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# Nail-Plate Combination for the Treatment of Pubic Symphysis Disruption and Pubic Rami Fractures

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**Abstract**

***Background.*** Anterior pelvic ring fractures, including pubic symphysis disruption and pubic rami fractures, represent a complex clinical challenge in traumatology. They are associated with significant pain syndrome, loss of weight-bearing function, and often with damage to the anterior abdominal wall caused by stomas, drains, etc. There remains a strong demand in pelvic surgery for effective treatment methods that provide stable bone fixation in this anatomical region, shorten rehabilitation, and improve functional outcomes with minimal complications.

***The aim of the study*** — to demonstrate a new method of simultaneous fixation of pubic symphysis disruption and pubic rami fractures using the nail-plate combination.

***Surgical technique.*** A 10-cm Pfannenstiel incision was made directly along the superior edge of the pubic symphysis, followed by vertical incision of the aponeurosis and dissection of the prevesical space. After revision of the symphyseal rupture zone, the identified diastasis was reduced using Weber or small Jungbluth forceps. Sequential fixation of the pubic rami fractures was then performed with interlocking nails on both sides, but without inserting the locking screws. Without removing the guide from the last inserted nail, a plate was positioned so that its midpoint corresponded precisely to the midline of the reduced pubic symphysis. The nail was then interlocked with two 3.5-mm cortical screws through the plate holes. The guide was removed and connected to the remaining nail (the nail ends usually protrude 1-2 mm from the entry points and are easily palpable).

***Conclusion.*** The method of combined fixation using the nail-plate system is a technically feasible and safe approach for the treatment of pubic symphysis disruptions and pubic rami fractures.

**Keywords:** pubic symphysis disruption; pubic rami fracture; interlocking nail; plate fixation; nail-plate combination.

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# Сопряженная фиксация разрыва симфиза и переломов лобковых костей системой «штифт – пластина»

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**Реферат**

***Актуальность.*** Переломы переднего полукольца таза, включая разрыв лонного симфиза и переломы лобковых костей, представляют собой сложную клиническую проблему травматологии. Они сопровождаются значительным болевым синдромом, нарушением функций опоры и нередко повреждением передней брюшной стенки стомами, дренажами и т. п. В хирургии таза сохраняется высокий спрос на новые эффективные методы лечения, которые бы обеспечивали стабильную фиксацию костей в этой анатомической области, раннюю активизацию и улучшение функциональных исходов с минимальными осложнениями.

***Цель исследования*** — представить новый метод одновременной фиксации разрыва симфиза и переломов лобковых костей сопряженной системой «штифт – пластина».

***Техника операции.*** Выполняли хирургический доступ по Пфанненштилю длиной 10 см непосредственно по верхнему краю лонного сочленения с вертикальным рассечением апоневроза и разведением клетчатки предпузырного пространства. После ревизии зоны разрыва лонного сочленения выявленный диастаз устраняли с помощью щипцов Weber или малых щипцов Jungbluth. Далее выполняли поочередную фиксацию переломов лобковых костей блокируемыми штифтами с обеих сторон, но без установки блокирующих винтов. Не снимая направитель с последнего установленного штифта, укладывали пластину таким образом, чтобы середина фиксатора находилась строго посередине сопоставленного лонного сочленения. Далее выполняли блокировку штифта двумя 3,5 мм кортикальными винтами через отверстия пластины. Направитель снимали и соединяли с оставшимся штифтом (концы штифтов, как правило, выстоят на 1–2 мм из точек входа и хорошо определяются).

***Заключение.*** Метод сопряженной фиксации системой «штифт – пластина» является технически осуществимым и безопасным при лечении разрывов симфиза и переломов лобковых костей.

**Ключевые слова:** разрыв симфиза; перелом лобковых костей; блокируемый штифт; накостный остеосинтез; сопряженный остеосинтез системой «штифт – пластина».

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## INTRODUCTION

Anterior pelvic ring fractures, including pubic symphysis disruption and pubic rami fractures, represent a complex clinical problem in trauma surgery [1, 2, 3, 4]. Such injuries occur in the setting of high-energy trauma (motor vehicle accidents, falls from height) and are associated with high mortality, a risk of urogenital organ injury, and prolonged rehabilitation [3, 5, 6]. The combined injury of the symphysis and pubic bones does not have an established incidence rate, as it is usually described in the literature as a component of broader pelvic trauma [3, 4]. Pelvic ring instability leads to impaired weight-bearing function, chronic pain, and reduced quality of life in affected patients [7, 8, 9].

Modern fixation methods, such as plate osteosynthesis, external fixation devices, and minimally invasive subcutaneous systems (INFIX), demonstrate various advantages and disadvantages. For example, traditional plates provide stability but require extensive surgical exposure, which may lead to infectious complications (4%) and neurovascular injuries (0.3-2.0%) [10]. External fixation, in turn, is associated with a high complication rate (up to 62% cases of pin-site inflammation) [10, 11], while INFIX, although reducing surgical invasiveness, may cause lateral femoral cutaneous nerve neuropraxia in 28% of cases, heterotopic ossification around screw heads in 9.4%, and infectious complications in 1-3% [12, 13].

These limitations underscore the need for continued development of new techniques that combine the stability of classical osteosynthesis with minimal invasiveness [14, 15, 16, 17, 18]. In this context, the nail-plate system, integrating intramedullary nailing and plate fixation, represents a promising solution.

*The aim of the study* — to demonstrate a new method of simultaneous fixation of pubic symphysis disruption and pubic rami fractures using the nail-plate combination.

### Surgical technique

To ensure maximum safety and predictability of the method, its performance was first practiced in an anatomical laboratory on cadaver specimens and is described in detail below with the illustration of the key steps. The optimal surgical approach was determined, the ideal entry points for the locking nails were identified, and the technical reproducibility of all stages of the combined fixation was confirmed. Based on these findings, a standardized operative protocol was formalized and subsequently applied to patients during the clinical phase.

For the procedure, the patient was positioned on a radiolucent surgical table, with rolls placed under the knees to achieve 20-30° of flexion. To monitor urine output and detect intraoperative bladder injuries, a Foley catheter was inserted. The surgical field was disinfected three times with antiseptic solution and draped with sterile linens. A 10-cm Pfannenstiel incision was made directly along the superior margin of the pubic symphysis (Figure 1a) [19]. The concept of the nail-plate combined system for the osteosynthesis of bilateral fractures of the superior pubic rami with nails and fixation of the pubic symphysis disruption with a plate is illustrated in Figure 1b. Intraoperative radiographic control of fragment reduction, as well as nail and locking screw placement, was performed throughout the surgery using a C-arm.

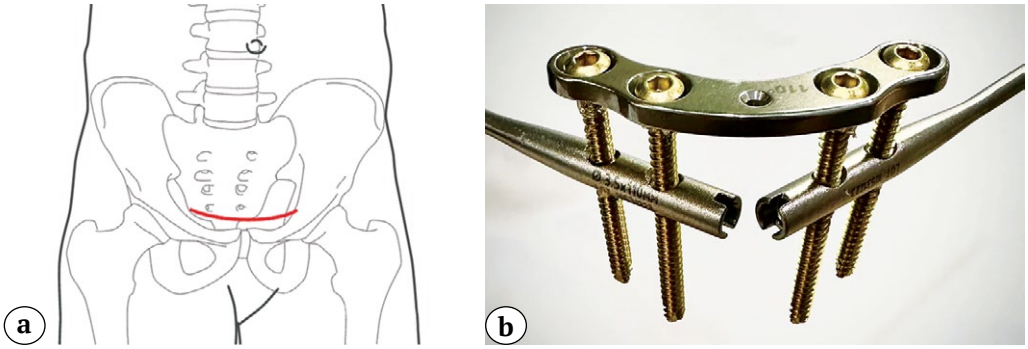


**Figure 1.** Schematic representation of the Pfannenstiel approach (a); conceptual model of the combined nail-plate system, comprising plate fixation of the symphyseal disruption and fixation of bilateral pubic rami fractures with interlocking nails (b)

The aponeurosis was vertically incised along the linea alba, and the rectus abdominis muscles were retracted with hooks. The prevesical (Retzius) space was then bluntly dissected, following the posterior surface of the pubic bone bases (Figure 2a). After the revision of the pubic symphysis disruption, the identified diastasis was reduced using Weber forceps or small Jungbluth clamps (Figure 2b).

The length of the nails was determined according to the Nakatani classification of pubic bone fractures: for fractures in zones I and II, a 110-mm nail was used; for zone III fractures, a 120-mm nail was used (for individuals taller than 190 cm, a 130-mm nail was selected) [20]. It is important to achieve symmetrical entry points for both nails: exactly at the midpoint of the height of the pubic bone base in the outlet view and at the apex of the anterior corner of the pubic bone base in the inlet view.

Sequential fixation of the pubic rami fractures was then performed using locking nails on both sides through a 1-cm contralateral skin puncture located below the Pfannenstiel incision, but without inserting the locking screws. Without removing the guide from the last inserted nail, the plate was positioned so that the midpoint of the implant lay exactly over the reduced pubic symphysis (Figure 3).

To prevent displacement, the plate was temporarily fixed with a 2-mm wire through the technical hole. A drill sleeve was inserted through the guide handle and aligned with the hole in the plate closest to the symphysis (Figure 4).

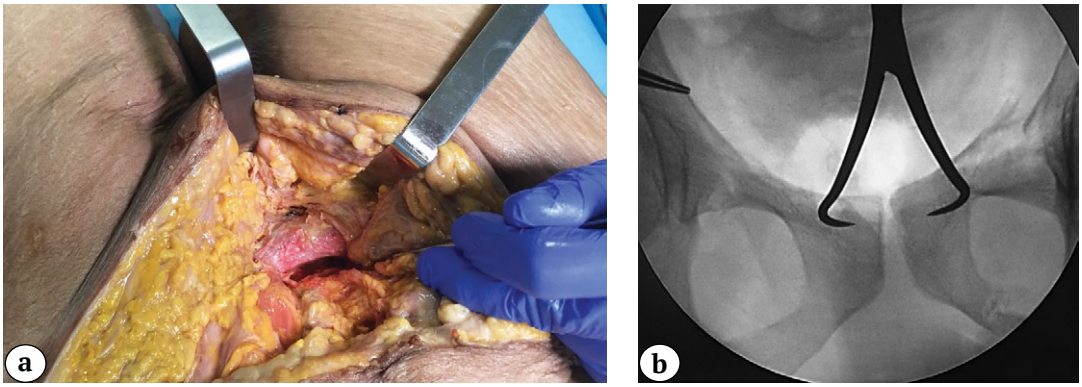


**Figure 2.** Anterior intrapelvic Pfannenstiel approach: a — the incision is extended to 30 cm for illustrative purposes; b — reduction of the symphyseal disruption using Weber forceps

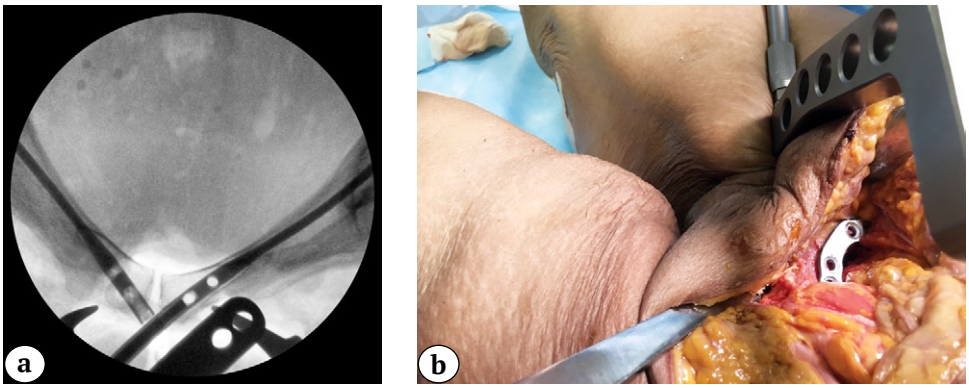


**Figure 3.** Intraoperative inlet view of the pelvic with nails inserted into both pubic bones (a); the plate is positioned at the midpoint of the superior symphyseal border via the surgical approach (b)

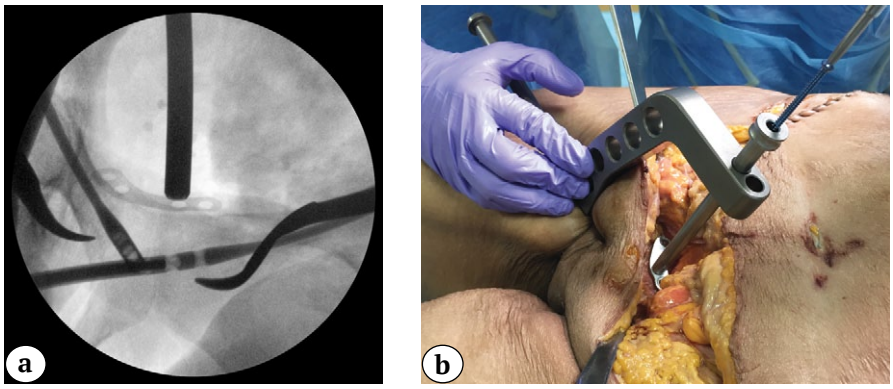

**Figure 4.** Intraoperative outlet view of the pelvis with the guide cannula aligned for nail locking through the plate hole (a); nail locking via the plate hole (b)

If necessary, the nail was slightly adjusted in a retrograde or antegrade direction to achieve precise alignment of the drill sleeve with the plate hole. The nail was then locked with two 3.5-mm cortical screws through the plate holes (Figure 5). The guide was removed and attached to the second nail (the ends of the nails usually protrude 1-2 mm from the entry points and are easily palpable). The optimal angle of the guide for subsequent nail locking was achieved by rotating it around the nail axis under C-arm control.

Standard positioning of the plate after osteosynthesis and the view of the surgical field prior to closure are shown below (Figure 6).

During the clinical phase, when performing this surgical technique, patients underwent drainage of the Retzius space using a Redon drain through a contralateral incision in the area of the Hesselbach triangle. The surgical field was irrigated with saline and closed in layers. Postoperative sutures were covered with a sterile dressing. Before wound closure, the absence of blood in the urinary catheter was verified.

The Pfannenstiel approach allows simultaneous osteosynthesis of bilateral pubic rami fractures with concomitant pubic symphysis disruption, even in the presence of various anterior abdominal wall defects. For example, this technique can be applied in patients with a colostomy or concomitant bladder rupture (Figure 7).

It is important to note that the presented method of anterior pelvic ring stabilization is usually part of a comprehensive surgical approach. In cases associated with posterior ring instability, it should be combined with appropriate fixation techniques, chosen individually based on the complete diagnostic assessment. In our practice, cannulated 6.5-mm screws were typically used (Figure 8).

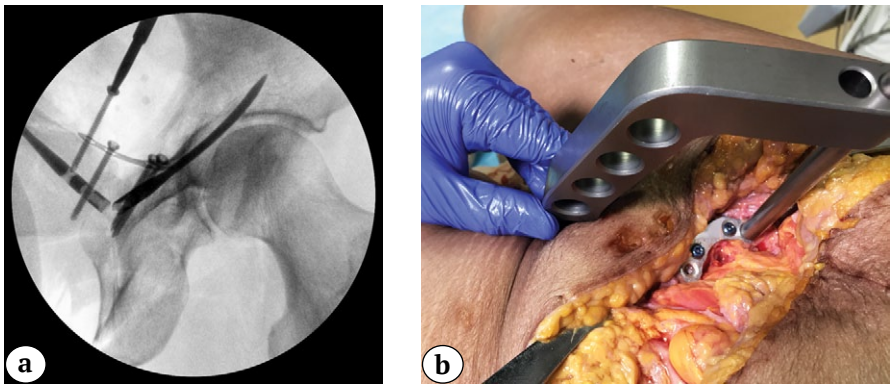

**Figure 5.** Intraoperative obturator-outlet view of the pelvis during locking of the nail with a 3.5-mm screw through the plate hole (a); intraoperative photograph of the surgical site showing interlocking of the second nail through the plate hole (b)

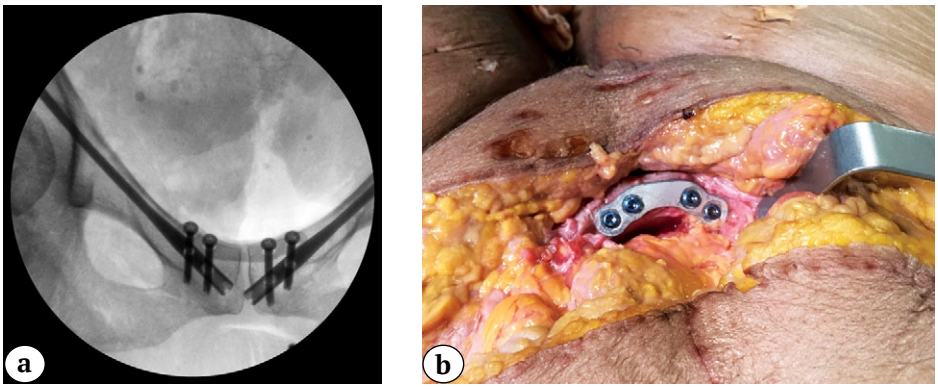

**Figure 6.** Intraoperative anteroposterior view of the pelvis after combined fixation with the nail-plate system (a); intraoperative photograph of the surgical site prior to wound closure (b)

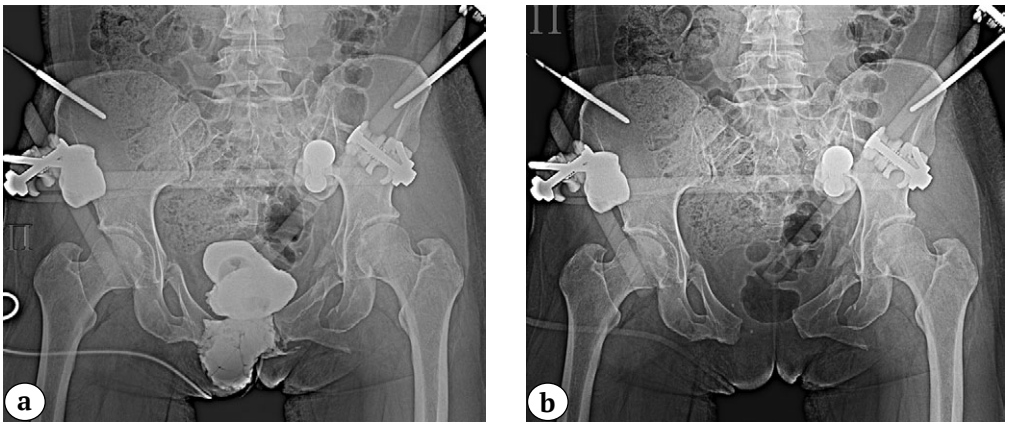

**Figure 7.** Pelvic X-ray in the anteroposterior view: symphyseal disruption with significant diastasis and fractures of both pubic bones (a); cystogram showing extravasation of contrast beyond the bladder contour (b)

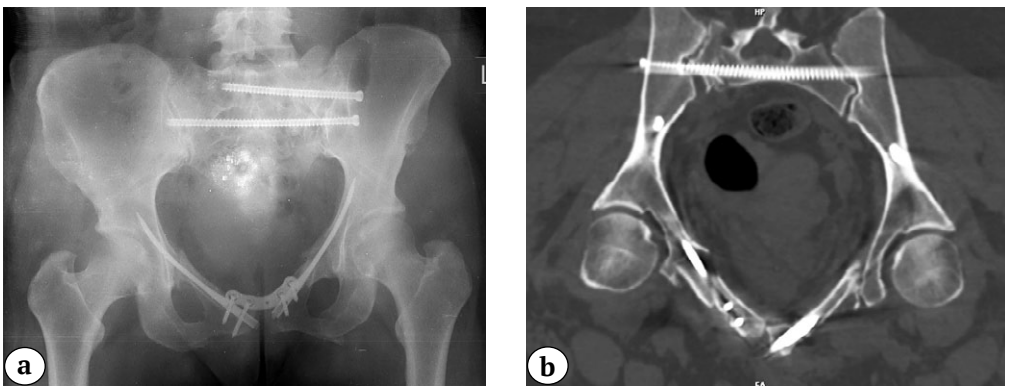

**Figure 8.** Postoperative X-ray: anterior fixation with the nail-plate system and sacral fixation with cannulated screws in S1 and S2 (a); 2D CT reconstruction of the pelvis postoperatively confirming restoration of the pelvic ring anatomy with fixation of the sacrum, pubic bones, and symphysis (b)

In 11 (84.6%) of the 13 patients who underwent the developed surgical technique, an anatomical reduction of the fractures was achieved, as confirmed by intraoperative fluoroscopy. Two patients (15.4%) demonstrated minor displacement (<5 mm) due to osteoporosis, which required correction.

The mean operative time was 120±25 minutes, with a blood loss of 150±50 ml. Postoperative wounds healed primarily in all patients within 10-14 days. Radiographic bone union was observed at 12±2 weeks. No implant-related complications (migration, breakage) were reported.

Functional outcomes were assessed using the Majee scale at 6 months: 9 (69.2%) patients had excellent results (85-100 points), 3 (23.1%) patients had good results (70-84 points), and 1 (7.7%) patient had satisfactory results (55-69 points).

## DISCUSSION

The treatment of anterior pelvic ring fractures (pubic symphysis disruption with concomitant fractures of the superior pubic rami) in patients with a colostomy, epicystostomy, drains, or laparotomy wounds presents a particular challenge due to limited surgical access, the risk of implant-associated infection, and technical difficulties in fixation. Patients with colostomies often have impaired immunity and may develop anemia or hypoproteinemia, increasing the risk of general surgical complications with large incisions.

Isolated fixation of the symphysis alone may be insufficient, and open reduction and fixation of the pubic bones can be technically difficult due to the limited surgical exposure [5].

Providing care for patients with pelvic fractures is generally a complex process that requires a multidisciplinary approach and the use of both surgical and non-surgical treatment methods [11, 21, 22]. The management of anterior pelvic ring injuries, in particular, remains a subject of ongoing discussion within the trauma community [23]. There is a continuous search for minimally invasive surgical techniques due to improving mechanical properties of fixation devices and constantly advancing osteosynthesis technologies [14, 20, 24, 25, 26]. These developments significantly reduce operative time, blood loss, and complication rates. Several surgical approaches for pubic symphysis disruption with concomitant pubic rami fractures have been described in the literature [13, 27, 28, 29]. The choice of treatment method depends on multiple factors, including the specific fracture morphology, the patient's condition, the presence of associated injuries, and the surgeon's preference.

*Plate fixation*. The use of a long J-shaped pelvic plate is considered the gold standard for the surgical treatment of simultaneous pubic symphysis disruption and pubic rami fractures. This method provides high stability even in osteoporotic bone and allows for the precise restoration of the pubic symphysis anatomy. Success is achieved in approximately 90% of cases [3]. Surgical approaches to the anterior pelvis vary and include the Pfannenstiel approach, the modified Stoppa approach, and the ilioinguinal approach according to Letournel, each with its own set of potential complications [10, 13, 19]. However, these methods are not without significant drawbacks: extensive exposure carries the risk of injury to major vessels and nerves, averaging around 4%, and there is potential for blood loss and postoperative infectious complications in about 5% of cases [31]. Screw or plate breakage is frequently observed during treatment, although it generally does not affect long-term outcomes.

*External fixation devices* are the most commonly used method for treating fractures of the anterior pelvic ring. They are employed both as a standalone treatment and as an auxiliary tool for stabilizing pubic bone fractures during the plate fixation of pubic symphysis disruptions [2, 5]. The most frequent complications associated with external fixation include soft tissue inflammation around Schanz screws (18-62%), device failure, and the need for readmission for device removal, which in itself increases treatment costs [14].

*Minimally invasive osteosynthesis with cannulated screws* is used both for the fixation of pubic symphysis disruptions and for osteosynthesis of pubic rami fractures, with screws able to be inserted retrogradely or antegradely. The osteosynthesis of pubic bone fractures with cannulated screws is typically combined with the plate fixation of the pubic symphysis. In this context, the antegrade insertion technique is primarily used, as retrograde screw placement is often impeded by

screws from the plate at the insertion site [31]. Moreover, the method is technically demanding, and in approximately 13% of cases it cannot be performed due to pronounced curvature of the anterior pelvic ring [25]. Complications are mainly related to screw placement outside the bony corridor and may include injury to major vessels, the femoral nerve, the spermatic cord and the suspensory ligament of the penis in men, or the round ligament in women [26].

*Subcutaneous systems: INFIX and Pelvic Bridge Plate*. It has been shown that a new method for treating pelvic fractures — the combination of lower pelvic coverage with a pubic plate — effectively addresses Nakatani type I, II, and III fractures, offering advantages such as rapid recovery, safety, simplicity, and improved aes-thetics [12, 25]. An alternative is the minimally invasive anterior pelvic ring internal fixator (INFIX), although it may not be suitable for all patients due to potential complications, such as femoral nerve palsy and vascular occlusion [31, 33, 34]. Furthermore, the management of the anterior component of unstable lateral compression pelvic ring injuries remains controversial. Researchers continue to compare different fixation methods to identify the most effective approach [35]. There is ongoing exploration of optimal pelvic osteosynthesis techniques, both traditional and novel, depending on fracture morphology and the patient's overall condition [12, 13, 31, 36].

Common complications associated with INFIX include injury to the lateral femoral cutaneous nerve, with reported incidence varying across studies, and heterotopic ossification around the screw heads [25, 32].

We hypothesized that for the osteosynthesis of tilt-fracture type injuries, the use of a combined nail-plate fixation system is entirely appropriate. The principle involves locking the nail through the plate holes, where the screws securing the plate do not interfere but, on the contrary, facilitate compact placement of the fixators within the limited bony space. This concept was made possible by the development of a locking nail [20]. The fundamental idea of hybrid use of fixators, where screws locking the nail pass through plate holes, is not new and has long been applied in osteosynthesis of other anatomical regions, such as femoral and tibial fractures [36, 37, 38].

When using standard symphyseal plates from foreign manufacturers (Synthes, Switzerland; Stryker, USA) or domestic producers (Osteomed, Russia), coaxial alignment between the plate lying over the pubic symphysis and the nail inserted into the pubic bone is lacking due to differing hole spacing in the plate and the nail. Additionally, the fixators are positioned at slight angles relative to each other in both the horizontal and frontal planes. These factors make locking the nail with two screws simultaneously practically impossible. As a result, plate fixation through the nail can only be achieved with a single screw, which is biomechanically suboptimal, since the screw in this configuration acts as a rotational axis for both the plate and the nail, theoretically creating an element of instability. The placement of anti-rotational screws through the remaining plate holes can be problematic due to the narrow bony corridor of the pubic bone base already occupied by the nail. Therefore, we developed a new plate design in which the holes are coaxially aligned with the nail holes to allow for secure locking.

The special design of the plate holes allows the surgeon to adjust the angle of the 3.5-mm screws within a 50° cone, facilitating the task of locking the nail with two screws. This biomechanical concept of dual-screw nail locking has been termed "doublet locking". The concept of "doublet locking" arose due to the technical difficulties of standard fixation, namely inserting screws into the narrow bony corridor of the pubic bone base already occupied by the nail. In our view, for maximal rigid stabilization of a nail locked at only one end, at least two fixation points are required. Moreover, the plate is designed to allow simultaneous locking of two nails in cases of bilateral pubic rami fractures, making it a versatile solution.

The key advantage of this method is the combination of minimal invasiveness (Pfannenstiel approach) with biomechanical stability. This aligns with studies showing that combined fixation methods achieve superior outcomes compared to isolated use of plates or nails [39, 40].

## Study limitations

The small sample size and the lack of long-term follow-up limit the interpretation of the results. Multicenter studies assessing long-term outcomes, such as heterotopic ossification, implant migration, or breakage, are needed to confirm the efficacy of the method.

## CONCLUSION

This study demonstrated that the combined nail-plate fixation method is technically feasible and safe for the treatment of pubic symphysis disruptions and pubic rami fractures. The nail-plate system combines a small Pfannenstiel approach with high fixation stability provided by double nail locking. This allows for reduced operative time and lower risks associated with extensive surgical exposure.

The proposed method aligns with current trends in trauma surgery and may be recommended for clinical implementation in the management of unstable anterior pelvic ring injuries, particularly in patients with polytrauma or a high risk of infectious complications.

## DISCLAIMERS

***Author contribution***

*Zadneprovskiy N.N.* — study concept and design, drafting the manuscript.

*Fain A.M.* — study concept, editing the manuscript.

*Ivanov P.A.* — editing the manuscript.

*Bogolyubsky Yu.A.* — literature search and review, editing the manuscript.

*Mansurov A.N.* — literature search and review, editing the manuscript.

All authors have read and approved the final version of the manuscript of the article. All authors agree to bear responsibility for all aspects of the study to ensure proper consideration and resolution of all possible issues related to the correctness and reliability of any part of the work.

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***Disclosure competing interests.*** The authors declare that they have no competing interests.

***Ethics approval.*** The study was approved by the local ethics committee of Sklifosovsky Research Institute For Emergency Medicine, protocol No 2, 30.04.2022.

***Consent for publication.*** The authors obtained written consent from patients to participate in the study and publish the results.

***Use of artificial intelligence.*** No generative artificial intelligence technologies were used in the preparation of this manuscript.

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