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# Analysis of Differences in FIB, D-D, and Inflammatory Factor Levels between Patients Undergoing Pelvic Fracture Surgery through the Pararectus Abdominis Approach and Traditional Ilioinguinal Approach

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**Abstract**

**Background:** Pelvic fractures require surgery to restore pelvic stability and ensure the restoration of normal physiological structure and function. In pelvic fracture surgery, the choice of surgical approach may have a significant impact on the postoperative recovery and prognosis of patients. This study compared the postoperative recovery effect, coagulation function, and inflammatory indicators of patients through two different surgical approaches: the pararectus abdominis approach and the traditional ilioinguinal approach, aiming to provide more evidence and guidance for clinical practice.
**Objectives:** To observe the differences in fibrinogen (FIB), D-dimer (D-D), and inflammatory factor levels between patients undergoing pelvic fracture surgery through the Pararectus abdominis approach and traditional ilioinguinal approach.
**Methods:** A total of 86 patients with pelvic fractures were divided into a control group (n=43) and an observation group (n=43). The control group received traditional ilioinguinal approach surgery, while the observation group underwent surgery through the Pararectus abdominis approach. Comparisons were between the two groups for the postoperative coagulation function level, inflammatory factor level, and postoperative hip joint function scores.
**Results:** Before surgery, there was no difference in FIB and D-D levels between the two groups (P>0.05). At 3 days and 7 days after the surgery, the levels of FIB and D-D in the two groups increased compared to before the surgery; however, the observation group was lower in this regard than the control group at the same time (P<0.05). The results of the repeated analysis of variance showed that there were group, time, and interaction effects between the two groups (P<0.05). One week after the operation, the scores of hip joint function were compared between the two groups (P>0.05). The hip joint function scores of the two groups were higher at 1 month and 3 months postoperatively than at 1 week, and the observation group was higher than the control group at the same time.
**Conclusion:** Compared with traditional ilioinguinal approach surgery, surgery through the Pararectus abdominis approach can reduce surgical stimulation, decrease coagulation factor secretion, and alleviate systemic inflammatory reactions after the surgery, promoting the recovery of hip joint function.

*Keywords:* Inflammatory factors, Pararectus abdominis approach, Pelvic fracture, Traditional ilioinguinal approach

## 1. Background

Pelvic fractures, as a serious traumatic injury, are often accompanied by severe physiological and biological changes, which have a significant impact on the rehabilitation and prognosis of patients. In the treatment of pelvic fractures, surgical intervention plays a crucial role in restoring pelvic stability and promoting fracture healing. However, choosing the appropriate surgical approach has always been a focus of attention for medical staff as different approaches may affect the effectiveness of surgery, postoperative recovery, and patient prognosis. Pelvic fractures (PFs) are severe traumatic fractures, after the occurrence of which, patients must undergo bed rest due to limited mobility and lower limb bone traction treatment. The incidence of pressure injuries, lung infections, and urinary system infections has significantly increased. Therefore, it has become a consensus to administer surgical treatment as soon as possible after PFs (1-4). The goal of surgical treatment is to reduce postoperative pain, reconstruct the pelvic ring structure and its stability period, and help patients move out of bed as soon as possible. The traditional ilioinguinal approach is currently a commonly adopted surgical approach for the treatment of pelvic fractures. However, from a physiological and anatomical perspective, the anatomical site of the pelvic ring is unique, with irregular shapes. There are various types of fracture forms, especially for acetabular fractures involving the quadrilateral body, which are difficult to expose and completely reduce. As a result, the traditional ilioinguinal approach is not effective in the treatment of PFs (5-6).

Recently, the pararectus abdominis approach has gradually attracted the attention of the medical community as a new surgical method. Compared to the traditional ilioinguinal approach surgery, the rectus abdominis approach has a body surface projection directly above the sacroiliac joint, which can fully expose the anterior aspect of the sacroiliac joint. It can handle fractures and bleeding from the presacral venous plexus under direct vision, reduce bleeding volume, and decrease surgical risk (7). Nevertheless, the differences in postoperative fibrinogen (FIB), D-dimer (D-D), and inflammatory factor levels are not yet clear between the pararectus abdominis approach and the traditional ilioinguinal approach in patients with pelvic fractures.

## 2. Objectives

Therefore, this study conducted an in-depth exploration of the reduction of surgical trauma and body stress in patients with PFs through the pararectus abdominis approach. The following report is presented.

## 3. Methods

### *3.1. General Information*

The statistical population consisted of patients with PFs who accepted treatments in the Second Department of Trauma and Osteology at Gansu Provincial Hospital of Traditional Chinese Medicine from January 2021 to December 2022. The sample size was calculated using the following equation:

$n1=n2=2[\mu_\alpha+\mu_\beta\sigma/\delta]^2$

where σ is the overall standard deviation, δ is the mean difference between two samples, n1=n2 are the sample sizes of the control group (CG) and the observation group (OG), respectively. If α=0.05, β=0.10, then $\mu_\alpha$=1.96, $\mu_\beta$=1.28. In the literature (8), σ=4.0, δ=3.2, its calculated sample size is n1=n2=34, and considering a 20% loss of follow-up rate, the required SS is at least (34+34) / (1-20%) ≈ 86. Finally, it is determined that n1=n2=43. This study was approved by the Ethics Committee and obtained the consent of patients and their families.

### *3.2. Inclusion and Exclusion Criteria*

Inclusion criteria were meeting the relevant diagnostic criteria in the Chinese Guidelines for Minimally Invasive Surgical Treatment of PF (2021) (9); having clinical manifestations, such as pain and limited mobility; being confirmed by clinical X-ray, computed tomography (CT) and other examination methods, pelvic separation, positive compression test, and perineal ecchymosis; having had the injury within the previous week; and having complete clinical data available.

On the other hand, ineligible individuals were patients with severe bleeding from ruptured organs, such as the spleen, liver, and kidney; combined abnormal coagulation function; with comorbidities, such as cerebrovascular diseases; systemic malignant tumors; with a Nutrition Risk Screening Form (NRS2002) score of ≥ 3 points; combined femoral head necrosis or osteoarthritis; chest and abdominal organ injuries or multiple fractures; and systemic infectious diseases. Using a computer random generator, numbers 1-86 were randomly generated into two sequences containing 43 random numbers each. Patients with numbers in the first sequence were assigned to the CG, while patients with numbers in the second sequence were designated as the OG.

### *3.3. Research Method*

The CG underwent traditional ilioinguinal approach surgery. (1) Anesthesia and posture: After tracheal intubation and general anesthesia, the patients were positioned flat on a full fluoroscopy surgical bed, with their upper limbs extended to the arm plate. The first step is to disinfect the towel. The bilateral anterior and inferior iliac spine (IS), umbilicus, and pubic symphysis are exposed in the field of vision. The affected limb is sterilized. The sterile sheet wraps the part below the knee joint to facilitate the traction of the affected limb during the operation, raise the popliteal fossa, and assume a hip flexion and knee flexion position to maintain the relaxation of the iliopsoas muscles. (2) Incision and exposure: An arc incision is made at the back 1/3 of the iliac muscle, starting from the groin area and ending at the pubic symphysis; the skin and subcutaneous tissue layer are cut by layer to expose muscles, blood vessels, joints, nerves, and fully expose the SJ and the inguinal ring; the inguinal nerve and spermatic cord/round ligament are separated and treated; and the fracture site is fixed after exposing the pubic branch and the square area. (3) Fixation: After exposing the fracture end, pelvic reconstruction plates or screws can be used for fixation. (4) Close the incision: After the internal fixation of the PF is completed, the pelvic stability and hip joint mobility are checked. The "C" arm X-ray machine is utilized to conduct a fluoroscopy imaging of the pelvic inlet, outlet, and upright position, and then the pelvic ring is checked to restore a symmetrical oval shape, fracture reduction, and screw position and depth. If there is active bleeding on the wound surface, hemostasis treatment is given. The wound surface is rinsed with physiological saline, 1-2 drainage tubes are removed, the abdominal wall muscles are sutured, and the incision is closed.

The OG underwent surgery through the pararectus abdominis approach. (1) Anesthesia and posture: the same as the CG. (2) Incision and exposure: The inner and outer of the line linking the anterior-superior IS and the umbilicus is used as the starting point of the lateral incision of the rectus abdominis (RA), and the femoral artery at the midpoint of the inguinal ligament is determined as the endpoint of the incision. The incision length is about 6-10 cm, and the skin, subcutaneous, and deep fascia are cut layer by layer. The lower side is the inguinal ligament, the upper side is the peritoneum, the outer side is the spermatic cord/uterine round ligament, and the inner side is the outer edge of the RA exposed. The anterior sheath of the rectus femoris muscle is obliquely incised from 1 cm away from the inner edge of the superficial inguinal ring, fully exposing the RA muscle, and bluntly separates the outer edge of the RA muscle to reach the extraperitoneal space. The internal and external oblique muscles and transversus abdominis muscle are pulled outward and upward. Different windows are selected for exposure based on different fracture sites, exposing the iliac fossa below the IS (window 1); the pelvic margin of the iliac pubic protrusion is separated and exposed on the surface of the iliopsoas muscle (window 2); the external iliac vessels (IV), femoral nerve, and the medial side of iliopsoas muscle are bluntly separated, exposing the superior pubic branch and pubic symphysis (the third window). The external IV, femoral nerve, and iliopsoas muscle are protected by stretching through the second and third windows; the periosteum is peeled off through the second window and the quadrilateral body is exposed, and the fractured end of the quadrilateral body is repositioned. (3) Fixation: point reduction forceps were used for reduction, Kirschner wire was used for temporary fixation, hollow nails (4.5 mm in diameter) were used for fixation between quadrilateral bone plates, and SJ, pubic branch, and pubic symphysis were replaced and then fixed with steel plates. (4) Close the incision: the same as the CG.

*3.4. Outcome Measures*

Coagulation function: 1 day, 3 days and 7 days after the surgery, the nurse collected 4 ml of the patient's fasting venous blood, left it at room temperature (RT) for 2 h, centrifuged it at 4,000 r/min for 15 min, separated the supernatant, and stored it in an ultra-low temperature refrigerator (-80°C) for testing. The coagulation function levels of FIB and D-D in peripheral blood were measured using a coagulation meter.

Inflammatory factors: 1 day, 3 days and 7 days after the surgery, the nurse collected 4 ml of fasting venous blood from the patient, left it at RT in 2 h, centrifuged it at 4,000 r/min for 15 min, separated the supernatant, and stored it in an ultra-low temperature refrigerator (-80°C) for testing. The serum levels of T-α, I-1β, and I-6 were checked using enzyme-linked immunosorbent assay (10).

HJF (Hip Joint Function) evaluation: 1 week, 1month and 3 months after the surgery, the nurse used the Merle d'Aubigne and Postel scoring system for improved HJF evaluation. This scoring system was developed by d'Ambigne RM in France in 1954 and was improved from 1972 to the D'Ambigne-Postel hip joint evaluation system. The scale mainly includes three dimensions, namely pain (2-6 points), walking (6-12 points), and range of motion (1-6 points), with a total score of 9-24 points. A score of ≥ 18 points is regarded as excellent, 15-17 as good, 13-14 as acceptable, and ≤ 13 points as poor (11).

*3.5. Statistics*

EpiData software was used to establish a database, and the accuracy of data input was ensured through parallel input by two people. The data collected in this study were analyzed in SPSS 26.0 software. Measurement data was represented by $\bar{x}\pm s$. A sample t-test was utilized for intergroup comparison. Relevant analysis of variance was utilized to compare different time points within the group. The counting data were expressed as frequency or percentage, with $\chi^2$ test and a $P < 0.05$ value indicating statistical differences.

## 4. Results

*4.1. Comparison of two sets of baseline data*

There was no significant difference between the OG and the CG in gender, age, cause of fracture, tile classification, and time from fracture to surgery (P>0.05), as shown in Table 1.

*4.2. Comparison of Coagulation Function Levels between Two Groups*

Comparison of FIB and D-D levels among the patients participating in the experiment before surgery (P>0.05); At 3 days and 7 days after surgery, the FIB and D-D in the patients participating in the experiment increased compared to before surgery, but the OG was lower than the CGmeanwhile (P<0.05); The results showcased that there were group, time, and interaction effects among the patients participating in the experiment (P<0.05), as shown in Table 2. The FIB and D-D in both groups of patients showed an upward trend. It is demonstrated in Figure 1.

**Table 1.** Comparison of Two Sets of Baseline Data ($\bar{x}\pm s$/n)

| Group | Gender (Example) | | Age (years) | Causes of fractures (examples) | | | Tile classification (example) | | Time from fracture to surgery (d) |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | | Traffic accident | Fall and hurt | Other | Type B | C Type | |
| **CG (n=43)** | 21 | 22 | 54.77±10.82 | 16 | 21 | 6 | 28 | 15 | 2.37±1.11 |
| **OG (n=43)** | 25 | 18 | 54.70±12.22 | 15 | 25 | 3 | 25 | 18 | 2.44±1.12 |
| ***t/x²*** | 0.748 | | 0.028 | | 1.380 | | 0.443 | | 0.291 |
| ***P*** | 0.387 | | 0.978 | | 0.502 | | 0.506 | | 0.772 |

CG: Control group; OG: Observation group

**Table 2.** Comparison of Coagulation Function Levels between Patients Participating in the Experiment ( $\bar{x}$±s)

| Group | FIB (g/L) | | | F | P |
|---|---|---|---|---|---|
| | Preoperative | AO3d | AO7d | | |
| ***CG (n=43)*** | 3.75±0.51 | 4.39±0.51 | 5.32±0.53 | $F_{group}$=68.319 | $P_{inter\ groups}$=0.000 |
| ***OG (n=43)*** | 3.61±0.60 | 4.06±0.47 | 3.99±0.65 | $F_{time}$=72.614 | $P_{time}$=0.000 |
| ***t*** | 1.249 | 3.120 | 10.399 | $F_{interactions}$=31.106 | $P_{interactions}$=0.001 |
| ***P*** | 0.215 | 0.003 | 0.000 | | |
| **Group** | **D-D（mg/L）** | | | ***F*** | ***P*** |
| | **Preoperative** | **AO3d** | **AO7d** | | |
| ***CG (n=43)*** | 0.87±0.15 | 1.15±0.16 | 1.31±0.22 | $F_{group}$=39.241 | $P_{inter\ groups}$=0.000 |
| ***OG (n=43)*** | 0.87±0.13 | 1.02±0.15 | 0.97±0.16 | $F_{time}$=109.696 | $P_{time}$=0.000 |
| ***t*** | 0.330 | 3.887 | 8.196 | $F_{interactions}$=26.941 | $P_{interactions}$=0.000 |
| ***P*** | 0.742 | 0.000 | 0.000 | | |

CG: Control group; OG: Observation group

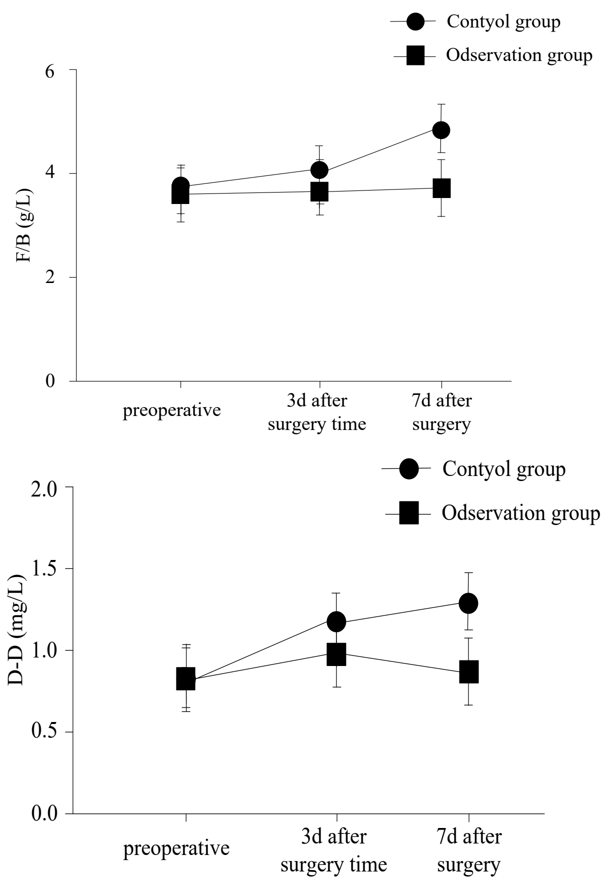


**Figure 1.** Changes in FIB and D-D Levels In the PatientsOf Patients

*4.3. Comparison of Inflammatory Factor Levels between Two Groups*

Before surgery, the levels of T-α, I-1β, and I-6 were compared among the patients participating in the experiment (P>0.05). At 3 and 7 days after the surgery, the levels of T-α, I-1β, and I-6 in both groups increased compared to the baseline; however, these levels were lower in the OG than in the CG during the same period (P<0.05). The results of the repeated analysis of variance illustrated that there were group, time, and interaction effects (P<0.05) in the levels of T-α, I-1β, and I-6 among the patients participating in the experiment, as shown in Table 3. The levels of T-α, I-1β, and I-6 in both groups of patients showed a gradual upward trend, as shown in Figure 2.

*4.4. Comparison of AOHJF Scores among the Patients Participating in the Experiment*

One week after the surgery, the HJF scores of the patients participating in the experiment were compared (P>0.05). The HJF scores of the patients were higher at 1 month and 3 months AO than at 1 week, and the CG was lower in this regard than the OG. The results of repeated analysis of variance showed that there were group, time, and interaction effects among the patients participating in the

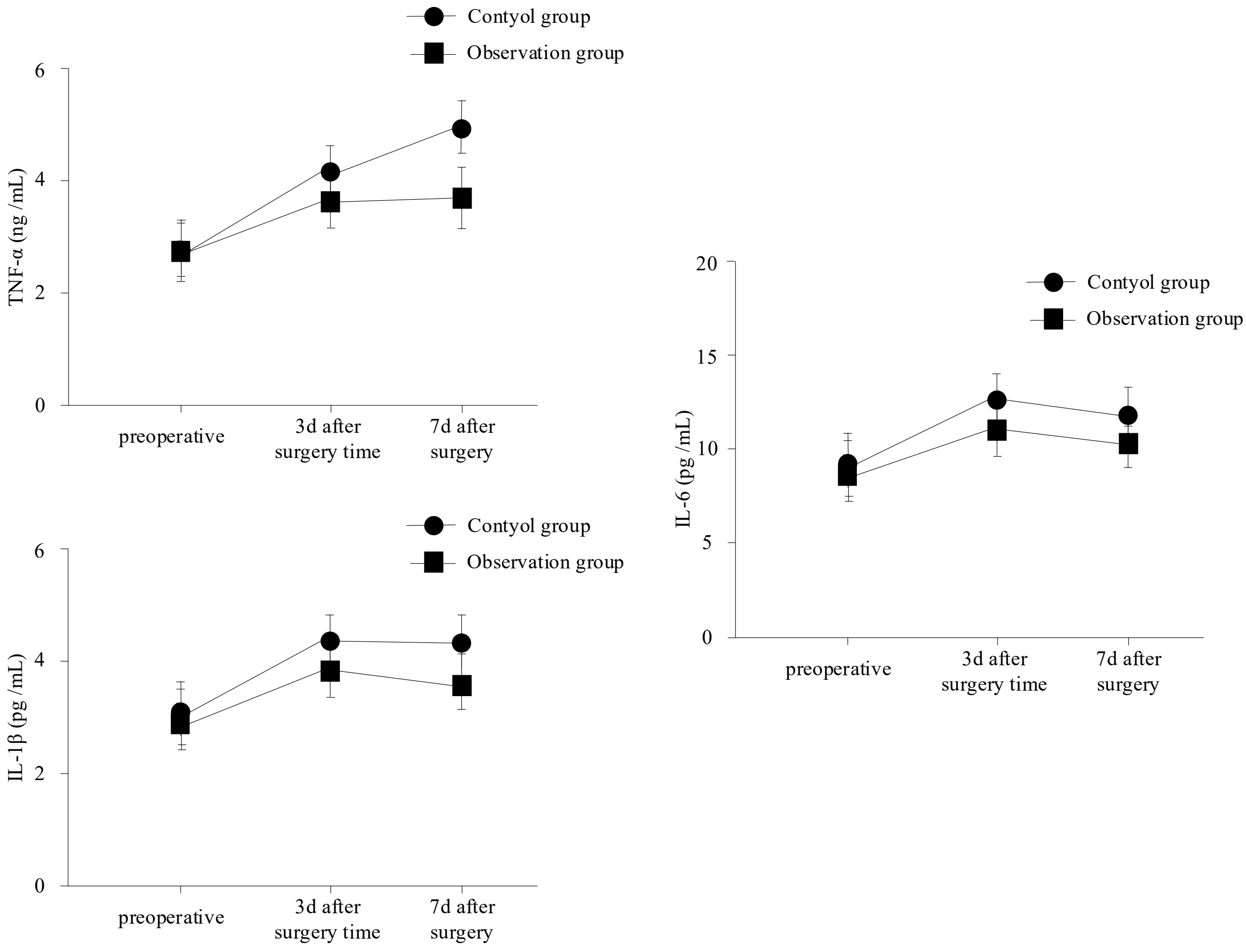


**Figure 2.** Two groups of patients with T-α, I-1β, and I-6 level change curve

experiment (P<0.05), as tabulated in Table 4. The changes in HJF scores in both groups of patients showed a gradual upward trend, as displayed in Figure 3.

**Table 3.** Comparison of Inflammatory Factor Levels between Patients Participating in the Experiment ( $\bar{x}$±s)

| Group | T-α (ng/mL) | | | *F* | *P* |
|---|---|---|---|---|---|
| | **Preoperative** | **AO3d** | **AO7d** | | |
| ***CG (n=43)*** | 2.64±0.53 | 4.19±0.45 | 4.61±0.46 | $F_{group}$=93.630 | $P_{inter\ groups}$=0.000 |
| ***OG (n=43)*** | 2.63±0.50 | 3.63±0.57 | 3.33±0.41 | $F_{time}$=213.356 | $P_{time}$=0.000 |
| ***t*** | 0.090 | 5.057 | 13.622 | $F_{interactions}$=36.599 | $P_{interactions}$=0.000 |
| ***P*** | 0.929 | 0.000 | 0.000 | | |
| **Group** | **I-1 β (pg/mL)** | | | ***F*** | ***P*** |
| | **Preoperative** | **AO3d** | **AO7d** | | |
| ***CG (n=43)*** | 3.51±0.77 | 4.35±0.72 | 4.30±0.75 | $F_{group}$=15.169 | $P_{inter\ groups}$=0.000 |
| ***OG (n=43)*** | 3.33±0.67 | 3.99±0.74 | 3.56±0.63 | $F_{time}$=33.375 | $P_{time}$=0.000 |
| ***t*** | 1.156 | 2.286 | 4.954 | $F_{interactions}$=4.773 | $P_{interactions}$=0.010 |
| ***P*** | 0.251 | 0.025 | 0.000 | | |
| **Group** | **I-6 (pg/mL)** | | | ***F*** | ***P*** |
| | **Preoperative** | **AO3d** | **AO7d** | | |
| ***CG (n=43)*** | 9.70±1.20 | 13.39±2.11 | 12.36±2.29 | $F_{group}$=17.142 | $P_{inter\ groups}$=0.000 |
| ***OG (n=43)*** | 9.51±1.73 | 12.12±1.88 | 10.60±1.51 | $F_{time}$=76.317 | $P_{time}$=0.000 |
| ***t*** | 0.592 | 3.782 | 4.207 | $F_{interactions}$=4.975 | $P_{interactions}$=0.009 |
| ***P*** | 0.556 | 0.000 | 0.000 | | |

CG: Control group; OG: Observation group

**Table 4.** Comparison of AOHJF Scores among Patients Participating in the Experiment ( $\bar{x}$±s)

| Group | HJF score (points) | | | F | P |
|---|---|---|---|---|---|
| | 1 week after surgery | 1 month | 3 months | | |
| *CG (n=43)* | 11.74±1.51 | 13.81±1.37 | 15.56±1.59 | $F_{group}$=27.915 | $P_{inter\ groups}$=0.000 |
| *OG (n=43)* | 12.23±1.67 | 15.60±1.45 | 17.70±2.46 | $F_{time}$=205.368 | $P_{time}$=0.000 |
| *t* | 1.427 | 5.884 | 4.791 | $F_{interactions}$=8.602 | $P_{interactions}$=0.009 |
| *P* | 0.157 | 0.000 | 0.000 | | |

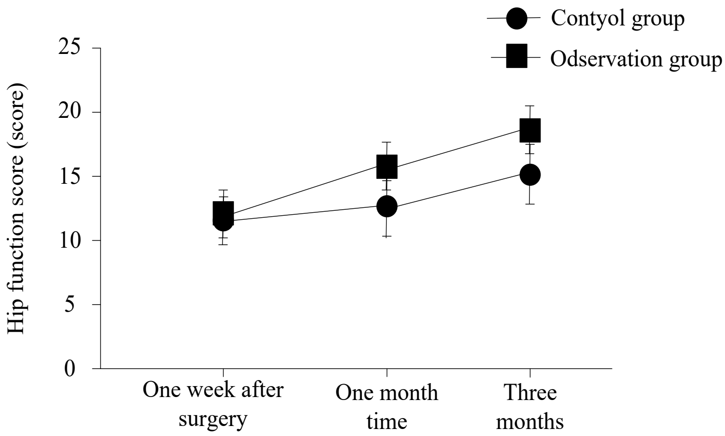


**Figure 3.** Changes in HJF Score Levels between Two Groups of Patients

## 5. Discussion

Research shows that PF accounts for 5-10% of the total body fracture incidence. Type A, B, and C fractures account for 31.8%, 25.1%, and 43.1%, respectively, with a mortality rate of over 8.7% (12). Timely and effective internal fixation treatment is particularly important to control pelvic bleeding, restore pelvic biomechanical stability, and reduce complications, such as traumatic hemorrhagic shock. There are two types of fixation methods for PF, namely internal and external. In the initial phase of fractures, external fixation is often used to stabilize the anterior pelvic ring and stop bleeding as soon as possible. However, this has significant damage to the skin, which can easily cause inconvenience to the patient's movement and increase the probability of infection (13-16). Internal fixation requires open reduction with steel plates, which can cause significant trauma and take a long time. The SJ supports the human torso and is fixed with screws or reconstruction plates to improve its stability. Choosing the correct approach and incision can improve the surgery's completion. The operation of the ilioinguinal approach is relatively complicated and requires full exposure of the front of the SJ to the pubic symphysis, and stripping of the iliac muscles on the inner surface of the hip bone, which will prolong the operation time. Meanwhile, this approach requires careful treatment of neurovascular bundles, with more bleeding and complicated surgical anatomy, which requires exposure of three windows, including the femoral nerve, spermatic cord, or oviduct arch, and vascular bundle of iliac perilymph. This can easily cause tissue damage, increase intraoperative bleeding, and increase the patient's stress response to surgery (11). The operation of the RA approach is relatively simple, with oblique cutting of the abdominal wall muscle and separation from the outside of the peritoneum, which can quickly expose the fracture end. Full-layer suture can be chosen to diminish the surgical time and decrease the risk of surgery and anesthesia (17).

Fractures and surgical trauma can stimulate the secretion of coagulation factors in the body, leading to a hypercoagulable state of the body's blood (18, 19) used immunoturbidimetry to detect D-D concentration in 130 hospitalized patients with fractures. The D-D concentration of fracture patients showed a significant upward trend compared to the healthy CG. Feng Gang et al. (20) conducted a joint detection of D-D and fibrin degradation products (FDP) in patients with fractures, and the findings showcased that the D-D and FDP in the fracture group exceeded those in the healthy. Before the surgery, FIB and D-D were compared among the patients participating in the experiment (P>0.05); 3 days and 7 days after the surgery, FIB and D-D in both groups increased relative to before the surgery, indicating an increase in related substance concentrations in both groups AO. This further indicates that surgical trauma increases the early AO hypercoagulable state of the body's blood. Further comparison among the patients participating in the experiment showcased that the concentrations of related substances in the CG exceeded those in the OG in the same period (P<0.05). The research results of this article are similar to those reported by Hu Xufeng and Feng Gang, indicating that surgery through the pararectus abdominis approach can reduce the blood hypercoagulability caused by surgical trauma. PF can cause adverse stress to the body in the early stages, and due to surgical trauma factors, they can further promote the secretion of relevant factors in the body and strengthen the inflammatory response in the short term after the surgery. Pro-inflammatory factors can effectively reflect the inflammatory stress state and severity of the body, and controlling their fluctuation has become an important indicator for evaluating the degree of surgical trauma. Among them, T-α, I-1β, and I-6 possess a positive impact on AO rehabilitation through mutual regulation and interaction with anti-inflammatory factors in the body. Before the surgery, the T-α, I-1β, and I-6 in the CG and OG were compared ($P>0.05$); at 3 and 7 days AO, the levels of T-α, I-1β, and I-6 in the CG and OG increased compared to before the surgery. This indicates that both approaches have certain trauma and increase the degree of early AO inflammatory response. Further comparison among the patients participating in the experiment showed that at 3 and 7 days after the surgery, T-α, I-1β, and I-6 in the CG exceeded those in the OG ($P<0.05$), indicating that surgical treatment through the pararectus abdominis approach had less trauma and caused weaker inflammatory stress response, thereby reducing body damage. The HJF scores of the patients participating in the experiment were compared one week after the surgery ($P>0.05$). The HJF scores of the two groups were higher at one month and three months after the surgery than at one week, and the OG was higher than the CG. The results of the repeated analysis of variance showed that there were group, time, and interaction effects among the patients participating in the experiment ($P<0.05$). It demonstrated that surgery through the pararectus abdominis approach promoted AO recovery of HJF (21).

## 6. Conclusion

Through a comparative analysis of patients undergoing pelvic fracture surgery through the pararectus abdominis approach and the traditional ilioinguinal approach, this study found significant differences in postoperative FIB, D-D, and inflammatory factor levels between the two surgical methods. The rectus abdominis approach surgery exhibits more stable coagulation function indicators with lower FIB and D-D levels, which may reflect its less interference with coagulation function. Meanwhile, the lower levels of inflammatory factors after the rectus abdominis surgery may indicate a better intervention effect on postoperative inflammatory response. However, it is also important to note that this study had some limitations. Firstly, the relatively small sample size might affect the generalization of the results. Secondly, this study focused only on FIB, D-D, and inflammatory factor levels, without considering other factors that can impact postoperative recovery. Finally, as this study is observational, causal relationships cannot be determined. Given these limitations, it is recommended to conduct studies on a larger sample and perform multicenter randomized controlled studies in the future, combined with more indicators and clinical observations, to further validate the results of this study and provide more specific clinical guidance.

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## Footnotes

**Conflicts of Interest:** There are no conflicts of interest in this study.

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