

Original Article

Fluoroscopy only for the placement of long iliac screws: A study on 14 patients

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Abstract

Background: Iliac screw placement is challenging due to the particular anatomy of the ilium. Most series have reported the use of relatively short (≤ 90 mm in length) screws despite a long iliac buttress, which has an average length of 129 mm in females and 141 mm in males. This study describes a series of 14 patients who underwent placement of long iliac screws (≥ 100 mm in length) as part of a spinopelvic fusion utilizing fluoroscopy alone.

Methods: All patients who received at least one long iliac screw were included in this study. Placement accuracy, the average distance from the screw tip to the anterior inferior iliac spine (AIIS), neurovascular injuries, acetabulum and/or sciatic notch violations, and screw prominence were all measured.

Results: Fourteen patients received 38 iliac screws, with 31 screws being ≥ 100 mm in length. The accuracy rate was 87.1% (27/31) for the long iliac screws. The average shortest distance from the iliac screw tip to the AIIS was 15.5 mm for the right-sided and 17.1 mm for the left-sided ilia. There were no neurovascular injuries, acetabulum, or sciatic notch violations, and no screws loosened or fractured. Of interest, only one patient required off-set connectors to link the rods to the iliac screws.

Conclusions: Placement of long iliac screws under intraoperative fluoroscopy only was shown to be feasible, with a high accuracy rate and few complications, in this series of patients.

Key Words: High-grade spondylolisthesis, iliac screws, sacral fractures, spinal instability, spino-pelvic fixation

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INTRODUCTION

Iliac screws are increasingly placed for spino-pelvic fixation to address deformities and lumbosacral instability.^[1,8] Accurate placement, however, is challenging due to the small confines of the iliac buttress and potential risks of violation of the acetabulum and sciatic notch.^[4] Although new intraoperative imaging technologies are now available to aid in iliac screw placement, these incur additional costs

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and may not be available in most spine centers.^[5] In this study, our goal was to present a series of patients for whom placement of long iliac screws (≥ 100 mm) was successfully achieved utilizing intraoperative fluoroscopy alone.

MATERIALS AND METHODS

Patient population: 14 consecutive patients, averaging 32.8 years of age (11–62 years), underwent placement of 38 screws (e.g., at least one long iliac screw ≥ 100 mm/patient) to address unstable sacral fractures, high-grade spondylolisthesis, lumbosacral fracture dislocation, and/or instability (spondylodiscitis, fusion failure).

Surgical technique

A midline incision was used in 13 patients extending down to S3 for appropriate exposure of the posterior iliac crests, while one patient with high-grade spondylolisthesis had a bilateral, paramedian mini-open approach. All iliac screws were placed under fluoroscopic guidance alone. Dissection of the lateral ilium for palpation of the sciatic notch was not performed in any case. After harvesting bone graft from the posterior superior iliac crest and recessing it down, a cannulating probe was advanced into the iliac buttress. This approach utilized tactile feedback, with the surgeon cannulating from the contralateral side of the patient, aiming at the anterior inferior iliac spine (AIIS). Fluoroscopy with a lateral pelvic view with perfect alignment of both sciatic notches and acetabular fossae was used during cannulation. The angle/trajectory of iliac screws was based on careful analysis of the preoperative pelvic computed tomography (CT) scans; the angle varies between 25° and 40° outwards from the midline. Palpation with a ball-tipped probe was used to check for intactness of the iliac cortices.

Any suspected intraoperative violation and/or misdirection could be verified by the obturator oblique outlet view allowing for visualization of the characteristic “teardrop” (e.g., the iliac buttress cortices aligned from the posterior superior iliac spine to the AIIS). The cannulating probe was usually advanced until an adequate length was achieved, or a cortex was touched. Different fluoroscopic views were obtained as needed to ensure correct screw positioning. After rod placement and deformity reduction, cross-linking between the two rods was employed.

Assessment of screw placement

Postoperative radiographs and CT scans of the lumbosacral spine and pelvis were utilized to assess the accuracy of iliac screw placement. Primary variables analyzed were: (1) adequate placement of iliac screws inside the iliac buttress (no violation $>$ screw diameter); (2) the shortest distance from the lowermost iliac screws tip to AIIS cortex; (3) incidence of neurovascular

injuries; (4) acetabular cortex or sciatic notch cortex violations > 1 mm. Secondary variables included: (1) iliac screw loosening, pullout, or breakage; (2) use of off-set connectors to link the rod to the iliac screws; (3) iliac screw prominence causing discomfort or pain.

All patients underwent neurological and radiographic assessment at a minimum of 6, 12, 24, and 52 weeks postoperatively.

RESULTS

Among a total of 38 screws placed in 14 patients, varying from 6.5 to 8.0 mm in diameter, 31 screws were ≥ 100 mm in length, with an average of 2.2 long screws per patient [Tables 1 and 2].

In the first two patients, postoperative CT scans demonstrated violation of the iliac buttress for four iliac screws. In the remaining 12 patients, the tips of the screws

Table 1: Overall characteristics

Sex	n (% of cases)
Male	06 (43%)
Female	08 (57%)
Average age	(In years)
Male	33.7
Female	32.2
Diagnosis	n (% of cases)
High grade spondulolisthesis	02 (14.3%)
L5-S1 fracture-dislocation	02 (14.3%)
Lumbar instability	02 (14.3%)
U-shaped sacral fractures	08 (57%)
Length of instrumentation	
Thoracolumbopelvic fixation	04
Lumbopelvic fixation	10

Table 2: Screw and purchase length

All iliac screws	102.2 mm (n=38)	
Male	100 mm (n=20)	
Female	104.7 mm (n=18)	
Iliac screws ≥ 100 mm (n=31)		
Male	109.3 mm (n=15)	
Female	109.4 mm (n=16)	
Iliac screws ≤ 90 mm (n=7)		
Male	72 mm (n=5)	
Female	67.5 mm (n=2)	
Supplementary screws (n=10)		
Male	82.5 mm (n=8)	
Female	82.5 mm (n=2)	
Average distance of screws tip to AIIS* (n=27)	Right ilium	Left ilium
Male	15.9 mm	18.8 mm
Female	12.8 mm	19.4 mm

*Note: only correctly placed screws were considered

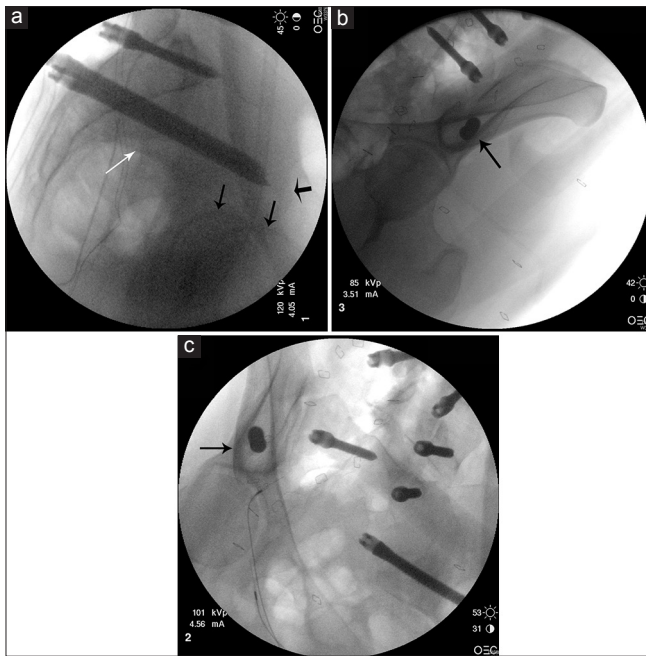


Figure 1: (a) Intraoperative lateral view, demonstrating the long iliac screws well above the sciatic notches, which are superimposed (thin white arrow). The superior rim lines of both acetabula are also well aligned (thin black arrows). The cortex of the AIIS can be seen as a curved concave line above the acetabulum (thick black arrow). (b and c) obturator oblique outlet views showing the iliac screws tips inside the “teardrop” (black arrows)

were 100% accurate, centered inside the “teardrop” in the obturator oblique outlet views [Figures 1 and 2]. The placement accuracy rate for all screws was 89.5% (34/38) and was 87.1% (27/31) for just the long iliac screws. The average shortest distance of the lowermost iliac screws to the AIIS cortex was 15.5 mm for the right-sided and 17.1 mm for the left-sided ilia. There were no neurovascular injuries or acetabular cortex and/or sciatic notch cortex violations >1 mm in any patient. In six patients we placed a total of ten supplementary iliac screws so as to obtain a stronger construct [Figures 2–4]. All patients had satisfactory restoration of the alignment of the lumbosacral spine postoperatively.

No patient exhibited iliac screw loosening, pullout, and/or breakage, and only one patient required the use of off-set connectors to link the rod to the iliac screws. Among the 38 screws placed, there was only one screw prominence, but has not required removal. Even in a small 11-year-old patient, recessing down the iliac crest allowed encasement of the iliac screw head, without any prominence [Figure 5]. In the first two patients with iliac screw misplacement, the strength of the construct was considered sufficient (e.g. adequate amount of iliac buttress purchase), and both had solid consolidation of their fractures, without operative revisions.

Other complications include two wound infections treated with antibiotics alone, one L5-S1 rod breakage

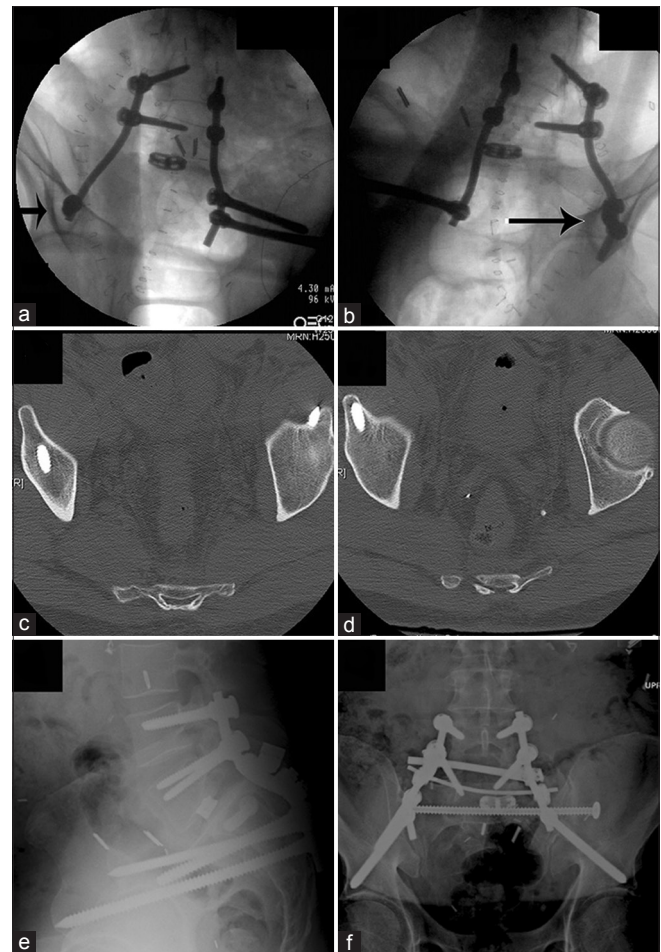


Figure 2: (a and b) Obturator oblique outlet views showing the iliac screws in the center of the “teardrop” (black arrows). (c and d) postoperative axial CT scans of the pelvis showing the right-sided and left-sided lowermost 140 mm-long screws touching the cortices of both AIIS and a 90mm-long supplementary screw. (e) lateral x-ray image demonstrating the postoperative construct and alignment. (f) AP x-ray image showing the screws above the sciatic notches and acetabula. An ilium-sacral screw and the rods directly connected to the iliac screws are visualized

requiring revision, one L5 screw breakage (e.g., with spondylolisthesis) requiring an L4-pelvic fusion, and one death unrelated to the lumbopelvic fusion, in a 62-year-old female patient with an L3-4 spondylodiscitis, due to abdominal complications.

DISCUSSION

The iliac buttress is the portion of the ilium that extends from the posterior iliac crest and courses above the sciatic notch and acetabulum down to the AIIS. It is quite thick, has two cortices similar to a diaphysis, varies from 110 to 150 mm in length, and may well accept placement of very long screws.^[7] Despite its length, most patients reported in the literature underwent placement of iliac screws measuring ≤ 90 mm.^[1,2,5,8] Biomechanically, the pullout strength of long iliac screws can be significantly

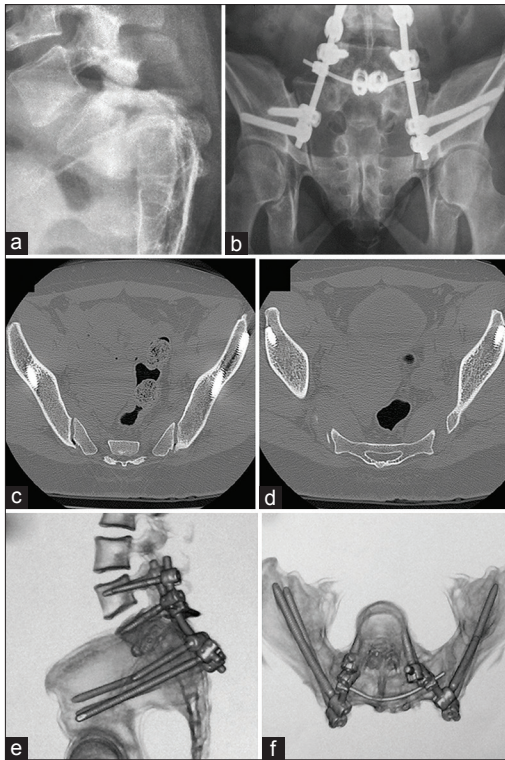


Figure 3: (a) Lateral x-ray demonstrating a L5-S1 spondyloptosis. (b) postoperative AP outlet view of the pelvis demonstrating the iliac screws above the sciatic notch and acetabulum. (c and d) axial CT scans demonstrating the three 120mm-long iliac screws in close proximity to the cortex of both AIIS. (e and f) postoperative 3D views demonstrating the final construct and the lumbosacral alignment

higher than short screws^[6,9] and placement of long screws provides a point of fixation well anterior to the pivot point of the L5-S1 disc.^[3] Some authors have suggested that long iliac screws should be always used, as opposed to the shorter, conventional screws that are commonly placed.^[6]

We obtained an 89.5% (34/38) accuracy rate for all screws and an 87.1% (27/31) accuracy rate for the long iliac screws only. There was a learning curve seen in the first two patients of our series, but afterwards we obtained a 100% accuracy rate in the other subsequent 12 patients.

Studies on iliac screws have neither documented placement accuracy using CT scans in all cases nor used long iliac screws in all patients, which makes a comparison to our accuracy rates somewhat difficult.^[1,2,5,8] New technologies may allow a safer and more accurate placement of iliac screws,^[5,8] and while they may significantly add costs and time to the procedure, they may certainly be a very suitable option when available.

We found that the lateral views are sufficient for adequate visualization of the sciatic notch, the acetabulum as well as the AIIS, and should easily guide the placement of an iliac screw along the iliac buttress.^[7] It is important

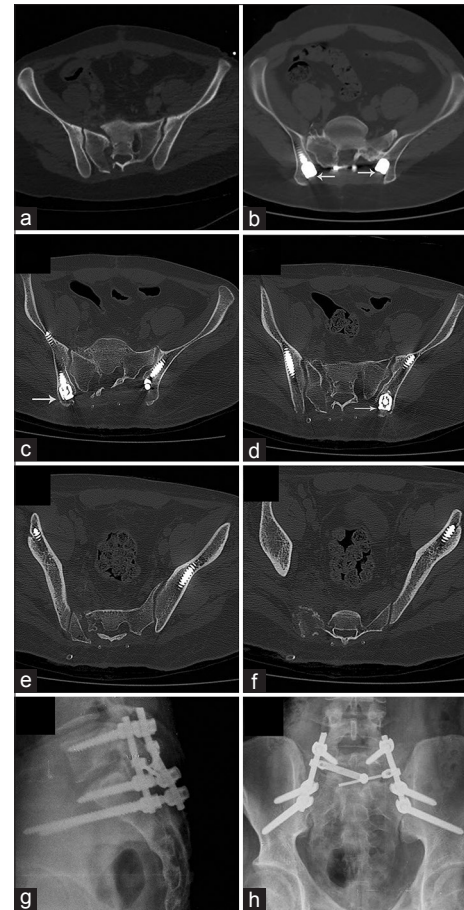


Figure 4: (a) Preoperative axial CT scan image showing a zone II unilateral sacral fracture leading to pelvic obliquity and sacral displacement. (b-d) axial postoperative CT scans demonstrating the head of the screws below the iliac crests (arrows) and the short iliac screws. (e and f) axial CT scans demonstrating the tips of the long iliac screws close to the cortex of both AIIS. (g and h) postoperative x-rays demonstrating the iliac screws above the sciatic notches and acetabula and the rods directly connected to the iliac screws

to direct the screws toward the AIIS, since directing the screws inferiorly carries the risk of acetabular injury. Additionally, purchasing the ilium inferior to the AIIS does not lead to any differences in torsional strength.^[6]

The anatomy may be particularly altered in cases of lumbosacral fractures and high-grade spondylolisthesis, rendering free-hand techniques rather unsuitable. We therefore preferred to rely on the intraoperative fluoroscopy, which precisely demonstrates the angulation of the iliac buttresses, as well as the acetabulum and sciatic notch.

The combination of long iliac screws and a more anterior starting point related to a recessed iliac crest enabled a long purchase of the iliac buttresses as evidenced by the short average distance from the screw tip to the AIIS seen. This likely increased the strength of the construct by providing a longer anchoring arm.^[3] Additionally, it allowed a direct connection of the rods to the iliac screws

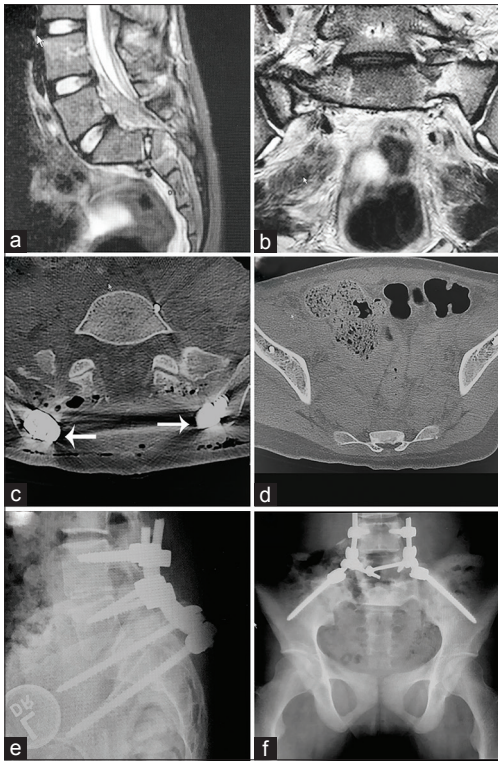


Figure 5: (a and b) Sagittal and coronal MR T2-weighted images demonstrating a U-shaped sacral fracture in an 11-year old child. (c) postoperative CT scan showing the recessed posterior iliac crests and the screw head below the iliac crest cortex (arrows), as well as the sacral laminectomy for decompression of neural elements. (d) postoperative CT scan showing the screws tips well in the center of the iliac buttresses. (e and f) postoperative x-rays showing the iliac screws well above the sciatic notches and acetabula, as well as the rods directly connected to the iliac screws

in 13 patients, which decreased the risk of failure related to the off-set connectors. The technique of recessing the iliac screw also enabled a low incidence of screw prominence, which was evidenced in only one screw, and was not influenced by the use of supplementary screws.

We found in this consecutive series of 14 patients that fluoroscopy enabled a safe and accurate placement of long iliac screws, including dual long screws, without major complications. Future studies should focus on whether long iliac screws, without the use of cross-connectors, are

better than short iliac screws and/or S2 alar-iliac screws in the setting of complex spinal conditions.

CONCLUSIONS

Safe and accurate placement of long iliac screws may be accomplished utilizing fluoroscopy alone. The lateral and obturator oblique outlet views can provide accurate information on the screw position and integrity of the acetabulum, sciatic notch, and iliac buttress cortices.

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Conflicts of interest

There are no conflicts of interest.

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