The Egyptian Journal of Hospital Medicine (April 2023) Vol. 91, Page 4145-4151

Surgical Outcome of Minimally Invasive U-Shaped Rod Strategy in Cases of L5 Pars Articularis Fracture

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ABSTRACT

Background: Isthmic spondylolysis commonly occurs at L5 with causing low back pain in younger adults. Pars interarticularis fracture produced by repeated cumulative stress of the pars interarticularis resulting in pars microfracture, leading to bony defect. Persistent back pain and sometimes-radicular pain are common complaint.

Objective: The aim of the current study was to evaluate the clinical results and complications after minimally invasive surgical approach of bilateral L5 pars interarticularis fracture by U shaped rod strategy technique.

Patients and methods: A total 12 consecutive patients were reviewed retrospectively during the period from February 2019 to February 2022 with bilateral L5 pars interarticularis fracture. Preoperative symptoms, and postoperative results for those patients who underwent minimally invasive surgical approach for treatment of bilateral L5 pars interarticularis fracture, are all recorded.

Results: Ten males and 2 females whose age ranged from 16 to 24 years. Clinical symptoms were: persistent low back pain in all patients (100%), radicular pain in 33% of patients (4 cases). The mean operative time was 82.5 (SD 11.8) minutes and the average blood loss was 206.5 (SD 47.8) ml. Post-operative assessments using the Oswestry scale showed improvement in 8 (66.6%). Three cases (25%) complain from mild back pain in exercise or during playing sport however the radiology showed good fusion. Failure of fusion with persistent of the complaint occurred only one case (0.08%) and re-surgery was done with the classic interbody fusion.

Conclusion: Direct pars repair using U shaped road technique in bilateral fracture pars articularis in the lumbar spine should be the procedure of choice in the indicated cases with short hospital stay and early recovery to normal life.

Keywords: Pars articularis fracture, U shaped rode, Fusion, Retrospective study, Sohag University.

INTRODUCTION

Isthmic spondylolysis commonly occurs at L5 with distinguishable low back pain in younger adults. Pars interarticularis fracture produced by repeated cumulative stress of the pars interarticularis resulting in pars microfracture, leading to bony defect. Up to 25% of cases may develop Spondylolisthesis. Persistent back pain and sometimes-radicular pain are the most common complaint [(1,2)].

The plan of management is conservative in most cases for at least three months with analgesics, anti-inflammatory, and muscle relaxant. Physiotherapy plays a role when deep abdominal strengthening exercises are indicated. Also, restriction of the flexion extension exercise is necessary [(3)].

Conservative treatment may last for maximum six months, if the conservative management failed and there is no evidence of fracture healing; surgical management will be the choice of management [(4,5)].

Decompression with lumbar fusion is the classic operative management for most cases especially with radicular pain is the main complaint. In young adult with no evidence of spondylolisthesis and healthy intervertebral disc material in MRI, minimally invasive surgery for pars repair will be of great value. Pars repair surgeries updated since 1968 when kimura advised to put a bone graft in the fracture site without any instrumentation then thinking about wiring fixation of the graft with Scout [(6-8)].

Buck in 1970 introduced lag screw 3.5 mm across the fracture line. Morscheret in 1984 advocated the use of laminar fixation with a hook screw device. More recently, authors advised the use of U shaped rod pars repair surgical technique (below the spinous process), as the best minimally invasive strategy [(9-13)].

The aim of the current study was to evaluate the clinical results and complications after minimally invasive surgical approach of bilateral L5 pars interarticularis fracture by U shaped rod strategy technique.

PATIENTS AND METHODS

From February 2019 to February 2022, at the Neurosurgery Department at Sohag University Hospitals, 12 patients with bilateral L5 pars interarticularis fracture were recruited and studied.

Inclusion criteria:

1. Age less than 24 years,
2. Average body built not over weight not more than 80 kg,
3. Persistent low back pain with failure of medical treatment for 6 months,

Received 20/01/2023
Accepted 23/03/2023

4. Tenderness on palpation,
5. MRI showed normal intervertebral disc,
6. No slippage with preserved sagittal balance and lumbar lordosis.
7. No previous spine surgery.

All patients underwent preoperative evaluation with complete neurological examination, lumbosacral X-ray with dynamic films, lumbosacral CT spine, and Lumbosacral MRI spine. Iliac bone graft was used in all patients.

The Oswestry disability index used in this study for all patients for evaluation the post-operative prognosis. Clinical and radiological assessment was done for all patients postoperatively: during hospital stay, 6 months, and 12 months later.

Surgical technique:

Under general anesthesia with prone position on surgical spine frame, midline spinal incision not exceeding 5 cm with the use of intraoperative fluoroscopy for determination of the level, using the periosteal elevator and gauze, paraspinal muscle dissection done with the limitation of the diathermy role to avoid muscle destruction and necrosis. Exposure of the facet in both sides without disruption of its capsule and exposure of the transverse process bilaterally.

Going through the point of entry; transpedicular screws average 6.5mm in diameter and 45-50 mm in length is inserted in the affected level bilaterally. Identification the line of pars defect and by the bipolar diathermy remove the pseudoarthrosis and slight curettage of the edges of the fracture line cautiously to avoid the injury to the underlying nerve root.

Through the same skin incision going through the lumbar fascia to take a bone graft from the outer part of the iliac bone crest; average 1cm in size by the osteotome. Graft site hemostasis with bone wax and closure of the lumbar fascia.

Putting each graft on the pars defect site bilateral and bending the rod as U shaped through the interspinous ligament with using the rod holder for compression between the screw and midline to fix the graft in its site bilateral. Thereafter, closure of the fascia, subcutaneous layer, and skin with no need for suction drain were done. Vancomycin 1 gm. Was used locally inside the wound.

Ethical Consideration

This study was ethically approved by the Institutional Review Board [IRB] of the Faculty of Medicine, Sohag University (Soh-Med-23-1-23). Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

The data were checked, coded and analyzed with SPSS version 22, then Data were presented as numbers and percentage.

RESULTS

In our study, male predominance was evident as ten male cases to two females only. The age varies from 16 to 24 years. All our cases presented by L5 pars interarticularis defect. Low back pain was the main complaint with four cases was associated with radicular pain (duration of symptoms 12-18 months). Table 1 summarizes the demographic and clinical data of the study group.

Table 1. Demographic and clinical data of the study group.

Variable	Male (N=10)		Female (N=2)		P value
	Mean ± SD	Median (range)	Mean ± SD	Median (range)	
Age	20.5 ± 2.7	20 (16-24)	19.5 ± 3.5	19.5 (17-22)	0.759
Weight	70.0 ± 5.3	70 (65-80)	75.0 ± 7.1	75 (70-80)	0.491
Low back pain	10 (100%)		2 (100%)		1.000
Radicular pain	3 (30%)		1 (50%)		0.576
Duration of symptoms	15.3 ± 2.5	15.5 (2-18)	13.5 ± 2.1	13.5 (12-15)	0.421

Post-operative assessment using the Oswestry scale showed improvement in 8 (66.6%) cases with return to normal life without any complaint even with exercise or playing sport. Three (25%) cases complain from mild back pain in exercise or during playing sport however the radiology showed good fusion.

Only 1 (0.08%) case showed failure of fusion with persistent of the complaint and re-surgery was done with the classic interbody fusion. Apart from the nonunion case we had only 1 case of superficial wound infection treated by antibiotics and frequent dressing. No other intraoperative or postoperative complications. The average hospital stay was 1-2 days.

Table 2 shows the operative and postoperative data of the study group, and **Table 3** shows the improvement of the mean Oswestry scale.

Table 2. Demographic and clinical data of the study group.

Variable	Male (N=10)		Female (N=2)		P value
	Mean ± SD	Median (range)	Mean ± SD	Median (range)	
Operative time (min)	82.5 ± 12.6	82.5 (65-100)	82.5 ± 10.6	82.5 (75-90)	1.000
Blood loss (ml)	202.5 ± 50.6	200 (150-300)	225 ± 35.3	225 (200-250)	0.529
Hospital stay (hours)	34.2 ± 9.4	33 (24-48)	36	36	0.560
Complete success	6 (60%)		2(100%)		0.549
Partial success	3 (30%)		0 (0%)		---
Failure	1 (10%)		0 (0%)		---
Infection	1 (10%)		0 (0%)		0.833

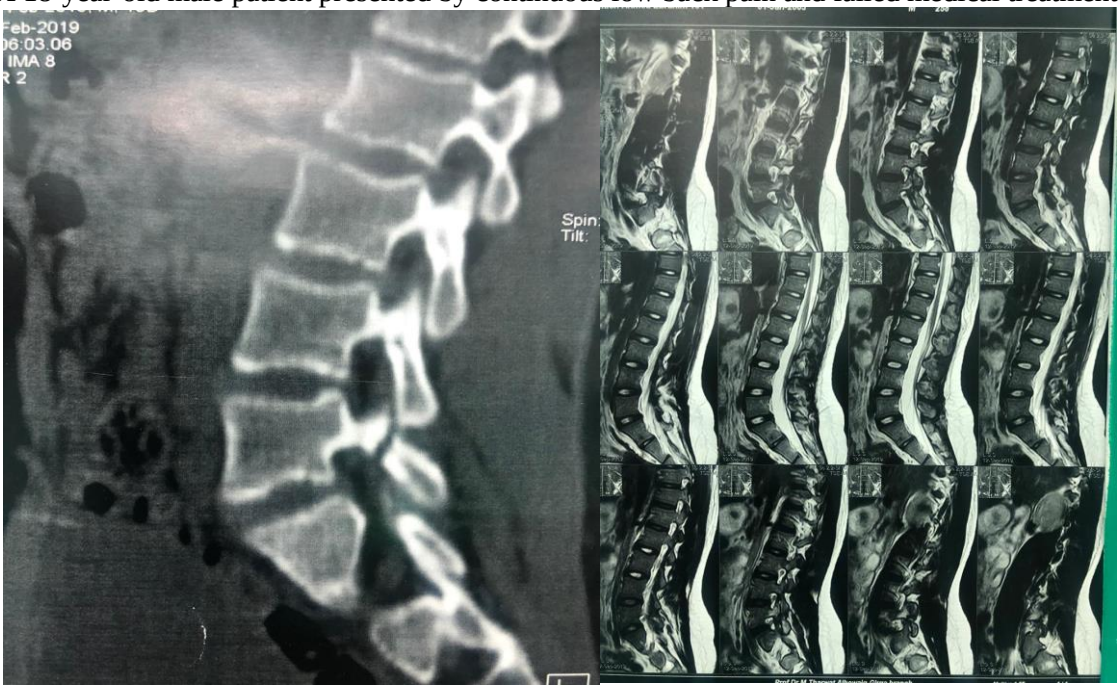
Table 3. Oswestry scale of the studied patients.

Variable	Male (N=10)		Female (N=2)		P value
	Mean ± SD	Median (range)	Mean ± SD	Median (range)	
Preoperative	38 ± 9.19	40 (20-50)	35 ± 7.07	35 (30-40)	0.676
Postoperative	15.5 ± 10.66	10 (0-35)	5 ± 7.07	5 (0-10)	0.220
P value*	0.009		0.157		---

*P value calculated using Wilcoxon test to compare postoperative scale compared to the preoperative one for each individual patient.

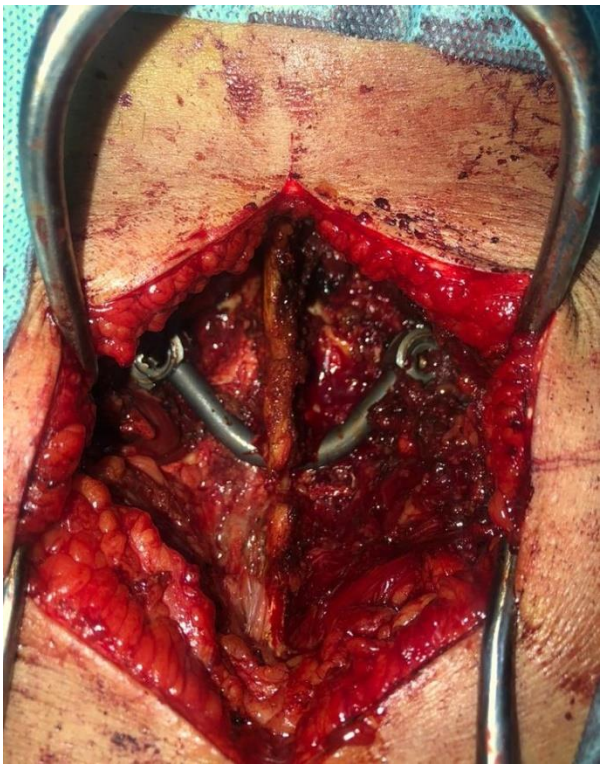
CASE 1

A 18-year-old male patient presented by continuous low back pain and failed medical treatment.

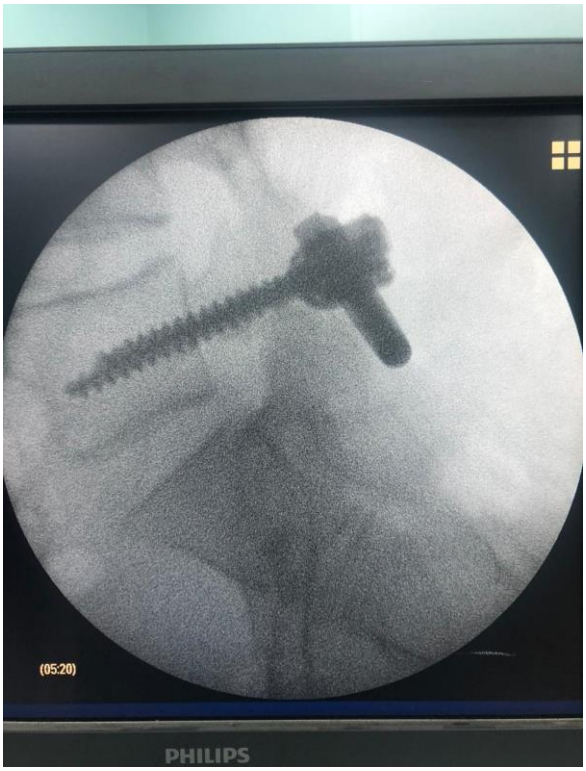


A **B**

A- Preoperative CT showing pars fracture, B- preoperative MRI showing no disc bulge

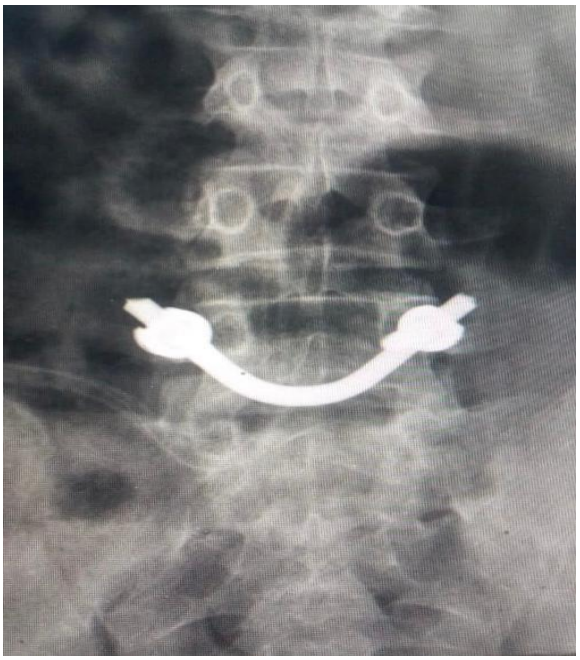


C



D

E

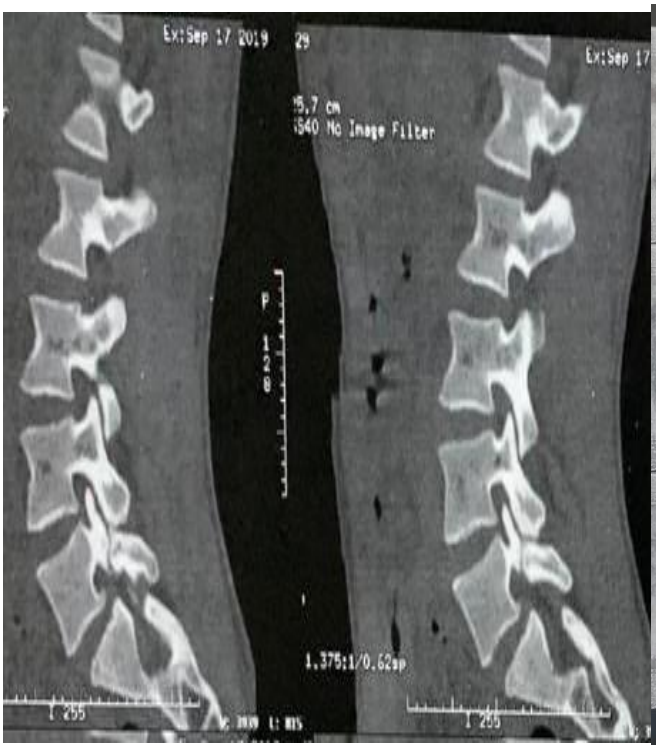


F

C and D (c- arm image) Intraoperative image, **E and F** Post-operative X ray

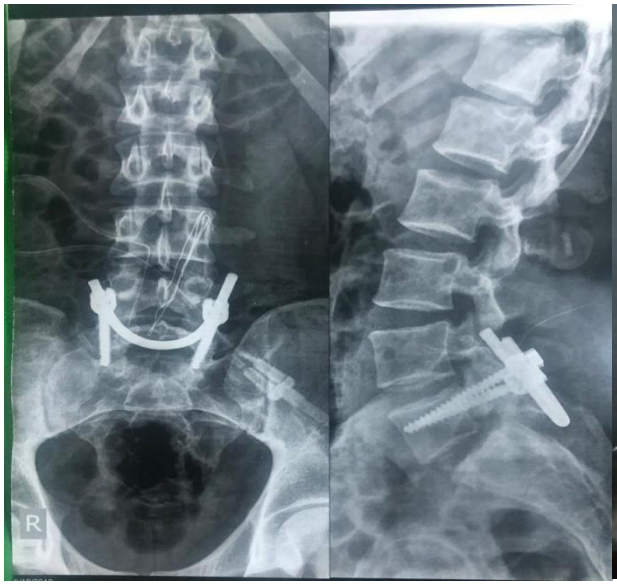
CASE 2

A 22-year-old male patient presented by persistent low back pain and failed medical treatment.



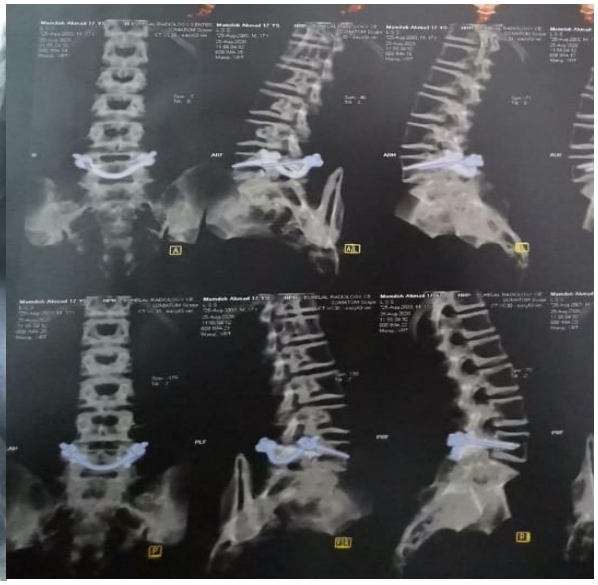
A - CT showing fracture

B -MRI shows No disc bulge



C

Post-operative x- ray



D

Post-operative 3D reconstructed CT

DISCUSSION

The target of surgery for pars interarticularis defect is to eliminate the pain origin by reconstruction and fixation of the pars defect. For many years spine surgeons tried to find out a surgical technique that achieve the goal of fixation and reconstruction with maintaining the biomechanical spinal unit [(3)].

Started with Kimura by putting bone graft chips in the fracture line without instrumentation for 4-6 months with lumbar corset until fusion occur. Buck applied a small lag screw 3.5 mm to enforce the stabilization with early mobilization of the patient but the liability of break of the small screws was the drawback [(10,14)].

Scott decided to use a wire to compress the graft against the defect but he faced the possibility of the loosening and breakage of the wiring system. Despite of this in ***Fan et al.*** series he found the superiority in the Scott wiring technique over Morscher's hook screw system which has high incidence of pseudoarthrosis reached 35% [(13,15-18)]. Also, ***Fan et al.*** directed his scope to the biomechanical stiffness following the repair and he found that Kakiuchi approach with the use of cephalic pedicle screw and caudal laminar hook screws showed biomechanical stiffness in dynamic films compared to Scott technique [(18,19)].

Also, many authors have reported, that the use of pedicle screws to stabilize the lamina with either a U-shaped rod under the spinous process or rod-hook construct, have low incidence of pseudoarthrosis and biomechanical stiffness. The U- rod method was named (smiley face rod method) because on the anterior-posterior plain radiograph the screw head and rod look like a smiley face emoji. It was proved to have very good biomechanical properties by ***Ulibarri et al.,*** in comparison to other modalities of direct surgical repair [(20,21)].

Our study with direct repair using U shaped road achieved significant improving in Oswestry disability index with 66.6% and these results can be near with the results obtained in previous studies, in 2017 when ***Yamshita et al.*** achieved 90% improvement and Drazein in 2011 achieved 84% improvement. Authors proved that good selection of the cases with young age, healthy disc, no lithesis play a good role in the post-operative improvement [(22,23)].

Authors in the last studies proved that there is no difference in the clinical outcome between the U-shaped repair in pars defect and the traditional PLIF approach bot the U-shaped approach came to be superior to PLIF as regard to biomechanical point [(20,24,25)].

Our series revealed short time hospitalization (one day postoperative) with back to normal life activity within 12 weeks except extensive sports. Previous studies achieved same results with recovery to work and normal life within 3-6 months. Persistent back pain seen in 10% of previous results was improved with simple medications [(26-28)].

Complications such as Breakage of screws, failure of wire, cable and slippage of wire from the transverse process are frequently detected in wiring or laminar hook and Buck screws but rare failures occur in U shaped pars repair surgical techniques. Also, there is increased risk of neural tissue injury during unsighted passage of wires below the transverse process [(29,30)].

Also, in our series we recommend the advantage of direct pars repair by U shaped road in highly selective patient as regard to the time of the surgical procedure that not exceeding one hour and as regard to the intraoperative blood loss that not exceeding 100 ml.

Few reports are present on blood loss and operative time. Ahmed et al, showed operative time (mean time 79 ± 13 min) and average blood loss (mean 186 ± 57 ml). In Buck's method, the authors reported that the mean operative time was 58 min (range from 45 to 75 min) and the mean blood loss was 98 ml (average 50 to 140 ml) [(21)].

CONCLUSION

Direct pars repair using U shaped road technique in bilateral fracture pars articularis in the lumbar spine should be the procedure of choice in the indicated cases with short hospital stay and early recovery to normal life with no difference in the fusion rate comparable with classic TLIF.

DECLARATIONS

- Conflict of interests: Nil.
- Financial support and sponsorship: Nil.

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