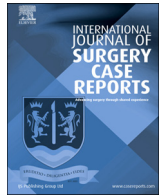




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Surgical technique of percutaneous iliosacral screw fixation in S3 level in unstable pelvic fracture with closed degloving injury and morrell lavalée lesion: Two case reports

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ABSTRACT

INTRODUCTION: Percutaneous screw fixation is considered the best option in unstable pelvic fracture with severe soft tissue injury. However, fixation technique at the level of S3 has not been well established. This paper showed the feasible surgical technique of S3 screw insertion in unstable pelvic fracture with severe soft tissue injury.

METHODS: We reported 2 cases of unstable pelvic injury of an 11 years old boy with Marvin-Tile (MT) C1 pelvic fracture with sacroiliac (SI) joint disruption, skin avulsion and Morel-Lavallée lesion. Second case was 30 years old male with open pelvic fracture MTB2 and vertical sacral fracture Denis zone I with Morel-Lavallée lesion, intraperitoneal bladder rupture, infected laparotomy wound dehiscence. We performed percutaneous screws insertion on both pubic rami and IS screw on S1 and S3 to both cases. Functional outcome was evaluated using Majeed and Hannover pelvic score.

RESULTS: All patients survived and had good reduction with no residual displacement on SI joint. The former case at 21-month follow up presented with excellent outcome (100/100) by Majeed score and very good outcome (4/4) by Hannover score; while the latter case, at 18-month, present with good outcome (85/100) Majeed score and fair outcome (2/4) Hannover score.

CONCLUSIONS: Percutaneous screw fixation at the level of S3 is feasible and can be inserted in S3 level by sacroiliac type and sacral type with minimal soft tissue intervention and good functional outcome.

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1. Introduction

Unstable pelvic ring injury on polytrauma patients can be life threatening. The goals of treatment are not only to ensure the survival of patient, but also to achieve optimal anatomical and functional restoration after surgery [1]. High-demanding surgical technique and detailed 3-dimensional anatomic knowledge is required to obtain this kind of configuration. Classic technique of internal fixation renders an extensive surgical exposure hence increasing the soft tissue injury and further higher surgical infection. A lesser invasive technique is advocated to prevent most of the pelvic fixation complications by means of percutaneous IS screw fixation [2].

Percutaneous sacroiliac screw placement is utilized in the fixation of unstable posterior pelvic ring injuries. In some cases of sacral dysmorphism pelvic injury or in complete vertical sacral fracture, when the elevated upper sacrum does not allow a secure SI

screw insertion into the S1 level, the S2 segment must be secured to achieve stable fixation. However, the bone quality of the S2 segment is thinner compared to that of the S1 vertebra and may cause biomechanical weakness. Hence, an additional SI screw insertion into the S3 may improve stability [2]. However, percutaneous IS screw insertion at the level of S3 has yet been well established. The aim of this study, in line with the SCARE guidelines [3] was to show technical feasibility in IS screw insertion at S3 level.

2. Method

We reported 2 cases of unstable pelvic injury admitted on our Dr. Cipto Mangunkusumo Emergency Room which were asked for consent for publication. First case was an 11 years old boy with pelvic fracture Torode and Zeig IV or Marvin Tile C1 who had right sacroiliac joint disruption, bilateral superior and inferior pubic rami fracture with soft tissue injuries of skin avulsion on the left hip and closed degloving with Morel-Lavallée lesion on the right hip (Figs. 1 and 2). After early management using pelvic binder, vigorous resuscitation, and skin avulsion debridement on the ER, we

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Fig. 1. Early stabilization of patient upon admission. A, emergency fixation using pelvic binder seen from the antero-posterior projection; B, left hip skin avulsion with muscle based and skin loss; C, closed degloving injury of the right hip with Morell Lavallee lesion.



Fig. 2. Pre-operative pelvic Xray. A, antero-posterior projection; B, inlet projection; C, outlet projection.

obtain pre-operative CT 3-dimension scan for the fracture configuration (Fig. 3).

We performed closed reduction internal fixation using percutaneous cannulated screw with fluoroscopy guide. Patient was positioned supine under image intensifier that was previously prepared for free mobilization in AP, lateral, and Judet views. First, we stabilize the bilateral pubic rami fracture then inserted the cannulated screw at the level of S1 for IS fixation using the lag technique in a flat-transversal fashion. Then we inserted another lag IS screw at the level of S3 due to instability after S1 IS screw insertion. The direction of IS on S3 was oblique from supero-cranial to infero-caudal on AP and the aim also oblique from anterior to posterior on lateral projection; similar with the sacral type. The whole process was always observed under image intensifier. The position was continuously changed between AP, inlet, outlet, and Judet view to check the implant position and fracture configuration (Fig. 4).

Patient was reviewed both clinically and radiologically by means of Majeed and Hannover pelvic scoring system. Radiological criteria were assessed by plain AP, inlet and outlet projections, included the quality of fracture reduction and evidence of union. Ten months

after the accident there was no residual displacement in the sacroiliac joint on plain x ray and the patient was able to return back to previous activities with Majeed score 80 out of 100 and good outcome of 3 of 4 by Hannover score. After 21 months of follow up there was excellent outcome Majeed score 100 and very good outcome of 4 out of 4 by Hannover score (Fig. 5).

The other case was thirty years old male with polytrauma ISS score Hannover Group I, consisted of open pelvic fracture Faringer zone III, Marvin-Tile B2, Young Burgess Combined type Lateral Compression I and vertical sacral fracture Dennis zone I with associated Morrell-Lavallee lesion, intraperitoneal bladder rupture, infected wound dehiscence and immunocompromised patient. Patient presented with skin loss at anterolateral thigh-pelvic-flank sized 30 × 10 cm and Morrell-Lavallee lesion on posterior thigh with necrotic muscle, fascia and bone exposed (Figs. 6 and 7).

Patient first underwent necrotomy and debridement of the wound, repair of bladder and pelvic binder application early on the emergency operating theater 12 h after the accident. Seven hours prior to accident patient haemodynamic had returned and we performed open reduction and internal fixation (ORIF) for the anterior

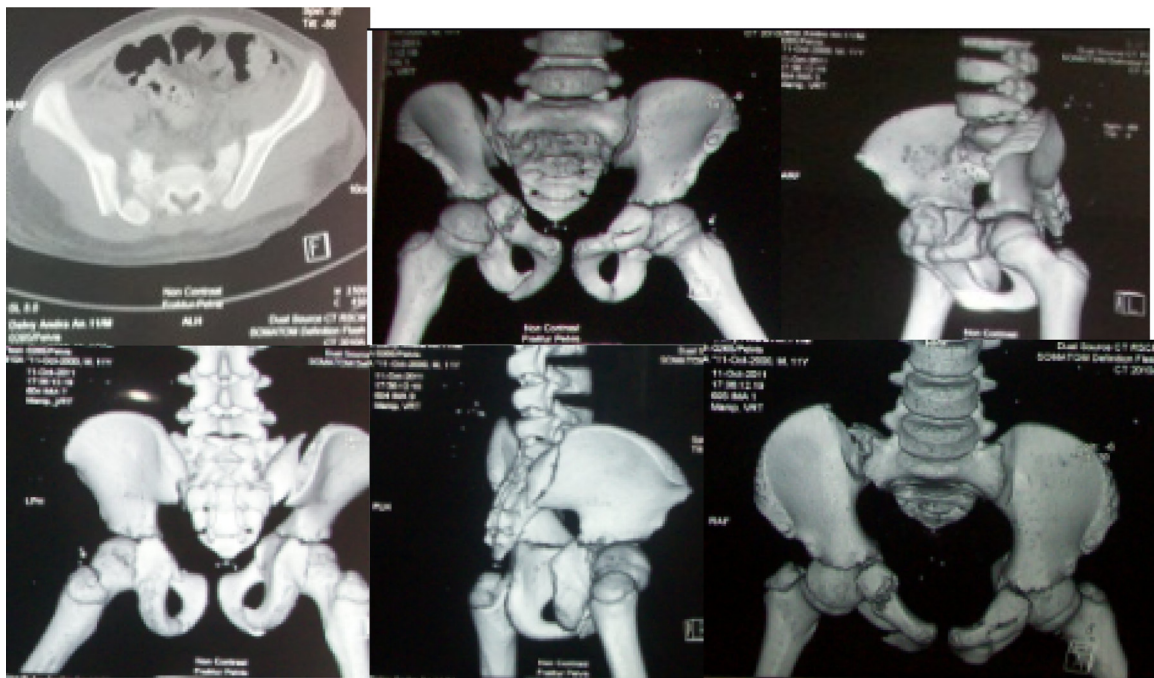


Fig. 3. Pre-operative CT-3D reconstruction of the pelvic ring showing disruption of the right sacroiliac joint, fracture of the bilateral superior pubic rami and right inferior pubic rami.

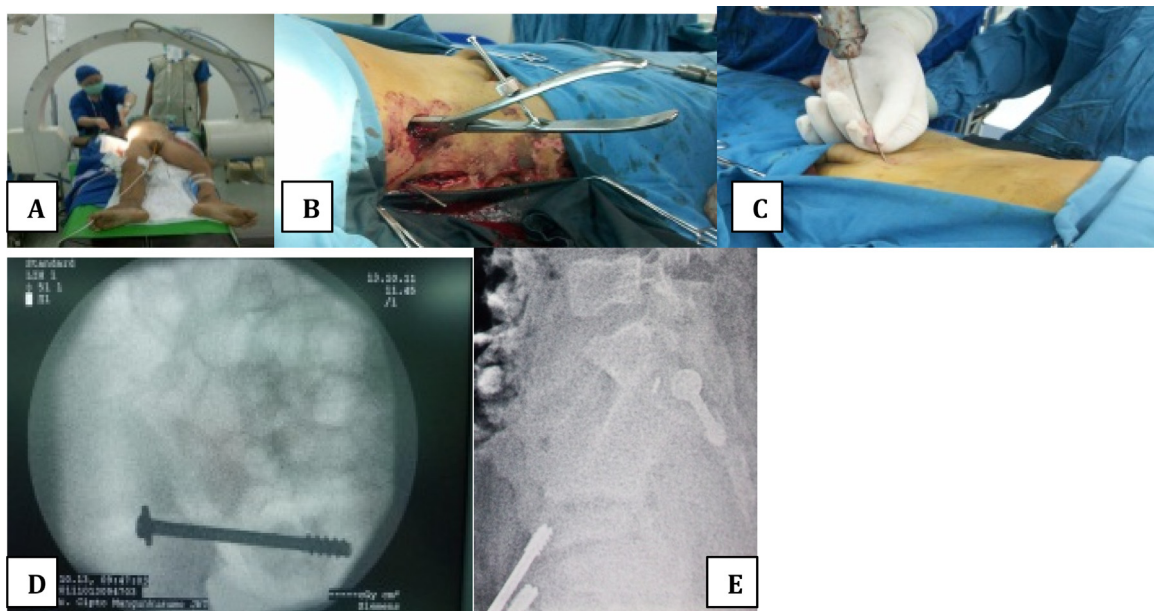


Fig. 4. Intraoperative imaging of the percutaneous IS screw insertion. A, image intensifier position to obtain the lateral projection; B, fracture fragment reduction; C, guide wire insertion on the S1 level; D, IS screw insertion on S1 level; E. IS S1 position evaluation on lateral projection.



Fig. 5. Post surgery pelvic radiograph showing bilateral fixation of pubic rami and IS screw fixation on S1 and S3 with no observable sacroiliac displacement and return of pelvic ring integrity. A, Anteroposterior view; B, Inlet view; C, Outlet view.



Fig. 6. A, B, Skin loss at anterolateral thigh-pelvic-flank exposing necrotic muscle, fascia and bone. C, Morell-Lavallee lesion on posterior thigh.

pelvic ring with percutaneous screw followed with insertion of iliosacral screw using sacral type to fix the sacral fracture on S1 and S3 level (Fig. 8).

After 18 months of follow up, we were able to obtain good outcome (85 out of 100) by Majeed score and fair outcome (2 out of 4) by Hannover score. Pohlemann radiographic score was 3 out of 3 and clinical score was 3 out of 4 (Fig. 9).

3. Discussion

Hemodynamically unstable pelvic fracture managements are challenging due to the massive blood loss from cancellous bony surfaces, pre-sacral venous plexus and/or iliac artery or venous



Fig. 7. Early clinical picture patient showing extensive soft tissue injury and early immobilization. A, B, Post repair bladder and debridement of skin avulsion and Morrell-Lavallee lesion on ER; C, Immobilization using pelvic binder.

branches that will lead to hemorrhagic shock. A high or very high energy commonly occurred in open pelvic fracture will lead to associated extrapelvic haemorrhage from other lesions (chest 15%, intra-abdominal 32%, and also long bones 40%). A combination of open unstable pelvic fracture hence will have a high mortality rate ($\pm 40\%$) ranging from 25% to 75% and exsanguination would be the leading cause of death during the first 24 h after injury, while multi-organ failure (MOF) causes the majority of deaths there-after. Application of external fixation and damage control orthopaedic is crucial in this phase. Venous bleeding usually decreases when pelvic ring injuries are stabilized by means of pelvic binder, external fixator, or a pelvic C-clamp which we have performed in these cases [1,4].

Unstable posterior pelvic ring injuries including OTA/AO Type C and vertically oriented Denis Zone II sacral fractures remain a challenge for orthopaedic surgeons despite vast technology and surgical technique advances [5]. Beside the challenging early management, unstable pelvic fracture with vertical sacral fractures mostly associated with clinical and biomechanical issues. Clinical issues including adjacent structure damage, high neurovascular complications, late mobilization, while biomechanical issues including high vertical instability and rather high failure rate (12%) might also happen [6]. Numerous modes of fixation available for sacral fracture fixation including transiliac plate, tension band plate, dorsal plate, sacral bars, transiliac screw, and lumbopelvic fixation serve no satisfactory outcome. Recent literatures however advocate the fixation via percutaneous fashion due to its superiority which allow to maintain intrapelvic tamponade and minimal intraoperative hemorrhage needed in such polytrauma cases with compromised hemodynamic patients found most often in an unstable pelvic cases [7]. Additionally, the traumatically compromised retropelvic soft



Fig. 8. A, Pre-operative pelvic radiograph view. A, Pelvic antero-posterior; B, Pelvic inlet; C, Pelvic outlet.

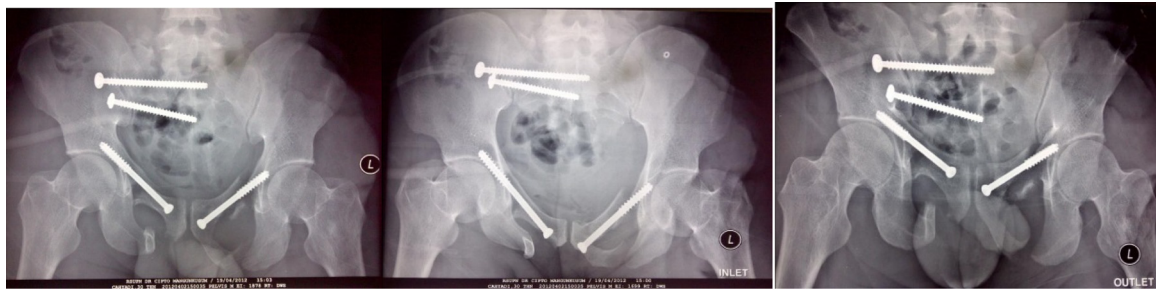


Fig. 9. Post-operative pelvic radiograph showing fixation of bilateral superior pubic rami and fixation of S1 and S3. A, anteroposterior view; B, inlet view; C, outlet view.

tissue integrity is not further violated which promoted further advantage in cases with associated soft tissue injuries such in our cases.

In cases with degloving injury, ORIF of the posterior pelvic ring is not recommended due to the risk of implant exposed and further long-standing infection. Another limitations for open reduction are patients with infection, extensive soft tissue damage, Morel-Lavallee lesions. Hence in both of our cases where there is soft tissue injury including skin avulsion, closed degloving injury and Morrell-Lavallee lesion with associated open pelvic fracture in the first case, the percutaneous fixation by using iliosacral screw placement is the best option.

In 1995, Routt et al. introduce fixation of percutaneous iliosacral screw and technique to be shown biomechanically and clinically effective for posterior pelvic ring injuries [8]. As described by several authors, these unstable injury patterns can be difficult to control with standard unilateral iliosacral screws and are at risk for failure [9,10]. In 2004 Sagi et al. showed the best biomechanical comparison among fixations of vertically unstable fractures is the IS screw placement at the level of S1–S2 [11]. Which later in 2006 by Griffin et al. reported failure in the ISS fixation at the level of S1–S2 and advise another more invasive fixation or weight-bearing limitation to prevent failure [6]. Gardner and Routt in 2011 described a technique using transiliac–transsacral screws inserted from the side of injury, traversing the sacral body, and exiting the contralateral iliac cortical bone. This technique allows for maximal thread purchase beyond fracture site and a longer lever arm to withstand perpendicular vertical shear forces than standard unilateral ilio-sacral screws. However, there is a potential disadvantage of using transiliac–transsacral fixation which violates the contralateral, uninjured sacroiliac joint [12]. Radetzki et al. in 2014 reported a morphometric study of ISS S3 placement for sacral dysplasia. In this study we reported the surgical technique of ISS placement at the level of S1 and S3 for both sacroiliac disruption and sacral fracture [13].

In trauma cases, the term “sacral dysplasia” occurs with an incidence of 25–54% [14,15]. It is defined as a more cephalad position of the upper sacral segments in relation to the iliac crests that makes an SI screw segments in relation to the iliac crests that makes an SI screw placement into the first sacral segment more difficult and even an osteosynthesis performed in a strict horizontal fashion in S1 impossible [14,15]. In such situation, we can consider S2 screw placement to achieve stable fixation. However, the bone density of the S2 lateral mass and S2 vertebral body is obviously lower compared with S1 and may cause biomechanical failure. Hence, additional screw into the S3 level might improve stability in these cases when the levated upper sacrum does not allow a secure transverse SI screw insertion into the S1 segment [16].

Insertion iliosacral screw on the level of S3 however render a rather more challenging technique for unstable pelvic fracture with vertical sacral fracture. Patient was first positioned supine which is more favorable compared to prone position due to the pelvic

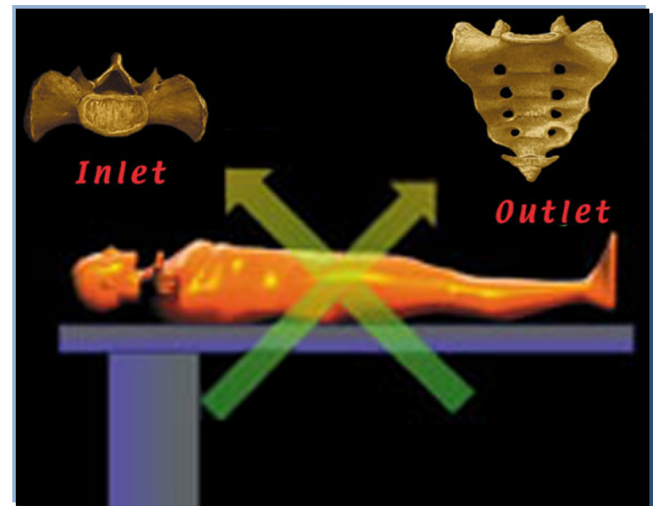


Fig. 10. Position of image intensifier regarding to operating table in supine position.

ring and hemodynamic instability, concomitant bladder injury and also skin avulsion needing debridement easier performed at supine. Supine positioning usually is more preferred in polytrauma individual especially with respiratory impairment. Because many unstable hemipelvic injury patterns present with posterior displacement, supine positioning may favor reduction and facilitate closed reduction techniques. Prone positioning, despite proper bolstering techniques may however accentuate deformity. Another attribute of supine positioning includes anterior ring access allowing simultaneous maneuvering of symphyseal and parasymphyseal structures. This may contribute toward effective “combined” closed or open anterior and posterior pelvic reduction techniques [17].

Fluorocopy guided screw intensifier is confirmed prior intubation and general anaesthesia administration (Fig. 10). Adequate fluoroscopic imaging is an absolute prerequisite toward safe and effective iliosacral screw placement. Intraoperative image intensifier is needed continuously changing between AP, inlet, outlet and Judet view. It is important that the base of the table not hinder the passage of the image intensifier. As a rule, the entry point is situated at the intersection of a line prolonging the axis of the femur and a vertical line passing 1–2 cm posterior to the anterior superior iliac spine (Fig. 11). The direction of S3 iliosacral type in the first case is oblique from supero-cranial to infero-caudal on AP and the aim was also oblique from anterior to posterior on lateral projection which is same with the sacral type. While for the second case we insert additional sacral type screw with washer on S3 level which direction is also oblique from supero-cranial to infero-caudal on AP and the aim was also oblique from anterior to posterior on lateral projection (Fig. 12). The inlet view provides a superior view of the sacrum while the outlet view enable us to show the anterior portion of sacrum.

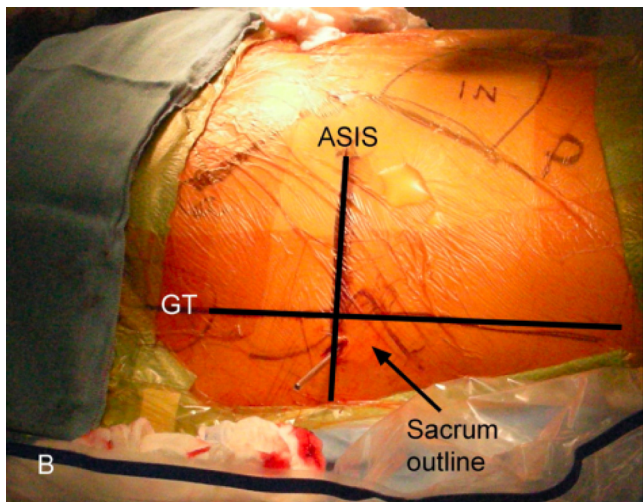


Fig. 11. Landmark for percutaneous IS screw insertion at the intersection between greater trochanter and a line perpendicular to ASIS.

Iliosacral screw insertion for the level of S3 differs from the level of S1 and S2 regarding the sacroiliac and the sacral style screws. For those level when we insert sacroiliac style screws we aim obliquely in axial, sagittal and coronal planes while in sacral style screws, they begin more posterior and caudal on the ilium and are directed cephalad and anterior. They are posterior to, and uncompromising of the more anteriorly situated chondral surfaces of the SI joint. The final position is cephalad to the S1 neural foramen, caudal to L5-S1 disk space terminating within the body of S1 and should not cross the midline anteriorly or risk extraosseous position. In the sacral screw type for S1 and S2 beside the horizontally directed screw, longer and fully threaded screws are more beneficial.

Griffin et al. stated placement of parallel ISS in S1–S2 will render failure because the screw held the cortical bone more to the lateral and less in the medial rendering axial force conversion from translational to rotational. This phenomenon will cause rotation around the parallel-arranged screw and cause failure. Another study also proved that there is always a movement of symphysis pubis in antero-posterior direction in this construction which is possible due to backward rotation of pelvis regarding the force conversion [6].

Griffin et al's study, showed that iliosacral screws with the horizontal direction is not strong enough to withstand axial forces, so it can happen loosening the screws, especially around the medial side and translational force can be converted easily into a rotational force to the rotary axis of the screw [5]. Illo-sacral screws occurs failure in the rotation forces. Iliosacral screw S3 improve stability and control rotation and did not need very long screw like in tran-

siliac screws technique. Iliosacral screw have another important advantages which could be performed in minimally invasive technique so preserve soft tissue, especially in unstable pelvic fractures are often involved by severe soft tissue damage [6].

According to biomechanical study in AO type C1.3 pelvic fracture, the use of ISS S1–S3 + pubic screw configuration is the best in translational stiffness, rotational stiffness and load to failure. Hence for our case we applied the pubic screw and percutaneous ISS S1–S3 to obtain the best possible fixation [18].

Percutaneous fixation using ISS on S1 and S3 proven to have good reduction with no residual displacement of the sacroiliac joint. In our first case, we can observe that after 10 months and 21 months after follow up there were no failure observed, patient's functional activity was fully restored in excellent outcome (80 out of 80) by Majeed score and showed a very good outcome (4 out of 4) by Hannover score. Patient and parents were satisfied after surgery. In the second case, insertion of percutaneous screw on the sacroiliac joint also resulted excellent fixation with no residual displacement or other complications of iliosacral screw placement. Proven at 18 months follow up, patient was satisfied and presented with good outcome (85 out of 100) Majeed score and fair outcome (2 out of 4) by Hannover score.

4. Conclusion

Percutaneous screw fixation at the level of S3 is feasible and can be inserted in S3 level by sacroiliac type and sacral type with minimal soft tissue intervention and good functional outcome.

Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Sources of funding

The authors declare that sponsors had no such involvement.

Ethical approval

The patient received an explanation of the procedures and possible risks of the surgery, and gave written informed consent.

Ethical approval has been granted in this study.

Consent

The patient received an explanation of the procedures and possible risks of the surgery, and gave written informed consent.

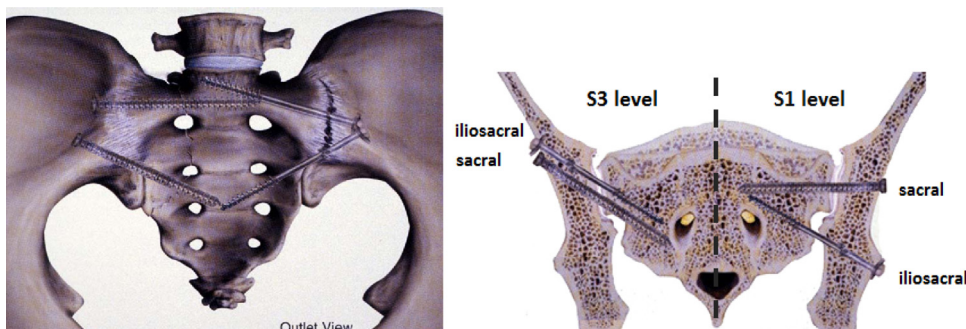


Fig. 12. A, Insertion of IS screw on level S1 view from outlet projection. B, Comparison of IS screw and sacral screw insertion on level S2 and S3. Note the different direction between IS and sacral screw insertion on the level of S1 and S3.

Author contribution

IHD contributed to performed the operation, data collection, analysis and interpretation, manuscript drafting, revising, and approval for publishing; JF contributed to assist the operation, data collection, analysis and interpretation, manuscript drafting, revising, and approval for publishing.

Guarantor

Guarantor in this study is IHD.

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