

# Pars Repair in Isthmic Spondylolysis in Young Adults

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## ABSTRACT

**Background Data:** Spondylolysis remains the commonest identifiable cause of low back pain in children and adolescents. Isthmic spondylolysis occurs most commonly at L5. Both repetitive trauma and inherent genetic weakness can make an individual more susceptible to spondylolysis. There are varieties of surgical treatments to spondylolysis whether surgical fusion or pars repair in patients with no evident slippage or disc degeneration.

**Purpose:** To evaluate the efficacy of pars repair in patients with spondylolysis in regard to pain improvement and fusion.

**Study Design:** Prospective case series study.

**Patients and Methods:** Ten cases with isthmic spondylolysis were reported in this study. Between January 2016 and December 2018, three males and seven females were recruited. Inclusion criteria were as follows: age <30 years; weight <80 kg; back pain not responding to conservative treatment; slippage <2 mm; healthy disc space; no previous operation; and preserved lumbar lordosis. All patients underwent direct pars repair surgery using smiley face-shaped rod technique (V-shaped rod technique) with iliac crest bone graft. All patients were examined clinically and radiologically at 6 and 12 months after surgery to assess back pain using Roland-Morris Disability Questionnaire (RMQ) and fusion by plain radiographs and MS-CT of lumbosacral spine.

**Results:** Good outcome was achieved in seven cases (70% of patients) with significant improvement in back pain, RMQ; radiologically, sound pars fusion was shown. Two cases (20% of patients) had fair outcome and sound pars fusion with occasional back pain occurring with sports and strenuous activities with sound pars fusion. One case (10% of patients) had poor outcome as there was no fusion radiologically with poor improvement in RMQ and underwent traditional surgery with 4 screws, 2 rods, and cage placement.

**Conclusion:** Direct pars repair with V-shaped rod technique provides good functional outcomes in young adult patients with isthmic spondylolysis and can be an alternative method for traditional fusion. (2019ESJ180)

**Keywords:** Spondylolysis; Pars repair; Isthmic spondylolisthesis; Lumbar spine; Roland-Morris Disability Questionnaire

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## INTRODUCTION

Spondylolysis remains the most commonly identified cause of low back pain in children, adolescents, and young adults.<sup>10</sup> Isthmic spondylolysis occurs most commonly at L5. The cause of spondylolysis in these patients is repetitive stress of the pars interarticularis with subsequent microfracture. It is believed that both repetitive trauma and an inherent genetic weakness can make an individual more susceptible to spondylolysis. The disorder is generally more prevalent in males compared to females and tends to occur earlier in males due to their involvement in more strenuous activities at a younger age. This in turn may lead to a bony defect and cause progressive spondylolisthesis in up to 25% of cases.

Most patients respond well to conservative treatment in the form of analgesic anti-inflammatory, muscle relaxant, bracing, activity restriction, extension exercises, flexion exercises, and deep abdominal strengthening administered through physical therapy. The duration of physical therapy varies upon the severity of spondylolysis and typically ranges from three to six months. The goal of physical therapy is to minimize movement at the unstable defect of the pars interarticularis. Those who remain symptomatic for more than 6 months with failure of conservative treatment often benefit from operative treatment.

There are varieties of surgical treatment in spondylolysis whether surgical fusion or pars repair if there is no evident slippage or disc degeneration. There are different techniques in pars repair. In 1968, Kimura<sup>12</sup> reported on bone grafting without internal fixation for spondylolysis defects. Although in 1968 Scott began using a wiring technique to augment bone grafting of the lytic defect, his results were not published until 1986.<sup>16</sup> Many authors use the Scott wiring method, whereas others have modified the technique to include pedicle screws or cable instead of wire.<sup>24</sup> In 1970, Buck<sup>7</sup> documented the use of a lag screw across the lysis, and many authors have described their outcomes following this technique.

In 1984, Morscheret al.<sup>15</sup> reported that the Buck technique of using a 3.5 mm lag screw did not work well with a thin or dysplastic lamina, and they advocated using laminar fixation with a hook screw device specially made for this purpose. That device, a modified Harrington hook that accepts a bone screw, is no longer available from the original manufacturer.<sup>13</sup> Other authors have reported using pedicle screws to secure the lamina with either a rod-hook construct or a V-shaped rod under the spinous process.<sup>2</sup>

The aim of this study is to prove efficacy of pars repair in isthmic spondylolysis, using smiley face-shaped rod technique, in terms of improvement of back pain and RMQ and fusion.

## PATIENTS AND METHODS

This prospective case series study reported ten patients with isthmic spondylolysis including three males and seven females. Patients underwent surgery between January 2016 and December 2018 in Alexandria Main University Hospital. Patients who fulfilled inclusion criteria were recruited for this study. We included young adults with age less than 30 y, weight less than 80 kg, back pain not responding to conservative treatment for at least 6 m, tenderness on palpation, no slippage or less than 2 mm, healthy disc, no previous disc operation, and preserved sagittal balance and lumbar lordosis. Patients' data were reported and collected during scheduled outpatient clinic visits and operative records. We operated on all patients using direct pars repair using smiley face-shaped rod technique (V-shaped rod technique). Iliac crest bone graft was used for fusion at the site of the pars defect (Figures 1 and 2).

Preoperatively all patients were evaluated clinically with regard to the back pain and functional status using Roland-Morris Disability Questionnaire (RMQ).

Radiologically it was confirmed that all patients have pars defect using plain radiography, MS-CT scan, and MRI of the lumbosacral spine. Eight

cases were suffering from fracture pars L5 and two cases fracture pars L4.

All patients were assessed clinically and radiologically at 6 months and 1 year postoperatively to assess back pain and functional outcome using RMQ and assess fusion with plain radiography and MS-CT-scan of the lumbosacral spine.

### **Surgical Procedure**

All patients underwent surgery in prone position under general anesthesia with use of frame: posterior longitudinal midline incision extending between two spinous processes according to the level affected which can be detected by using fluoroscopy (C-arm) intraoperatively; stripping of the paravertebral muscles with subperiosteal elevation of the muscles until exposure of the lamina, both facet joints and root of the transverse process at its junction with the facet. We identify the bilateral pars interarticularis defect by rocking movement of the spinous process avoiding injury to the facet capsule and interspinous and supraspinous ligaments. Then, we clear the fibrous and cartilaginous tissue from the defect and removal of the pseudoarthritic changes at the site of the defect bilaterally using deferent curettes until we prepare cancellous bone on both ends of the defect bilaterally. We applied two pedicle screws bilaterally at L4 or L5 according to the level affected. Two corticocancellous iliac crest bone grafts were taken in all patients from the same incision by opening of the lumbar fascia covering the iliac crest and the graft taken from the outer wing of the iliac crest. This graft was about 1 cm in its widest dimension and we took the graft by using osteotome. Good homeostasis was done at the graft site by using bone wax followed by closure of the lumbar fascia covering the iliac crest. Then, we insert each graft at the site of the defect bilaterally, making sure that cancellous bones face each other. The rod was bent the like letter U to connect the two pedicular screws of the affected vertebrae on both sides; this rod facilitates compression of the iliac crest bone graft at the fracture site by compressing the screw on each side against the rod holder and this action allows maintaining of the bone graft at its place without migration until the fusion occurs. During

insertion of the graft, it is important to avoid injury of the underlying root in its traversing foramen.

## RESULTS

In this study, the mean age was  $23.4 \pm 2.4$  (range, 20–28 years), including 8 patients who were  $\leq 25$  years old and 2 patients  $> 25$ . The mean duration of symptoms was  $1.6 \pm 0.5$  (range, 12–24 months). The level of vertebrae affected was L5 pars in eight cases and L4 pars in two cases. The mean operative time was  $62.5 \pm 7.9$  (range, 50–75 minutes). The mean blood loss was  $230 \pm 48.3$  (range, 150–300 ml). The mean postoperative hospital stay was  $1.6 \pm 0.7$  (range, 1–3 days).

Good outcome was achieved in seven (70%) patients with significant improvement in back pain and RMQ and they returned to their usual daily activities without limitations. Two (20%) patients had fair outcome with occasional back pain occurring with sports and strenuous activities, although both cases showed radiological fusion. One (10%) patients had poor outcome with no improvement in back pain and limitations of daily activities and the patient showed no fusion after 6 months. This patient underwent traditional surgery with pedicle screw fixation and interbody fusion with accepted results.

There was significant improvement in the RMQ comparing the three studied intervals. The mean preoperative RMQ was  $17.5 \pm 2.01$  (range, 14–20 months), whereas the 6-month postoperative RMQ was  $4.9 \pm 1.5$  (range, 2–7) and the 12-month postoperative RMQ was  $1.7 \pm 1.9$  (range, 0–5) in nine patients who completed the study. Significant improvement had been reported to be from 72.59% to 91.03%. There was no significant correlation between the duration of patient complaints and the postoperative RMQ at 6- and 12-month follow-up (Tables 2 and 3).

Apart from the abovementioned nonunion case and another case of superficial wound infection treated by dressing and antibiotics, there was no other intraoperative or postoperative complication.

**Table 1.** Distribution of the studied cases according to different parameters (N=10).

Parameters	No. (%)
Sex	
Male	3 (30%)
Female	7 (70%)
Age/years	
≤25	8 (80%)
>25	2 (20%)
Duration of complaint/years	1.6±0.5 (1–2)
Level affected	
L4	2 (20%)
L5	8 (80%)
Operative time/minutes	62.5±7.9 (50–75)
Blood loss	230±48.3 (150–300)

**Table 2.** Correlation between duration of complaint and postoperative RMQ.

RMQ	Duration of complaint	
	$r_s$	<i>P</i>
Preoperative	0.033	0.927
% of change:		
Preoperative/6 months	-0.005	0.991
Preoperative/12 months	0.329	0.388

$r_s$ : Spearman's coefficient.

**Table 3.** Comparison between the three studied periods according to RMQ

RMQ/24	Preoperative (N=10)	Postoperative		Fr	<i>P</i>
		6 months (N=9#)	12 months (N=9#)		
Median	18	5	1	17.543*	<0.001*
Mean	17.5±2.01(14–20)	4.9±1.5(2 – 7)	1.7±1.9(0 – 5)		
% of change		↓72.597.32±	↓91.0310.18±		
Significance periods	P <sub>1</sub> = 0.025*, P <sub>2</sub> < 0.001*, P <sub>3</sub> = 0.059				

Fr: Friedman's test, significance between periods was done using Post Hoc Test (Dunn's).

*P*: comparison between the studied groups.

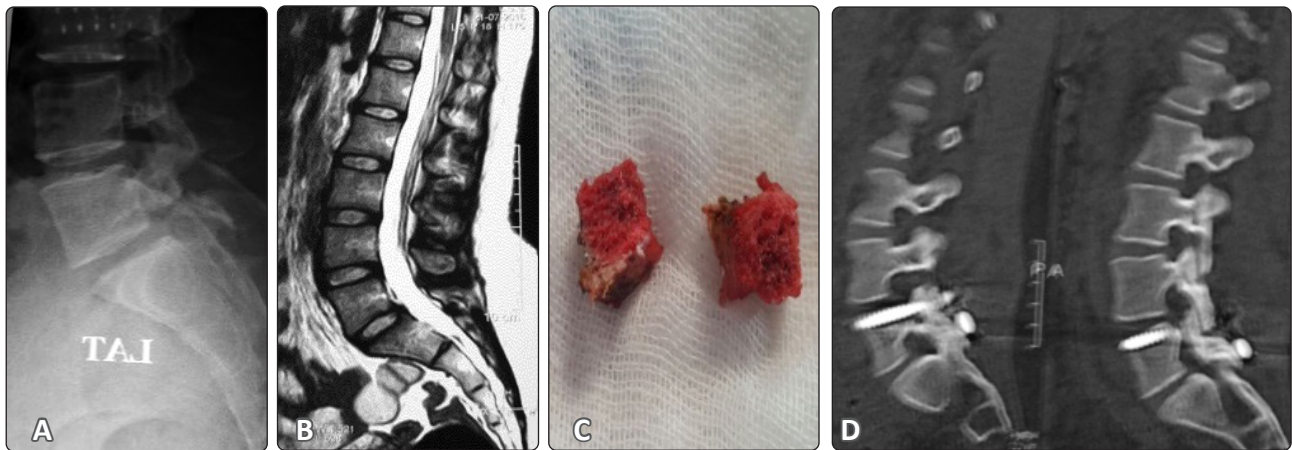
*P*<sub>1</sub>: comparison between preoperative and 6-month period.

*P*<sub>2</sub>: comparison between preoperative and 1-year period.

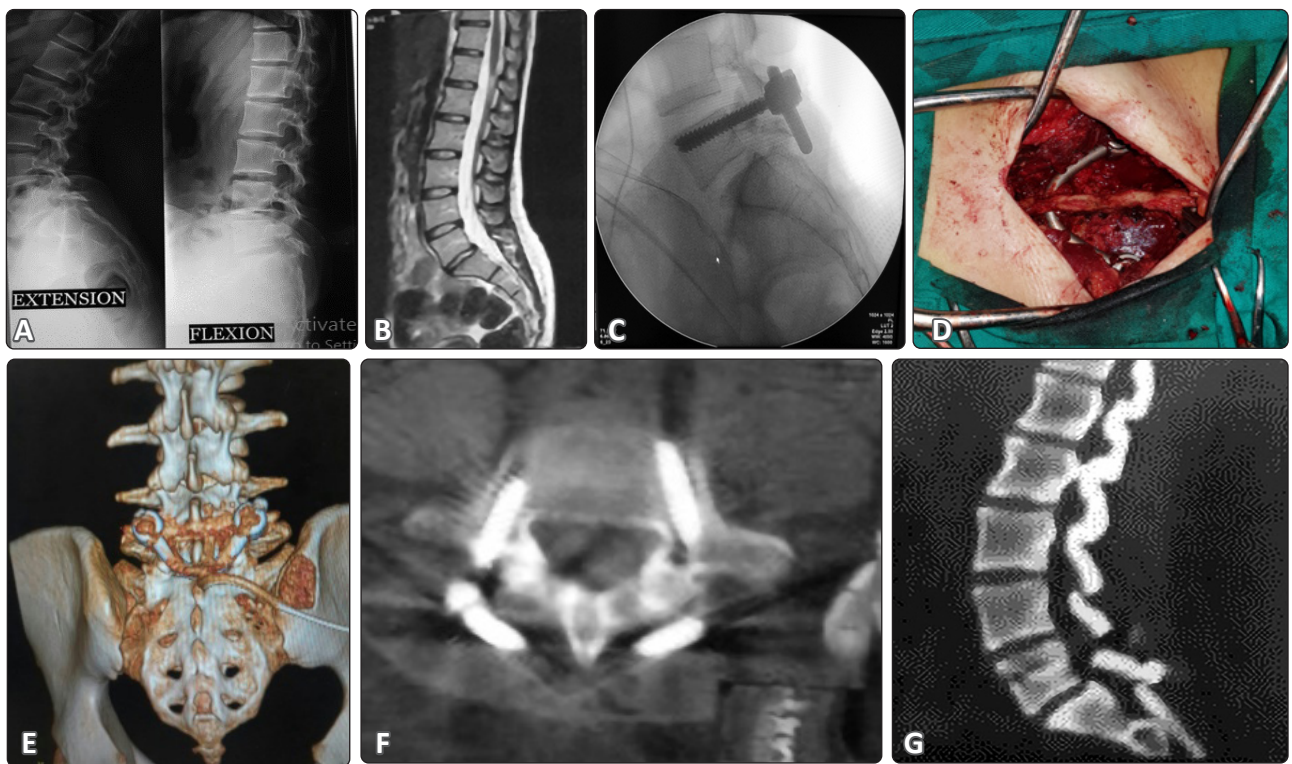
*P*<sub>3</sub>: comparison between 6-month and 1-year period.

\*: statistically significant at *P* ≤ 0.05.

#: one case who underwent traditional surgery.



**Figure 1.** A 23-year-old female patient with (A) plain radiograph showing L5 pars defect, (B) sagittal MRI showing healthy L5/S1 disc, (C) harvested iliac crest bone graft, and (D) postoperative with CT sagittal view after 6 months showing sound fusion of the pars.



**Figure 2.** A 23-year-old female patient with (A) plain radiograph showing L5 pars defect, (B) sagittal MRI showing healthy L5/S1 disc, (C) intraoperative fluoroscopy (D) intraoperative image, postoperative MS-CT scan (E) immediate 3D scan, (F) axial view (G) and sagittal view 6 months follow up showing sound fusion of the pars.

## DISCUSSION

The traditional method for managing isthmic spondylolysis with segmental spinal fusion is safe and effective method in patients who do not respond to conservative measures.<sup>23,21,4</sup> Direct pars repair procedure was first introduced by Kimura from Japan to preserve the motion segment, avoid drawbacks of fusion, retain lumbar spinal mobility, and restore normal anatomy.<sup>12</sup> Pars repair is more or less a minimally invasive procedure and targeted directly to the pathology. There are different techniques of pars repair reported in the literature including Buck's technique (direct pars screw), the Scott wiring technique, the modified Scott wiring, sublaminar hook facet screw technique, sublaminar hook pedicle screw technique, and, the most recent one, the smiley face-shaped rod technique.

Each of the pars repair techniques has its own advantages and disadvantages. Kimura's technique has the advantage of preserving motion in the affected motion segment. Kimura used bone graft without internal fixation. In this technique, patients have to be confined to bed for 2 months and wore a corset for additional 4–6 months. Buck<sup>5,6</sup> described his technique of bilateral lag screw fixation and allowed his patients to perform early activities. However, the problem of this technique was using small-sized screws that were liable to break. Morscher's technique<sup>15</sup> used hooks placed underneath the lamina and fixed to the vertebra by a lag screw. This technique was associated with facet arthropathy.

According to the literature, direct repair of spondylolysis gives good results in 60–90% (Beckers<sup>3</sup>, 60%; van der Werf et al.<sup>25</sup>, 66%; Hefti et al.<sup>9</sup>, 79%; Pedersen & Hagen<sup>19</sup>, 83%; Louis<sup>14</sup>, 86%; Buck<sup>6</sup> 1979, 88%; Albassir et al.<sup>1</sup>, 90%; Ohmori<sup>18</sup>, 90%). Good results usually depend on age of the patient, healthy disc space without any signs of degeneration, and fusion of the pars using iliac crest bone graft. The most recent technique in pars repair is the smiley face-shaped rod technique.

In our series, good results were obtained in seven cases (70%) with significant improvement in RMQ and the patients returning back to their usual daily activities without back pain within 3–6 months with only occasional pain occurring with strenuous sports. Two patients (20%) had fair outcomes with improved RMQ from 18/24 to 5/24 in the first patient and from 20/24 to 5/24 in the second patient. One patient (10%) had poor outcome due to failure of fusion with screw fracture and this patient required reoperation with traditional bony fusion and discectomy.

Reviewing the literature showed that, in Xiongsheng chen et al.<sup>28</sup> series, 20 patients out of 21 showed sound fusion. In Yamshita et al.<sup>27</sup> (2017), excellent results have been achieved in 90% of cases. In 2011, a study was conducted by Drazien et al.<sup>8</sup> and reported direct pars repair of spondylolysis in young adults and this study reported that 84% of the cases, whether athletes or not, returned back to their normal activities and sports within 5 months. In a systematic review done in 2012 by Westacott et al.<sup>26</sup> reporting the functional outcome following direct repair of pars or intervertebral disc fusion for adolescent spondylolysis, they conclude that there is no difference between PLIF and smiley face-shaped rod technique except for the motion segment preservation in pars repair. Long-term back pain and ODI were better with V-shaped rod technique.

Reported complications with these techniques were shown to be uncommon. Hardware failure is uncommon but has been reported with all of the techniques including screw breakages, wire and cable fractures, and wires pulled out from the transverse process.<sup>17</sup> Ranawat et al.<sup>20</sup> reported the case of a professional fast bowler who had undergone L3–S1 fusion after conservative treatment had failed. It was discovered that a screw had broken, and the patient was taken to surgery to remove the screw. Screw breakage happened a second time during the season, and thus all hardware from the fusion was removed. Nonunion has been reported in several cases.<sup>26</sup> Pseudarthroses have been reported to be not

uncommon, with Ivanic et al.<sup>11</sup> finding that 15 of 113 patients treated with the Morscher technique had pseudarthroses and 5 required second surgeries. Rarely, authors reported persistent low back pain after surgery.<sup>22</sup>

This study has some limitations including the small size of the population and the short-term follow-up period and those with obesity, degenerated discs, and >2 mm slippage were not included in our study. A large-sized study population with long-term follow-up duration is recommended.

## CONCLUSION

Direct pars repair with V-shaped rod technique provides good functional outcomes in young adult patients with isthmic spondylolysis and can be an alternative method for traditional fusion.

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## الملخص العربي

### اصلاح الجزء بين المفاصل في الانحلال الفقاري في البالغين الصغار

البيانات الخلفية: الانحلال الفقاري هو السبب الرئيسي المحدد لآلام أسفل الظهر لدى الأطفال والمراهقين. تعتبر الفقرة القطنية الخامسة (L5) أكثر المواقع شيوعاً لتحلل الفقار. ويعزى سبب الانحلال الفقاري في هؤلاء المرضى إلى الإجهاد المتكرر للجروح بين المفصل مع كسر دقيق لاحق؛ ويعتقد أن ضعف الجينات الوراثية الموروثة يمكن أن يجعل الفرد أكثر عرضة لتحلل الفقار. هناك أنواع مختلفة من التقنيات الجراحية في علاج انقسام الفقاري سواء كان الانصهار الجراحي التقليدي والتثبيت الفعال أو إصلاح الجزء بين المفاصل (بارس) المباشر إن لم يكن هناك انزلق واضح أو انحطاط القرص أو ضيق بالقناة العصبية.

**الغرض:** تقييم فعالية إصلاح بارس فيما يتعلق بالالتئام العظمي، والحفاظ على قطاع الحركة مع عدم وجود مرض المستوى المجاور.

**تصميم الدراسة:** دراسة على حالات متسلسلة مستقبلية.

**المرضى والطرق:** أجريت دراستنا على 10 مرضى يعانون من انحلال الفقاري. ثلاث ذكور وسبع إناث (بين عامي 2016 و 2018) عن طريق إصلاح البارسال مباشر باستخدام تقنية قضيب على شكل وجه ميتسم (تقنية قضيب على شكل حرف V) مع إدخال تطعيم عظم الحرقف الحرقفي في موقع العيب ثنائياً لتعزيز اندماج العظم عند موقع الكسر. العمر أقل من 30 سنة، الوزن أقل من 80 كيلوجرام، آلام الظهر لا تستجيب للعلاج التحفظي. لا يوجد انزلق أو أقل من 2 مم، مساحة القرص الصحية غير متدهورة، عدم فتق القرص أو تضيق القناة، لا توجد عمليات سابقة للظهر، الحفاظ على التوازن السهمي والقعس القطني.

**النتائج:** تم تقييم جميع الحالات سريريا وإشعاعياً لأكثر من عام واحد لتقييم التحسن في آلام الظهر باستخدام RMQ ولتقييم الالتئام العظمي إشعاعياً من خلال الأشعة العادية والمقطعية على العمود الفقري القطني. تم تحقيق نتائج جيدة في سبع حالات (70٪ من المرضى) مع تحسن كبير في آلام الظهر و RMQ. حالتان (20٪ من المرضى) كان لها نتائج عادلة مع آلام الظهر في بعض الأحيان تحدث مع ممارسة الرياضة والأنشطة الشاقة. كانت حالة واحدة (10٪ من المرضى) مصابة بالخروج بسبب تعرض المريض لصدمة في الظهر أدت إلى كسر المسامير في الفقرة الخامسة وإعادة إجراء العملية الجراحية التقليدية مع 4 مسامير وقضبان ووضع قفص. كانا للالتئام العظمي سليماً في جميع الحالات باستثناء مريض واحد تعرض لصدمة مباشرة في الظهر بعد 3 أشهر من الجراحة وكان مصاباً بكسر مسامير واحد، الأمر الذي تطلب إجراء عملية إعادة للجراحية مع تثبيت رسمي باستخدام 4 مسامير وقضيبين وقص بين الفقرات.

**الاستنتاج:** يمكن أن يوفر إصلاح بارس المباشر نتائج وظيفية جيدة في المرضى البالغين الصغار المصابين بالانحلال الفقاري.