Direct spondylolysis repair in young adults

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Introduction
Spondylolysis is a common problem affecting all ages, but in adolescent and young adults, especially the athletes, it represents a significant dilemma, as most of them are in their initial phase of their life and need a stable free spine. A minority of old people affected by this disease need medical care, and only a few require surgery, but in athletes and young adults, surgery usually has a main role. Reconstruction of the pars interarticularis is an alternative to segmental fusion; this technique has the advantage of preserving segmental motion. Most authors report good results of spondylolysis repair for young patients without intervertebral disc or facet affection.
Patients and methods
In this study, the fixation of the isthmus was done with a pedicle screw hook system. This stable and strong device is easy to use, allows anatomic pars interarticularis reconstruction, avoids postoperative bracing, and allows early ambulation. A total of 11 patients were assessed in this study. Their mean age at operation was 24 (range: 16–32 years), and the average follow-up was for 24 months (range: 6–36 months). Nine patients showed no preoperative degenerative disc disease and two patients had grade 1 changes. The visual analogical scale and the Oswestry disability index were used for assessment of pain and clinical outcome before and after surgery.
Results
The results were from 'excellent' to 'good' for 10 patients and 'fair' for one of them. The fusion rate was observed in all cases. Among the patients, the results were from 'good,' to 'excellent' in all cases, and consolidation was always observed. All of them showed normal disc height after the surgery.
Conclusion
Direct spondylolysis repair by pedicle screw hook system is an excellent and reliable method in the management of spondylolysis, especially in intact disc in young adults.

Keywords:
pedicle screw hook system, spine, spondylolysis

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Introduction

Spondylolysis is usually an asymptomatic pars interarticularis defect caused by a stress fracture in one or both sides of the neural ring. These fractures can lead to stimulation of the free nerve endings and cause significant back pain, mostly in young adults, especially athletes [1,2]. The goals of treatment are the alleviation of pain and the restoration of stability. Conservative management with activity restriction for pain control followed by 3–6 months of lordotic bracing is recommended [3].

Despite decrease in their daily activities and prevention of all strenuous sports, some patients will continue to complain from low back pain. Although the incidence of unmanageable back pain in these competitive athletes is low, some individuals experience debilitating symptoms that could prevent them from following their excitement for sports [4]. Direct surgical repair of spondylolysis is well documented as an effective treatment in young patients in whom nonoperative treatment fails [1,2,5–7].

Kimura (1968) described a direct repair. Buck (1970) established his repair with screws but stressed the technical difficulties of accurate screw placement. Nicol and Scott (1986) developed a wiring technique to establish the repaired defect. Bradford and Isa's reported on the Scott technique and stressed on an upper limit of 30 years.

Symptomatic spondylolysis is always a challenging problem, especially when presented in young people. Pars defect in these cases causes instability that needs stabilization. To maintain motion segment, segmental

fusion needs to be avoided. Direct repair of the pars defect is ideal in these cases, especially when the related intervertebral disc is healthy or grade one degeneration in which posterior decompression is not necessary.

Lumbar spondylolysis also called fatigue fracture of the pars interarticularis is a radiographic finding, which is appeared in spine radiographs. The main cause of spondylolysis is repetitive stress on the pars interarticularis (isthmus) of the lumbar vertebrae in the form of loading and unloading on the pars from repetitive spinal motion, especially lumbar flexion extension, and to a lesser degree rotation as a part of abnormal counter-movements in the low lumbar spine during physical activity. In-situ spinal fusion of the involved level is widely accepted as the treatment of choice for symptomatic. The disadvantages of two-level posterolateral spinal fusion are loss of motion at the fused segment and an increase in the rate of the adjacent segment degeneration.

Direct repair and reconstruction of the pars defect, in cases without degenerative changes, is a logical and less-aggressive approach, and has the advantage of maintaining the motion segment, with compression across the bone-grafted defect to enhance and ensure better fusion [8–10]. Moreover, it is ideal in cases of spondylolysis in which posterior decompression is not necessary.

The goals of the pars repair are obtaining fusion of the defect, restoration of the anatomy, gaining spine stability, preservation of segment mobility, minimization of adjacent segment disease, and prevention of development of slippage.

Kimura, in 1968, was the first to develop this concept as an alternative to segmental fusion. Since then, several confusion alternative techniques have been described in an attempt to directly repair the pars defect. Available techniques include either direct osteosynthesis across the pars defect with a lag screw or indirectly applying compression across the defect using a combination of wires, hooks, pedicle screws, and rods.

Although various techniques have not been compared regarding clinical or radiological outcome, the overall clinical outcome seems to be encouraging, especially in terms of quality of life. Those techniques were mainly used in young populations: children, adolescents, and young adults. Good results using these techniques with young people without spondylolisthesis, facet arthritis, or degenerative disc disease have been reported. Deguchi *et al.* [8] compared the biomechanical performance of these various fixation techniques and found that the pedicle screw hook system brings a greater biomechanical stability to the defect during motion, hence better fusion [8].

In this study, clinical results were reported using segmental pedicle screw-hock fixation with refreshment of fracture site and bone grafting.

Patients and methods

In this study, 11 patients were operated. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery,el Azhar University, Cairo Egypt. The inclusion criteria included: first, lytic defect, with no or minimal spondylolisthesis; second, healthy disc; third, negligible movement of the vertebra; fourth, no associated any significant cord or root compression; and fifth, failed conservative treatment in the form of moderation of daily activity and lordotic lumbar brace. Exclusion criteria included first, grade II or higher spondylolisthesis; second, dysplastic lamina, which could make fixation unlikely; third, significant disc degeneration at the level of the lysis; fourth, associated significant cord compression that need decompression; and fifth, a patient age greater than 32 years [2,11]. In the presence of any of these criteria, direct repair of lumbar spondylolysis is ruled out.

The study was carried between September 2012 and January 2016. The mean age at operation was 24 (range: 16–32 years) years, and the average follow-up was for 26 months (range: 12–40 months). There were seven males and four females. All of them experienced a heavy work.

All patients were evaluated clinically and radiologically. Clinical evaluation was done by history taken, and evaluation of the low back pain was done by Oswestry disability index. The Oswestry disability index was used for assessment of pain and clinical outcome before and after surgery.

Radiological evaluation include plain anteroposterior, lateral, and oblique views demonstrating the defect. Flexion and extension radiographs can clearly demonstrate any degree of slippage or any motion abnormality in the vertebrae [12]. Computed tomography (CT) scans was done for all patients to define the bony anatomy of the pars [2,3]. It also allows the detection of an occult and acute stress fracture that would otherwise be missed on plain radiographs [10]. Moreover, it would ensure the presence of metabolic

activity in the lysis, which may be the cause of pain, a factor that would increase the surgical chances of osseous union [6]. MRI also was done for all patients to assess disc status and neural condition. Proper evaluation of the disc is done via MRI, and also it allows proper evaluation of the canal to rule out any other soft tissue causes of back pain, or any cord compression. Disc space is considered acceptable if its height is at least two-thirds its normal height and if the slippage is less than 10 mm [13].

The surgery was done under general anesthesia in prone position, was fluoroscopically guided, and done through the posterior approach. Direct exposure of pars defect was done, followed by placement of pedicular-screws in the vertebra with the defect, refreshment of fracture site (lytic defect), cleaning of the defect, and curettage of soft and cartilaginous tissue until bleeding bone was evident. The pars defect was then grafted with a cancellous bone autograft from corresponding spinous process that was packed into the defect, followed by placement of hooks catching the corresponding lamina from both sides, application of suitable rods connecting each hook with corresponding laminar screw, and secure fixation by tightening of the construct.

This operation carries a modification of special hooks by using the ordinary laminar hooks instead which are easy to do and allow secure fixation, and early postoperative motion (Fig. 1).

Postoperatively the patients were allowed to wear a lumbar brace with early ambulation as tolerated. Follow-up by radiography was done at postoperative day 1 or 2 and every 3 weeks to assess fusion. Removal of stitch after 2 weeks was done and then the patient started limited activity for 6 weeks and full daily activity after 3 months. Sports and heavy work were delayed till 4–6 months after complete fusion. CT scan were done after 3 months to assess the fusion rate.

Results

All cases in this study showed postoperative improvement of their pain and activities. The results were from 'excellent' to 'good' for 10 patients and 'fair' for one of them. The fusion rate was observed in all cases in plain radiography and CT scan. The patients were graded as follows: excellent with no pain, return to normal occupation and normal previous activities; good when occasional pain after strenuous activity, return to normal occupation and less strenuous activity; fair when pain with activity, return to a less strenuous work and can get some of previous activity; and poor when pain persists postoperatively, unable to return to occupation or gaining previous activities.

Discussion

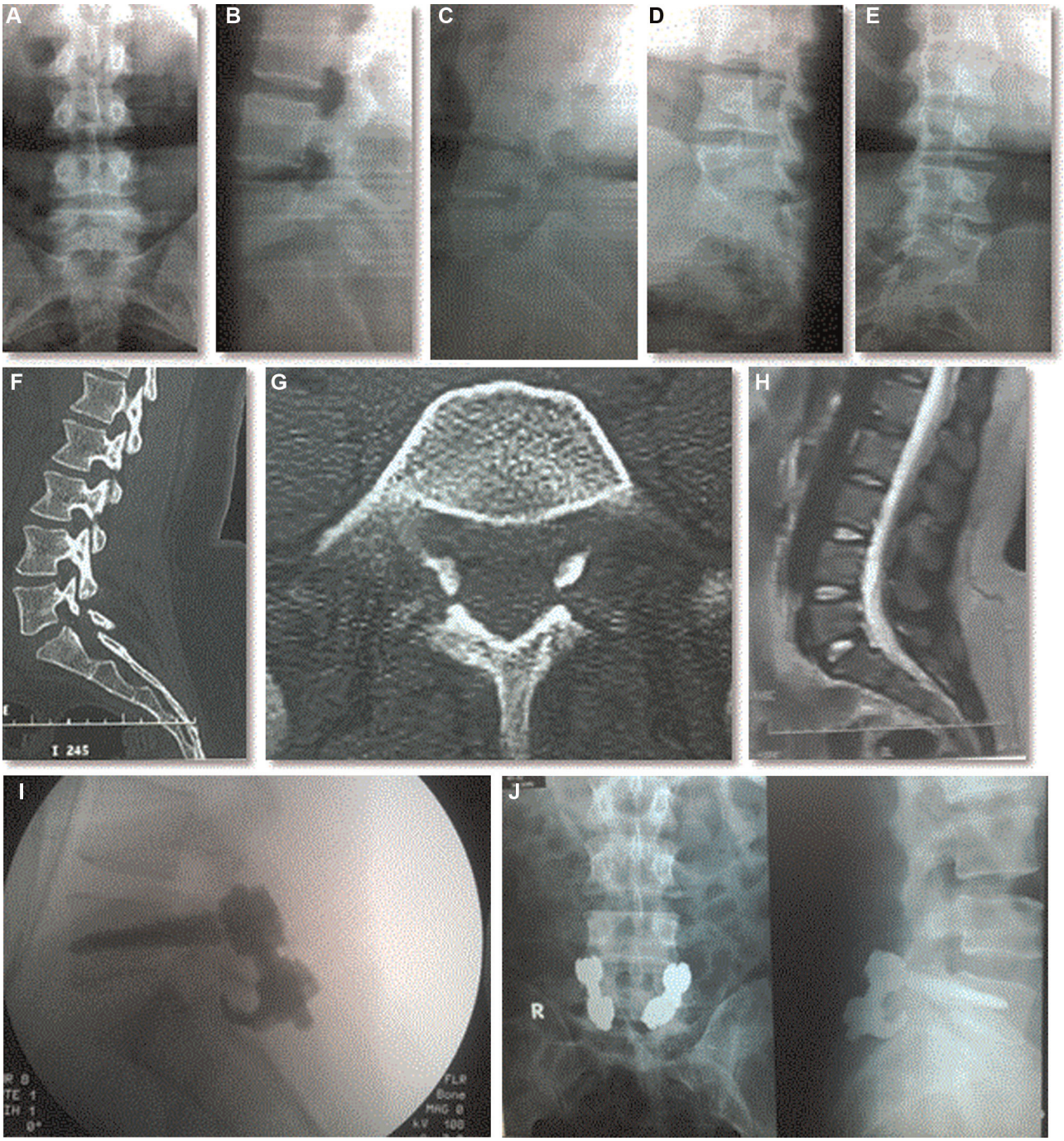
Works involving repetitive hyperextension of the spine along with axial loading seem to most predispose athletes and active persons to spondylolysis. Specifically, these actions are thought to overload the posterior elements, leading to pars fractures [14]. In Egypt, there is a large category of people working as a heavy worker since their early life as well as house wives, so they are exposed to repetitive spine trauma by continuous lifting heavy objects.

During the acute phase, most symptomatic spondylolysis cases can be successfully treated conservatively, but those who remain symptomatic, namely, failed conservative treatment, may benefit from surgery.

Early diagnosis and good assessment are important factors for good prognosis in the healing of the defect. Morita *et al.* [15] classified the pars defects in spondylolysis into three stages: early, progressive, and terminal [8,15]. Conservative management gives good results in the early stage, produced healing in 73%; in the progressive stage, healing was 38.5%; and in cases with terminal defects, 0% (no cases) showed union, which more probably required surgical intervention. Wiltse *et al.* [16] and Blanda *et al.* [17] suggest that spondylolysis can be successfully treated using conservative treatment if diagnosed at an early stage.

Patients not responding to conservative management and those with late presentation with significant pars defect are candidates for surgery. Preferably, direct repair of pars defect is recommended for them. The prerequisite of surgery includes young patients with spondylolysis experiencing back pain, not responding to conservative treatment, not associated with significant foreword slippage of the proximal vertebral body, and not associated with any neurological affection, with healthy discs evident in MRI, with no or minimal forward slipping.Pars repair has been described in many studies using many techniques: Kimura in 1960 [18], Buck's screw fixation in 1970 [19], Morscher *et al.* [20] with hooks and screws in 1984, Scott's transverse process wiring in 1986 [21], and others [18–22]. The difficulty is to create an adequate compression and strong fixation to the pars defect, allowing healing process without breaking the lamina, and without injury to the neural element or facet irritation. This study is in

Figure 1



Preoperative imaging (a) anteroposterior plain radiography, (b and c) lateral flexion and extension, showed no mechanical instability, (d and e) oblique views showed bilateral pars defect, (f and g) computed tomography scan proving the defect, (h) MRI showed healthy disc, (i) intraoperative, (j) postoperative radiography.

agreement with Hardcastle *et al.* [23] that fusion of the spondylolysis defect restores normal anatomy and preserves movement at the involved level.

In this study, repair was done by pedicle screw hook system with slight modification by using ordinary laminar hooks, as they are easy to use, available, inexpensive, applicable with secure fixation, and is safer, with less soft tissue dissection. Follow-up revealed that this repair gives early good results as most of the patients were improved from pain at early postoperative period. Most of the cases returned to previous activities with highly satisfactory results.

Conclusion

Direct repair of pars defect by pedicle screw hook system is an excellent and reliable method in the management of spondylolysis in young adults who complain of low back pain from this defect with

relatively healthy disc and no associated significant slippage or neurological affection.

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Conflicts of interest
There are no conflicts of interest.

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