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CASE REPORT — WITH LITERATURE REVIEW

Type C (Tile 3) Pelvic Fracture in a Child Under 3 Years of Age: Case Report and Literature Review

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ABSTRACT

Pediatric pelvic fractures are rare, with an approximate incidence of 1 per 100,000 children per year, and in children under 3 years of age the incidence is exceptionally low, almost always associated with high-energy trauma. Although infrequent, these are serious injuries that require rapid diagnosis, evaluation for associated lesions, and strict surgical criteria, as they do not remodel and may lead to sequelae if not treated promptly. The ideal treatment for unstable fractures is surgical reduction and fixation. We conclude that any pediatric pelvis with signs of instability should be managed surgically to prevent future complications.

Introduction

Although pelvic fractures are relatively common in adults and widely documented in the literature, general orthopedic surgeons must be familiar with this condition in children so that, when it occurs, management can be immediate and effective[1,14,19].

Pelvic fractures in the pediatric population are uncommon, with an estimated incidence of 1 per 100,000 children per year. Despite their rarity, these injuries are identified in 2.4–7.5% of traumatized pediatric patients, and up to 10% are unstable lesions[19,20]. There is a limited number of studies describing the clinical course of pediatric patients with these fractures in Mexico[2,8,10].

Due to the scarcity of statistical information on fractures in the pediatric age group—and even more limited in children under 3 years of age—we consider the presentation of this case essential. The motivation for our report lies in the need to document the available casuistry, describe the management provided, and report the outcomes obtained, with the aim of enriching the existing scientific body of knowledge on this pathology.

Trauma is the leading cause of disability and death in the pediatric population. Although mortality rates have decreased in recent years, they remain high[1,14,19,20].

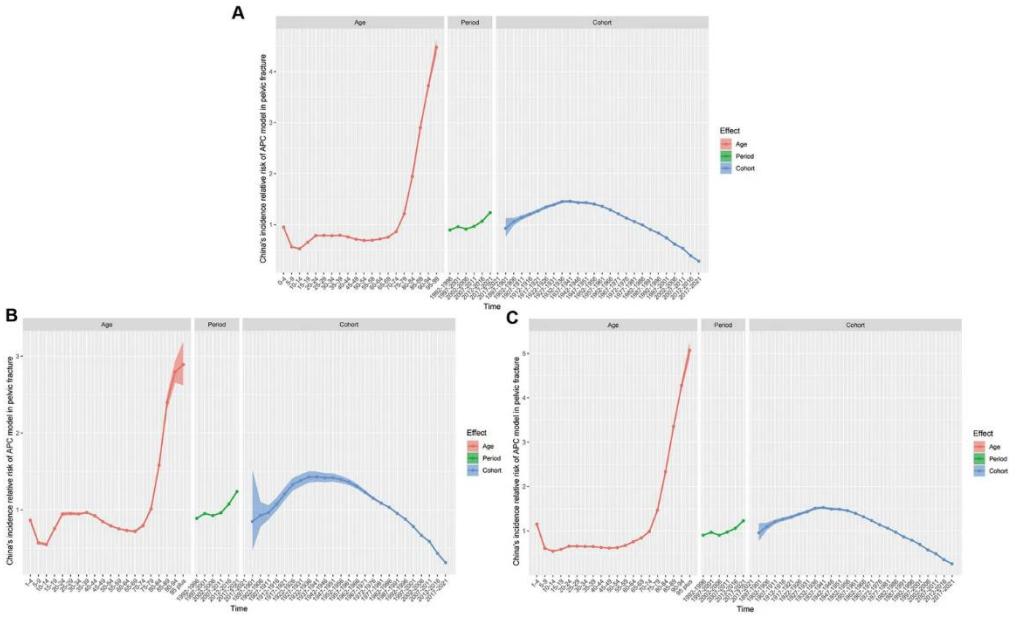
Pelvic fractures in children are indicative of significant high-energy trauma. Patients often present with associated injuries, some of which require urgent intervention to prevent death and disability. The pediatric pelvis and the adult pelvis respond differently to traumatic forces, necessitating distinct approaches for each population[3,14,20].

In trauma centers, approximately 10% of patients with severe trauma sustain a pelvic fracture[5,19].

Regarding the distribution of fractures by sex, there is no exact consensus on the number of cases by age and sex. In his age-period-cohort analysis of epidemiological trends in fractures in China, Chen conducted a 20-year follow-up evaluating the number of cases across all ages and the age-standardized incidence rate. He concluded that children have a lower risk of pelvic fractures, mainly because they are less exposed to high-risk factors. The incidence of pelvic fractures is higher among older adults, which is related to osteoporosis, where even low-energy impacts may cause fractures[5,13,14].

The study conducted by Arturo Brunicardi reported that the risk of pelvic fracture in the general population increases with age, with the lowest risk in the 10–14-year age group (RR = 0.53, 95% CI 0.52–0.54) and the highest risk in individuals over 95 years (RR = 4.47, 95% CI 4.33–4.62). In men, the incidence first decreases and then rises again, with the lowest risk in the 10–14-year group (RR = 0.55, 95% CI 0.53–0.57) and the highest in those over 95 years (RR = 2.89, 95% CI 2.62–3.19). In women, the incidence trend also shows an initial decline followed by a gradual increase, with the lowest risk in the 10–14-year age group, as detailed in Figure[17,15,17,20].

Figure 1: Estimated relative risks of the effects of age, period, and cohort on the incidence of pelvic fractures.



Source: Adapted from *"Age–Period–Cohort Analysis of Epidemiological Trends in Pelvic Fractures in China from 1992 to 2021 and Projections to 2046,"* image, by Chen, Q., Li, T., Ding, H., Huang, G., Du, D., & Yang, J. (2024). *Frontiers in Public Health.* https://doi.org/10.3389/fpubh.2024.1428068

Pelvic fractures were more common among Caucasians than among African American and Asian populations, and more common in males than in females. The most frequent types of pelvic fractures were iliac fractures (42%), pubic fractures (18%), sacral fractures (11%), ischial fractures (10%), and acetabular fractures (8%). The most common associated injuries included lower-extremity injuries (43%), intracranial injuries (16%), thoracic injuries (13%), abdominal injuries (9%), and urogenital injuries (3%). Common complication rates associated with malunion included low back pain (10%), acquired leg-length discrepancy (1%), and acquired scoliosis (0.3%)[7,15,17].

In Mexico, information on pediatric pelvic fractures is very limited; available studies show that they represent less than 1% of all fractures in children, occurring more frequently in males and in school-aged and adolescent populations. In children under 3 years of age, the incidence is exceptionally low and almost always associated with high-energy trauma[2,11].

There are no extensive national registries detailing exact incidence by age and sex. Existing data come from hospital series and local theses, which limits generalizability[10,14].

Classification and Diagnosis:

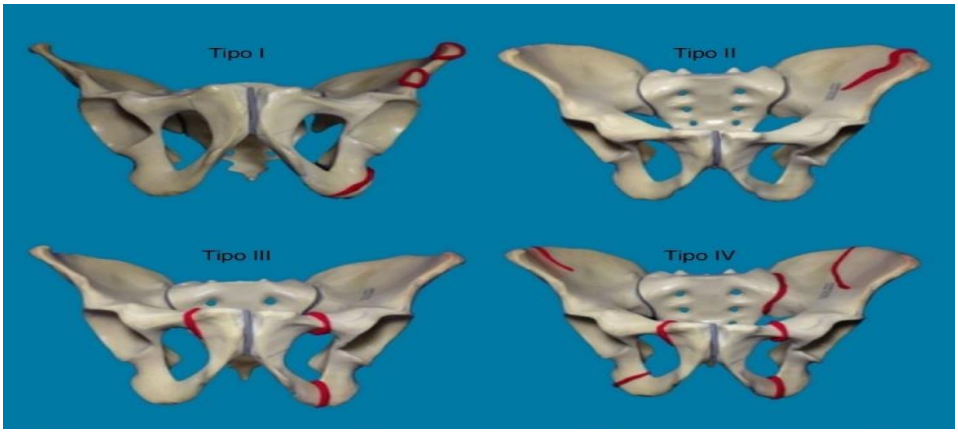
A wide variety of classification systems are currently used to assess the need for surgical fixation in pediatric pelvic fractures. One of the most commonly used systems is the Torode and Zieg classification, which serves as a guide to evaluate the likelihood of associated injuries and the expected outcome, such as the survival of the injured child. Another frequently used system is the Tile classification, which focuses on biomechanical instability but does not take skeletal maturity into account, as it is based on the characteristics of the adult pelvis.

However, the pediatric pelvis has the unique ability to fracture through a single break in the pelvic ring. This is due to the greater elasticity of the pediatric pelvis, attributed to its relatively high cartilage content. Additionally, the pediatric pelvis can absorb extremely large amounts of energy before fracturing, unlike the adult pelvis. Despite these differences, the Tile classification continues to be widely used in both research and clinical practice to determine the need for surgical fixation in pediatric pelvic fractures[6,12].

TORODE AND ZIEG CLASSIFICATION:

- **Type I:** Avulsion fractures of the iliac spines, ischial tuberosity, or iliac crest.
- **Type II:** Simple pelvic fractures without significant displacement.
- **Type III:** Unstable fractures with displacement of the pelvic ring.
- **Type IV:** Associated acetabular fractures. See Figure 2.

Figure 2 Torode and Zieg Classification.



TILE CLASSIFICATION:

- **Type A – Stable (posterior arch intact):** o **A1:** Avulsion injuries. o **A2:** Iliac wing fractures or anterior arch fractures from direct impact. o **A3:** Transverse sacrococcygeal fracture.

In pediatrics, these are usually managed conservatively.

- **Type B – Partially stable (rotational instability with partial integrity of the posterior arch):** o **B1:** Lateral compression injury. o **B2:** Anteroposterior compression injury with pubic symphysis diastasis. o **B3:** Bilateral injury with rotational instability. → In children, these fractures require close monitoring and, in some cases, surgical fixation.

• **Type C – Completely unstable (posterior arch disrupted):** o **C1:** Unilateral injury with vertical and rotational instability. o **C2:** Bilateral injury with complete instability. o **C3:** Injury associated with an acetabular fracture. → In pediatrics, these are the most severe fractures, with a high risk of hemorrhage and the need for urgent surgery.

Pediatric pelvic fractures can be divided into two main groups: fractures that do not involve the pelvic ring (e.g., avulsion fractures or isolated iliac wing fractures) and the so-called pelvic ring fractures, in which the stability of the mechanical ring may be compromised. Fractures that do not involve the pelvic ring are the most common patterns (60% to 80%), but they are relatively benign, stable, and generally associated with good outcomes. However, pelvic ring fractures are more challenging to manage in children[4,12].

Nguyen et al. analyzed current evidence on the incidence and pathophysiology of pelvic injuries. The initial assessment of the patient upon admission should allow us to classify them as severe or potentially complicated[20]. In the following figure (Figure 3), the characteristics that constitute high-risk indicators for pelvic injury are identified; the presence of any of these features places the patient within this high-risk category[3,13,20].

Figure 3: High-Risk Indicators for Pelvic Injury

Indicator	Description
Mechanism of Injury	Pedestrian struck by a vehicle, bicycle collided with a car, vehicle collision with an unbelted passenger, rollover, or ejection.
Abnormal Pelvic Examination	Abnormalities detected during the physical examination of the pelvis.
Lower Limb Deformity or Discrepancy	Difference in length or alignment of the extremities.
Neurological Status	Patient intubated on admission or with a Glasgow Coma Scale score <13.
Hemodynamic Instability	Hemodynamic Instability: Tachycardia, hypotension, need for blood transfusion, hematocrit <30%.

Source: Modified from Nguyen, A. T. M., Drynan, D. P., & Holland, A. J. A. (2022). *Pediatric pelvic fractures – an updated review of the literature.* ANZ Journal of Surgery, 92(12), 3182–3194. https://doi.org/10.1111/ans.17890 [3].

The orthopedic clinical examination of the pelvis must be approached critically, assessing the pelvis for asymmetry, soft-tissue injuries, and discrepancies in leg length or rotation. Through pelvic palpation, clinicians should evaluate for crepitus, stability, or pain at the sacroiliac joints and the pubic symphysis. Morel-Lavallée lesions (separation of the subcutaneous tissues from the underlying fascia) are occult injuries that may go unnoticed if not suspected.

Clinical factors that suggest the need for a pelvic radiograph include hip/pelvic pain, pelvic instability, pelvic contusion/abrasion, externally rotated hip, abdominal pain, abdominal contusion, femoral deformity/thigh pain, or back pain[3,15,20].

Radiographic criteria in pediatric pelvic fractures include discontinuity of the pelvic ring, displacement of the pubic symphysis and sacroiliac joints, and abnormalities on inlet/outlet views. CT scanning is essential to confirm the extent of the injury and to plan treatment.

1. Plain Radiograph (Pelvic AP View)

• **Pelvic ring discontinuity:** any interruption in the cortical line.
• **Displacement of pubic or ischial rami:** indicates an unstable fracture.
• **Asymmetry of the sacroiliac joints:** widening or loss of congruence.
• **Pubic symphysis displacement:** separation greater than 1 cm suggests instability.
• **Indirect signs:** elevated hemipelvis, abnormal rotation of pelvic bones.

2. Additional Projections

• **Inlet view:** evaluates anteroposterior displacement of the sacrum and pubic symphysis.
• **Outlet view:** demonstrates vertical and rotational displacement of the hemipelvis.
• These views help classify the fracture as stable or unstable.

3. Computed Tomography (CT)

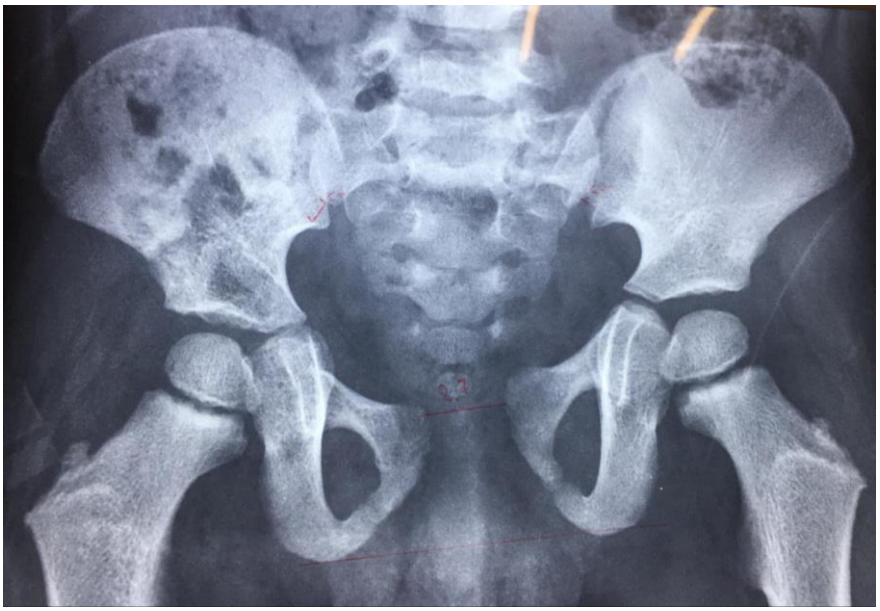
• The **gold standard** for defining the extent and complexity of the injury.
• Allows assessment of: o Sacral and acetabular fractures.
• **Involvement of the sacroiliac joints.**
• **Associated retroperitoneal hemorrhage**[5,6,11].

Clinical Case:

This is a 2-year-and-6-month-old male patient who was injured in a traffic accident in 2018 after being ejected from a moving vehicle during a frontal collision. The child was referred to the Memorial Hospital in the city of Zitácuaro, Michoacán, where he was admitted unconscious but with stable vital signs.

Immediate hemodynamic stabilization and trauma-series radiographs were performed. After resuscitation, the patient regained consciousness, with no clinical evidence of spinal cord injury. The anteroposterior (AP) pelvic radiograph showed a 15-mm diastasis. However, the patient was discharged against medical advice before a pelvic computed tomography (CT) scan could be performed.

Figure 4 Anteroposterior Pelvic Radiograph of the Patient.

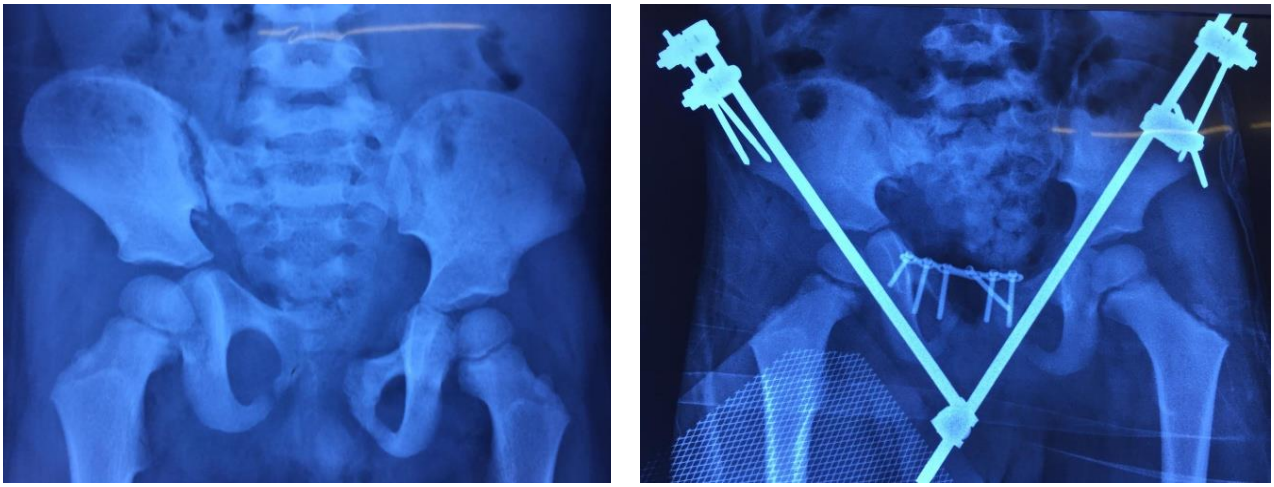


After hospital discharge, the patient was evaluated at a tertiary-care center in Mexico City, where further assessment was performed and conservative management was chosen.

The mother later noticed gait irregularity, as well as changes in the child's usual behavior. Ten days after the initial injury, she returned to the Emergency Department at Memorial Hospital due to the child presenting a Trendelenburg gait, irritability, pain while walking, somnolence, and evident discomfort during ambulation. A new AP pelvic radiograph was obtained, showing a 2-cm pubic symphysis diastasis and a 5-mm sacroiliac joint separation, along with elevation of the iliac wing.

Given these findings, surgical intervention was indicated due to limb-length discrepancy and shortening of the lower extremities. A 2.0 mini-plate was placed at the pubic symphysis, and a wrist mini external fixator was applied to the iliac crest to achieve closure of the anterior pelvic ring.

Figure 5 Pre- and Postoperative Anteroposterior Pelvic Radiograph.



A) Preoperative anteroposterior radiograph of the patient showing diastasis of the right sacroiliac joint and pubic symphysis, corresponding to anterior and posterior pelvic instability. **B)** Postoperative radiograph showing placement of the plate at the pubic symphysis and the external fixator applied to the iliac crests.

The patient remained hospitalized for 5 days following the surgical intervention. During this period, he received multimodal analgesia, prophylactic antibiotics, and strict hemodynamic monitoring. The immediate postoperative course was favorable, with no infectious complications or signs of hemodynamic instability.

Figure 6: Postoperative Photograph of the External Fixator.

At two weeks, physical therapy was initiated, focusing on hip mobility and progressive muscle strengthening. The external fixator was removed at six weeks, while the plate at the pubic symphysis was left in place.

At the three-month follow-up, the patient demonstrated independent ambulation, although mild pain persisted during prolonged walking. At six months, a 1-cm limb-length discrepancy and a residual Trendelenburg gait were noted. Intensive rehabilitation and periodic radiographic monitoring were continued.

At one year post-intervention, the patient showed significant functional improvement, with acceptable mobility and reduced pain.

Treatment:

Although fewer than 10% of patients require surgical fixation, there is a growing trend toward operative management of unstable pelvic fractures (those involving two or more fractures of the pelvic ring with displacement and/or pubic symphysis diastasis). This reflects concern that any asymmetry or displacement will not correct spontaneously, thus requiring surgical intervention to prevent long-term complications such as chronic pain, gait abnormalities, and limb-length discrepancy[3,17,18].

Pelvic ring fractures are more difficult to treat in children. They are rare but severe injuries that pose significant therapeutic challenges. Due to their low incidence, there is no consensus regarding fracture stability or optimal treatment[4,8,10,18].

Studies by Guimarães et al. and Smith et al. demonstrated that the pelvic ring does **not** remodel in any pediatric patient, regardless of age at the time of injury. Therefore, any degree of displacement in pediatric pelvic fractures may become increasingly problematic over time[6,15]. For this reason, conservative management should not be considered for most cases, contrary to what earlier literature suggested[15,18].

Biomechanical studies show that forces up to **6000 N** are required to cause a pelvic fracture in children up to 14 years of age. In one-year-old children, forces up to **10,000 N** did not result in a fracture but instead produced plastic deformation. Additionally, cadaveric experimental studies show that lateral compression of the pelvis up to **55%** is

tolerated in children before a fracture occurs[18,19,20]. Thus, the presence of one or more fractures in the pediatric pelvis is itself an indicator of the immense force sustained and the displacement that occurred prior to structural failure[6,13,15].

Children have tight ligaments and greater joint laxity, which may result in minimal displacement and an apparently stable fracture pattern on initial imaging—even when more than one fracture through the pelvic ring is present or significant displacement occurred during trauma[18,20]. During follow-up, progressive displacement may be observed, retrospectively indicating instability and resulting in pelvic asymmetry. Therefore, the absence of displacement in a pediatric pelvic fracture at initial presentation should not be interpreted as evidence of stability[6,12,13,15].

Although external fixation may be useful in the management of hemodynamically unstable patients, it provides mechanical stability only to the anterior pelvic ring. Therefore, the role of external fixation alone as definitive treatment for pelvic ring fractures is limited. Evidence regarding optimal treatment remains scarce, but experts recommend managing pediatric patients with Tile B and C fracture patterns with open reduction and internal fixation, either anterior alone or both anterior and posterior[4,15,16]. Some guidelines even suggest performing fixation in a delayed fashion rather than during the initial phase, once the patient has achieved overall clinical stability[17,18].

Discussion:

The findings of this case are consistent with what has been reported in the literature: although pediatric pelvic fractures are uncommon—and exceptionally rare in children under 3 years of age—they represent high-energy injuries that require immediate and thorough evaluation. In our patient, the initial 15-mm pubic diastasis and its subsequent progression to a 2-cm widening, along with sacroiliac separation and elevation of the iliac wing, confirm the unstable behavior described in pediatric pelvic ring fractures.

The clinical course reinforces a critical point highlighted by several authors: the absence of significant displacement on initial imaging does not guarantee true stability, due to the elasticity of the pediatric pelvis and the potential for progressive displacement during follow-up. This was clearly observed in our patient, who developed increased displacement and functional alterations (Trendelenburg gait, irritability, pain, and limb-length discrepancy), retrospectively confirming pelvic ring instability.

Our findings also support evidence indicating that the pediatric pelvis does not remodel adequately when displacement is present; therefore, conservative management of unstable fractures may lead to functional sequelae. In this case, the decision to perform surgical reduction and fixation of the anterior ring corrected the asymmetry and prevented long-term complications, in accordance with current recommendations for Tile B and C fracture patterns.

Finally, this case underscores the importance of integrating trauma biomechanics, radiologic findings, and clinical evolution to determine optimal management. The progression of displacement and the emergence of gait abnormalities were key factors in indicating surgical intervention, aligning with the growing trend toward more aggressive management of unstable pediatric pelvic fractures.

Conclusion:

Based on the review conducted, we conclude that it is essential to consider the kinetics of the accident together with the previously described elements, evaluating the pediatric patient according to the particularities of their structural anatomy rather than applying the same parameters used in adults. This approach allows for timely and appropriate initial therapeutic management, including surgical treatment in any pelvis that demonstrates signs of instability or pelvic ring injury. Age alone should not be used as a determinant of regenerative capacity, as early surgical intervention helps reduce long-term sequelae and decreases the need for future rehabilitation.

Multiple studies have demonstrated that surgical management in pediatric patients with unstable pelvic ring injuries offers better short-, medium-, and long-term outcomes. Therefore, surgical indication should not be delayed in cases where it is warranted, always within a multidisciplinary approach and with teams trained to manage these complex injuries.

Ethical Responsibilities Protection of humans and animals:

The authors declare that the procedures followed were in accordance with the ethical standards of the responsible human experimentation committee and with the World Medical Association and the Declaration of Helsinki.

Data confidentiality:

The authors declare that they have followed their institution's protocols regarding the publication of patient data.

Right to privacy and informed consent:

The authors obtained informed consent from the patients and/or subjects mentioned in the article. This document is held by the corresponding author.

Conflict of Interest Statement:

The authors declare that they have no conflicts of interest.

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