Clinical Outcomes Following Repair of the Pars Interarticularis

Travis Clegg, MD, Leah Carreon, MD, Ian Mutchnick, MD, and Rolando Puno, MD

Abstract

Spondylolysis is a source of back pain in adolescents and young adults.

The purpose of this study was to report clinical outcomes in 49 patients treated with isolated motion-sparing repair of the pars interarticularis. Patients who underwent direct repair of the pars interarticularis between 2002 and 2009 were identified. Standard demographic and radiographic data, needed for further surgeries, and radiographic evidence of healing were collected.

Of 49 patients with 90 total pars defects (41 bilateral, 8 unilateral), 7 required reoperation. No serious complications were seen. None of the risk factors analyzed in our study were predictive of reoperation. The strongest preoperative predictor of Oswestry Disability Index score was Fujii chronicity (P = .041).

Motion segment sparing repair of the pars is a safe and effective procedure for refractory cases of spondylolysis.

Spondylolysis is a condition of the lumbar spine that involves a defect in the pars interarticularis (pars) commonly involving the L5 level. The incidence is 6% in the adult population. The highest rate of spondylolysis is found in the Inuit populations and young Caucasian athletes.[1,2] The athletes most at risk are those who are involved in repetitive hyperextension activities.

The natural history of spondylolysis is usually benign. Most cases do not require medical intervention and of those that do, they are usually self-limited requiring only activity modification and occasionally bracing.[3,4] There is however, a small subpopulation of patients with debilitating back pain despite conservative measures.

The management of patients with refractory cases of spondylolysis is still somewhat controversial. Surgical options for these cases can involve single-level posterolateral fusion or direct repair of the pars defect. Several different procedures for direct repair of the pars defect have been proposed.[5-9] Kimura[6] was the first to describe the procedure in 1968. While a number of articles have been written regarding the various techniques used to perform this procedure, little data is available regarding validated outcome measures following isolated pars repair. The purpose of this study was to report on the clinical outcome measures for 49 individuals treated with direct repair of 90 pars defects using pedicle screw/Songer cable constructs (Pioneer Surgical Technology Inc, Austin, TX).

Materials and Methods

After obtaining Institutional Review Board approval, we reviewed the surgical database of the Norton Leatherman Spine Center (Louisville, Kentucky) to identify patients who underwent direct repair of pars defects. A retrospective review of hospital and clinic charts was done to collect standard demographic and surgical parameters. Preoperative radiographic computed tomography (CT) scans and standing lateral radiographs were also reviewed to measure lumbar lordosis, slip percentage, pelvic incidence, and to confirm the diagnosis of spondylolysis.[9-11] Patients who had dysplastic pars were excluded. Preoperative magnetic resonance imaging (MRI) studies were reviewed to determine the degree of degeneration of the lumbar disc caudal to the spondylolytic segment using the Modified Pfirrmann Scale.[8]

All patients were placed prone on a Wilson Frame (Mizuho OSI, Union City, California). Pre-incision localization of the defect was performed using a plain radiograph. A midline incision is made and the dissection is carried out down to the spinous process. The paraspinal musculature is then elevated until adequate exposure of the lamina, pars, and the transverse processes is achieved. The correct vertebral level is confirmed using anatomic landmarks and plain radiographs. Care is taken not to injure the facet joint capsule. The pars interarticularis defect is then thoroughly debrided of any fibrocartilaginous tissue until bleeding bone is seen on both the laminar and pedicle sides of the defect (**Figure 1**). The bony area surrounding the pars defect including the base of the transverse processes and the lamina are then decorticated in order to encourage new bone formation (**Figure 2**). Two corticocancellous strip grafts are taken from the top of the iliac crest. Each rectangular piece measuring approximately 10 mm in width by 20 mm in length with a thickness of about 5 mm. Additional cancellous bone

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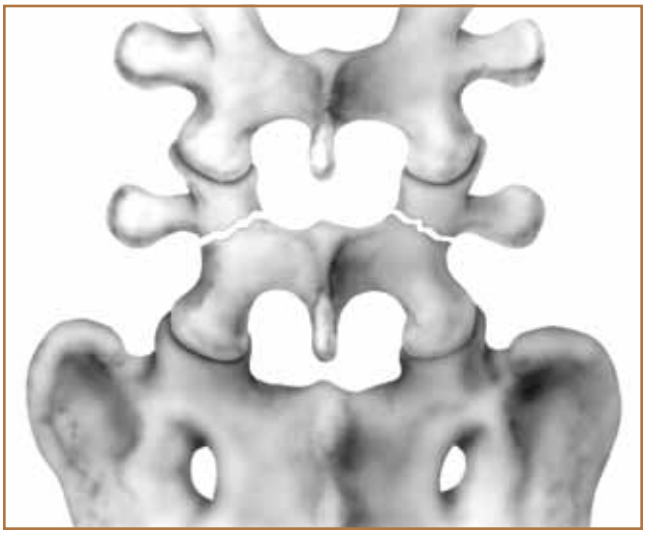

Figure 1. Thorough debridement of all fibrocartilaginous tissue on both the laminar and pedicle sides of the defect is performed. Care is taken not to injure the facet joint capsule.

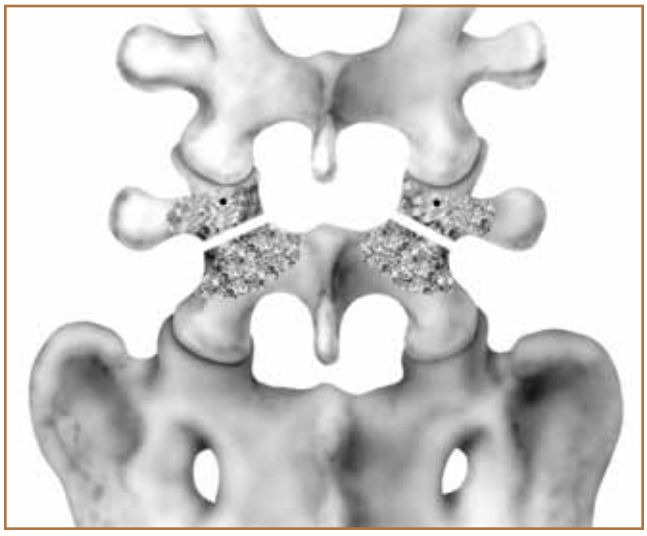

Figure 2. The bony area surrounding the pars defect including the base of the transverse processes and the lamina are decorticated. Defects are packed with autogenous cancellous bone graft.

grafts are harvested in between the outer and inner table of the iliac crest. The defects are then packed with autogenous cancellous bone graft. A 4.5-mm titanium monoaxial (CD Horizon Legacy 4.5, Medtronic Sofamor Danek, Memphis, Tennessee) pedicle screw is then inserted bilaterally. Radiographs are taken to confirm pedicle screw placement. In addition, intraoperative electromyographic screw stimulations are performed to assure that the screws have not gone through the walls of the pedicle and touching the corresponding nerve root. A 1-mm titanium cable is then looped around the head of the pedicle screw, passed below the spinous process and then looped around the other pedicle screw head (**Figure 3**). The corticocancellous strip grafts are then placed under the cable on top of the pars defect and the cancellous bone graft. The 2 ends of the cable are then tensioned in order to apply compression on the corticocancellous graft and across the defect (**Figure 4**). Care is taken to ensure that the bone graft remains firmly seated in the pars defect and that the bone grafts are in contact with the transverse processes and the lamina (**Figure 5**). Final imaging is used to confirm correct placement of the pedicle screw-cable construct. Patients were mobilized on postoperative day 1 without any external orthosis. CT scans were routinely ordered on all patients postoperatively to evaluate for solid fusion of the defect and to guide return to normal activity.

Standardized questionnaires were administered post-surgery. These questionnaires included the Short Form-36 (SF-36) general health instrument[12] and the Oswestry Disability Index[13] (ODI), which measures low back related functional disability. CT scans were reviewed in order to measure parameters previously described by Fujii and colleagues.[10] These included chronicity grade of the defect, the angle of the defect with respect to the posterior margin of the vertebral body, and the distance of the defect in respect to the posterior vertebral body.

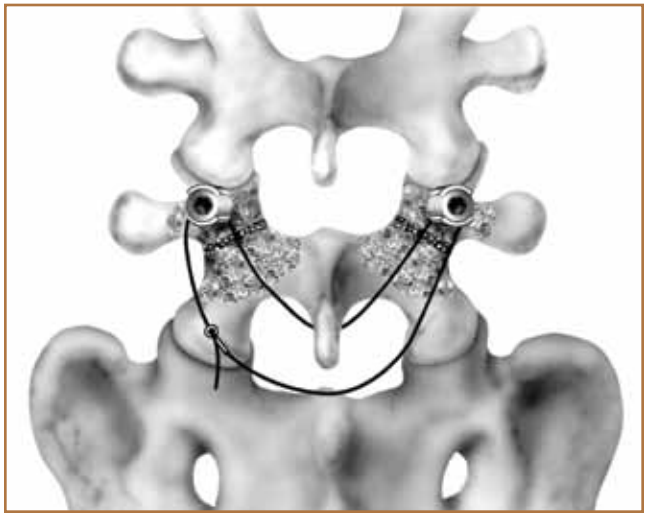

Figure 3. A 4.5-mm titanium monoaxial (CD Horizon Legacy 4.5, Medtronic Sofamor Danek, Memphis, Tennessee) pedicle screw is then inserted bilaterally. A 1-mm titanium cable is then looped around the head of the pedicle screw, passed below the spinous process and then looped around the other pedicle screw head.

Factors predictive of post surgical ODI score were determined. Factors included in the model were age at surgery, Fujii chronicity, Fujii distance, and degree of preoperative slip statistical analysis was performed using IBM SPSS software (SPSSv19, Somers, New York).

Results

Forty-nine patients were identified (25 men, 24 women) with a mean age of 17.7±6.0 years (range, 10-22 years). The mean duration of symptoms prior to surgery was a mean of 28.8±5.0 months. The average length of follow up was

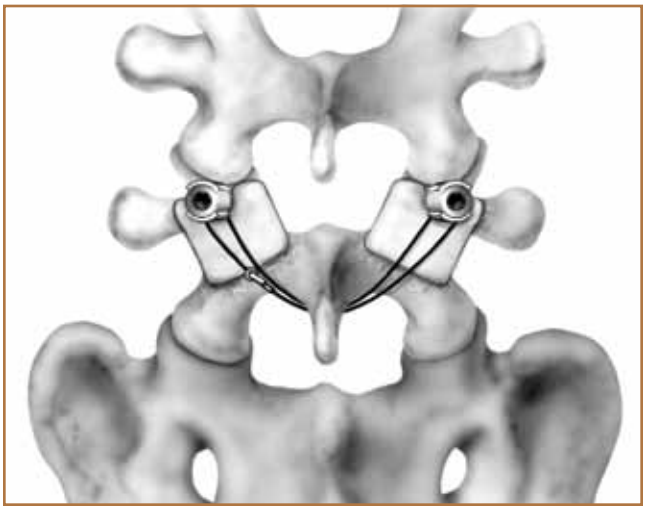

Figure 4. Corticocancellous strip grafts are placed under the cable on top of the pars defect and the cancellous bone graft. The 2 ends of the cable are then tensioned in order to apply compression on the corticocancellous graft and across the defect.

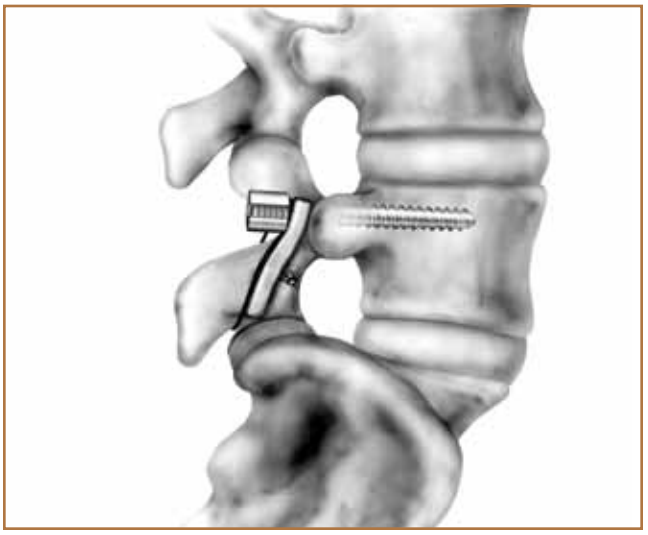

Figure 5. Care is taken to ensure that the bone graft remains firmly seated in the pars defect and that the bone grafts are in contact with the transverse processes and the lamina.

21.7±5.5 months. In order of frequency, these defects were: 72 bilateral at L5 (80%), 6 left unilateral at L5 (6.7%), 4 bilateral at L4 (4.4%), 4 bilateral at L3 (4.4%), 2 bilateral at L6 (2.2%), and 1 each right unilateral at L4 (1.1%) and L6 (1.1%). Fifteen patients had an associated spondylolisthesis, all of which were Grade 1 with a mean percentage slip of 15.9±6.6% (**Table I**). None of the patients had sacral doming. All pars defects were treated with the technique described previously. Although no serious complications were seen (eg, death, neurologic injury, pulmonary embolus, infection, etc), 1 patient required an evacuation of a seroma and 1 patient had some wound drainage that responded to local wound care. None of the patients were braced postoperatively.

Standardized outcomes questionnaire data (ODI and SF-36) was available for 42 patients (**Table II**). The average postoperative ODI score was 10.2±15.9. The average postoperative Physical Composite Summary/SF-36 was 51.3±9.7. At most recent follow-up (n = 49), 33 patients were asymptomatic (67%), 14 reported mild to moderate low back pain (29%), and 2 reported no improvement in low back pain (4%). None of the risk factors analyzed in our study were predictive of reoperation.

Seven of the 49 patients (14.3%) went on to require reoperation, only 1 patient required a second reoperation. Five patients received a direct re-repair of the affected level with the above described procedure; 4 patients went on to be cured and 1 patient was explored for persistent back pain and received a hardware removal; intraoperative assessment revealed a solid

Table I. **Demographics**

Variable	Mean
Age, years	17.7±6.0
Males	25
Duration of symptoms, (months)	28.8±5.0
Length of follow-up	21.7±5.5
Pre-operative radiographs	
Lumbar Lordosis	30.0±10.2
Slip (%)	15.9±6.6
Pelvic Incidence	60.6±10.7
Fujii Distance	0.57 (0.08)
Fujii Angle	21.2 (13.0)
Pfirrman Grade	
1	25.00
2	11.00
3	0.00
4	1.00
5	1.00
6	4.00

Table II. **Mean (±SD) ODI and SF-36 scores stratified into postoperative symptoms**

	ODI	SF-36 PCS	SF-36 MCS
Asymptomatic	2.5±3.3	56.1±3.4	55.7±6.2
Mild to Moderate	25.3±6.8	38.9±8.4	44.4±12.1
Unchanged	57.0±12.7	32.0±8.2	22.5±5.2
Total	**10.2±15.9**	**51.4±9.7**	**51.5±11.4**

Abbreviations: ODI, Oswestry Disability Index; SF-36, Short Form 36; PCS, Physical Composite Summary; MCS, Mental Composite Summary.

fusion of the pars and no new instrumentation was placed. Two of the reoperations patients received posterior spinal fusions from L5 to S1 and went on to cure. All 7 patients requiring reoperation had bilateral pars defects at L5. Six of 7 patients undergoing a second procedure were women.

The distribution of Pfirrmann grades is summarized in **Table I.** There was no correlation between Pfirrmann grades and ODI scores. Per Fujii and colleagues[10] in 2004, we analyzed chronicity grade, angle, and distance of the pars defects on the preoperative CT scan. For chronicity grade, 66 were assessable; 51 defects were terminal (77.3%), 11 were progressive (16.7%), and 4 were early (6%). Among the 7 patients requiring reoperation, chronicity was assessable in 6 patients; 4 defects were terminal and 2 were progressive. Average distance to the posterior margin for all patients was 0.60±0.13 cm. Mean angle for all patients was 21.81±12.68°. There was no significant difference in the posterior margin distance or angle between patients requiring reoperation and those who did not require reoperation. None of the risk factors analyzed in our study were predictive of reoperation. The strongest preoperative predictor of ODI score was Fujii chronicity ($P = .041$).

Discussion

While the incidence of debilitating low back pain is low among young adults, some patients with spondylolysis continue to suffer from persistent pain despite exhaustive conservative treatment.[14,15] This pain often precludes these patients from participating in many of the typical activities of adolescent life and may warrant surgical intervention in this small subset of patients. A number of papers have been written describing the technical aspects of isolated pars repair.[5-9,16] However, little information is available to demonstrate the clinical outcomes of pars repair using validated outcome measures.

The standard posterolateral fusion sacrifices motion over the particular segment, which may lead to adjacent level degeneration. Motion preserving techniques such as the technique described in this paper and Buck's technique[5] allows for compression across the pars defect, which produces a better environment for fracture healing. The main advantage of the current technique is the larger surfaces are available for bone healing. There is no screw occupying space across the pars defect; the area surrounding the pars defect including the base of the transverse processes and the lamina are also decorticated and packed with autogenous cancellous bone graft, giving an additional surface for bone healing and increasing the surface exposed for vascular ingrowth from the surrounding soft tissues. The use of wires instead of laminar hooks also allows for a greater surface area of bone healing as well as minimizing the volume of instrumentation within the spinal canal.

The results of our study indicate that excellent clinical outcomes can be obtained following isolated repair of the pars interarticularis. In our study, 96% of patients were either completely asymptomatic or had only mild to moderate low back pain at the most recent follow up. The average postoperative ODI score was 10.2 denoting minimal disability after surgery. The average postoperative SF-36 Physical Composite Summary was 51.3, which is the same as the general population signifying minimal to no disease burden.

Fujii and colleagues[10] evaluated radiographic factors predictive of healing of the pars defect in patients treated conservatively. Fujii described the chronicity grade of the defect, the angle of the defect with respect to the posterior margin of the vertebral body, and the distance of the defect in respect to the posterior vertebral body. Chronicity was graded as early, progressive, or terminal stage. An early defect was defined as a fissure in the pars. In the progressive stage, the defect was still narrow, but with rounded edges. In the terminal stage, the defect was wide with sclerosis. We found a significant correlation between the Fujii chronicity score and the final ODI rating in this population. Patients with terminal lesions were found to have lower ODI ratings postoperatively. This finding suggests that terminal pars lesions were more likely to have poorer ODI outcomes scores. This information is potentially helpful in preoperative counseling of patients of expected postoperative results.

We acknowledge several limitations in this study. First is the retrospective nature of the study. While our patients had excellent postoperative ODI and SF-36 scores, we do not have the preoperative data available to determine if this is significantly improved from before surgery. ODI and SF-36 data was available in only 42 of 49 patients (86%). Future directions of study would be to perform a prospective study looking at both pre- and postoperative outcomes measurements with possible randomization into pars repair group versus a single-level fusion group.

Dr. Clegg is Resident, Department of Orthopaedic Surgery, University of Louisville School of Medicine, Kentucky. Dr. Carreon is Clinical Research Director, Norton Leatherman Spine Center, Louisville, Kentucky. Dr. Mutchnick is Attending Neurosurgeon, Norton Neuroscience Institute, Norton Healthcare, Louisville, Kentucky. Dr. Puno is Associate Professor, Department of Orthopaedic Surgery, University of Louisville School of Medicine, Kentucky.

Address correspondence to: Leah Carreon, MD, Norton Leatherman Spine Center, 210 E Gray St, Suite 900, Louisville, KY 40202 (tel, 502-584-7525; fax, 502-589-0849; e-mail, leah.carreon@nortonhealthcare.org).

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This paper will be judged for the Resident Writer's Award.