The EGYPTIAN SPINE Journal

Online ISSN : 2314-8969
Print ISSN: 2314-8950
www.esj.journals.ekb.eg

CLINICAL ARTICLE EgySpineJ 33:14-25, 2020 DOI: 10.21608/esj.2020.18970.1113

Efficacy and Safety of Minimally Invasive Percutaneous Ilio–Sacral Fixation Technique for Sacral Fractures in The Initial Twenty Cases at Department of Neurosurgery in Alexandria University.

Abdelrahman Magdy Elhabashy, MD., Alaa Eldin Mohamed Issa, MD., Ahmed Hasan Abo Alfa, MD.,* Wael Ahmed Foad, MD., Wael Mahmoud Khedr, MD.

Neurosurgery and Orthopaedic Departments, Faculty of Medicine, University of Alexandria, Alexandria. Egypt*

ABSTRACT

Background Data: Sacral fractures constitute a major entity of pelvic fractures. 50% of these sacral fractures are not recognized on initial physical examination of the traumatized patients. The most important prognostic factor in management of sacral fractures is the presence or absence of neurological deficit. Some studies adopt the concern regarding fixation of sacral fractures in poly-traumatized patients to avoid systemic effects and complications of recumbency.

Purpose: Evaluation of the efficacy and safety of the minimally invasive percutaneous ilio-sacral fixation technique in management of initial twenty cases of sacral fractures at department of Neurosurgery in Alexandria University.

Study Design: Retrospective clinical case cohort study.

Patients and Methods: Between March 2017 and January 2019; 20 patients were presented at Neurosurgery Department in Alexandria University hospitals with traumatic sacral fractures. They were 13 males and 7 females with the mean of 34 years (ranged from 18-55 years). Plain X ray of pelvis including antero-posterior, inlet and outlet views of pelvis, CT scan with 3D reconstructions were done. We used Dennis classification and Roy-Camille classification in our study. Stabilization of sacral fracture was done percutaneously using 7 mm cannulated partially threaded ilio-sacral screws. Clinical, neurologic and radiographic examinations were performed in the follow up period (6 months) to assess healing, evaluate clinical improvement and to detect any implant changes.

Results: Total 39 percutaneous ilio-sacral screws were placed in 20 patients. Partially threaded cancellous 7.0-millimeter cannulated screws were used. Fifteen patients had unilateral double screws; one patient had unilateral triple screws; two patients had bilateral single screws for bilateral sacral fracture and two

Address correspondence and reprint requests: Abdelrahman Magdy Elhabashy. MD.
Neurosurgery Department, Faculty of Medicine, University of Alexandria, Alexandria. Egypt
Email: abdo.alex.1986.ns@gmail.com

Submitted: July 2nd, 2019.
Accepted: December 20th, 2019.
Published: January, 2020.

The article does not contain information about medical device(s)/drug(s).
No funds were received in support of this work.
The authors report no conflict of interest.

patients had unilateral single screw. Two Misplaced screws out of thirty-nine screws were found in the post-operative CT. One patient developed post-operative foot drop. All fractures healed clinically and radio-graphically except one case fixed by single screw and did not show radiological healing.
Conclusion: Percutaneous ilio-sacral fixation for sacral fractures is a safe minimally invasive method for management of sacral fractures. It is effective regarding pain relief with high fusion rate. It needs a long learning curve. Single screw fixation is not a rigid fixation and may lead to hardware failure. (2019ESJ193)
Keywords: Sacral fractures, percutaneous fixation, ilio-sacral screw.

INTRODUCTION

Sacral fractures constitute a major entity of pelvic fractures and range from 5% as an isolated fracture up to 54% in concomitant with other pelvic ring injuries.[13] About 50% of these sacral fractures are not recognized on initial physical examination and even this number increase up to 75% in case of normal neurological examination. That is why CT scans are very crucial for identification of these fractures.[14] The most important prognostic factor in management of sacral fractures is the presence or absence of neurological deficit in the form of motor deficit, sensory deficit, urinary dysfunction, rectal dysfunction or sexual dysfunction.[12]

Surgical role for management of such fractures is unclear and many studies support conservative management for sacral fractures.[28] On the other hand, other studies adopt the concern regarding fixation of sacral fractures in poly-traumatized patients to avoid systemic effects and complications of recumbency.[24,27] The most accepted popular methods for fixation of sacral fractures nowadays are open lumbo-pelvic fixation and percutaneous ilio-sacral fixation.[5,17,20,22,27,33,37]

Although posterior open reduction and internal fixation techniques provide good visualization of the fractured sacrum and allow neurovascular decompression, they are associated with many disadvantages like blood loss, infections, prolonged operating time and prolonged prone positioning. The percutaneous approach avoids these hazards and allow for rapid fixation of posterior pelvic or sacral pathologies either in supine or prone position and doesn't interfere with central sacral decompression if indicated.[15] Minimally invasive percutaneous ilio-sacral fixation technique is associated with some reported complications like hardware screw failure, iatrogenic neural injury, misplaced screws and incomplete reductions.[30]

In this study, we presented our results and evaluated the efficacy and safety of the percutaneous ilio-sacral fixation technique in management of the initial twenty cases operated at Neurosurgery Department in Alexandria University.

PATIENTS AND METHODS

Between March 2017 and January 2019; 20 patients were presented at neurosurgery department at Alexandria University hospitals with traumatic sacral fractures. They were 13 males and 7 females with the mean of 34 (range, 18-55) years. The mode of injury was falling from height in ten cases, motor car accident in six cases, gunshot injury in two cases, and motor bike accidents in two cases.

Associated injuries were found in eight cases; with thoracolumbar fractures in two cases, calcaneal fractures in two cases, one case of flail chest with multiple lung laceration and hemothorax, lumbosacral plexus injury in two cases (with gunshot injury), tibial fracture in one case. Stable pubic fracture were found in two cases who were managed conservatively by orthopaedic surgeons; probably this incidence is relatively lower compared to the literature because most of the cases presented with sacral fractures and associated pelvic fractures were transferred to the Elhadara University Hospitals and operated by our orthopaedic colleagues.

Detailed radiological investigations were done in form of; (1) Radiographic evaluation of pelvis including antero-posterior, inlet and outlet views, (2) CT scan, and (3) MRI lumbosacral spine whenever possible.

We used Dennis Classification[4] and Roy-Camille classification[32] in our study. They were eight cases of Denis type 1, nine case of the type 2, and three cases of the type 3 with U shaped pattern. Denis type 3 sacral fractures were classified according to Roy Camille et al. classification. There were two cases Type 1, one case Type 2. Type 3 Roy Camille fractures were excluded from the study because of failure of closed reduction and were operated by open lumbo-pelvic techniques (Table 1, 2).

Physical examination was done after admission. The examination included: Motor power, Sensory examination, rectal and bladder control. Lower limb reflexes, bulbo-cavernous and cremasteric reflexes.

A written consent was taken including the nature of the fracture and the procedure, type of the anaesthesia, possible risks of the surgery.

Osteoporotic sacral fractures, Sacral fractures with unstable anterior pelvic ring disruptions, metastatic sacral fractures, vertically unstable displaced sacral fractures and sacral dysmorphism were excluded from our study.

Operative Technique:

Surgery was done in supine or prone position according to other co-morbidities (example, a case with flail chest has to be operated in supine position). We used a radiolucent operating table. General anaesthesia was used folded blankets beneath the patient in supine position were beneficial to make slight extension for reduction of the displaced fracture. Lower limb traction facilitated by flexing the knee in the prone position in some cases was also beneficial to achieve and maintain reduction.

True lateral views of the sacrum, inlet and outlet views were ensured on the C-arm and reduction of the fracture was confirmed (Figure 1).[34] A true lateral view was confirmed when both sciatic notches and end plates of S1 vertebra overlap each other. For a safe entry point, we had to define the iliac cortical density (ICD) on the lateral view. Also we had to define true inlet view which was confirmed when anterior edges of S1 and S2 overlap each other with full visualization of the central sacral canal. Finally, true outlet view was ensured when superior border of symphysis pubis overlap the body of S2.

Entry point of ilio-sacral screw was behind and below the ICD on the lateral view. Then C-arm was rotated for the inlet and outlet views. When our osseous trajectory was S1, the guide wire was above S1 foramen and below L5- S1 disc space in the outlet view. But in case of S2 ilio-sacral screw, the guide wire was between S1 and S2 foramen. In the inlet view, the guide wire was anterior to the central sacral canal and posterior to the anterior border of ala of the sacrum It means that the guide wire will anterior to the central sacral canal and posterior to the anterior border of the sacrum to make sure that the wire will have a perfect intra-osseous trajectory to avoid invasion of the central canal posteriorly and injury of root L5 and internal iliac vessels anteriorly.

A skin incision was done after confirmation of the entry point and drilling of the guide wire was done under guidance of the three pelvic views. After application of the guide wire inside its specific osseous trajectory either in S1 or S2 body, we decided the length of the ilio-sacral screw by subtraction method. Then a cannulated drill was introduced under the guidance of the lateral, pelvic inlet and pelvic outlet views through the same osseous trajectory of the guide wire. Finally, a 7 mm cannulated ilio-sacral screw and its washer were introduced and the guide wire was removed. We didn't do central sacral decompression for all cases. We depended on high quality C-arm images to compare between sacral foramina on both sides, however this was not always available in some cases especially in cases with morbid obesity. The wound was irrigated and closed. We didn't use electrophysiological monitoring in our series.

Postoperatively, neurological examination was done for all patients to detect any neurological deficit and to compare neurological status before and after surgery. Plain X-rays including lateral view, pelvic inlet and pelvic outlet views were done. Computed topographies of the sacrum with 3D reconstruction were done to assess the osseous trajectory and to document screw safety after surgery.

Depending on the CT scans, the osseous trajectory of the ilio-sacral screw was classified to *intra-osseous pathway when ilio-sacral screw was bounded by cancellous bone in all CT cuts *Juxta-foraminal pathway when there was a lack of cortical continuity in some CT sections *extra-osseous pathway when the ilio-sacral screw was completely outside the cortex and in front of the sacral ala.[9]

After discharge, patients were followed for 6 months clinically and radiologically to evaluate healing of the fracture and to detect any implant changes. Neurologic injuries were classified before and after surgery according to Gibbons et al.[10] as 1, none; 2, paraesthesia only; 3, motor loss with bowel and bladder intact; or 4, bowel or bladder function impaired. Majeed Functional Score[23] was used for functional outcome taking in account of pain (30 points), return to work (20 points) sitting (10 points), sexual activity (4 points) and standing (walking aids; 12 points, gait; 12 points and walking distance; 12 points). Score >85 was considered excellent, 70 to 84 good, 55 to 69 fair and <55 poor.

RESULTS

The study included 20 patients, 13 males and 7 females with the mean of 34±15.3 (range, 18-55) years. Fifteen cases were operated prone and five cases were operated supine. Total 39 percutaneous ilio-sacral screws were placed. The mean duration of screw insertion was 34±14.1 (range, 20-50) minutes.

Total 39 percutaneous ilio-sacral screws were placed in 20 patients (Table 3). Partially threaded cancellous 7.0-millimeter cannulated screws were used. Fifteen patients had unilateral double screws. One patient had unilateral triple screws. Two patients had bilateral screws for bilateral sacral fracture. Two patients had unilateral single screw; they were the first and second cases in our series and it took a lot of time to insert the screw safely and we decided to stop because of the radiation risk.

One patient (who had associated displaced calcaneal fracture) developed post-operative deep vein thrombosis.

Two Misplaced screws out of thirty-nine screws were observed in two case with ventral protrusion of the screw in front of the sacral ala where root L5 passes, one of these cases developed foot drop postoperatively and we had to modify the misplaced screw. The neurological deficit in the form of foot drop recovered partially three months later with physiotherapy. The second case did not show any neurological deficit and we did not have to modify the screw. These two cases were the second and third cases in our series and in the beginning of our learning curve (Table 4). Two screws out of thirty-nine screws were found to be juxtra-foraminal in the postoperative CT scans with no violation of the sacral foramen (Table 5). The other thirty-five screws had a perfect intra osseous trajectory. We had no cases of spinal canal violations. No other screw related problems were detected in the follow up pelvic x rays or CT scans. No infection was detected.

All fractures healed clinically and radio-graphically (bony trabecular appearance and reactive sclerosis) in the follow up period (6 months) except one case who was operated by a single ilio-sacral screw and did not show radiological healing in the follow up (Table 6).

Of the twenty patients operated for sacral fracture, nine patients presented with preoperative neurologic abnormalities. Of the nine cases, one patient presented with paraesthesia, two patients with lateral compression injury Denis type 1

fracture presented with foot drop, six patients presented with sphincter control loss, two of them had burst thoracolumbar fractures, another two cases had a gunshot injury with lumbosacral plexus injury and two cases presented with Denis type 3 Roy type 1 sacral fracture.

After surgery, three patients had neurologic deficits; two of them had lumbar burst fractures and underwent decompression and fixation for their lumbar fractures. Both patients presented with complete paraplegia with loss of bowel and bladder control before and after surgery. The third case had a misplaced screw postoperatively and developed foot drop which was not present before surgery. The four cases (2 cases with gunshot injury and 2 cases with Denis 3 Roy 1 sacral fracture) who presented with sphenceteric dysfunction; had recovered within 6 months after surgery. Also the two cases presented with foot drop after lateral compression sacral fracture type 1 recovered after 3 months with physiotherapy (Table 7).

At the end of the follow up, clinical scoring by Majeed score was excellent in nine cases, good in seven cases, fair in two cases (one case had a misplaced screw and developed foot drop post operatively and recovered partially with physiotherapy and another case fixed by single screw and didn't have sufficient healing) and poor in two cases (who had burst lumbar fractures with complete paraplegia before and after surgery), (Table 8).

Table 1. Distribution of the studied cases according to Denis classification (N=20).

Denis classification	No.	%
Type I	8	40.0
Type II	9	45.0
Type III	3	15.0

Table 2. Distribution of the studied cases according to Roy Camille classification (N=3).

Roy Camille (Type III Denis)	No.	%
Type I	2	10.0
Type II	1	5.0
Type III	0	0.0

Table 3. Distribution of cases according to side and number of inserted ilio-sacral screws (N=20).

Side and number of inserted ilio-sacral screws	No.	%
Unilateral double screws	15	75.0
Unilateral triple screws	1	5.0
Bilateral screws	2	10.0
Unilateral single screw	2	10.0

Table 4. Distribution of cases according to complications (N=20).

Complications	No.	%
Deep vein thrombosis	1	5.0
Misplaced screws	2	10.0
Foot drop	1	5.0

Table 5. Distribution of cases according to foraminal osseous trajectory (N=37).

Osseous trajectory	No.	%
Intra-osseous	35	89.7
Juxta-foraminal	2	5.1
Misplaced	2	5.1

Table 6. Distribution of cases according to radiological healing (N=20).

Radiological healing	No.	%
Present	19	95.0
Absent	1	5.0

Table 7. Distribution of cases according to Gibbons Classification of neurologic injuries (N=20)

Neurologic injuries	Preoperative		Postoperative		c^2	^{MC}p
	No.	%	No.	%		
1(None)	11	65.0	17	85.0	4.496	0.152
2 (paresthesia)	1	5.0	0	0.0		
3 (motor loss)	2	10.0	1	5.0		
4 (sphincter control loss)	6	20.0	2	10.0		

χ^2: Chi square test. MC: Monte Carlo, P: P value for comparing between preoperative and postoperative

Table 8. Distribution of cases according to clinical outcome scoring by Majeed Score (N=20).

Clinical scoring by Majeed score	No.	%
Excellent	9	45.0
Good	7	35.0
Fair	2	10.0
Poor	2	10.0

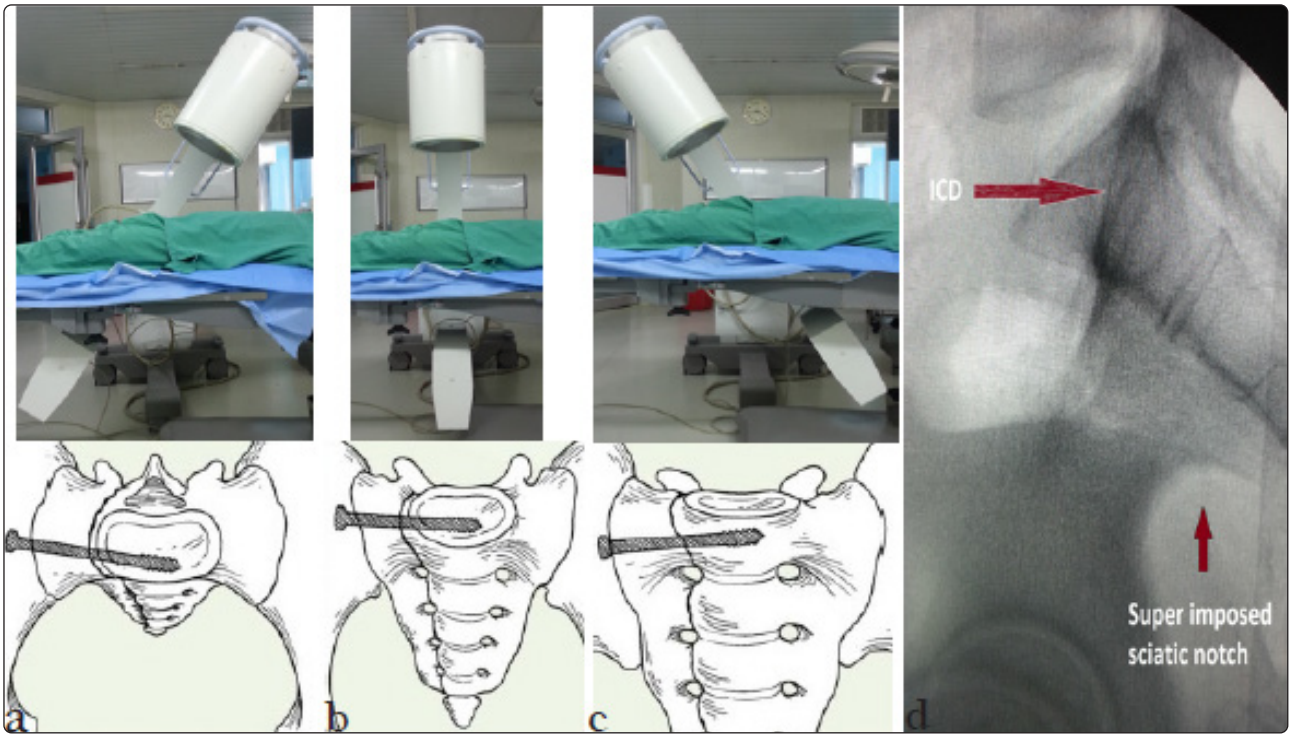

Figure 1. Position of Fluoroscopy set and schematic images of inlet, AP and outlet views (a to c), lateral view showing iliac cortical density (ICD) and overlapped sciatic notch.[34]

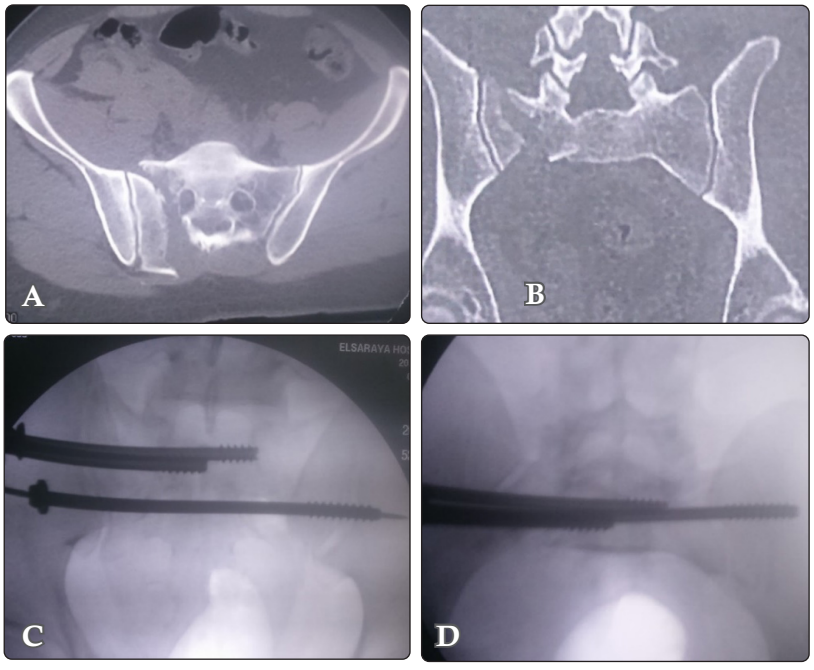

Figure 2. Thirty-three years aged obese male patient, sustained road traffic accident, (A) Axial CT scan demonstrating the Denis type 1 sacral fracture, (B) Coronal reconstruction CT scan of the sacral fracture, (C) Fluoroscopic pelvic outlet view after percutaneous fixation of the fracture with three unilateral partially threaded ilio-sacral screws. (D) Ilio-sacral screws in pelvic inlet view

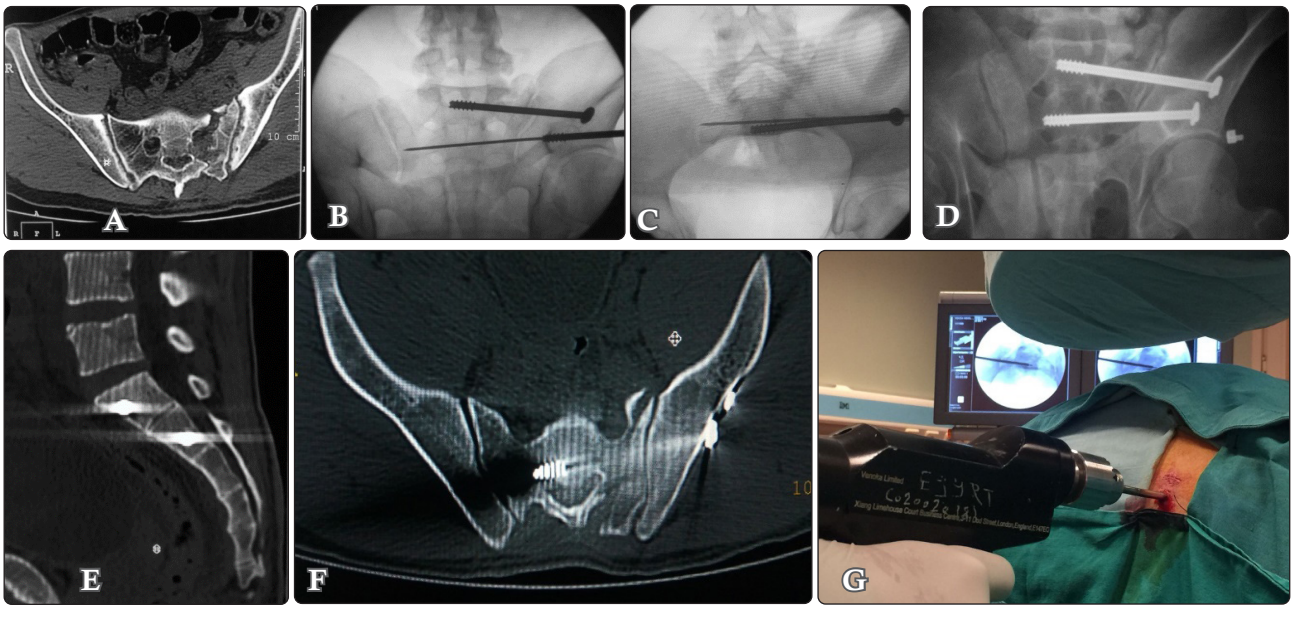

Figure 3. Forty-two years aged male patient, sustained road traffic accident, diagnosed as left Zone 1 vertical sacral fracture, operated by unilateral double percutaneous ilio-sacral screws in first and second sacral vertebra, (A) Coronal reconstruction of the sacral fracture demonstrating lateral and upward displacement of the fracture. (B) Intraoperative pelvic outlet view fluoroscopy demonstrating the inserted ilio-sacral screw in S1 body above S1 sacral foramen and the trajectory of S2 screw during the insertion between S1 and S2 sacral foramina, (C) Intraoperative pelvic inlet view fluoroscopy demonstrating the osseous trajectory of the ilio-sacral screw inside S1 and S2 body away from the central canal, (D) Post-operative plain radiograph pelvic outlet view, (E) Post-operative CT scans with sagittal reconstruction, (F) Post-operative CT scans with axial reconstruction, (G) Intra-operative photo with inlet view during insertion of the first ilio-sacral screw.

DISCUSSION

Sacral fractures are uncommon sacral traumatic injuries and usually develop after spinal axial loading. Its diagnosis is considered difficult and based mainly on clinical suspicion.[3,6,10,27] Unstable pelvic and sacral fractures are considered rare and usually a life threatening condition. Early reduction and fixation to achieve early mobilization is the optimal for these unusual fractures. External fixation can improve the outcome but not as rigid as internal fixation.[2,25,31,35]

The first open technique for ilio-sacral screw fixation was published in 1934.[11] Although open fixation technique with its posterior wide exposure gives the opportunity for sacral decompression of nerve roots and central sacral canal, it still carries a high complication rate. Impaired wound healing was reported as high as 25% in one study.[16] Posterior open approaches are also associated with many disadvantages like blood loss, infections, prolonged operating time and prolonged prone positioning. The percutaneous approach avoids these hazards and allow for rapid fixation of posterior pelvic or sacral pathologies either in supine or prone position and doesn't interfere with central sacral decompression should it be indicated.[15]

In our series, fifteen cases were operated prone and 5 cases were operated supine. We prefer the prone position because it gives an easier accessibility to change the surgical plane to open lumbo-pelvic technique when closed reduction can't be achieved. Also reduction means like skeletal traction with knee flexion is easier in prone position than in supine position. We also found that pelvic fluoroscopic views in obese patients is much clearer in prone position. However supine position gives the surgeon a better orientation of the sacrum and the whole pelvic bony land marks. If patient require assess to abdomen, it is not possible in prone position.[34]

Total 39 percutaneous ilio-sacral screws were placed in 20 patients. The mean duration of screw insertion was 34 (range, 20-50) minutes. The longer durations were recorded at the start of our series and in obese patients. It is considered a longer time compared to the literature. El-desouky et al.[8] reported a mean duration of screw insertion about 17 minutes. Routt et al.[30] decided the number of inserted ilio-sacral screws in every patient according to the purchase of the initially inserted screw. If the purchase was strong enough, there was no need for the second screw. When the purchase was not that strong, second or third screw was essential to obtain rigid fixation. A more recent study showed that single screw technique is biomechanically unstable.[38]

One study reported a specific Technique-related complication in one patient which was screw disengagement in a geriatric patient operated by a single ilio-sacral screw. They stated that this complication was limited to the only patient operated by a single ilio-sacral screw and thus they recommended the use of double or triple screws to obtain more rigid fixation.[27]

In our series, the first 2 cases were operated by a single ilio-sacral screw. All patients in our series healed clinically and radiologically in the follow up period (6 months) except one patient operated by single screw and didn't show any radiological healing. He partially recovered from pain and had fair Majeed score post-operatively. The reason for non-healing may be due to rotational instability caused by single screw fixation.

Most of complications of the percutaneous ilio-sacral screw technique arise from poor orientation of the pelvic and sacral bony anatomy and poor understanding the different pelvic fluoroscopic views. Inaccurate placement of the screw may be very hazardous and injurious to many vascular structures like gluteal vessels as well as neural structures especially fifth lumbar root and first sacral root. The incidence of these hazards increases in cases of altered pelvic or sacral anatomy like sacral dysmorphism and in case of partially reduced or non-reduced sacral fractures.[30] Thus accurate evaluation of X-rays, CT scans with 3D reconstructive cuts of pelvic and bony sacral

anatomy is very crucial to ensure safe osseous pathway for ilio-sacral screw.[26]

The most risky complication of the ilio-sacral screw is iatrogenic injury to the lumbar plexus and S1 root because of extra-osseous pathway. This injury was estimated to be between 0.5% and 7.7% of cases while rate of screw mal-positioning under fluoroscopic guidance was reported to be 2-15% in cases operated for percutaneous ilio-sacral screw fixation.[35,36] However, El-Desuoky et al.[8] stated that no screw malposition was found because he started all screw placements with ensuring entry point in true lateral view.

In our series, two misplaced screws out of thirty-nine screws were observed in two cases with ventral protrusion of the screw in front of the sacral ala where root L5 passes, one of these cases developed foot drop postoperatively and we had to modify the misplaced screw. Electrophysiological monitoring is very helpful to avoid iatrogenic neural injury.[9] Even with electrophysiological monitoring, iatrogenic neural injury has been reported. Ricci WM et al.[29] reported an incidence of 4% neuronal injury with electrophysiological monitoring in his series. In our series, we couldn't use electrophysiological monitoring and depended on careful and detailed evaluation of the pre-operative X-rays and CT scans to obtain good understanding of the sacral anatomy and to exclude any cases with a variant anatomy like sacral dysmorphism. We also focused on obtaining good and clear fluoroscopic images during the surgery to avoid extra-osseous pathways.

The nature of this minimally invasive approach is responsible for the very low incidence rate of infection. Routt et al.[30] stated that he had no infection in his series of 177 cases operated for ilio-sacral screw fixation. In our series we did not have infection.

Neural injuries and abnormalities are a common association with sacral fractures and can reach up to 85% of cases with displaced unstable sacral fractures. Unfortunately, associated lumbar fractures in patients with sacral fractures complicates the neurological examination relative to these sacral fractures. However, surgical decompression and its role in improving the neurological status postoperatively is not well defined.[3,10]

Some studies reported that the incidence of neurological recovery is surprisingly similar either surgical decompression is done or not.[18,19] On the other hand, other reviews showed that the patient gets benefit from decompression of the canal.[1,7,21,39]

We had similar results in our series. Of the twenty patients operated for sacral fracture, nine patients presented with pre-operative neurologic abnormalities. After surgery, three patients had residual neurologic deficits, two cases had lumbar burst fractures that required decompression and instrumented fusions. Both patients had paraplegia with loss of bowel and bladder control before and after surgery. The third case with a misplaced screw developed foot drop after surgery which was not present before surgery (Table 7).

The limitation of this study was the low number of patients because sacral fractures are not a common form of injury and most of cases usually referred to orthopaedic department in Alexandria University. Another limitation is the short period of follow up.

CONCLUSION

Percutaneous ilio-sacral fixation for sacral fractures is a safe minimally invasive method for management of sacral fractures. It is effective regarding pain relief with high fusion rates. It needs a long learning curve. Single screw fixation is not a rigid fixation and may lead to hardware failure.

REFERENCES

1. Ayoub MA: Vertically unstable sacral fractures with neurological insult: outcomes of surgical decompression and reconstruction plate internal fixation. International orthopaedics 33(1):261-7, 2009

2. Ben-Menachem Y, Coldwell DM, Young J, Burgess AR: Hemorrhage associated with pelvic fractures: causes, diagnosis, and emergent management. AJR American journal of roentgenology 157(5):1005-14, 1991
3. Bucknill T, Blackburne J: Fracture-dislocations of the sacrum: Report of three cases. The Journal of bone and joint surgery British volume 58(4):467-70, 1976
4. Byrnes DP, Russo GL, Ducker TB, Cowley RA: Sacrum fractures and neurological damage: report of two cases. Journal of neurosurgery 47(3):459-62, 1977
5. Bellabarba C, Schroeder GD, Kepler CK, Kurd MF, Kleweno CP, Firoozabadi R, et al: The AOSpine sacral fracture classification. Global Spine Journal 6(1_suppl): s-0036, 2006
6. Denis F, Davis S, Comfort T: Sacral fractures: an important problem. Retrospective analysis of 236 cases. Clinical orthopaedics and related research 227:67-81, 1988
7. Ebraheim NA, Biyani A, Salpietro B: Zone III fractures of the sacrum: a case report. Spine 21(20):2390-6,1996
8. El-Desouky II, Mohamed MM, Kandil AE: Percutaneous iliosacral screw fixation in vertically unstable pelvic injuries: a refined conventional method. Acta Orthop Belg 82(1):52-9,2016
9. Gardner MJ, Farrell ED, Nork SE, Segina DN, Routt Jr MLC: Percutaneous placement of iliosacral screws without electrodiagnostic monitoring. Journal of Trauma and Acute Care Surgery 66(5):1411-5, 2009
10. Gibbons KJ, Soloniuk DS, Razack N: Neurological injury and patterns of sacral fractures. Journal of Neurosurgery 72(6):889-93, 1990
11. Gras F, Marintschev I, Wilharm A, Klos K, Mückley T, Hofmann GO: 2D-fluoroscopic navigated percutaneous screw fixation of pelvic ring injuries: a case series. BMC musculoskeletal disorders 11(1):153, 2010
12. Gribnau A, van Hensbroek PB, Haverlag R, Ponsen K, Been H, Goslings J: U-shaped sacral fractures: surgical treatment and quality of life. Injury 40(10):1040-8, 2009
13. Hak DJ, Baran S, Stahel P: Sacral fractures: current strategies in diagnosis and management. Orthopedics 32(10), 2009
14. Hunt N, Jennings A, Smith M: Current management of U-shaped sacral fractures or spino-pelvic dissociation. Injury 33(2):123-6, 2002
15. Keating J, editor: Vertically unstable pelvic fractures: the outcomes of iliosacral screw fixation of the posterior lesion. Paper presented at the Annual Meeting of the Orthopaedic Association, 1994
16. Kellam J, McMurtry R, Paley D, Tile M: The unstable pelvic fracture: Operative treatment. The Orthopedic clinics of North America 18(1):25-41, 1987
17. Kelly M, Zhang J, Humphrey CA, Gorczyca JT, Mesfin A: Surgical management of U/H type sacral fractures: outcomes following iliosacral and lumbopelvic fixation. Journal of Spine Surgery 4(2):361, 2018
18. Kempen DH, Delawi D, Altena MC, Kruyt MC, van den Bekerom MP, Oner FC, et al: Neurological outcome after traumatic transverse sacral fractures: A systematic review of 521 patients reported in the literature. JBJS reviews 6(6): e1, 2018
19. Kepler CK, Schroeder GD, Hollern DA, Chapman JR, Fehlings MG, Dvorak M, et al: Do Formal Laminectomy and Timing of Decompression for Patients With Sacral Fracture and Neurologic Deficit Affect Outcome?. Journal of orthopaedic trauma 1;31:S75-80, 2017
20. König M, Jehan S, Boszczyk A, Boszczyk B. Surgical management of U-shaped sacral fractures: a systematic review of current treatment strategies. European Spine Journal 21(5):829-36, 2012

21. Li P, Qiu D, Shi H, Song W, Wang C, Qiu Z et al: Isolated Decompression for Transverse Sacral Fractures with Cauda Equina Syndrome: Medical science monitor. International medical journal of experimental and clinical research 25:3583, 2019
22. Lindtner RA, Bellabarba C, Firoozabadi R, Kurd MF, Shafi KA, Schroeder GD: Should Displaced Sacral Fractures Be Treated by an Orthopedic Traumatologist or a Spine Surgeon? Clinical spine surgery 29(5):173-6, 2016
23. Majeed SA: Grading the outcome of pelvic fractures. J Bone Joint Surg 71-B:304-6, 1989
24. Matta JM, Saucedo T: Internal fixation of pelvic ring fractures. Clinical orthopaedics and related research (242):83-97, 1989
25. Mears D, Fu F: External fixation in pelvic fractures. The Orthopedic clinics of North America 11(3):465-79, 1980
26. Miller AN, Routt Jr MLC: Variations in sacral morphology and implications for iliosacral screw fixation. JAAOS-Journal of the American Academy of Orthopaedic Surgeons 20(1):8-16, 2012
27. Nork SE, Jones CB, Harding SP, Mirza SK, Routt Jr MC: Percutaneous stabilization of U-shaped sacral fractures using iliosacral screws: technique and early results. Journal of orthopaedic trauma 15(4):238-46, 2001
28. Phelan S, Jones D, Bishay M: Conservative management of transverse fractures of the sacrum with neurological features. A report of four cases. The Journal of bone and joint surgery British volume 73(6):969-71, 1991
29. Ricci WM, Padberg AM, Borrelli J: The significance of anode location for stimulus-evoked electromyography during iliosacral screw placement. Journal of orthopaedic trauma 17(2):95-9, 2003
30. Routt Jr MC, Simonian PT, Mills WJ: Iliosacral screw fixation: early complications of the percutaneous technique. Journal of orthopaedic trauma 11(8):584-9, 1997
31. Routt MC, Simonian PT: Closed reduction and percutaneous skeletal fixation of sacral fractures. Clinical Orthopaedics and Related Research 329:121-8, 1996
32. Roy Camille R, Saillant G, Gagna G: Transverse fracture of the upper sacrum. Suicidal jumper's fracture. Spine 10:838–845, 1985
33. Schildhauer TA, Bellabarba C, Nork SE, Barei DP, Routt Jr MLC, Chapman JR: Decompression and lumbopelvic fixation for sacral fracture-dislocations with spino-pelvic dissociation. Journal of orthopaedic trauma 20(7):447-57, 2006
34. Shrestha D, Dhoju D, Shrestha R, Sharma V: Percutaneous ilio-sacral screw fixation in supine position under fluoroscopy guidance. Kathmandu University Medical Journal 13(1):56-60, 2015
35. Tonetti J: Management of recent unstable fractures of the pelvic ring: An update Conference supported by the Club Bassin Cotyle (Pelvis-Acetabulum Club). Orthopaedics & Traumatology: Surgery & Research 99(1): S77-S86, 2013
36. van den Bosch EW, van Zwienen CMA, van Vugt AB: Fluoroscopic positioning of sacroiliac screws in 88 patients. Journal of Trauma and Acute Care Surgery 53(1):44-8, 2002
37. Yi C, Hak DJ: Traumatic spinopelvic dissociation or U-shaped sacral fracture: a review of the literature. Injury 43(4):402-8, 2012
38. Yinger K, Scalise J, Olson SA, Bay BK, Finkemeier CG: Biomechanical comparison of posterior pelvic ring fixation. Journal of orthopaedic trauma 17(7):481-7, 2003
39. Zelle BA, Gruen GS, Hunt T, Speth SR: Sacral fractures with neurological injury: is early decompression beneficial?. International orthopaedics 28(4):244-51, 2004

الملخص العربي

درجه كفائه و امان التقنيه محدوده التدخل عبر الجلد بأستخدام المسمار الحرقفي العجزي لتثبيت كسور الفقرات العجزيه في أول عشرين حاله بقسم جراحه المخ و الأعصاب بجامعه الاسكندريه.

البيانات الخلفيه: تشكل كسور الفقرات العجزيه جزء أساسي من كسور الحوض. ولا يتم اكتشاف ٥٠ ٪ من هذه الكسور في الفحص البدني الأولى في حالات الحوادث المتعدده الاصابات. و يعتبر وجود او عدم وجود أصابه عصبيه او عجز عصبي من أهم العوامل المنذره و المؤثر على طرق و نتيجه علاج مثل هذه الكسور. تتبنى بعض الدراسات مبدأ تثبيت الفقرات العجزيه في الحالات متعدده الاصابات لتجنب الآثار الجانبيه و مضاعفات الاستلقاء لمدد طويله.

الغرض: تقييم درجه كفائه و امان تثبيت كسور الفقرات العجزيه بواسطه التقنيه محدوده التدخل عبر الجلد بأستخدام المسمار الحرقفي العجزي في أول عشرين حاله بقسم جراحه المخ و الأعصاب بجامعه الاسكندريه.

تصميم الدراسه: تحليل البيانات عن طريق التقييم بأثر رجعي للبيانات التي تم الحصول عليها من 20 مريض مصاب بكسر بالفقرات العجزيه و الذين تم اجراء تثبيت هذه الكسور بهم بأستخدام التقنيه محدوده التدخل عبر الجلد بأستخدام المسمار الحرقفي العجزي.

المرضي والطرق: تحليل البيانات عن طريق التقييم بأثر رجعي للبيانات التي تم الحصول عليها من من أول عشرين مريض خضع لتثبيت الفقرات العجزيه في قسم جراحه المخ و الأعصاب بجامعه الاسكندريه بأستخدام التقنيه محدوده التدخل بواسطه المسمار الحرقفي العجزي. و شملت الدراسه متابعه المريض بواسطه الفحص الاكلينيكي و الأشعات العاديه و المقطعيه لتحديد مدى التحسن الاكلينيكي و تققيم درجه إلتئام الكسور

النتائج: تم إستخدام ٣٩مسمار حرقفي عجزي في ٢٠ مريض مصاب بكسر بالفقرات العجزيه. حيث تم تركيب عدد ٢ مسمار من ناحيه واحده في ١٥مريض و تركيب عدد ٣ مسمار من ناحيه واحده في مريض واحد و تركيب عدد ١ مسمار من كلا الناحيتين في مريضين و تركيب مسمار واحد من ناحيه واحده في عدد ٢مرضى. و قد تبين وجود عدد ٢ مسمار من مجموع ٣٩مسمار خارج مساره الصحيح في مريضين و نتج عن هذا حدوث سقوط مؤقت في القدم في مريض واحد فقط. تم حدوث إلتئام كلي في ١٩ مريض و لم يحدث إلتئام للكسر في مريض واحد فقط.

الاستنتاج: التقنيه المستقله محدوده التدخل عبر الجلد بأستخدام المسمار الحرقفي العجزي في تثبيت كسور الفقرات العجزيه تعتبر تقنيه آمنه و فعاله من حيث زوال الألم و إلتئام الكسور و لكنها تحتاج إلى وقت كبير لتعلمها وإتقانها.