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RESEARCH

Association between sacroiliac joint reduction quality and acetabular fracture alignment: a comparative study of the lateral window and pararectus approaches

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Abstract

Purpose Simultaneous ipsilateral sacroiliac joint (SIJ) injury and acetabular fracture are relatively common. Inadequate SIJ reduction may compromise the anatomical alignment of associated acetabular fractures. However, the optimal surgical approach for managing both injuries remains uncertain. In this study, we aimed to compare the efficacy of pelvic ring injury reduction using either the lateral window or the pararectus approach and to analyze associated radiological outcomes in patients with concurrent SIJ injury and acetabular fracture.

Methods This retrospective study included 44 patients who underwent open reduction and internal fixation (ORIF) for SIJ injury. Patients were divided into two groups based on the surgical approach: *L* group (lateral window of the ilioinguinal approach) and *P* group (pararectus approach). A subgroup of patients with simultaneous ipsilateral SIJ injury and acetabular fracture was selected for comparative analysis using postoperative computed tomography (CT) to assess SIJ reduction and acetabular fracture alignment.

Results Improvements in SIJ distance on axial and coronal CT planes were observed in both groups, with greater reductions observed in the *P* group. Among patients with combined injuries, the *P* group demonstrated significantly improved SIJ reduction in the coronal plane ($P=0.008$), which was associated with smaller residual fracture gaps and articular step-offs in the axial, coronal, and sagittal planes.

Conclusion When ORIF is indicated for SIJ injury, the pararectus approach may offer enhanced SIJ reduction in the coronal plane. This technique is also associated with improved acetabular fracture alignment in patients with simultaneous ipsilateral injuries.

Keywords Sacroiliac joint · Acetabular fracture · Reduction quality · Pararectus approach · Open reduction

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Introduction

Acetabular fractures are complex injuries involving the hip joint, typically resulting from high-energy trauma incidents, such as motor vehicle collisions, falls from height, or direct impact to the pelvic region. These injuries can severely compromise hip function and stability, potentially leading to long-term complications such as femoral head osteonecrosis and post-traumatic osteoarthrosis if not appropriately managed [1, 2]. Surgical treatment is often necessary to achieve anatomical reduction and stabilization, which are critical for restoring hip joint function and minimizing long-term morbidity [3, 4].

Because the acetabulum is an integral part of the pelvic ring, concomitant pelvic ring injuries are frequently observed in patients with acetabular fractures [5–10]. In such cases, prioritizing pelvic ring reduction and stabilization is generally considered beneficial [8–10], as residual misalignment of the pelvic ring may impede anatomical acetabular reduction [9, 10]. However, some reports suggest that in select cases—particularly in younger patients with relatively stable posterior ring injuries and displaced acetabular fractures—an "acetabulum-first" strategy may offer better results [11, 12].

One particularly challenging scenario involves simultaneous sacroiliac joint (SIJ) injury and a two-column acetabular fracture. The ilioinguinal approach, especially through its lateral window (LW), is commonly used to address these combined injuries [13, 14]. Over time, anterior exposure techniques have evolved, leading to the development of the anterior intrapelvic (AIP) approach, which provides access to the pelvic brim and quadrilateral plate. While some authors view the AIP as a medial extension of the ilioinguinal technique, others consider it a distinct approach with potential advantages in certain fracture patterns [14, 15]. More recently, the pararectus approach has emerged as an alternative with favorable reported outcomes [10].

Given the variety of available approaches to treat concurrent SIJ and acetabular injuries, we focused on determining the approach that offers superior intraoperative advantages. Therefore, we aimed to assess and compare the efficacy of pelvic ring reduction—focusing specifically on SIJ alignment—using either the LW or pararectus approach. We also analyzed associated radiological outcomes in patients presenting with combined injuries to better understand the performance of these surgical techniques.

Materials and methods

Study protocol

We retrospectively analyzed patients who underwent osteosynthesis for pelvic ring and/or acetabular fractures between 2018 and 2022. Overall, 44 patients were diagnosed with pelvic ring injuries involving SIJ diastasis and underwent open reduction and internal fixation (ORIF). Among them, 20 patients presented with simultaneous ipsilateral SIJ injury and acetabular fracture.

The surgical approaches for SIJ and anterior acetabular fractures included the LW of the ilioinguinal approach, AIP approach, and pararectus approach. In cases requiring posterior access for acetabular fixation, the Kocher–Langenbeck or modified Gibson approach was used sequentially.

The study protocol was approved by the Institutional Review Board of our hospital (approval number: 202200293B0).

Perioperative protocol

Following initial resuscitation in the emergency department, patients were transferred to either a general ward or the intensive care unit for clinical stabilization. Preoperative imaging included radiographs (anteroposterior, inlet, outlet, iliac oblique, and obturator oblique views) and multiplanar computed tomography (mpCT) images, which were used for surgical planning.

Definitive surgery was scheduled once patients were deemed fit for anesthesia and operative intervention. Fracture classification was standardized using the Arbeitsgemeinschaft für Osteosynthesefragen system for pelvic ring injuries [16] and the Judet and Letournel classification system for acetabular fractures [17].

Surgical procedures

All procedures were performed by a single surgeon with experience in both the LW (ilioinguinal/AIP) and pararectus approaches. The choice of surgical approach evolved over time with increasing clinical experience. Initially, either the ilioinguinal or AIP approach was used; however, as familiarity with the pararectus technique increased, it became the preferred method in later cases. No fixed protocol was followed for selecting the surgical approach.

Osteosynthesis was performed on a radiolucent table (Modular Table System; Mizuho OSI, CA), with patients positioned supine under general anesthesia. Prior to sterile draping, each patient underwent pelvic ring assessment under anesthesia to detect occult injuries. The standard sequence of reduction involved addressing the SIJ first, followed by the anterior and then the posterior components of the acetabulum.

Diastatic SIJs were reduced using a Farabeuf clamp (DePuy Synthes, Paoli, PA), with 3.5-mm cortical screws placed on both the ilium and sacrum to serve as anchor points (Fig. 1). During the LW approach, the clamp was inserted beneath the iliacus muscle to access the SIJ (Fig. 2a). Although the ilioinguinal approach includes three windows, all SIJ reductions in this study were performed through the LW due to its direct access to the posterior ilium and improved safety profile. The middle and medial windows were avoided owing to concerns related to limited instrument maneuverability and increased neurovascular risk.

In the pararectus approach, the Farabeuf clamp was inserted through the second window, located between the iliopsoas muscle and the external iliac vessels (Fig. 2b). Following reduction, SIJ stabilization was achieved with a three-hole 3.5-mm reconstruction plate (DePuy Synthes). If necessary, a second plate was added after releasing the holding screws and repositioning the clamp.

Following SIJ reduction and stabilization, the anterior acetabular fracture was addressed using one of the anterior approaches—ilioinguinal, AIP, or pararectus—based on intraoperative considerations.

Reduction of the posterior acetabular component was typically performed with a ball-spike pusher and a collinear reduction clamp (both DePuy Synthes, Paoli, PA). When adequate anatomical reduction could be achieved through the anterior approach, fixation was completed using a posterior column screw and an infra-acetabular screw (Fig. 3).

However, in cases where anatomical reduction of the posterior column was not feasible via anterior access—or in the presence of a posterior wall fracture—an additional posterior approach (e.g., Kocher–Langenbeck or modified Gibson) was employed to directly visualize and treat the lesion (Fig. 4).

Rehabilitation protocol

Patients were encouraged to begin body-rolling exercises and assume a sitting position shortly after surgery. Unless contraindicated by associated injuries, non-weight-bearing ambulation was initiated in the early postoperative period. For patients without additional lower limb trauma, the standard rehabilitation timeline included non-weight-bearing for 6 weeks, followed by toe-touch weight-bearing for approximately 4 weeks, and progressive transition to full weight-bearing by 3–4 months postoperatively. Adjustments to this timeline were made in polytrauma cases or based on individual clinical status.

Routine chemical prophylaxis for venous thromboembolism (VTE) was not employed, as prior studies have reported a relatively low incidence of VTE in certain East Asian trauma populations [18]. Instead, mechanical prophylaxis—including the use of compression stockings—and routine screening with lower extremity venous ultrasonography were

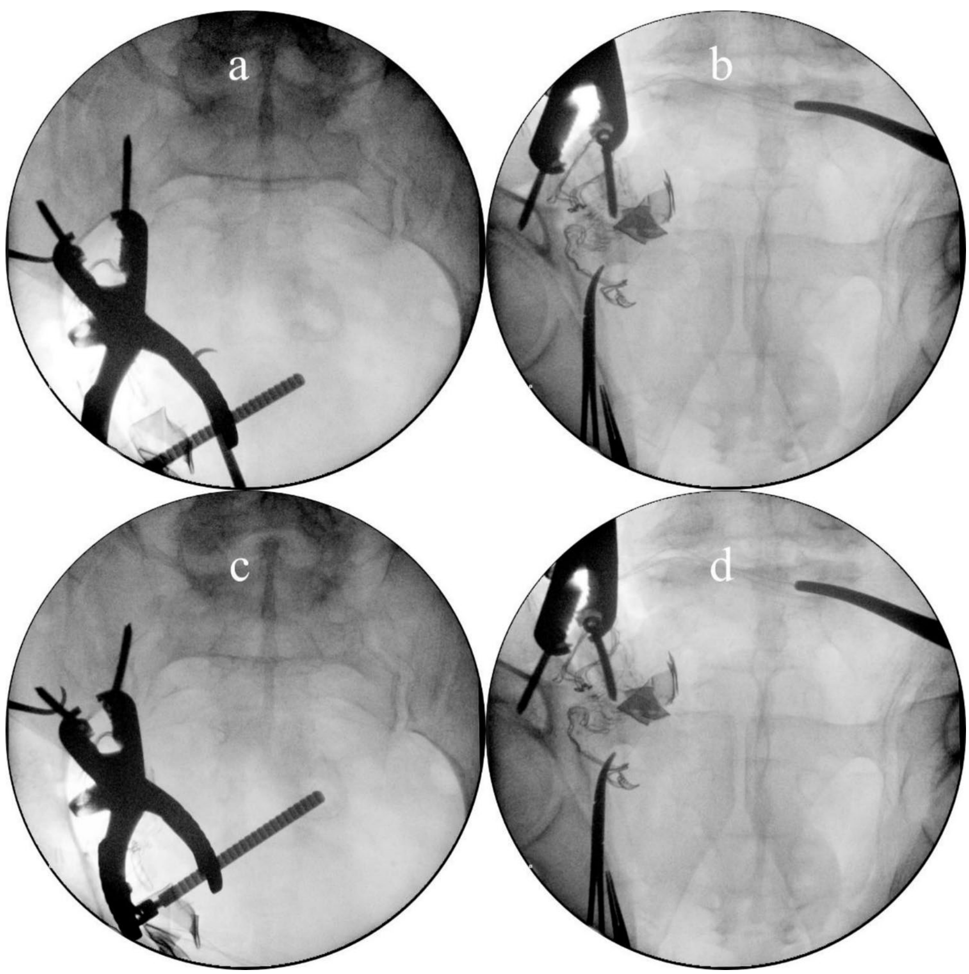

Fig. 1 Application of the Farabeuf clamp and reduction screws for sacroiliac joint (SIJ) stabilization. **a**, **b** Inlet and outlet radiographic views prior to SIJ reduction. **c**, **d** Inlet and outlet views following SIJ compression using the Farabeuf clamp. A surgical lap sponge is visible in the outlet views (b and d), partially obscuring visualization of the SIJ

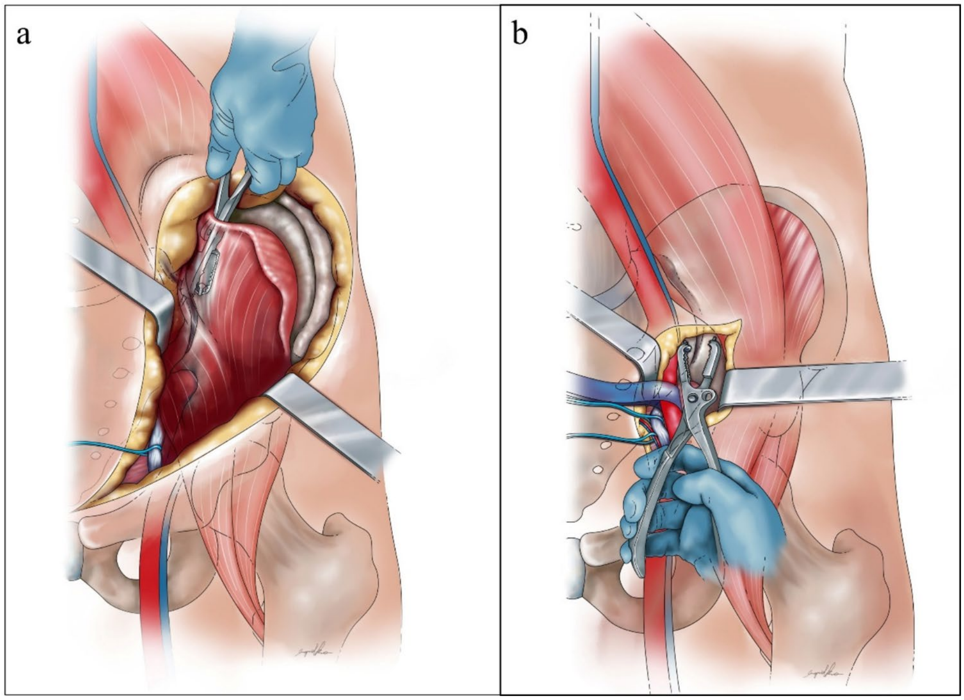

Fig. 2 Schematic illustration showing the positioning of the Farabeuf clamp for sacroiliac joint (SIJ) reduction. The clamp is inserted via the lateral window of the ilioinguinal approach, passing beneath the iliacus muscle to access the SIJ. Although the medial and middle windows may theoretically offer alternative access routes, only the lateral window was used in this series due to considerations of safety and instrument maneuverability. The clamp positioned through the pararectus approach, entering between the iliopsoas muscle and the external iliac vessels

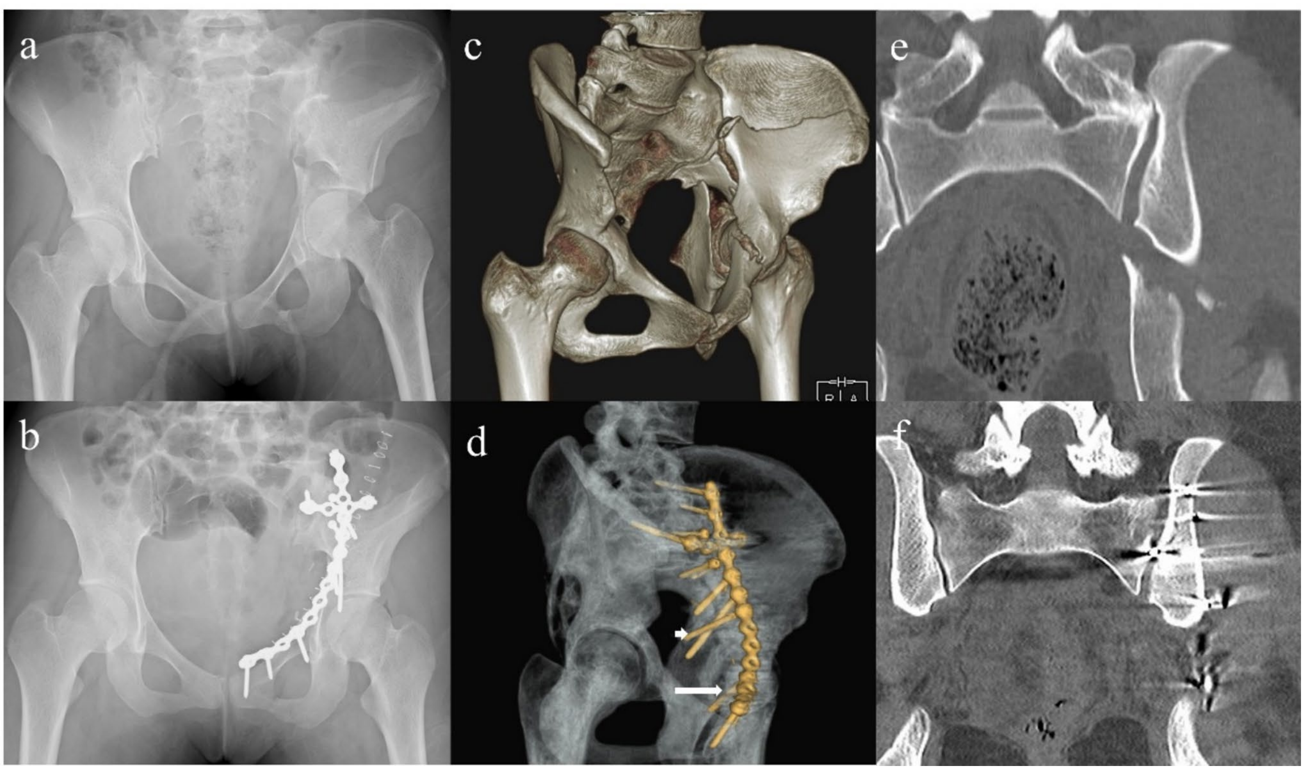

Fig. 3 Representative case from the pararectus (*P*) group. Assessment of preoperative and postoperative radiographs and multiplanar computed tomography (CT) images. **a**, **b** Anteroposterior pelvic radiographs before and after osteosynthesis. **c**, **d** Iliac oblique CT reconstructions showing the fracture before and after fixation. The short arrow indicates posterior column screws, while the long arrow denotes the infra-acetabular screw. **e**, **f** Coronal CT views demonstrating sacroiliac joint alignment before and after reduction

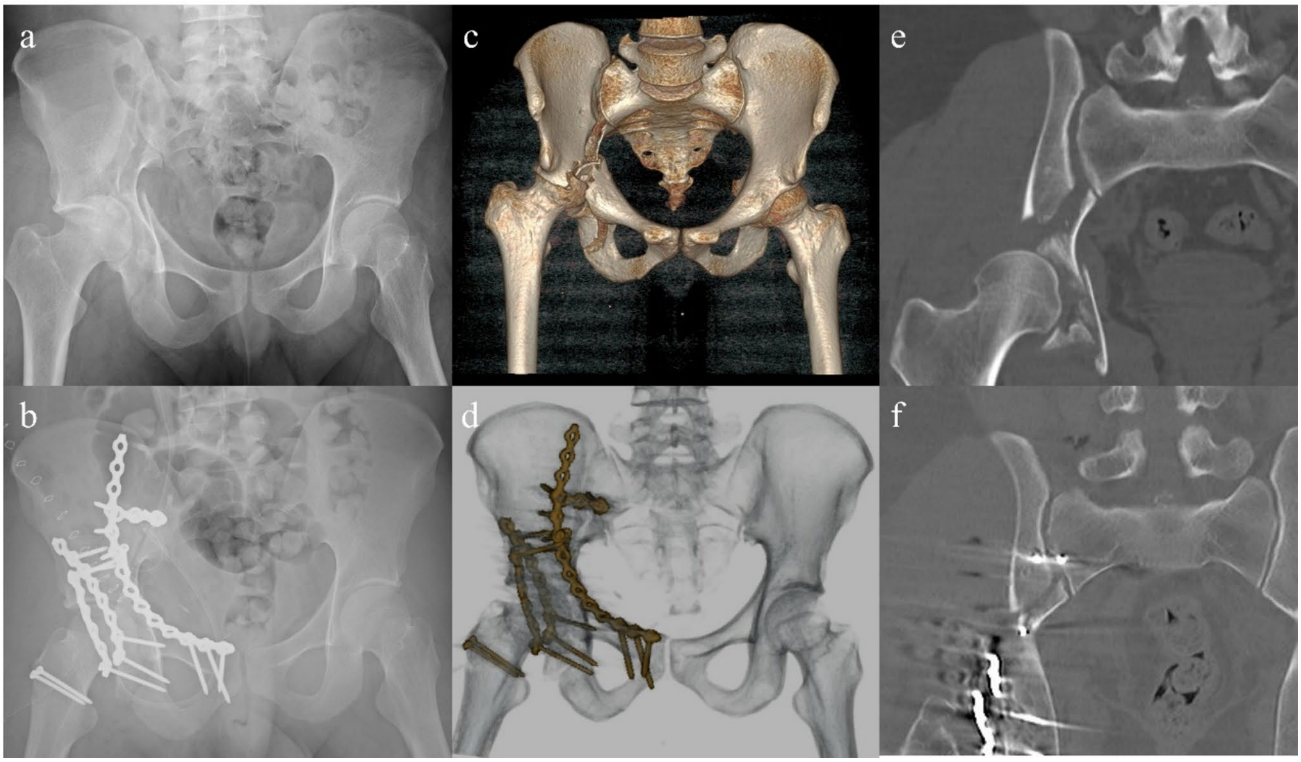

Fig. 4 Representative case from the lateral window (*L*) group. Combined use of anterior and posterior approaches for pelvic ring and acetabular fracture management. **a**, **c** Preoperative images of the pelvic injury **b**, **d** Postoperative images following sequential anterior and posterior surgical interventions **e** Coronal view of the sacroiliac joint (SIJ) before surgical reduction. **f** Postoperative image showing SIJ stabilization with plate osteosynthesis

implemented for all patients. If clinical symptoms developed or if ultrasound screening yielded positive findings, anticoagulant therapy was initiated.

Image assessment protocol

Postoperative imaging assessments, including radiography and mpCT, mirrored the preoperative evaluations. We used the Lefaivre criteria [19], Matta/Tornetta criteria [20], and inlet/outlet ratio [21] for pelvic ring injury reduction quality evaluation. The assessment of SIJ reduction involved axial and coronal mpCT views. SIJ reduction was evaluated by identifying the widest distance between the sacrum and ilium on axial and coronal CT images. We evaluated acetabular fracture reduction quality by assessing axial, coronal, and sagittal mpCT views to quantify improvement and residual gaps/step-offs in articular injuries.

Statistical analysis

Categorical data were analyzed using the Chi-squared test, and between-group comparisons of continuous variables were performed using the Mann–Whitney U test. Statistical significance was set at $P < 0.05$. Correlations between variables were examined using a linear regression test. All statistical analyses were performed using the SPSS 26.0 program for Windows (IBM Corp, Armonk, NY).

Results

During the study period, 34 patients with SIJ diastasis underwent ORIF via the LW (*L* group), and 10 patients were treated using the pararectus approach (*P* group). Participant demographics are summarized in Table 1. Among the baseline variables, only age differed significantly between groups ($P = 0.04$).

Radiographic and mpCT evaluations (Table 2) showed smaller residual SIJ gaps in the *P* group compared to that in the *L* group, particularly in axial (2.12 ± 1.66 mm vs. 2.55 ± 1.07 mm) and coronal views (1.80 ± 1.16 mm vs. 2.87 ± 1.58 mm). However, these differences were not statistically significant ($P = 0.33$ and 0.05, respectively).

Further analysis was conducted on a matched cohort of 10 patients per group with simultaneous ipsilateral two-column acetabular fractures (Table 3). Operative time was significantly longer in the *L* group than in the *P* group (350.6 ± 135.2 min vs. 248.8 ± 52.5 min, $P = 0.04$).

The residual SIJ gap in the coronal plane was significantly smaller in the *P* group ($P = 0.008$; Table 4). Additionally, the *P* group exhibited significantly smaller residual fracture gaps and articular step-offs across all three planes (axial, coronal, and sagittal) compared to the *L* group (Table 4).

To evaluate the relationship between surgical approach and acetabular fracture reduction, linear regression analysis was performed with "Group" as the independent variable. The pararectus approach was significantly associated with smaller residual fracture gaps and step-offs across all planes ($P < 0.01$; Table 5). The variable "Difference (coronal)," representing coronal SIJ displacement, was included due to the significant intergroup difference observed in Table 4.

Discussion

Improvements in SIJ distance on axial and coronal planes were observed in both groups, with slightly greater reductions observed in the pararectus group compared to that in

Table 1 Demographic and injury characteristics of patients with sacroiliac joint (SIJ) injuries treated via the lateral window (*L* group, $n = 34$) or pararectus (*P* group, $n = 10$) approaches

	L group	*P* group	*P* value
Patient number	34	10	
Age*	49.20 ± 18.02	35.00 ± 15.13	0.04
Sex			0.16
Male	5	6	
Female	5	4	
Injury severity score, median (IQR)	19.5 (13)	22 (19.5)	0.89
New injury severity score, median (IQR)	23.5 (14)	24 (19.5)	0.89
Classification[a]			
Pelvic ring			
B2.2	16	0	
B2.3	7	7	
B3.1	0	1	
B3.3	3	0	
C1.2	6	1	
C2.2	2	0	
C3.2	0	1	
Operative time (min)	217.4 ± 124.0	248.8 ± 52.5	0.45
Estimated blood loss (mL)	770.0 ± 521.9	1090 ± 784.2	0.11
Hospital stay (days)	17.2 ± 8.3	16.6 ± 8.0	0.84

The full *L* group includes all patients with SIJ injuries treated through the lateral window, regardless of associated acetabular fracture laterality. For comparative analysis of fracture reduction quality (see Tables 3, 4, and 5), only patients with simultaneous ipsilateral SIJ injury and bicolumn acetabular fractures were selected (10 in each group)

IQR: interquartile range

*$P < 0.05$, statistical significance

[a]The pelvic ring injury classification is based on the Arbeitsgemeinschaft für Osteosynthesefragen(AO)/Orthopaedic Trauma Association (OTA) classification

Table 2 Postoperative reduction quality assessments of pelvic ring injuries

Assessment tool	Parameters	*L* group	*P* group	*P* value
Radiograph	Lefaivre (mm)	7.4 ± 5.7	4.3 ± 3.7	0.10
	Matta/Tornetta (mm)	5.4 ± 3.4	4.5 ± 1.7	0.45
	Inlet ratio	0.97 ± 0.13	0.98 ± 0.07	0.89
	Outlet ratio	1.08 ± 0.30	1.09 ± 0.26	0.91
mpCT (SIJ difference)[a]	Axial (mm)	2.55 ± 1.07	2.12 ± 1.66	0.33
	Coronal (mm)	2.87 ± 1.58	1.8 ± 1.16	0.05

SIJ, sacroiliac joint; mpCT, multiplanar computed tomography

[a]SIJ difference refers to the difference between the lesion site (postoperative) and healthy (contralateral) site

Table 3 Patients undergoing open reduction for sacroiliac injury with ipsilateral acetabular fracture

	L group	*P* group	*P* value
Age	49.20 ± 18.02	35.00 ± 15.13	0.09
Sex			0.65
Male	5	6	
Female	5	4	
Injury severity score, median (IQR)	19.5 (13)	22 (19.5)	0.62
New injury severity score, median (IQR)	23.5 (14)	24 (19.5)	0.99
Classification			
Pelvic ring[a]			
B2.2	4	0	
B2.3	2	7	
B3.2	0	1	
B3.3	1	0	
C1.2	3	2	
Acetabulum[a]			
Anterior column	1	3	
AC + AW	0	1	
Transverse	1	0	
Transverse + PW	4	0	
T type	1	3	
ABC	3	1	
ACPHT	0	2	
Operative time* (min)	350.6 ± 135.2	248.8 ± 52.5	0.04
Estimated blood loss (mL)	1270 ± 527.4	1090 ± 784.2	0.48
Hospital stay (days)	20.00 ± 7.63	16.60 ± 8.00	0.34
Complication			
Hip dislocation	1	0	
Surgical site infection	1	0	

IQR, interquartile range; AC, anterior column; AW, anterior wall; PW, posterior wall; ABC, associated both columns; ACPHT, anterior column plus posterior hemitransverse

*$P < 0.05$, statistical significance

[a]Pelvic ring" and "Acetabulum" refer to the classification of fracture types based on the Arbeitsgemeinschaft für Osteosynthesefragen and Judet–Letournel systems, respectively

the LW group. Among patients with concurrent ipsilateral SIJ injury and acetabular fracture, SIJ reduction in the coronal plane was significantly better in the pararectus group, corresponding to smaller residual fracture gaps and articular step-offs in the axial, coronal, and sagittal planes.

Multiple surgical approaches and fixation techniques have been described for SIJ injuries, including iliosacral screws, trans-iliac–trans-sacral screws, posterior tension band plating, and bridging plates spanning the SIJ, applied via either closed or open reduction strategies [13, 14, 22–25]. Although no single method has demonstrated clear superiority, closed iliosacral screw fixation is often favored for its minimally invasive nature, safety profile, and effective stabilization [22–25]. However, open reduction remains essential in selected cases—particularly those involving significant SIJ diastasis [9, 10, 26, 27].

The classical anterior approach for open SIJ reduction involves the LW of the ilioinguinal approach [13, 14, 28]. Although the second and third windows of the ilioinguinal technique may theoretically offer alternative reduction trajectories, all SIJ reductions in this study were performed through the LW due to its direct access to the posterior ilium and favorable neurovascular profile. The middle and medial windows were not utilized due to concerns regarding limited working space and instrument maneuverability.

The LW approach offers several advantages: direct visualization of the SIJ, straightforward placement of reduction clamps, and the ability to perform simultaneous iliac reduction maneuvers [13, 14, 28]. However, our findings suggest a potential limitation in achieving optimal SIJ reduction when using the Farabeuf clamp through the LW approach. This constraint is primarily attributed to interference from the iliopsoas muscle, which may alter the vector of force applied

Table 4 Sacroiliac joint and acetabular fracture comparisons between the lateral window and pararectus approaches

	L group	*P* group	*P* value
SIJ difference (mm)[a]			
Axial plane	2.82 (1.00)	2.11 (1.66)	0.347
Coronal plane*	3.91 (1.41)	1.79 (1.14)	0.008
Acetabular fracture gap (mm)			
Axial plane*	5.18 (1.53)	1.63 (1.84)	0.003
Coronal plane*	4.86 (1.32)	1.9 (1.65)	0.002
Sagittal plane*	4.48 (1.49)	1.73 (1.57)	0.004
Articular step-off			
Axial plane*	3.17 (0.63)	1.48 (1.22)	0.002
Coronal plane*	3.33 (1.21)	0.6 (0.74)	< 0.001
Sagittal plane	2.31 (1.4)	1.57 (1.31)	0.305

SIJ, sacroiliac joint

*$P < 0.05$, statistical significance

[a]SIJ difference refers to the difference between the lesion site (postoperative) and healthy (contralateral) site

by the clamp, resulting in a non-perpendicular reduction trajectory relative to the SIJ. As a result, the accuracy of SIJ reduction may be affected.

While we observed iliopsoas-related challenges when using the Farabeuf clamp via the LW, we acknowledge that experienced surgeons may still achieve satisfactory reductions through this approach using alternative techniques or instruments. In our study, a single clamp type was employed across all cases to maintain methodological consistency.

Among the anterior approaches used for managing pelvic ring injuries and acetabular fractures, the pararectus approach is a relatively recent addition [10, 29, 30]. Previous studies have highlighted several potential advantages of this technique, including a minimally invasive skin incision, expanded surgical field, greater screw purchase length, and easier placement of reduction clamps [29–31].

When applied to SIJ injuries, the pararectus approach enables the application of a perpendicular reduction force without obstruction by the iliopsoas muscle. This technical advantage may facilitate higher-quality reduction in the coronal plane. In addition, the same surgical corridor can be extended to treat associated acetabular fractures without requiring a change in patient positioning or additional incisions [10].

Reduction criteria differ between pelvic ring and acetabular injuries. For acetabular fractures, the objective is anatomical reduction of the articular surface [31–35], whereas for pelvic ring injuries, the focus is on achieving symmetry and stability [36, 37]. In cases involving simultaneous ipsilateral SIJ injury and acetabular fracture, accurate SIJ reduction is especially critical [6–10], as it serves as a foundation for realigning acetabular fragments.

In acetabular fractures involving both columns, anatomical SIJ reduction provides a stable reference for aligning the iliac wing and facilitating precise acetabular reduction. However, in complex pelvic ring injuries with associated pubic symphysis or ramus fractures, residual pelvic mobility may permit acceptable acetabular alignment even in the presence of suboptimal SIJ reduction [5–10].

In this series, SIJ reduction using the pararectus approach was associated with improved coronal plane alignment compared to the LW approach. This radiographic improvement corresponded with significantly smaller fracture gaps and articular step-offs in the associated acetabular fractures across all three planes. While these findings suggest a potential technical advantage, the absence of functional outcome data precludes any causal inference.

Although enhanced SIJ reduction may support acetabular alignment, this relationship is likely multifactorial. Other contributing factors—including fracture morphology, reduction techniques, and patient-specific variables—may also influence acetabular reduction quality. Furthermore, while the 1-mm improvement in coronal SIJ reduction was statistically significant, its clinical relevance remains uncertain.

Table 5 Linear regression analysis of surgical approach (Group) and radiographic reduction quality. "Difference (coronal)" indicates residual SIJ displacement in the coronal plane (from Table 4). All models used Group as the sole predictor. Negative *B* values favor the pararectus group

Factor	*B*	STD	*β*	95% CI	R^2	*P* value
Fracture gap* (axial)	− 3.55	0.76	− 0.74	− 5.142, − 1.958	0.55	< 0.01
Fracture gap* (coronal)	− 2.96	0.69	− 0.72	− 4.365, − 1.555	0.52	< 0.01
Fracture gap* (sagittal)	− 2.75	0.68	− 0.69	− 4.187, − 1.313	0.47	< 0.01
Articular step-off* (axial)	− 1.69	0.44	− 0.68	− 2.601, − 0.773	0.46	< 0.01
Articular step-off* (coronal)	− 2.54	0.38	− 0.77	− 3.342, − 1.747	0.79	< 0.01
Difference (coronal)[a]	0.28	0.09	0.34	0.081, 0.474	0.081, 0.474	< 0.01

B, coefficient; STD, standard deviation; *β*, beta; CI: confidence interval

*Statistical significance

[a]Difference (coronal) refers specifically to the coronal plane measurement of the sacroiliac joint distance, which was the only parameter demonstrating significant group differences.

Radiographic differences of this magnitude may not independently determine outcomes, which are influenced by a range of factors such as age, injury severity, and rehabilitation capacity. Nevertheless, achieving more anatomical SIJ alignment may provide a biomechanically favorable foundation for recovery.

This study highlights the importance of individualized surgical planning. Although the pararectus approach showed radiographic advantages, both the pararectus and LW approaches can achieve acceptable reductions when applied appropriately. Given that acetabular fracture configuration often dictates the surgical strategy, it may be more appropriate to prioritize fracture pattern over SIJ involvement when selecting the surgical approach.

Despite efforts to maintain methodological rigor, several limitations must be acknowledged. First, this was a retrospective study with a relatively small sample size, which limits generalizability. Second, a higher proportion of B2.3 pelvic ring injuries in the pararectus group may have influenced the reduction outcomes; however, subgroup analysis was not feasible due to sample size limitations. Third, all surgeries were performed by a single surgeon, and the pararectus approach was implemented later in the study period. As such, improvements in outcomes may partially reflect a learning curve rather than intrinsic advantages of the technique.

Additionally, functional or clinical outcome measures were not assessed, limiting interpretation of the radiographic findings. SIJ reduction was evaluated using the widest observed joint distance on postoperative CT, without standardized anatomical landmarks, which may introduce variability due to obliquity or image selection.

Future prospective studies with larger cohorts, functional outcome assessment, and standardized imaging protocols are warranted to further validate these findings.

Conclusions

In the treatment of simultaneous ipsilateral SIJ injury and two-column acetabular fractures, the pararectus approach was associated with improved radiographic SIJ reduction compared to the LW of the ilioinguinal approach. This enhanced reduction corresponded with smaller residual fracture gaps and articular step-offs in associated acetabular fractures. These findings suggest that the pararectus approach may offer technical advantages in selected cases, although further studies are needed to confirm its impact on clinical outcomes.

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Author contribution P.-J. T., I-J. C., and Y.-H. Y. contributed to the conceptualization; C.-Y. L., Y.-H. H., and Y.-C. C. were involved in the investigation; P.-J. T. assisted in writing; S.W.-N. U. and Y.-H. Y. contributed to writing—review and supervision. All authors have read and approved the final manuscript.

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Data availability No datasets were generated or analyzed during the current study.

Declarations

Conflict of interests The authors declare no competing interests.

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