Management of complex pelvic fracture and sacral fracture Denis type 2 using spanning unilateral fixation of L5 to S2AI screw

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A B S T R A C T

INTRODUCTION: Posterior sacropelvic ring injury due to vertical shear type sacral fracture is the result of high-energy trauma. This fracture may be accompanied by neurological injury in 50% of cases. An understanding of sacral anatomy, its mechanisms of injury and types of sacral fracture, as well as treatment options may change the rational of the approach. The unique anatomic shape in the sacropelvic junction and the complex biomechanical forces can present challenges when attempting anterior and posterior pelvic reconstruction and instrumentation.

PRESENTATION OF CASE: In this case, we present a complex pelvic fracture and sacral fracture Denis type 2 managed with staged operations consisting of anterior reconstruction followed by posterior reconstruction using spanning unilateral fixation of 5th lumbar to 2th Sacral-Alar-Iliac with different incision technique from the normal conventional approach.

DISCUSSION: The use of 2th sacral Alar iliac screws (S2AI screw) offered immediate stability and helped in fracture reduction while creating good biomechanical strength, there was no need for cross-connectors which minimized the prominence of the implant, and also decreased the risk of post-operative wound infection.

CONCLUSION: The new technique of spinopelvic fixation provides increased immediate postoperative stability. Success of this procedure can be achieved by performing the procedures systematically on appropriately selected patients.

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1. Introduction

Depending on a fracture’s personality and patient’s comorbidity, surgical therapy of the sacral fracture needs special concern. This fracture may be accompanied by neurological injury in 50% of cases [1,2]. Sacropelvic fixation is commonly done by an iliac screw device. However, this procedure has many disadvantages. The technique may require several fascial skin incisions and extensive muscle dissection to expose the ilium or the use of offset connectors that will cause prominence of the skin over the posterior superior iliac spine [3].

Fixation of a sacral fracture requires stability in vertical and horizontal directions, but current procedures, including tension band trans iliac plate fixation, local plate fixation open or percutaneous iliosacral screw fixation and trans iliac bars, do not entirely fulfill these stabilization requirements and may result in 2–17.3% fixation failure [7]. Accordingly, we present the new technique of spanning unilateral fixation of L5 to S2AI screw combined with a modified lateral approach for inserting the S2AI screw.

This case report is presented and written in line with the SCARE 2018 criteria [14].

2. Case report

We present a case of a male, 28 years old with history of motorcycle accident with close pelvic ring injury, sacral fracture Denis type 2 with vertical shear type C, close fracture of the right acetabulum Letournel posterior column, close fracture of bilateral superior and inferior pubic rami. The surgery was done by spine surgeon, The figures below show the initial fracture presentation (Fig. 1).

Six days after the admission, the patient’s general condition was stable and amenable to undergone surgery. Then, we planned staged operations consisting of anterior reconstruction followed by posterior reconstruction using spanning unilateral fixation of L5 to S2AI screw.
We planned the 2nd procedure after the 1st ORIF, but the procedure was delayed because of concern about the patient’s general condition that might be affected by the long operation duration (8 h), blood loss (1300 cc), and effect of prolonged general anesthesia from the 1st procedure. We also waited for the inflammation marker and other laboratory markers to be decreased before performing the 2nd operation (Hb 8.0 g/dL–10.2 g/dL, AL 11.200/μL–15.200/μL, Procalcitonin 1.64 ng/mL to 0.08 ng/mL, and the CRP was at constant number >150 mg/L).

We performed the second procedure to fix the posterior pelvic ring using spanning unilateral fixation of L5 to S2AI screw and also planned to reduce the vertical type sacral fracture Denis Type 2 using gentle manipulation through the S2AI screw and rod holder.
Patient underwent plain X-rays, including an AP view with the patient in supine position, a pelvic inlet view, and an outlet view as shown in Fig. 2. Inlet and outlet views were performed to assess rotational, translational, and vertical displacement.

The principle of this technique involves stabilization of the hemipelvis to the axial skeleton via rods and screws that were inserted into the sacroiliac and lumbar spinal pedicles. With the patient in the prone position under general anesthesia, we performed prepping and draping, with aseptic and antiseptic procedures on operation area. Levelling used fluoroscopy. A midline skin incision was made from S3 to L5 spinous process, and the dissection was continued to the lumbodorsal fascia, superficial latissimus dorsi muscle, erector spinae muscle and multifidus muscle. We developed the intermuscular plane between the multifidus and erector spinae muscles. This plane helped to direct us onto the L4/5 facet joint and 5th lumbar transverse process. The 5th lumbar pedicle access point was located lateral to the L4/5 facet joint, and the pedicle screw (6.5 mm in diameter and 4.5 cm in length) was inserted into right 5th lumbar pedicle.

We performed a different incision technique from the normal conventional approach. From the cranial edge of midline incision, we made extension of the incision perpendicular to the 1st incision as far as the right PSIS. A triangular flap was developed, that was then elevated in the suprafascial (thoracodorsal fascia) plane. When we found the outer side of iliac wing, we medially exposed the latissimus dorsi muscle as far as the lateral side of 2nd sacral level. The difference between our technique and the conventional one was that the approach was through the lateral side of the fracture site, avoiding the fracture site of the sacrum where dural tears are common. The schematic approach is explained in Fig. 3.

After we found the S2, we inserted the S2AI screw 2 mm medial to the lateral sacral crest to fix the sacrum to the ilium. First, we pointed the S2AI screw toward the sacro-iliac (SI) joint approximately 20° angulation caudally in sagittal plane and 30° angulation horizontally in the coronal plane. The screw was inserted to about 3–4 cm as far as SI joint. After crossing the SI joint, the screw continued through the cancellous channel of the ilium heading above the superior rim of the sciatic notch (Fig. 4).

After the pedicle screw and iliac screw had been inserted, we applied the rod submuscularly spanning between the L5 pedicle screw and S2AI screw. Then, we proceeded with the reduction to the fracture site by applying gentle manipulation through the locked S2AI screw to mobilize the pelvic segment into medial and inferior under fluoroscopy and direct visualization with a rod holder to help control the rod and reduce the fragment. After the fracture was reduced and the spinopelvic was stable, we finally locked the rod to the right L5 pedicle. The pelvic was stable in rotational and vertical direction as assessed intraoperative fluoroscopy (Fig. 5) then we inserted the drain and closed the surgical site layer by layer. After the posterior procedure was finished, we continued the second procedure to evacuate the anterior screw with the patient in the supine position. Post operative X-ray radiographs show stable pelvic by rotational and vertical direction (Fig. 6). The patient stated the improvement of VAS score from 6 to 3.

3. Discussion

Sacral fractures are common in pelvic ring fractures. The actual incidence is not clear, but it is estimated as 30%. In case of sub optimal management, the fracture may cause persistent pain, reduced motility, gait problems and neurologic deficits [4].

There are some classifications of sacral fracture, This Denis classification system and its modifications are commonly used. Zone II Denis fractures were associated with neurological deficits in 28.4% of the patients. These pathologies are mostly located in the L-5, S-1, or S-2 nerve roots and are associated with bowel and/or bladder dysfunction. All vertical shear injuries assessed involved L-5 with some involving the lumbar plexus and sacral plexus [1].

Sacral fractures do not always require surgical treatment, and the indications for surgical treatment include: severe axial or sagittal spinal misalignment, unstable fractures, and neurologic deficit. Many surgical options are available including: posterior or posterolateral neural decompression, resection of the distal sacrum, reduction and fixation of the lumbosacral spin with spinopelvic fixation and direct reduction and fixation [5].
Fixation of sacroiliac joint fractures and fracture dislocations includes anterior or posterior sacroiliac plates, the use of iliosacral screws, open or percutaneous sacroiliac screw fixation under fluoroscopic guidance, trans-iliac treated compression rods, and sacroiliac fixation using a sacral screw and lateral pressure on the iliac wing with the Galveston technique. Those various techniques have different advantages and disadvantages and should be determined case by case [6].

The main goal of fixing the posterior pelvic ring is the good alignment among ilium, sacrum and the lumbar spine. This is achieved to maintain vertical and rotational stability [7].

In 2007, Paul Sponseller created the S2-alar-iliac screw (S2AI), which, unlike the conventional iliac screw, the S2AI screw has an entry point in the sacral ala. This results in a low profile, more medialized screw head, so the S2AI screw reduces the incidence of prominence related complications [8].

The S2AI screw insertion point and trajectory can be different for each individual because of their different sacral anatomy. This screw allows the surgeon to use an in-line rod construct without the need to bend the rod. Furthermore, other advantages of this technique are that the screw causes less morbidity to the patient by minimizing the size of the incision and reduces dissection of the paraspinal muscle [9].

The normal conventional approach for the placement of S2AI screw is that we expand the dissection field from the previously-made midline incision as far as lateral side of S2 level from midline to lateral, but it requires extensive manipulation and large soft tissue dissection at the fracture site, which can injure the dura mater, cause leakage of cerebral spinal fluid and produce many possible complications. Intraoperative dural tears are a common minor complication of management of sacral fractures (55% of minor complications) and the overall rate of dural tears is 18.6% [13].

Aberrant screw placement has the potential to damage important neurovascular structures including the superior gluteal artery, the sciatic nerve, the obturator nerve, the internal iliac vein and artery and the lumbosacral plexus. Furthermore, a misplaced screw can cause chondral injury to the hip joint if the acetabulum is violated [10].

Comparison studies showed that the incidence of wound infection is significantly lower in the S2AI screw group (overall risk reduction of 22.8%) compared to the group who received IS screw. This difference is because the IS technique requires dissection of...
the subcutaneous tissue off the lumbosacral fascia to the level of the posterior superior iliac spine [11].

Prominence of iliac screw heads was a frequent problem especially in thin patients who performed conventional spinopelvic fixation using iliac screws. It was associated with complications such as screw prominence, gluteal pain, and wound breakdown, primarily because of superficial PSIS entry point [12]. In this case, the S2AI screw had a sacral ala entry, creating a lower profile, more medialized screw head, so the rate of screw prominent is reduced.
4. Conclusions

The new technique of spinopelvic fixation provides increased immediate postoperative stability, decreased surgical site infection and reduction of hardware associated pain, but it is a demanding procedure with significant potential for complications. Success of this procedure can be achieved by performing the procedures systematically on appropriately selected patients.

Declaration of Competing Interest

The authors report no declarations of interest.

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Ethical approval

The informed consent form was declared that patient data or samples will be used for educational or research purposes. Our institutional review board also do not provide an ethical approval in the form of case report.

Consent

We have obtained all patient’s consent and had the statement included in the consent section in the manuscript. We also do not include any of the patients name or the institution.

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

Yudha Mathan Sakti conceived the study. Akbar Mafaza, Zikrina Abyanti Lanodiyu and Galih Prasetya Sakadewa, drafted the manuscript and critically revised the manuscript by Rahadyan Magetasari for important intellectual content. Akbar Mafaza, Zikrina Abyanti Lanodiyu and Galih Prasetya Sakadewa facilitated all project-related tasks.

Registration of research studies

The manuscript is a case report, not considered a formal research involving participants.

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