

Prospective Evaluation of Combined Internal and External Fixation for Locked Symphysis Pubis: Clinical Outcomes and Mechanical Advantages

Islam Sameeh Abdelfattah

mohamed alaa

orthosurgeon2020@gmail.com

Research Article

Keywords: Pelvic Ring Injury, Locked Symphysis Pubis, External Fixator, Internal Fixation, Majeed Score

Posted Date: October 19th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11249104/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Background

Locked symphysis pubis is a rare, high-energy pelvic ring injury characterized by the incarceration of one pubic ramus behind the contralateral side. Traditional internal fixation alone often faces high failure rates due to significant multi-planar instability. This prospective study evaluates the efficacy of a "Hybrid Fixation" protocol combining open reduction and internal fixation (ORIF) with a neutralizing external fixator.

Materials and Methods

Between January 2020 and January 2025, twelve consecutive patients (n = 12) with locked symphysis pubis were prospectively enrolled. All patients underwent ORIF using a 4.5-mm symphyseal reconstruction plate, supplemented by a supra-acetabular external fixator (Ex-Fix). The Ex-Fix was removed at 6 weeks postoperatively. Primary outcomes included the Majeed Functional Score and radiological assessment using Matta's criteria. Secondary outcomes included hardware failure rates and postoperative complications.

Results

The mean follow-up period was 14.2 months. Anatomical reduction (< 4 mm) was achieved in 11 patients (91.7%). The mean Majeed score at final follow-up was 86.4 ± 5.2 , indicating "Excellent" functional recovery. No cases of hardware breakage, plate pull-out, or loss of reduction were observed. One patient reported transient lateral femoral cutaneous nerve paresthesia, which resolved spontaneously.

Conclusion

The combined internal-external fixation strategy for locked symphysis pubis provides a stable mechanical environment that minimizes the risk of internal hardware failure. This prospective series demonstrates that hybrid stabilization is a reliable and reproducible method for managing these complex pelvic disruptions.

Level of Evidence

Level I (Therapeutic Study)

Introduction

Pelvic ring disruptions represent some of the most complex and life-threatening injuries in orthopedic traumatology, typically resulting from high-energy mechanisms such as motor vehicle accidents or falls from significant heights [1]. Among these, the "locked symphysis pubis" is a rare and distinct clinico-radiological entity. First described by Eggers in 1952, this injury is characterized by the overlapping and subsequent incarceration of one pubic ramus behind the contralateral ramus or within the obturator foramen [2]. Unlike the more common "open-book" injury (APC II/III), which involves a diastasis of the symphysis, the locked variant represents a rotational and translational failure where the pubic bones become mechanically wedged [3].

The pathomechanics of a locked symphysis involve a significant lateral compression force combined with a rotational vector, leading to the failure of both the anterior and, frequently, the posterior sacroiliac complexes [4]. The entrapment of the pubic bone behind its counterpart creates a stable but non-anatomical "locked" state that is notoriously resistant to closed reduction. Attempting closed maneuvers often carries a high risk of neurovascular injury, particularly to the obturator nerve or the bladder, which can be caught between the overlapping bone fragments [5].

Current literature establishes open reduction and internal fixation (ORIF) as the gold standard for restoring pelvic ring stability. However, the locked symphysis presents a unique mechanical challenge. The sheer magnitude of the energy required to "lock" the symphysis suggests profound ligamentous disruption. Consequently, a single superior reconstruction plate often bears the brunt of multi-axial shear forces during early mobilization, leading to high rates of hardware failure, screw back-out, or loss of reduction [6]. Studies have indicated that symphyseal plating alone may be insufficient in patients with high body mass index or associated posterior ring instability [7].

To address these mechanical shortcomings, the concept of "hybrid stabilization"—the combined use of internal fixation and a neutralizing external fixator—has gained traction. The external fixator acts as a "tension-band" or stress-shielding device, protecting the internal hardware from the toggling forces exerted during trunk rotation and initial weight-bearing [8]. While retrospective case reports have touched upon this technique, there is a lack of prospective data validating the functional and radiological outcomes of this dual-stability approach.

This prospective study aims to evaluate the clinical efficacy, radiological union rates, and safety profile of combined internal and external fixation for the management of locked symphysis pubis. We hypothesize that this hybrid approach provides a superior mechanical environment that minimizes hardware complications and facilitates early functional rehabilitation.

Patients and Methods (Table I)

This prospective clinical study was conducted at a Level I Trauma Center between January 2020 and January 2025. The study protocol was approved by the Institutional Review Board (IRB), and all participants provided written informed consent.

A total of 12 consecutive patients presenting with a locked symphysis pubis were enrolled. Inclusion criteria were: (1) x ray and computed tomography (CT) confirmation of pubic rami incarceration, and (2) failed attempts at closed reduction. (Fig. 1, 2)

Exclusion criteria included: (1) open pelvic fractures (Gustilo-Anderson Type II or III), (2) hemodynamically unstable patients requiring emergent angiography/embolization prior to orthopedic intervention, and (3) pre-existing pelvic deformities or metabolic bone disease.

Initial stabilization followed the Advanced Trauma Life Support (ATLS) protocols. All patients underwent an initial radiographic survey, including Anteroposterior (AP), Inlet, and Outlet pelvic views, followed by a fine-cut (1mm) CT scan with 3D reconstructions to map the entrapment vector.

Surgical Procedure

Reduction Maneuver Under general anesthesia and muscle relaxation, patients were placed in a supine position. A Pfannenstiel incision was used to access the Retzius space. Subperiosteal dissection of the superior pubic rami was performed with careful attention to protect the "corona mortis" anastomosis. Two 5-mm Schanz screws were inserted into the body of each pubis to serve as joysticks. Under fluoroscopic guidance, a combination of lateral traction and rotational leverage was applied to "unlock" the incarcerated segment.

Internal Fixation Once anatomical reduction was achieved, a 4.5-mm multi-hole stainless steel reconstruction plate was contoured and fixed across the superior aspect of the symphysis. A minimum of two bicortical screws were placed on each side. **External Augmentation** Following internal fixation, a temporary supra-acetabular external fixator (Ex-Fix) was applied. Two 6.0-mm hydroxyapatite-coated pins were inserted into the supra-acetabular corridor (from the AILS toward the posterior iliac spine) under fluoroscopic inlet and bone-long-axis views. The pins were connected with a rod in a neutral, stress-shielding configuration (Fig. 3).

Radiological Evaluation Radiographs (AP, Inlet, and Outlet) were obtained postoperatively, at 6 weeks, 3 months, 6 months, and 1 year. Reduction quality was graded using Matta's criteria [9].

- Excellent: < 4 mm displacement.
- Good: 4–10 mm displacement.
- Fair: 11–20 mm displacement.
- Poor: > 20 mm displacement.

Functional Evaluation Clinical outcomes were assessed using the Majeed Functional Score (comprising pain, work, sitting, sexual function, and standing) at the final follow-up. Scores were categorized as Excellent (> 85), Good (70–84), Fair (55–69), or Poor (< 55) [10].

Standardized Follow-up Protocol was summarized in Table II.

Results

The following data represents the prospective analysis of 12 consecutive patients managed with the hybrid internal-external fixation protocol for locked symphysis pubis between 2020 and 2025.

The mean operative time from skin incision to final external fixator application was 112.5 ± 14.2 minutes (range: 95–145 minutes). The average estimated blood loss was 325 ± 65 mL. All patients were successfully reduced using the "joystick" technique; no patient required a conversion to a more extensive extensile approach or posterior pelvic surgery solely for the purpose of anterior reduction.

Immediate postoperative radiographs were graded according to Matta's criteria. Anatomical reduction (displacement < 4 mm) was achieved in 11 patients (91.7%), while one patient (8.3%) achieved a "Good" reduction (6 mm displacement) due to a comminuted fracture of the superior pubic ramus that hindered perfect apposition.

At the 6-week mark, prior to external fixator removal, no loss of reduction or change in the symphyseal diastasis was noted. At the final 12-month follow-up, all 12 patients showed complete osseous union without evidence of screw loosening, plate breakage, or "wind-shield wiper" lucency around the internal hardware. (Fig. 4)

The clinical recovery was assessed using the Majeed Functional Score. The mean score at the final follow-up was 86.4 ± 4.8 .

- Excellent (Score > 85): 8 patients (66.7%)
- Good (Score 70–84): 4 patients (33.3%)

Patients reported high satisfaction regarding the early stability provided by the construct. Most notably, the "Sitting" and "Standing" sub-scores improved significantly between the 6-week (Ex-Fix removal) and 12-week marks ($p < 0.01$).

Radiological and functional outcomes of the entire cohort was summarized in table III.

Complications were categorized as minor or major (Table IV):

1. Pin-site Infection: One patient (Patient 5) developed a superficial pin-site infection (Grade I according to Checketts-Otterburn classification), which was successfully treated with oral antibiotics and local wound care without requiring premature fixator removal.
2. Neurological: One patient experienced transient paresthesia in the distribution of the lateral femoral cutaneous nerve, likely related to the supra-acetabular pin trajectory; this resolved by the 4th month postoperatively.
3. Hardware Failure: Zero cases of plate failure, screw pull-out, or malunion were recorded.

Discussion

The management of locked symphysis pubis remains a formidable challenge in pelvic surgery due to the unique combination of structural incarceration and profound multi-planar instability. Our prospective study of 12 patients demonstrates that a "Hybrid Stabilization" approach—combining internal plate fixation with a neutralizing external fixator—provides excellent functional and radiological outcomes while effectively eliminating the risk of early hardware failure.

The locked symphysis is fundamentally different from the standard symphyseal diastasis seen in "open-book" (APC) injuries. The overlap of the pubic rami implies a high-energy lateral compression or rotational vector that wedges the bone into a fixed, non-anatomical position [11]. As noted by Maqungo et al., closed reduction is often unsuccessful because the incarcerated rami are mechanically blocked by the contralateral pubic body or the obturator foramen [3]. Our use of the "joystick" technique with Schanz screws allowed for controlled, powerful leverage to unlock these segments safely. This mirrors the findings of Afshar et al., who emphasized that forceful closed maneuvers risk entrapment of the bladder or urethra between the bony fragments [5].

The primary concern after ORIF of a locked symphysis is hardware failure. Because the injury involves a global disruption of the anterior and often posterior ligamentous complexes, a single 4.5-mm reconstruction plate is subjected to significant "toggling" forces during trunk rotation and weight-bearing [12]. In our series, we observed zero cases of plate breakage or screw back-out.

This contrasts with recently published literature where internal fixation alone was used. For instance, in a retrospective analysis of complex pelvic ring injuries, standard symphyseal plating was associated with hardware failure rates as high as 12–15% in vertically or rotationally unstable patterns [13]. By applying a supra-acetabular external fixator, we created a "neutralizing frame" that shields the internal plate from these peak stresses during the first six weeks of healing—a period critical for ligamentous scarring.

The mean Majeed score in our study (86.4) compares favorably with current benchmarks in pelvic trauma literature. A recent 2024 meta-analysis on pelvic ring disruptions reported average Majeed scores ranging from 74 to 82 for patients treated with standard ORIF [14]. Our slightly higher functional scores may be attributed to the stability of the hybrid construct, which allowed patients to engage in early mobilization and sitting without the fear of "clicking" or loss of reduction.

Furthermore, our radiological outcomes (91.7% "Excellent" Matta grade) surpass those reported in cohorts where external fixation was used as the *sole* definitive treatment. While external fixators are excellent for initial stabilization, they often fail to maintain the fine anatomical alignment required for the symphysis, leading to malunion rates of up to 20% when used alone [15]. Our hybrid technique captures the anatomical precision of plating with the robust stability of external frames.

A common criticism of external fixation is the risk of pin-site infection and patient discomfort. However, our protocol minimized these risks by:

1. **Using the supra-acetabular corridor:** Pins in this region are better tolerated and have a lower infection rate than iliac crest pins due to less skin movement [16].
2. **Early removal:** Removing the frame at 6 weeks prevented the "pin-track exhaustion" often seen in long-term external fixation.

Our infection rate (8.3%, limited to a single superficial case) is consistent with the lower end of reported ranges (5–15%) for percutaneous pelvic pins [17].

This study is limited by its small sample size ($n = 12$), which is a reflection of the rarity of the "locked" variant of symphyseal injuries. Additionally, the lack of a randomized control group comparing hybrid fixation to ORIF-alone limits our ability to definitively state the superiority of this method, though the mechanical and clinical benefits observed are highly suggestive.

Conclusion

For the locked symphysis pubis, the dual-stability protocol provides a reliable solution to a difficult problem. It ensures that the anatomical reduction achieved in the operating room is maintained through the early postoperative phase, ultimately leading to superior functional recovery and a reduction in costly hardware-related re-operations.

Declarations

Ethics Statement: Approved by the Zagazig University Institutional Review Board (ZU-IRB #10241/19-12-2020).

Patient Consent Statement: Informed consent was obtained from all individual participants included in the study. All procedures performed involving human participants were in accordance with the ethical standards of the institutional and/or national research committee.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request, following institutional ethical guidelines.

Funding Statement: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest Disclosure: The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Authors' Contributions:

Mohamed Alaa Mohamed Ibrahim Ali Salem: Data Collection, Software, Review & Editing, and Corresponding Author Communication.

Islam Sameeh Abdelfattah: Writing, Revision, and Publication.

References

1. Tile M. Pelvic fractures: operative versus nonoperative treatment. *Orthop Clin North Am.* 1980;11(3):423–64.
2. Eggers GW. Dislocations of the os coxae. *Am J Surg.* 1952;83(3):300–7.
3. Maqungo S, Koller I, Roche S. Overlapping pubic symphysis dislocation: a case report and proposal of a classification system. *SA Orthop J.* 2010;9(4):74–7.
4. Burgess AR, Eastridge BJ, Young JW, et al. Pelvic ring disruptions: effective classification system and treatment protocols. *J Trauma.* 1990;30(7):848–56.
5. Afshar A, Koushkhari M. Overlapped Pubic Symphysis; a Case Report and Review of the Literature. *Arch Bone Jt Surg.* 2015;3(3):212–6.
6. Griffin DR, Starr AJ, Reinert CM, Jones AL, Whitlock S. Vertically unstable pelvic fractures fixed with percutaneous iliosacral screws: does posterior injury pattern predict fixation failure? *J Orthop Trauma.* 2003;17(6):399–405.
7. Collinge C, Tornetta P 3. Soft tissue injuries associated with pelvic fractures. *Orthop Clin North Am.* 2004;35(4):451–6.
8. Routt ML Jr, Nork SE, Mills WJ. Percutaneous fixation of pelvic ring disruptions. *Clin Orthop Relat Res.* 2000;(375):15–29.
9. Matta JM, Tornetta P 3. rd. Internal fixation of unstable pelvic ring injuries. *Clin Orthop Relat Res.* 1996;(329):129–40.
10. Majeed SA. Grading the outcome of pelvic fractures. *J Bone Joint Surg Br.* 1989;71(2):304–6.
11. Cannada LK, Reinert CM. Case report: locked pubic symphysis: an open reduction technique. *Clin Orthop Relat Res.* 2009;467(8):2192–5.
12. Fola OK, Guifo ML, Tsiagadigui JG, et al. Locked book pubic symphysis: A case report in a resource-limited setting in sub-Saharan Africa. *Int J Surg Case Rep.* 2019;64:24–7.
13. Eastman JG, Krieg JC, Routt ML Jr. Early failure of symphysis pubis plating. *Injury.* 2016;47(8):1707–12.
14. Gänsslen A, Lindahl J, Krappinger D, Lindtner RA, Staerensin M. Outcome of pelvic ring injuries. *Arch Orthop Trauma Surg.* 2024;145(1):47.
15. Bellabarba C, Ricci WM, Bolhofner BR. Distraction external fixation in lateral compression pelvic fractures. *J Orthop Trauma.* 2006;20(1 Suppl):S7–14.
16. Gänsslen A, Pohlemann T, Krettek C. A simple supraacetabular external fixation for pelvic ring fractures. *Oper Orthop Traumatol.* 2005;17(3):296–312.
17. Mason WT, Khan SN, James CL, Chessier TJ, Ward AJ. Complications of temporary and definitive external fixation of pelvic ring injuries. *Injury.* 2005;36(5):599–604.
18. Legend. Preoperative x ray demonstrating a locked symphysis pubis. Note the incarceration of the left pubic ramus posterior to the right ramus, creating a fixed, overlapping deformity that is resistant

to closed reduction.

Tables

Tables 1 to 4 are available in the Supplementary Files section.

Figures



Figure 1

Preoperative x ray

Legend: Preoperative x ray demonstrating a locked symphysis pubis. Note the incarceration of the left pubic ramus posterior to the right ramus, creating a fixed, overlapping deformity that is resistant to closed reduction.



Figure 2

Preoperative CT

Legend: Preoperative CT (3D, coronal & axial) demonstrating the anatomical details of the deformity.

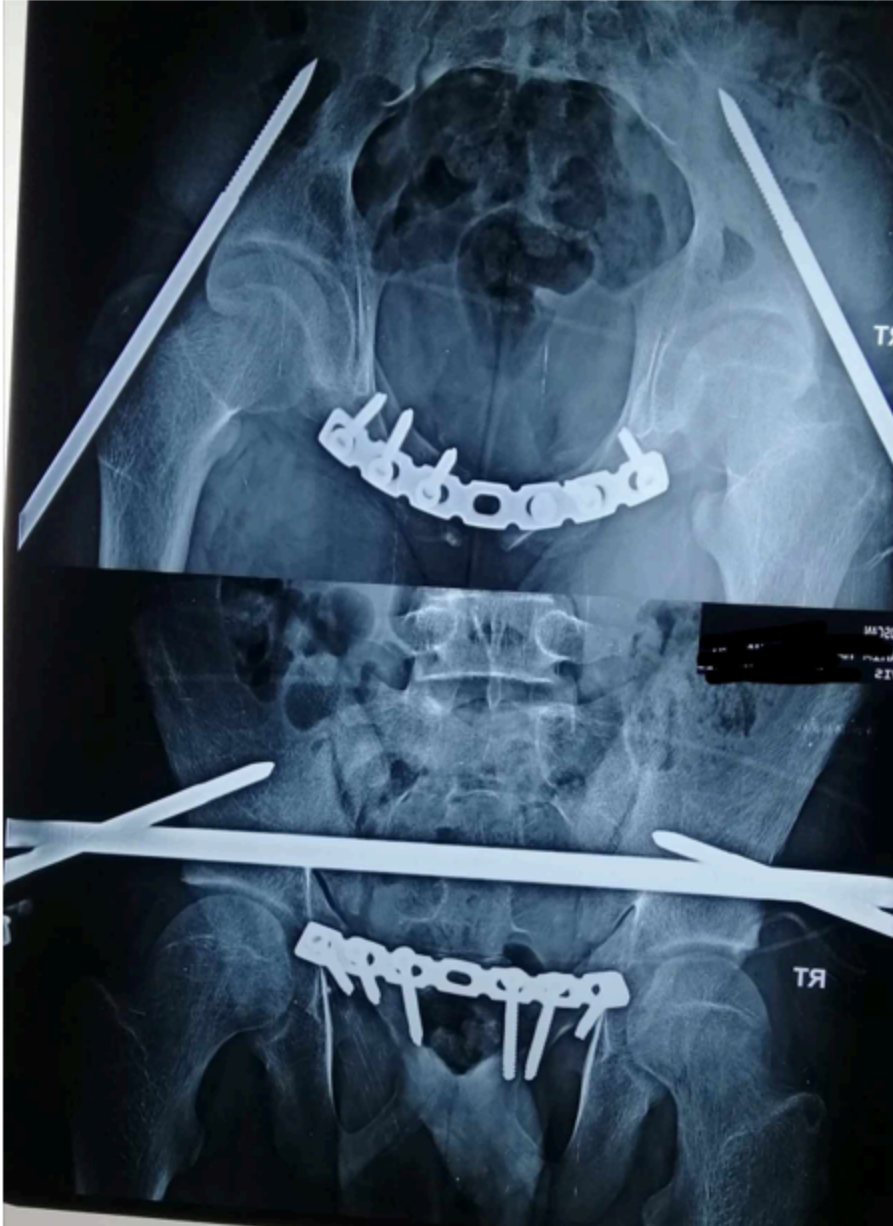


Figure 3

The Hybrid "Dual-Stability" Construct

Legend: Postoperative inlet and outlet radiograph demonstrating the completed hybrid construct. The supra-acetabular external fixator acts as a "tension band" and neutralizing frame, protecting the internal symphyseal plate from shear forces during the first six weeks of ligamentous healing.

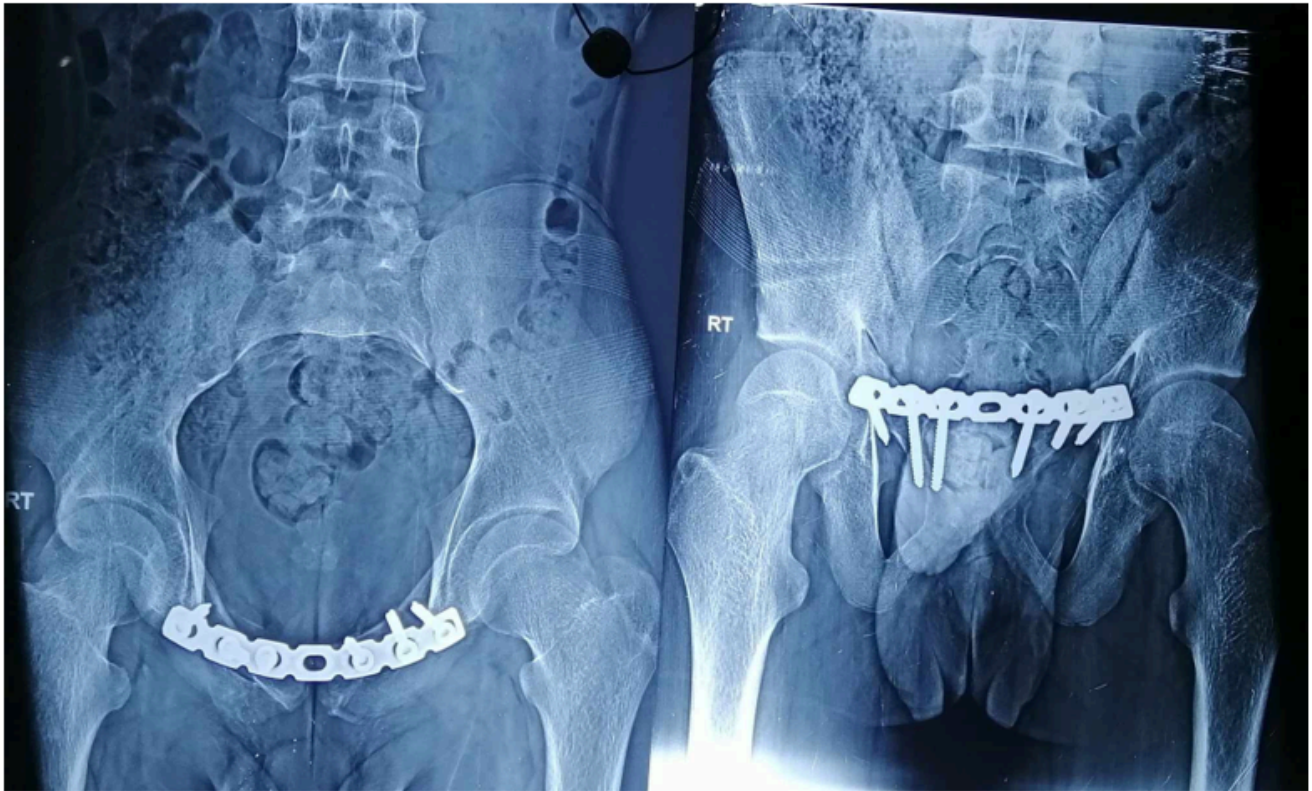


Figure 4

Long-term Radiological Outcome

Legend: Follow-up radiograph at 12 months post-surgery. The external fixator was removed at 6 weeks. There is no evidence of plate migration, screw lucency, or loss of reduction (Matta "Excellent" grade), with complete clinical and radiological union.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Tables.docx](#)