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## Case Report

# Percutaneous sacroiliac screw fixation in a pediatric with unstable bilateral superior rami and sacral fracture-dislocation; a case report and review of the literature

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## ARTICLE INFO

## Keywords:

Case report  
Sacroiliac screw  
Fracture-dislocation  
Pediatric pelvic fracture  
Screw fixation

## ABSTRACT

Complex pelvic ring injuries in childhood can be difficult to treat, and literature mentions several techniques for fixing SIJ fracture-dislocations. In accordance with the CARE (CARE) guidelines, this study describes a five-year-old boy with a complex pelvic ring fracture caused by a car accident: vertically unstable pelvic fracture consists of bilateral superior rami fractures and type I of Denis sacral fracture. Fixation was achieved by inserting a 6.5 mm major diameter cannulated screw with a 60 mm length and 16 thread into the SIJ at the level of S1. The pelvic inlet view corrected the anterior-posterior position, and the pelvic outlet view adjusted the superior-inferior position to determine a suitable sacral level. After three months, the SI joint has shown an anatomically fracture consolidation, and he could ambulate with full weight-bearing and full ROM with no pain. A 3-year follow-up showed promising results in radiological and functional terms.

We conclude that percutaneous SI screw fixation using a cannulated screw is a suitable technique for pediatrics because it provides anatomic reductions and is minimally invasive. Children as young as five can be treated safely with SI screws for sacral fractures and SIJ injuries.

## Introduction

Pelvic fracture is rare in children and consists of about 0.2% of pediatric fractures [1–10]. 50% of pediatric pelvic fractures are unstable and cause serious morbidity. Around half of the children with unstable pelvic fractures have sacroiliac joint (SIJ) dislocation [11]. Following unstable pelvic fractures, low back pain, limping, scoliosis, limb length discrepancy, and pelvic asymmetry are common morbidities [3–5]. SI arthrosis or premature fusion may occur after trauma, but the incidence of these changes can be reduced by ensuring adequate reduction and fixation [3].

Complex pelvic ring injuries can be challenging to treat. Literature mentions several techniques for fixing a SIJ fracture-dislocation, including external fixators and the Kirschner wire [1,7], traction and spica cast [1], iliac screw and rods [10], screw and plate [12], and sacroiliac (SI) screw [2–6,9]. Children with SI fracture-dislocations may heal more quickly and have fewer complications with percutaneous screw fixation with SI screws [2,13].

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According to the CAse REport (CARE) guidelines [14], the present study describes a five-year-old boy who suffered a complex pelvic ring fracture as a result of a car accident. The vertically unstable pelvic fracture, which included bilateral superior rami fractures and a type I Denis [15] sacral fracture was fixed with one percutaneous cannulated screw. To our knowledge, the technique has not been extensively studied in these rare cases of the age group.

### Case presentation

A five-year-old boy who was involved in a car accident was referred to our institute's emergency service. During serial examinations and imaging, he revealed that he had no abdominal solid organ damage or intra-abdominal free fluid. He had gross hematuria, dominant pelvic and sacral tenderness, and painful bilateral hip joints that had restricted ranges of motion (ROM). An anterior-posterior (AP) pelvic radiograph and CT-scan (Fig. 1), bilateral superior rami fractures, and left sacrum fracture (type I of the Denis classification). We did urology consult for his hematuria, and conservative treatment has been done.

After suitable optimization, we decided to fix his SIJ fracture with one percutaneous cannulated screw (Figs. 2). After three months, his SI joint has shown fracture consolidation anatomically (Fig. 3a), and he could ambulate with full weight-bearing and full ROM. He has neither pain nor tenderness in his SIJ in his three-year follow-up (Fig. 4) nor deformity or union problems (Fig. 3b). Full ROM in his hip and vertebra, and his pelvic shape has no asymmetry. Regarding patient-reported outcomes, the level of pain using the visual analog scale (VAS) scale and function using the Oswestry Disability Index (ODI) were obtained from the case at a 3-years follow-up. The patients reported a VAS pain score = 0 and ODI of 0 (minimal disability).

### Surgical technique

After appropriate anesthesia at a supine position on a radiolucent operation bed and under a C-ARM guide, a 6.5 mm major diameter cannulated screw with 60 mm length and 16 thread (Figs. 3 and 4) was inserted in his SIJ at the level of S1. A lead shield was placed over the patient's thyroid during the procedure.

### Discussion

This study describes the surgical technique for percutaneous SI screw fixation of a pediatric pelvic fracture with acceptable results after a three-year follow-up period. Moreover, similar cases in the literature were reviewed (Table 1). A variety of methods is available to treat pediatric pelvic fractures, including traction, external fixators, k-wires, and spica casts, alone or in combination [1,7]. For

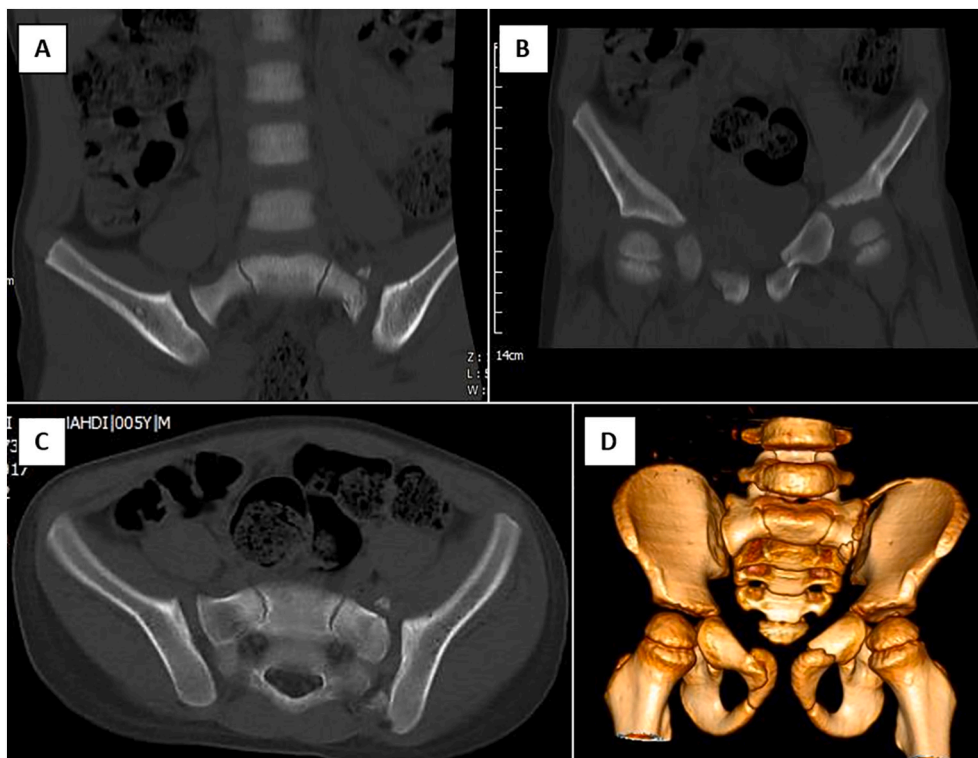


Fig. 1. Pelvic radiography CT-scan. A, B. Axial plane. C. Coronal plane. D. 3D reconstruction.

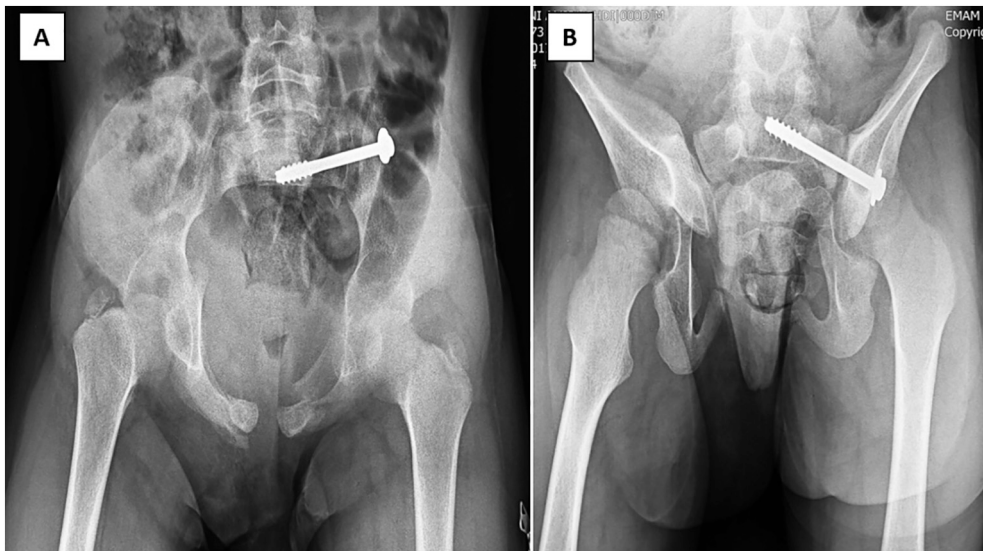


Fig. 2. Post-op pelvic radiograph. A. Inlet view. B. Outlet view.



Fig. 3. 3-months and 3-years follow-up radiographs.

children with pelvic fractures, the treatment depends on their age, pelvic ring stability, fracture classification, concurrent injuries, and hemodynamic stability [16].

Healing of the SI joint is necessary for pelvic ring fractures that include disruption of the SI joint. Immobilization in a near-anatomic position is required to heal [9]. It is possible to reduce anatomic structures via closed manipulation or traction; thus, conservative treatment for these kinds of pediatric injuries is common; however, in the event of both vertical and horizontal instability, this cannot be achieved and may lead to a long time of immobility and suffering for children. Furthermore, it may cause pelvic asymmetry and chronic pelvic pain [4,6,9,12]. This non-operative management includes a pelvic sling, traction, or a spica cast.

Pelvic ring injuries associated with complex, unstable ring fractures are highly likely to develop deformities. Surgical intervention rates, residual deformity, and low back and SI joint pain are higher in complex displaced injuries [5]. Therefore, anatomic reduction and internal fixation may be beneficial in pediatric patients with unstable pelvic fractures [17].

As a surgical treatment, anterior external fixation is efficient in patients with open-book compression fractures. In severe fractures, both rotationally and vertically, it cannot adequately stabilize the fracture [18,19]. The most common treatment for displaced posterior rings is open reduction internal fixation (ORIF). Despite its merits, ORIF has some demerits that can limit its usage in some cases. This technique is more invasive and imposes a risk of infection, wound complications, and blood loss on the patients [20]. In place of ORIF, SI screws can be inserted percutaneously through the iliac wing and into the sacral vertebral bodies under the C-arm [9].

In this study, we used a 6.5 mm cannulated screw with 60 mm length and 16 threads inserted precisely under C-ARM control into SIJ at the level of S1 to fix the SIJ. The long-term follow-up showed promising results in terms of radiological and functional outcomes.





Fig. 4. Patients examination at 3-years follow-up with full ROM and no pain and movement limitations.

The authors believe that the described technique is safe and efficient for unstable pelvic ring fracture and SIJ fracture-dislocations. Authors find it novel to report using percutaneous SI Screw Fixation in a young child aged 5 years with complicated sacral fractures-dislocations and observing excellent outcomes after 3 years of follow-up.

Because a small pediatric pelvis has a narrow safe sacral corridor, SI screw insertion is a challenging surgical procedure requiring high surgical skill and CT guidance. Also, inserting this screw under certain circumstances, such as when the patient is very young, has pelvic dysmorphism, or has displaced fractures with bilateral injury, can increase the risk of iatrogenic complications like neurovascular injury and implant jamming [12]. As a major complications of the injury and its management, SIJ fusion and arthritis are most important [3]. Engelhardt described a case of bilateral SIJ disruption and rami fractures in a 7-year-old patient that fused both SIJs after external fixation [21]. This debilitating complication resulted in a significant pelvic deformity. SIJ affection cause pelvic incongruity and results in leg length discrepancy reported in 4 out of 7 cases [21].

Sa-ngasoongsong et al. [12] introduced a novel spinal pedicle screw-plate (PSP) system to stabilize bilateral posterior pelvic injury in pediatrics. They claimed that their approach was minimally invasive, lowered the risk of iatrogenic neurovascular injury, and produced more stability than SI screws [12]. In their opinion, this method is a very safe and helpful technique, especially with very young children and those with bilateral injuries. Also, Blondel et al. [10] explained using pedicular screws and rods for anterior SIJ dislocations. It could be an attractive therapeutic option to manage these rare pelvic lesions in a unique posterior manner, as suggested by them. Contrary to percutaneous SI screws, this procedure is more invasive, and wound healing must be attended to carefully [10].

Using the cannulated screw with the percutaneous technique has shown promising results for pediatric pelvic fractures in literature [2,6,9,18] and shows excellent outcomes in patients in extended follow-up. Abdelgawad et al. [2] reported 11 pediatric pelvic fracture cases fixed by this technique. One case cursed neurological complications because a screw damaged the nerve root at the insertion site that healed at the latest follow-up. In one of the cases, fixation failed. Thus, Except for one patient, all patients healed of their injuries without displacement or implant failure with full recovery [2].

Baskin et al. [9] had three similar cases that all achieved union. However, one of them complained of pain and tenderness at the surgical site after about one year because of screw migration that healed after screw removal. We also used this technique in our case and achieved perfect union and full function without any complications or pain in our patient's usual activities and sports activities.

No compelling recommendation exists regarding metal removal after healing in this age group. 2 out of 11 patients in Abdelgawad et al.'s study had removed SI screws, and they did not recommend removal routinely except when parents decide to do so [2]. Also, 3 out of 16 in the Kruppa et al. study removed the hardware after healing [5]. However, Baskin et al. reported a 2 mm migration of SI screw after 12-months that caused pain and limping [9]; therefore, they removed the screw. The authors believe the SI screw will not

**Table 1**  
Current literature on complex unstable pelvic ring fracture.

Authors	Age	Sex	Fracture	Fixation	Outcome	Follow-up
Qi Zhang et al. (2009) [11]	3 years	Boy	Anterior dislocation of the right SI joint, separation of the symphysis pubis, fractures of pubic rami and right iliac wing	External fixator	Right leg appeared 1 cm shorter, limping, mild subluxation of the right hip joint	13 months
	7 years	Boy	Anterior dislocation of the left SI joint, diastasis of the symphysis pubis, fractures of pubic rami	Two Kirschner wire and spica cast	Equal long legs, satisfactory walking and running ability	11 years
	2 years	Boy	Anterior dislocation of the right SI joint, fracture of right superior pubic ramus	Bilateral traction for 6 weeks	Equal long legs and satisfactory functional recovery	11 months
	4 years	Boy	Bilateral dislocation of the SI joints, right ilium dislocated anterior to sacrum, symphysis diastasis, fractures of the right posterior ilium and pubic rami	Traction for 3 weeks	Good hip function and walking normally, asymmetry developed in the bilateral buttocks	10 years
Dae-Hee Lee et al. (2011) [4]	8 years	Boy	Diastasis of the symphysis pubis, bilateral SI joint dislocation, left superior and inferior pubic ramus fractures	Bilateral SI joint cannulated screw, plate fixation for pubic synthesis	Equal length legs, full knee extension, full range of motion in both hips, and unassisted ambulated	18 months
Benjamin Blondel et al. (2011) [10]	12 years	Girl	Pubic rami and ilia on the left side, symphysis diastasis, transverse process of lumbar vertebrae	Four iliac screws and one pedicular screw in L5 with two rods	unassisted ambulated, the full force of both lower extremities	6 months
Amr A. Abdelgawad, et al. (2016) [2]  11 cases	17 years	Girl	Sacral fracture, bilateral iliac wing fracture	SI joint cannulated screw	9 patients achieved healing with the return of function; one of the patients lost the follow-up, One of the patient's fixations failed	The average follow up in this study was 15.1 months (range, 1 to 75 months)
	14 years	Girl	SI joint disruption Superior and inferior pubic rami fractures	SI joint cannulated screw	One of the patients had neurological complication related to screw insertion	
	17 years	Girl	Bilateral sacral fracture Left acetabulum anterior column fracture with posterior Hemi transverse extension	SI joint cannulated screw		
	17 years	Boy	Sacral fracture	SI joint cannulated screw		
	15 years	Boy	SI joint disruption	SI joint cannulated screw		
	17 years	Boy	SI joint disruption	SI joint cannulated screw		
	13 years	Boy	SI joint disruption, Pubic symphysis widening	SI joint cannulated screw and anterior plating		
	15 years	Girl	Sacral fracture	SI joint cannulated screw		
	10 years	Boy	SI joint disruption	SI joint cannulated screw		
	6 years	Boy	SI joint disruption	SI joint cannulated screw		
	13 years	Boy	SI joint disruption, Bilateral pubic rami fractures, right acetabulum fracture	SI joint cannulated screw		
Brian R. Dilworth et al. (2017) [6]	13 years	Boy	SI joint disruption, symphysis diastasis, Bilateral pubic rami fractures, bilateral groins wound extended to the rectum	SI joint cannulated screw	Full weight-bearing, full range of motion in both hips, and unassisted ambulated	2 years
Kevin M. Baskin et al. (2004) [9]	13 years	Girl	SI joint disruption, symphysis diastasis, pubic rami fractures	SI joint cannulated screw and external fixator	Full weight-bearing, unassisted ambulated, low back pain	3.5 years
	8 years	Girl	SI joint disruption, symphysis diastasis, pubic rami fractures, T11–T12 spinal cord contusion	SI joint cannulated screw and external fixator	Ambulatory in braces because of spinal cord injury	17 months
	14 years	Boy	SI joint disruption, symphysis diastasis, pubic rami fractures	SI joint cannulated screw and external fixator	Full weight-bearing, unassisted ambulated, surgical site tenderness because of screw migration that solved with screw removal	12 months
Walid A. Elnahal et al. (2018) [7]	4 years	Boy	Fracture-dislocation of the sacroiliac joint, pubic rami fractures	Kirschner wires through the S1 and S2	Full weight-bearing, unassisted ambulated, able to participate in	5 years

(continued on next page)

**Table 1** (continued)

Authors	Age	Sex	Fracture	Fixation	Outcome	Follow-up
Aphon Sangasoongsong et al. (2015) [12]	2 years	Girl	Right SI fracture-dislocation, left SI joint dislocation, and left pubic rami fractures open and bilateral unstable pelvic fracture with a perineal and anal tear, left sciatic nerve injury	sacral segments, external fixator, spica cast  Spinal pedicle screw-plate	sports activities, 9 mm pelvic asymmetry, left side triradiate cartilage fused, dysplastic changes of the left hip  Full weight-bearing, unassisted ambulated, no sign of infection, leg length discrepancy, or recurrent pelvic instability	18 months
Hua Zhang et al. (2013) [22]	14 years	Girl	Right pubic rami and acetabulum fracture, anterosuperior SI disjunction on the right side, and sacral fracture on the left side	SI joint cannulated screw and multiple plating	Full weight-bearing, unassisted ambulated, moderate strength in the left knee extension, right foot drop, pain in the right hip when walking	6 months

cause SIJ fusion, and it's logical to leave the screw in place until no consequences occur or the parents decide to remove it.

Percutaneous SIJ screw is a suitable technique, especially in multiple trauma patients, due to minimally invasive and low blood loss during operation and minimal soft tissue and wound complications [2,9]. However, this technique has some limitations, e.g., this technique is highly demanding due to various narrow safe sacral colliders, certainly in pediatrics because of the small pelvic size to avoid neurovascular injuries [12]. Moreover, this surgery method needs fluoroscopy and C-arm, and the radiolucent operative bed. Since high precision is required during this technique, and we perform imaging in different views during the surgery, the patient is exposed to radiation. Surgeons should minimize the radiation exposure to patients by using as little imaging as possible during surgery, and a lead shield should protect the thyroid gland. In some studies, SI screw fixed under the CT-scan guide is more accurate but has a higher risk of radiation [9,20]. Hence, children with unstable pelvic fracture-dislocation may benefit from this method under precaution.

## Conclusion

The percutaneous SI screw fixation with cannulated screw is suitable in pediatrics due to its minimal invasiveness and low blood loss. Furthermore, it is useful in achieving anatomic reduction and appropriate fixation of an unstable pelvic fracture in children. For children as young as five, SI screws can be used to treat sacral fractures and SIJ injuries. The procedure was performed without any serious complications, and it was a successful operation. Equipment is essential for every surgery, but experience is equally important, especially with this technique.

## Patient perspective

In our 3-years follow-up, the patient expressed his complete satisfaction upon completing the surgery and treatment. It was reported by the patient that he did not experience any pain or functional impairment after the surgery.

## Funding

There is no funding source for authors to declare.

## Informed consent

Written informed consent was obtained from the participant and his parents.

## Declaration of competing interest

There is no conflict of interest with the authors to declare.

## Acknowledgments

None.

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