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"In situ fusion for spondylolysis" is regaining its lost popularity

Hamid Behtash, MD.[1], Ebrahim Ameri, MD.[2], Ganjavian Mohamadsaleh, MD.[3], Farzad Omidi-Kashani, MD.[4], Marzieh Nojomi, MD., MPH.[5]

Departments of Orthopedic Surgery, Rasul-e-Akram and Mehrad Hospitals, Tehran, Iran.

Abstract

Background: Spondylolysis and spondylolisthesis can be associated with significant low back pain, especially in physically active adolescents. Non-operative management is usually successful in improving symptoms, but surgical intervention is occasionally required. The aim of this study was to determine the effect of in situ posterolateral fusion in the treatment of refractory cases with spondylolysis.

Methods: In this prospective before and after study, we described our experience in13 patients managed by in situ fusion after failing multimodality non-operative treatment. All surgical procedures were performed by the senior author and by a similar technique. The spondylolytic vertebra and the one below were fused, in situ. Finally, clinical outcome and recovery rates of clinical symptoms were evaluated by Henderson's functional capacity and Oswestry Disability Index version 2.1, respectively.

Results: The mean duration of non-operative management was 36 (12-72) months. There were 8 males and 5 females. Average pre- and postoperative Oswestry Disability Indices were 28.4%±13.7% and 4.9±7.8 respectively (P=0.001, significant). All patients had follow-up contact on an average of 42.3 months (range 30 - 62 months). Based on Henderson's clinical outcome functional capacity at the final follow-up stage clinical outcomes were excellent in 10, good in 2 and poor in 1 patient. The case with poor result had a pseudoarthrosis and was re-oprated. Finally he had an excellent outcome.

Conclusion: We accept that the number of our cases is not high significantly but it can be claimed that in situ fusion is a safe and effective modality to treat symptomatic patients with spondylolysis and low-grade spondylolisthesis. A study with much more cases is strongly recommended.

Keywords: spondylolysis, intertransverse fusion, posterolateral approach, in situ fusion.

Introduction

Spondylolysis is characterized by a defect in the pars interarticularis of the vertebral arch. This defect is estimated to occur in 3-7% of adolescents and young adults and is often asymptomatic[1]. However, in some cases, it can be associated with significant low back pain (LBP). This is especially true in the young athletic population which nearly 50% of cases of low back pain can be attributed to spondylolysis or spondylolisthesis. This is in contrast to patients older than 25 years which only 5% of cases of LBP are caused by spondylolysis and

1. Assistant Professor of Orthopedic and Spine Surgery, Iran University of Medical Sciences, Tehran, Iran.
2&3. Assistant Professor of Orthopedic and Spine Surgery, Iran University of Medical Sciences, Tehran, Iran.
4. **Corresponding author**, Assistant Professor of Orthopedic, Spinal fellowship, Mashhad University of Medical Sciences, Mashhad, Iran. Address: No 226, South Bozorgmehr 20, Sajad Street, Mashhad, Iran. Tel: +98915 5149248 – +98511 7646500, email: omidif@mums.ac.ir
5. Associated Professor of Community Medicine, Iran University of Medical Sciences, Tehran, Iran.

spondylolisthesis [2,3].

Anatomically the fifth lumbar vertebra is affected most often, followed by L4 and then L3. Although the exact mechanism is still unknown, pars injuries are mainly believed to be the result of repetitive microtrauma [3]. Symptomatic patients often describe LBP that often radiates into the buttocks or proximal thigh. True symptoms and signs of radiculopathy are uncommon and necessitate evaluation for disc herniation, foraminal stenosis or instability. When radicular symptoms are present, radiographic evaluation should include dynamic (flexion and extension) radiographs, and MRI should be considered [4,5].

Non-operative management should be attempted prior to operative intervention. Restriction in activity, followed by rehabilitation and abdominal strengthening exercises, are often successful in improving symptoms [6]. These treatments rarely result in bony fusion across the defect in the pars interarticularis. Recurrence of symptoms can occur with resumption of competitive activities and results in dropout of athletes as physical demands increase on the body. This dropout probably accounts for a lower incidence of spondylolysis and spondylolisthesis in professional football player whencompared with high-school or college athletes [7].

The young patients (<25years) with spondylolysis or grade I spondylolisthesis (Meyerding grading system [8]) who fail non-operative management are offered either direct repair of the pars defects [9,10] or in situ posterolateral intertransverse fusion [11,12].

In this study, we have explored in situ fusion for spondylolysis with or without low-grade spondylolisthesis in affected patients. The aim of this study was to determine the effects of in situ posterolateral fusion in the treatment of refractory cases with spondylolysis.

Methods

A prospective before and after study was utilized to analyze patients treated with in situ fusion. All surgical procedures were performed by the senior author (HB) from October 2002 to June 2005. All patients underwent a work up, which included a minimum of anteroposterior, lateral, dynamic (flexion-extension) radiographs, and MRI. Once operative management was indicated, a standard informed consent was obtained; patients were taken to the operating room and then placed in a standard prone position on a surgical table. Prior to induction of general anesthesia, all patients were given 1 gram intravenous cefazolin.

Surgical technique

Once the L5 level was localized through intra-operative plain radiographs, a midline longitudinal skin incision with two paraspinal fascial incisions was done. Blind dissection with the index finger could direct one to the transverse processes in the interval between multifidus and lateral (longissimus and iliocostalis) muscles. The transverse processes, pars interarticularis and facets of the levels to be fused were exposed. The spondylolytic vertebra and the one below were fused, in situ. We did not violate the facet joint at the highest transverse process exposed.

In the cases with associated disc herniation, we performed discectomy also, but in this peculiar group we performed midline longitudinal approach without intermuscular dissection for both discectomy and fusion. Iliac crest bone graft was harvested, prepared in corticocancellous strips and placed over the decorticated bony surface for fusion.

Postoperation

All patients were placed in a thoracolumbosacral orthosis for a period of 12 weeks, and the patients underwent a post-operative physical therapy prior to returning to full activity. After achieving of a solid posterolateral fusion, patients were permitted to return to their normal activities. Radiographic follow-up included dy-

Evaluation	Functional Capacity
Excellent	No pain Able to return to his former occupation with no restriction Sports or recreational activities are not restricted
Good	Occasional pain, no more than 12 hours after extraordinary strenuous activity Able to return his occupation Not restricted from engaging in less strenuous sports
Fair	Less pain than preoperatively, but it remains a problem Must either wear an external support or is restricted to lighter work than before Sports and recreation are restricted
Poor	No better than preoperatively Unable to work Continues to seek medical help for pain

Table 1. Henderson functional capacity.

namic radiographs and in doubtful cases, oblique views, Fergusson view or CT scanning were also performed to assess the presence or degree of bony fusion.

In this study, clinical outcome was evaluated by Henderson's functional capacity [13] (Table 1). Functional capacity was evaluated as excellent, good, fair or poor. Recovery rates of clinical symptoms were calculated by Oswestry Disability Index (ODI) version 2.114 pre- and post-operatively at the time of latest follow-up. Statistical analysis was carried out with Wilcoxon-signed rank test and p value of less than 0.05 was interpreted as statistically significant.

Results

In this study, we described our experience in13 patients (8 males and 5 females) managed by in situ fusion after failing multimodality non-operative treatment. The mean duration of non-operative management was 36 months, ranging from 12 to 72 months. At the time of surgery patients' age ranged from 8 to 40 years, with an average of 22.2. All patients complained of low back pain and 7 patients (53.8%) complained of thigh and/or leg pain. The pain was produced by lumbar spine extension and flexion in 6 patients (46.2%) and 2 (15.4%) respectively.

Radiographically, in addition to L5 spondylolysis, minimum spondylolisthesis with an average slip of 15.6% (range, 10 - 35%) was observed in 9 patients, and lumbar disc herniation was detected in 4 patients, which thought to be the main cause of symptoms in these patients. A

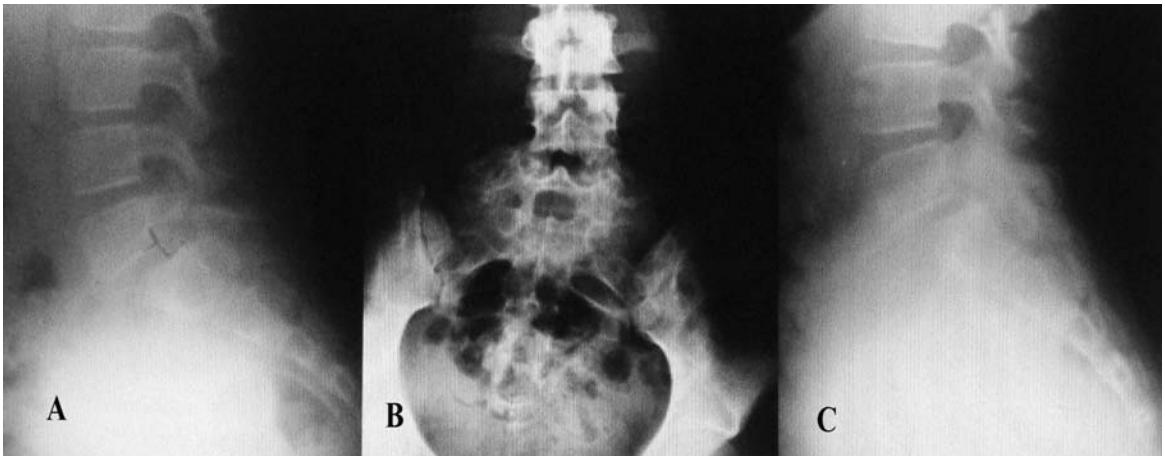

Fig. 1. Case No. 8: A. Preoperative lateral view, B. After 45 months from surgery.

No	Patient ID	Age (y)	Level of spondylolysis	MRI	Spondylolisthesis (%)	Unilateral/ Bilateral	Pre-operative ODI (%)	Presenting symptoms
1	MM	18	L5	No DH*	-	Bilateral	24	LBP* (mainly in sitting position)
2	RK	21	L5	L5-S1 DH	10	Bilateral	38	LBP
3	MRR	19	L5	No DH Spina bifida	-	Bilateral	30	LBP (mainly in extension position)
4	HRS	38	L5	No DH	15	Bilateral	26	LBP (mainly in sitting position), Rt* thigh pain
5	AR	40	L5	No DH	10	Bilateral	48	LBP with Rt thigh pain
6	SC	33	L4	L4-5 DH	15	Bilateral	34	LBP with Lt thigh pain
7	RGR	30	L5	No DH	-	Bilateral	18	LBP, bilateral thigh pain
8	DA	8	L5	No DH	15	Bilateral	12	LBP (mainly in extension position)
9	AD	30	L5	No DH	-	Unilateral (Lt*)	42	LBP (mainly in extension position), Lt thigh pain
10	PE	10	L5	No DH	10	Bilateral	6	LBP
11	PA	9	L5	No DH	20	Bilateral	10	LBP (mainly in extension position)
12	MP	28	L5	L4-5, L5-S1 DH	10	Bilateral	40	LBP (mainly in extension position), Lt thigh pain
13	HS	9	L5	L5-S1 DH	35	Bilateral	42	LBP (mainly in extension position), Rt thigh pain

* DH: Disc Herniation
* Rt: Right
*LBP: Low Back Pain
*Lt: Left

Table 2. The patients' characteristics preoperatively.

summary of patient characteristics preoperatively is illustrated in Table 2.

Average pre- and postoperative Oswestry Disability Indices (ODI) were 28.4%±13.7% and 4.9±7.8 respectively (p=0.001, significant). Postoperative ODI was measured at the latest following up. All patients were followed for an average of 42.3 months (range 30 - 62 months). Based on Henderson's clinical outcome functional capacity at the final follow-up stage clinical outcomes were excellent in 10, good in 2 and poor in 1 patient. The patient with poor result (case 6) had a pseudoarthrosis and was the only case in our study with L4 spondylolysis. He was treated again with the same technique at about 21 months after the primary surgery and finally, he was completely asymptomatic (excellent outcome) in 27 months after the second operation.

A summary of our results was listed in Table 3. Surgery was uncomplicated in all cases, with an average length of hospital stay 4.4 days, ranged from 3 to 9 days. After a period of postoperative bracing and physical therapy, all patients except one (who developed pseudoarthrosis) returned to full activity.

In fact, 84.6% of all patients reported no residual symptoms at the time of the last fol-

No	Patient ID	Length of stay (d)	Clinical Outcome	Post operative ODI (%)	Fusion	Residual symptoms	Follow up (months)
1	MM	4	Excellent	2	Yes, by plain radiography	-	30
2	RK	4	Excellent	0	Yes, by plain radiography	-	43
3	MRR	5	Good	12	Yes, by plain radiography and CT scan	Minimal LBP*	62
4	HRS	4	Good	6	Yes, by plain radiography and CT scan	Minimal LBP	49
5	AR	4	Excellent	8	Yes, by plain radiography and CT scan	-	40
6	SC	9	Excellent (poor after first operation)	0 (28%, after first operation)	Pseudo-arthrosis by plain radiography and CT scan (successfully revised)	None (after 2nd operation)	48
7	RGR	5	Excellent	0	Yes, by plain radiography	-	30
8	DA	3	Excellent	0	Yes, by plain radiography	-	45
9	AD	5	Excellent	4	Yes, by plain radiography	-	43
10	PE	3	Excellent	0	Yes, by plain radiography	-	40
11	PA	4	Excellent	0	Yes, by plain radiography	-	30
12	MP	4	Excellent	2	Yes, by plain radiography	-	40
13	HS	3	Excellent	2	Yes, by plain radiography	-	50

*LBP: Low Back Pain

Table 3. The patients' outcome.

low-up visit. 15.4% of patients had no symptoms at rest, but developed minor symptoms (slight LBP) with prolonged or strenuous physical activity. There were no immediate or delayed complications (including neurologic deterioration or nerve root deterioration) in any patient after the procedure. Dynamic radiographs follow-up at 24 months demonstrated solid fusion in all except 1 patient (Fig. 1). CT scanning was performed on several patients. We did not have any significant progression of the slip in our patients in the time we followed them up.

Discussion

After Kimura [15] from Japan in 1968 who first described a method for treatment of spondylolysis by direct repair of the defect by interposing spongy bone, a variety of management strategies for patients with symptomatic spondylolysis with or without accompanying low-grade isthmic spondylolisthesis have been advocated [9,10,16-18]. The successful outcome after direct repair of the pars interarticularis ranged from 63% (by Jeanneret19) to 100% of patients (by Tokuhashi and Matsuzaki20); depend upon the client age, presence of significant disc degeneration, rigidity of the construct or the surgical technique itself [9,16,21-24]. The accuracy of plain radiographs to predict the status of a surgical union

at the pars area has been corrected in 69% of cases, especially in the presence of the instrumentation [25]. CT scanning in comparison with plain radiography reveals higher rate of surgical repair for lumbar spondylolysis [11].

Failure of direct pars repair has been attributed to the presence of significant disc degeneration or segmental instability [9,16]. Szypryt et al [26] recommended segmental fusion instead of direct pars repair in patients >25 years due to the increased incidence of disc degeneration and less satisfactory results in older patients.

Segmental spinal fusion is the traditional method for treatment of symptomatic isthmic spondylolisthesis in patients not responding to non-operative measures. It is a safe procedure with a high success rate and few complications [27]. De Loubresse and co-authors reported the outcome for 25 patients in whom low grade spondylolisthesis with radicular pain was treated with posterolateral fusion alone with an average follow-up of 32 months. Posterolateral fusion in situ provided excellent or good results in 88% of patients according to the modified classification of Stauffer and Coventry. Radicular pain disappeared at exertion and rest in 92% and 88% of the patients, respectively [28].

According to Schlenzka D [23], who compared the direct repair procedure with segmental in situ fusion for a mean follow-up of 14.8 years; although repair of the pars defect seems an appealing option for symptomatic patients who have failed to respond to conservative measures, this procedure has several disadvantages:

It is generally said direct repair requires preoperative MRI to exclude more proximal disc degeneration (Schlenzka D [23] found no association between disc degeneration on MRI and the outcome of the patients).

It requires instrumentation, with its inheritance increased complications.

The duration of the procedure is much longer.

Lumbar spine mobility decreases after direct repair and the procedure does not seem to be capable of preventing the olisthetic disc from degeneration.

The probability of re-operation is greater in the direct repair group.

After direct repair, the ODI deteriorated with time leading to a clinically moderate but statically significant difference in favour of segmental fusion.

Other disadvantages of the repair procedures were a lack of space for bone grafting, the difficulty of treating patients with more displacement or canal stenosis and increment in the price with the use of instrumentation [29]. With instrumentation in place, it is obvious that detecting the nonunion or solid union across the pars defect, may be more cumbersome [21].

Therefore, the expected theoretical benefits of the direct repair procedure (preservation of lumbar spine motion and protection of the adjacent segment above) could not be proven when compared to a group of patients treated by uninstrumented posterolateral fusion [23]. Lamberg TS et al [30] in the study of long-term clinical, functional and radiological outcome 21 years after standard uninstrumented posterolateral spinal fusion in childhood and adolescence spondylolysis and low-grade isthmic spondylolisthesis concluded this operation gives a satisfactory long-term fusion rate and good functional outcome and patient satisfaction. Although, the lumbar flexion is diminished, the patients perform, on average, as well as the general population in nondynamometric trunk strength measurements.

Conclusion

We accept that the number of cases is not high enough but it can be claimed that in situ fusion is a safe and effective modality to treat symptomatic patients with spondylolysis and low-grade spondylolisthesis. A trial of conservative management is always warranted, after which further studies, including dynamic radiographs, CT scanning, MRI or even pars injections can help discriminate which patients will

benefit from in situ fusion. This technique may be ineffective in patients with high grade unstable spondylolisthesis, severe degenerative disease, and L4 spondylolysis. For more potent recommendation, a study with much more cases is strongly suggested.

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