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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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 CAse REport (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 institution'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].

Fig. 1. Pelvic radiography CT-scan. A, B. Axial plane. C. Coronal plane. D. 3D reconstruction.
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 SLJ at the level of S1 to fix the SLJ. The long-term follow-up showed promising results in terms of radiological and functional outcomes.

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

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

| Authors                        | Age  | Sex | Fracture                                                                 | Fixation                        | Outcome                                               | Follow-up |
|--------------------------------|------|-----|--------------------------------------------------------------------------|---------------------------------|-------------------------------------------------------|-----------|
| Qi Zhang et al. (2009) [1]     | 7    | Boy | Anterior dislocation of the left SI joint, diastasis of the symphysis pubis, fractures of pubic rami and right iliac wing | Two Kirschner wire and spica cast | Equal long legs, satisfactory walking and running ability | 11 years  |
| Dae-Hee Lee et al. (2011) [4]  | 8    | Boy | Diastasis of the symphysis pubis, bilateral SI joint dislocation, left superior and inferior pubic rami 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  | Girl | Pubic rami and ilia on the left side, symphysis diastasis, transverse process of lumbar vertebrae | Four iliac screws and one pedicular screw in il with two rods          | Unassisted ambulated, the full force of both lower extremities | 6 months  |
| Amr A. Abdelgawad, et al. (2016) [2] | 17  | 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) |
| 11 cases                      |      |     |                                                                          |                                 |                                                       |           |
| 14 years                      | 17   | 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                      | 17   | Boy | Bilateral sacral fracture Left acetabulum anterior column fracture with posterior Hemi transverse extension | SI joint cannulated screw       |                                                       |           |
| 15 boys                       | 15   | Boy | SI joint disruption                                                   | SI joint cannulated screw       |                                                       |           |
| 17 years                      | 13   | Boy | SI joint dislocation, Pubic symphysis widening                         | SI joint cannulated screw and anterior plating |                                                       |           |
| 15 years                      | 15   | Girl | Sacral fracture                                                        | SI joint cannulated screw       |                                                       |           |
| 10 years                      | 10   | Boy | SI joint dislocation                                                   | SI joint cannulated screw       |                                                       |           |
| 6 years                       | 6    | Boy | SI joint dislocation                                                   | SI joint cannulated screw       |                                                       |           |
| 13 years                      | 13   | Boy | SI joint dislocation, Bilateral pubic rami fractures, right acetabulum fracture | SI joint cannulated screw       |                                                       |           |
| Brian R. Dilworth et al. (2017) [6] | 13  | Boy | SI joint dislocation, 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  | Girl | SI joint dislocation, 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                       | 8    | Girl | SI joint dislocation, 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                      | 14   | Boy | SI joint dislocation, 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   | 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)
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.

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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.

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