelvic fractures with sacral dysplasia or sacroiliac joint dislocations, proving the safety of this method through finite element analysis. Therefore, we advocate using new technologies to reduce surgery time for older patients and improve treatment outcomes. A consensus on the treatment of osteoporotic pelvic fractures has not been reached, and standardizing treatment, increasing awareness, researching new minimally invasive techniques, and reducing the high disability and mortality rates remains challenging. On the basis of our results and recent technological advancements, minimally invasive treatment for older patients with FFP pelvic fragility fractures is a recommended option.

This study has limitations. First, it is a retrospective study conducted at a single center with a small sample size, which may limit generalizability. Additionally, patients were not randomly assigned to groups, and some patients in the conservative group who were advised to undergo surgery declined because of their current health status (comorbidities) and personal preferences. Third, response bias cannot be ruled out as QoL was assessed on the basis of self-reported questionnaires.

Conclusion

In summary, minimally invasive surgery and conservative treatment for FFP type II fractures yield similar clinical outcomes, but minimally invasive surgery offers superior QoL improvements. These findings support the consideration of surgical options for patients with FFP type II who are seeking enhanced functional recovery and better overall QoL.

Author contributions

Yaqi Zong, JingWei Li and Zhiyong Li are the co-first authors. Wenzhi Wang designed the research and performed surgery. JingWei Li and Zhiyong Li collected and analyzed data. Yaqi Zong was a major contributor in writing the manuscript. All authors read and approved the final version of the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Tianjin Medical University. All methods were in accordance with Declaration of Helsinki, and participants provided written informed consent.

Consent to participate
The participants were informed about the procedures, risks, and benefits and signed a written informed consent form.

Consent for publication
Agreement of anonymous dissemination of data for research purposes (publication) was agreed by the participants.

Competing interests
The authors declare no competing interests.

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