Minimally Invasive Placement of Iliac Screws: A Technical Note

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Abstract: The surgical treatment of destructive processes involving the lower lumbar spine and the sacrum often require attachment of a long hardware construct to the pelvis for improved stability. In an effort to minimize surgical morbidity and postoperative pain, and improve quicker patient mobilization, we describe a novel minimally invasive technique of percutaneously placed iliac screws. We explain the procedure in detail, while presenting the case of a patient suffering from a lytic lesion of the sacrum that was treated successfully with this method. This technique is a viable alternative to open surgery and an asset in the armamentarium of contemporary spinal surgery.

Keywords: Minimally invasive surgery, iliac screws, lumbar spine, spinal instrumentation, spinal trauma.

INTRODUCTION

Spinal fixation to the pelvis, originally described in 1982 by Allen and Ferguson (L-rod technique) for the treatment of neuromuscular scoliosis that includes pelvic obliquity [1], has been increasingly used by spinal surgeons for several other conditions, such as lumbosacral instability and pseudarthrosis, lower spinal trauma and destructive lesions of the sacrum [2-6]. The unique anatomy of the human pelvis with long bicortical walls surrounding the cancellous bone allows the placement of thick and long screws into the cancellous part of the ilium, thereby allowing the secure docking of long hardware constructs and avoiding the dislodgement of the screws despite significant axial loading.

The need for minimal destruction of the surrounding muscles and supportive soft tissues, better control of postoperative pain and the reduction of significant blood loss, especially in moribund patients, has led to the development of minimally invasive techniques [7-9]. These techniques are not necessarily associated with less perioperative complications, such as bleeding from pelvic vessels or injury of nerve roots; however, they can be safely performed with appropriate intraoperative radiographic support and/or navigation tools.

This article illustrates a novel technique, originally described in 2008 by the senior author (MYW) [10], of percutaneously placed, cannulated iliac screws. The screws are similar to the ones that are used with open methods. Their placement requires significantly smaller incision, thereby minimizing surgical trauma and postoperative pain.

MINIMALLY INVASIVE SCREW AND ROD PLACEMENT TECHNIQUE

Preoperative Preparation and Surgical Technique

After endotracheal anesthesia is administered, the patient is positioned prone on the operating table. Appropriate padding is required to minimize the incidence of pressure sores. Since this technique is dependent on radiographic assistance, the surgeon needs to ensure that the pelvis is away from the base of the table and other metallic instruments do not obstruct the fluoroscopic view. Therefore, we advocate the use of a radiolucent table, such as the Jackson Spinal Table (Mizuho OSI, Tokyo, Japan). Should a regular operating table be used, the patient should be positioned in a way that the base of the table does not obstruct the proper placement of the fluoroscope.

Once the patient is prepped and draped in the usual sterile fashion, the fluoroscope is used to localize the sciatic notch. This is an important step prior to the incision, in order to avoid pelvic vessel injuries or damage of the sciatic nerve. Image guidance is assisted with the use of an "obturator-outlet view," which allows visualization of the inner and outer tables of the ilium. The fact that the plane shifts from anterior to posterior results in a "teardrop" like projection of the ischial body, which is the ideal target of the distal screw tip (Fig. **1**).

A 3-cm incision is then carried out over the PSIS. The sacro-iliac joint and the PSIS should be felt. A small drill hole or osteotomy is placed over the most superficial portion of the PSIS. This allows for seating of the polyaxial screw head into a recess to minimize hardware prominence. A Jamshidi needle is then inserted through the drill hole and advanced medially and ventrally. Particular attention should be paid to the sacro-iliac joint that should not be violated.

With the help of the fluoroscope, the Jamshidi needle is advanced within the cancellous part of the ilium (Fig. **2**). Bad quality of the surrounding bony structures may lead to disruption of the cortical wall and consequent soft tissue, vascular or nerve injury. Therefore, insertion of the Jamshidi needle should be carefully guided by the fluoroscope. AP and lateral views are needed to make sure that sciatic notch is not violated.

The needle is consequently advanced from 6.5 to 10 cm inside the ilium, and then replaced by a K-wire that the surgeon can slide into the ilium through the needle. A ball-tipped probe is inserted adjacent to the K-wire, in order to verify absence of cortical wall breach. A cannulated screw

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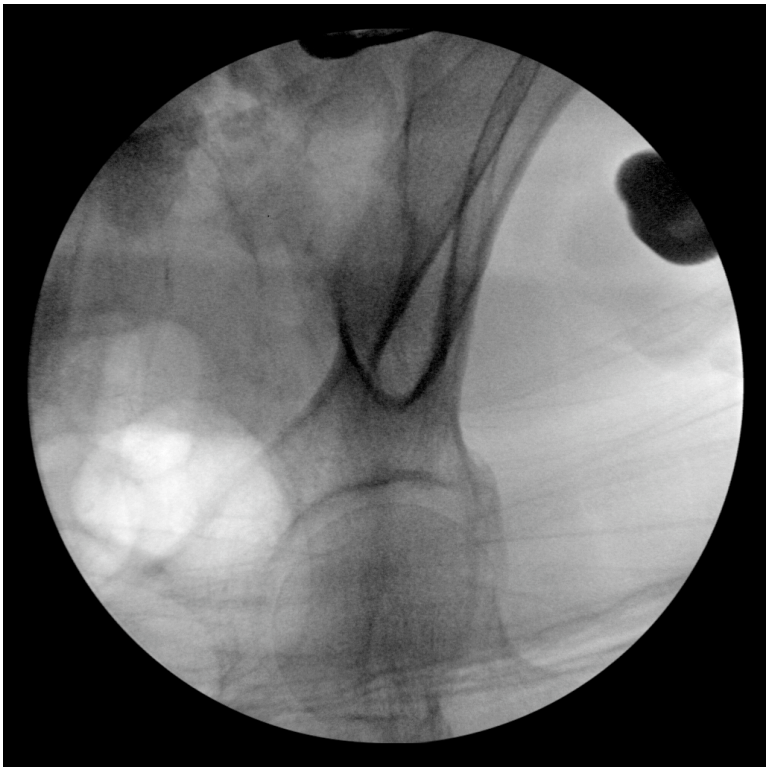


Fig. (1). Fluoroscopic view of the obturator outlet, which allows visualization of the inner and outer tables of the ilium.

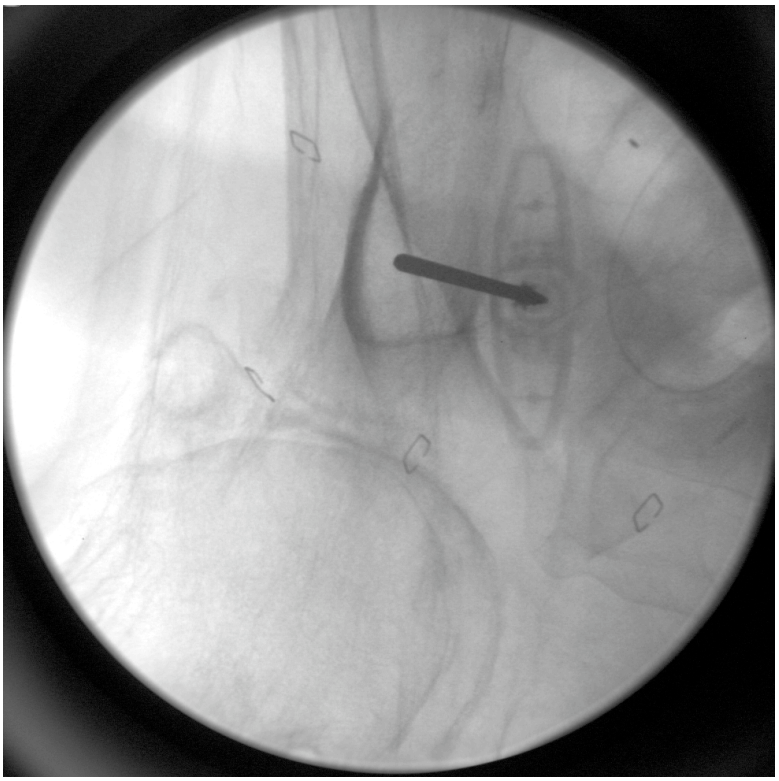


Fig. (2). Fluoroscopic view of a Jamshidi needle that is advanced within the cancellous part of the ilium.

can then be placed over the K-wire after serial path enlargement with cannulated cancellous screw taps. Cannulated self-tapping screws can also be utilized. The correct placement of the iliac screw should always be verified by the fluoroscope in both AP and lateral views. The screw can then be stimulated with the help of electrophysiology to confirm lack of iliac cortical breach, as well as possible sciatic nerve injury.

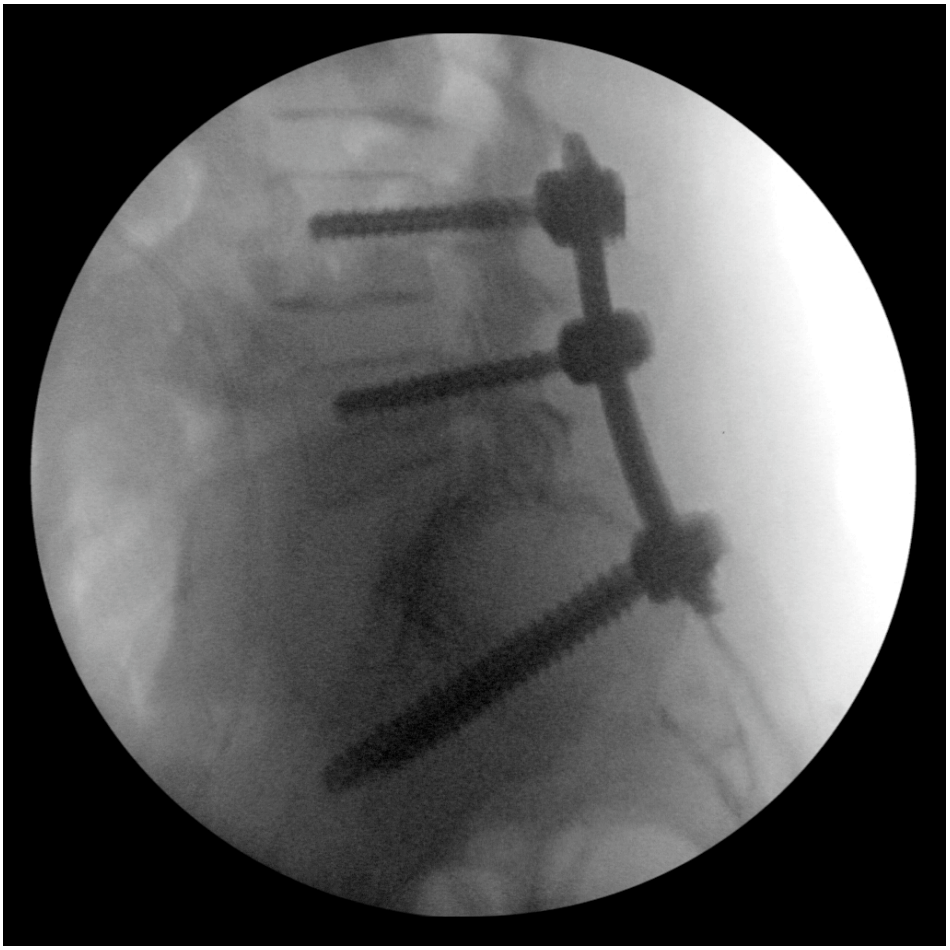


Fig. (3). Lateral intraoperative radiograph showing L4 – Ilium stabilization.

Once the contralateral screws are positioned, they can then be connected with rods with various systems that are nowadays used routinely for percutaneous pedicle screw placement (Fig. **3**). Finally, a crosslink may connect the two rods and minimize shearing forces and potential for failure of the procedure. No suction drains are needed for this procedure. The skin should be closed carefully in layers to avoid complications, such as infections, bleeding or skin breakdown through the hardware. After a day of bed rest, the patient can be mobilized on postoperative day 1 with the help of the physical and occupational therapists.

ILLUSTRATIVE CASE

History and Physical Examination

Our patient was a 48-year-old female that developed lower back pain a year prior to her presentation to our hospital. Her pain was thought to be musculoskeletal in nature, and she was treated by her primary care physician with non-steroidal anti-inflammatory drugs without significant improvement. Her symptoms progressed; however, they did not cause any functional impairment and therefore, no further workup was done. Two weeks prior to her admission, she developed pain-limited bilateral lower extremity weakness, and her ability to walk was compromised. She was admitted to another hospital, and imaging demonstrated a large, destructive, lytic lesion of the sacrum with extension into the epidural space, measuring about 6cm in largest diameter. The lesion involved the left lumbo-sacral plexus and S1-3 nerve roots. The tumor involved the posterior half of the right sacro-iliac joint, as well. A CT-guided biopsy was performed, which confirmed the presumed diagnosis of multiple myeloma. A bone scan revealed multiple areas of increased radiotracer uptake, consistent with extensive disease. She was neurologically intact; however, due to her intractable back pain, her pain-related inability to walk and her prolonged bed rest, the patient opted for surgical stabilization. Her extensive sacral disease made the placement of sacral screws impossible and therefore, bilateral iliac and L4-5 screws were placed percutaneously.

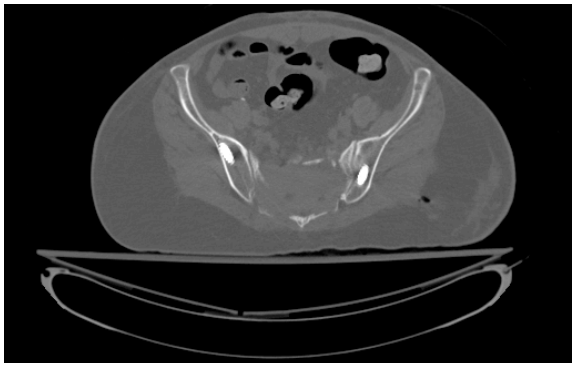
Operative Procedure

After bilateral L4 and L5 screws were placed percutaneously, the appropriate iliac landmarks were identified. A small 3-cm incision was carried out and the sacro-iliac joint, as well as the PSIS could be felt. A drill was used at the entry point, followed by introduction of a Jamshidi needle under AP fluoroscopic guidance. A K-wire was then inserted and its position was verified with fluoroscopy. Cannulated cancellous screw taps were placed over the K-wire to the desired depth, followed by 7 x 70 mm cannulated screws inside the ilium. The same procedure was performed to the opposite side, as well. An appropriately bent rod connected

all ipsilateral screws and was secured with caps. The Medtronic O-Arm® was then used and three-dimensional images of the screws were obtained and their appropriate placement was confirmed. A crosslink at the L4-5 level connected the two rods. Final AP and lateral fluoroscopic images were obtained, and electrophysiological stimulation confirmed the absence of any abnormal EMG activity at 20 mA. The surgical blood loss was minimal and the postoperative neurological examination was unchanged.

Postoperative Course

With appropriate pain management, Physical and Occupational therapy, the patient was eventually discharged home on postoperative day 5 with a simple brace for comfort. A postoperative CT-scan demonstrated adequate placement of the iliac screws (Fig. **4a-c**). The medical and radiation oncology teams evaluated her, and her further treatment plan was established, prior to her discharge.



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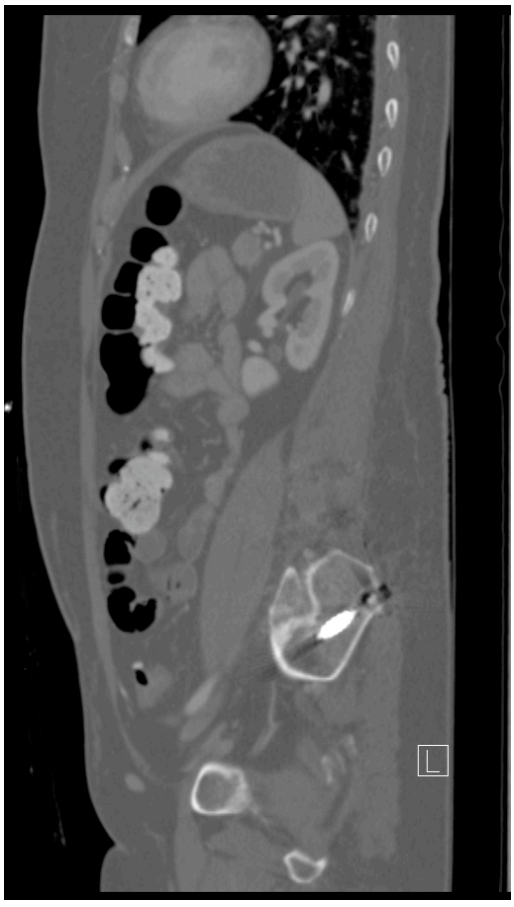

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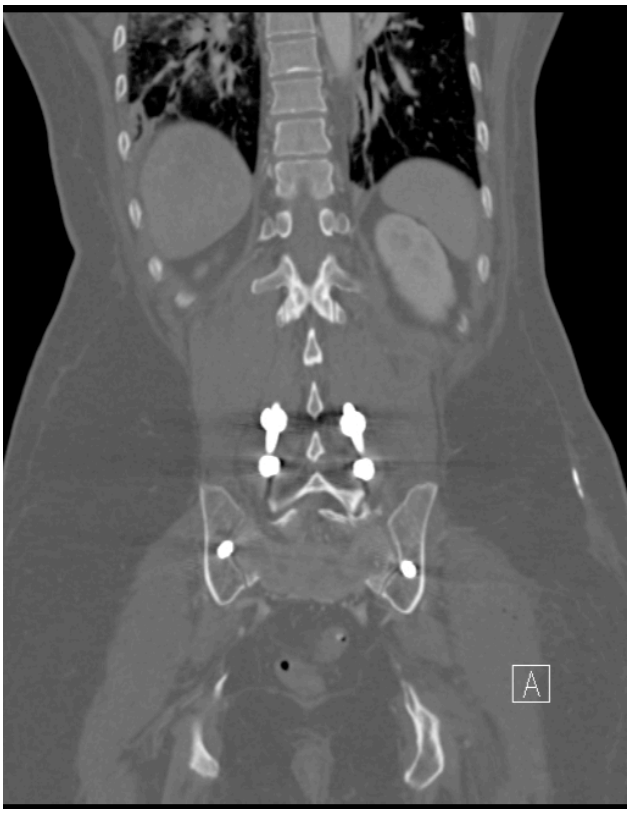

c

Fig. (4a-c). CT scan of the pelvis demonstrating appropriate screw placement between the cortical walls of the ilium.

DISCUSSION

Minimally invasive techniques are nowadays commonly used in a wide diversity of cases. Reduced trauma to the bones and soft tissues, less postoperative pain, less scarring, quicker mobilization and reduced mortality from surgical blood loss make percutaneous techniques a very attractive alternative to open spinal procedures [11-15].

This paper describes a novel technique for percutaneous iliac screw placement. Indications for iliac screw placement include destructive lumbosacral, processes (tumors, infections or traumatic injuries), L5-S1 pseudoarthrosis, high-grade L5-S1 spondylolisthesis, symptomatic spinal deformity and the need for extra stability after long instrumentation constructs that involve the sacrum [2-6]. The method we described is primarily used for stabilization of the sacro-pelvic joints, in order to facilitate quick mobilization of the patient. Therefore, we believe that it is a viable choice when fusion is not the primary objective of the surgery.

The incision required for the screw placement is fairly similar to the one performed for tricortical iliac graft harvest, which is associated with significant postoperative pain [16, 17]. However, the muscular dissection required for the percutaneous method is less prominent and hence, it is thought to be better tolerated. Continuous local anesthetic infusion to the operative site can help control excessive postoperative pain and result in quicker mobilization [18, 19].

As mentioned previously, this procedure relies heavily on pre- and intraoperative imaging. A preoperative CT scan of the lower spine and the pelvis is necessary, so that the ilium thickness and orientation can be determined. *This is imperative, especially for older people with osteoporosis that are in higher risk for cortical breach and neurovascular injury (sciatic nerve, superior and inferior gluteal nerves and vessels, posterior femoral cutaneous nerves, internal pudendal vessels), and consequent nerve palsies or pelvic hematomas.* In our case, the screw placement was verified by both AP and lateral fluoroscopic views, as well as with intraoperative 3D imaging that is available at our institution. Modern neuronavigation systems can also be used for accurate screw placement [20, 21].

Although the Galveston rod technique has been successfully utilized in the past, when sacro-iliac stabilization was necessary, we feel that our technique has significant advantages. The required muscular dissection is reduced and hence, there is less intraoperative blood loss, which is associated with lower morbidity rates. It is thought that the screws ensure a firmer attachment to the ilium compared to the smooth Galveston rods that need to be carefully contoured [22]. Nonetheless, the screw and rod pullout rates have never been directly compared and further studies are needed for comparison of these two techniques. Furthermore, the minimally invasive procedure is usually less time consuming, resulting in less need for prolonged general anesthesia [23]. New instruments developed for minimally invasive spine surgery may facilitate easier connection of pedicle and iliac screws, especially when sacral screws are avoided.

To summarize, percutaneous iliac screw placement is an excellent alternative to open surgery, especially when spinal fusion is not the primary endpoint. It does require careful preoperative evaluation of the patient and relies heavily on spinal imaging. It is less invasive than open iliac screw or Galveston rod placement and likely associated with less surgical morbidity. However, further studies are necessary for proper evaluation of this technique.

DISCLOSURE

There was no financial support associated with this article. Dr. Wang is a consultant to DePuy Spine. Informed consent was obtained prior to submission of the manuscript.

ABBREVIATIONS

AP	=	Anterior posterior
CT	=	Computed tomography
EMG	=	Electromyography
K-Wire	=	Kirschner wire
mA	=	Milliampere
PSIS	=	Posterior superior iliac spine of the pelvis

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