Degenerative spondylolisthesis: single-level fusion

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Introduction. A retrospective study was carried out of a series of grade I and II degenerative spondylolistheses subjected to a single-level fusion, comparing circumferential to posterolateral fusion.

Materials and methods. Our series comprises 33 patients (22 females and 11 males) operated between 1999 and 2002. In all cases a single-level fusion was performed through a posterior approach: a posterolateral fusion was conducted in 15 patients (group 1), and a circumferential fusion in 18 (group 2). Mean age in group 1 was 54.2 years (range: 34-78), and follow-up at least 3 years (range: 3-5.6 years). Mean age in group 2 was 50.8 years (range: 25-76 years) and follow-up at least 3.2 years (range: 3.2-5.5 years). There were no significant age-related differences between both groups. Clinical results were analyzed with the SF-36 functional scale and with a subjective pain assessment by the patient. We radiologically analyzed fusion of the vertebral space.

Results. Circumferential fusion obtained a mean score of 47.7 points on the SF-36 scale vs 38.4 points for posterolateral fusion. X-ray results as to the success of the fusion procedure are very similar in both groups.

Conclusions. In our experience, surgical treatment of degenerative spondylolistheses achieves better clinical and radiological results when a circumferential fusion is performed.

Key words: *degenerative spondylolisthesis, posterolateral fusion, circumferential fusion.*

Espondilolistesis degenerativas: fusión a un nivel vertebral

Introducción. Se realiza un estudio retrospectivo de una serie de espondilolistesis degenerativas de grado I y II, intervenidas quirúrgicamente llevando a cabo una fusión vertebral en un nivel, comparando la fusión circunferencial con la fusión posterolateral.

Material y método. La serie consta de 33 pacientes (22 mujeres y 11 varones) que fueron intervenidos entre 1999 y 2002. En todos los casos se hizo un abordaje posterior y una artrodesis vertebral en un único nivel: en 15 pacientes se efectuó una artrodesis posterolateral (grupo 1) y en 18, una artrodesis circunferencial (grupo 2). La media de edad en el grupo 1 fue de 54,2 años (rango: 34-78 años) y el seguimiento mínimo, de 3 años (rango: 3-5,6 años). La media de edad en el grupo 2 fue de 50,8 años (rango: 25-76 años) y el seguimiento mínimo, de 3,2 años (rango: 3,2-5,5 años). No hubo diferencias significativas en la edad entre ambos grupos. Analizamos los resultados clínicos con el cuestionario funcional SF-36 y con una valoración subjetiva del dolor por parte del paciente. Analizamos radiológicamente la fusión del espacio vertebral.

Resultados. Las artrodesis circunferenciales obtienen una puntuación media de 47,7 puntos en el SF-36, superior a los 38,4 puntos de las artrodesis posterolaterales. Los resultados radiológicos en cuanto a la obtención de la artrodesis son muy similares.

Conclusiones. En nuestra experiencia, se obtienen mejores resultados clínicos y radiológicos en el tratamiento quirúrgico de las espondilolistesis degenerativas cuando se realiza una artrodesis circunferencial.

Palabras clave: *espondilolistesis degenerativa, artrodesis posterolateral, artrodesis circunferencial.**I***

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INTRODUCTION

In degenerative spondylolisthesis one vertebral body slips forward over another, but the posterior vertebral arch remains whole, which is the difference between this condition and isthmic spondylolisthesis. Degenerative spondylolisthesis arises due to instability of a vertebral segment caused by disc and sagittal facet joint degeneration; first there is decrease of the height of the intervertebral disc and subsequently there is overloading of the facets due to accelerated degenerative changes that finally result in spondylolisthesis. The true deformity of degenerative spondylolisthesis does not seem to be simple slippage, but a rotational deformity that may worsen existent spinal stenosis[1].

It predominates in patients over 40-50 years of age and there is greater prevalence in females. The most affected level is L4-L5, followed by L5-S1[1-3].

The most usual symptoms are lumbar pain, associated on many occasions with symptoms of root involvement and also neurogenic limping due to stenosis. Spondylo-listhesis progression leads to disc degeneration and, according to the progression of the listhesis, secondarily to hypertrophy of the facet joints and the *ligamentum flavum*.

In this manner, symptoms of degenerative spondylolisthesis are caused by 3 different mechanisms[1,3]:

1) Neurogenic limping caused by stenosis of the canal secondary to vertebral displacement, by hypertrophy of the yellow ligament and by osteophytes on the facet joints.

2) Root pain with motor or sensory deficits in the territory of the affected nerve, due to compression in the foramen or in the lateral recess.

3) Mechanical pain associated with daily living activities. Due to instability of the vertebral segment caused by degeneration of the intervertebral disc and the facet joints.

There is disagreement as to the most appropriate treatment for degenerative spondylolisthesis[4-15]. Most publications and surgeons agree on the need to decompress the foramen and spinal canal in association with arthrodesis of the affected level. There are greater discrepancies on the need for instrumentation: on one hand there are surgeons who after achieving decompression carry out associated arthrodesis without instrumentation, on the other hand there are those who carry out associated arthrodesis with instrumentation[4,8,13]. There are different opinions as to whether it is best to perform a posterolateral arthrodesis or a circumferential arthrodesis and different results are seen. We use a posterior midline approach, we expose the spinous processes and the lamina, decompress the canal and the foramina, and perform posterolateral or circum-ferential arthrodesis with instrumentation in all patients.

MATERIALS AND METHODS

In this series there are 33 patients (11 men and 22 women) with degenerative spondylolisthesis grade I or II according to the Meyerding scale. All patients underwent surgery for one level vertebral fusion during the period 1999-2002. In 15 of them (45.4%) we carried out posterolateral arthrodesis (Group 1) and in 18 (54.5%) circumferential arthrodesis (Group 2). The mean age of group 1 was 54.2 years (range: 34-78 years) and minimum follow-up was 3 years (range: 3-5.6 years). The mean age of group 2 was 50.8 years (range: 25-76 years) and minimum follow-up was 3.2 years (range: 3.2-5.5 years).

Surgery was indicated for lumbar pain associated or not with radiculopathy that did not improve when treated with non-steroid antiinflammatory drugs (NSAIDs) and physical measures.

In group 1 (posterolateral arthrodesis), the affected joint was L4-L5 in 9 patients (27.2%) and L5-S1 in 6 patients (18.2%).

In group 2 (circumferential arthrodesis), the affected joint was L4-L5 in 7 patients (21.2%) and L5-S1 in 11 patients (33.3%).

We used the Low Back-Specific Version of the SF-36 Physical Functioning Scale (Table 1) questionnaire[16,17]. This measures the patient's limitations in carrying out different daily living activities, the score is from 0 to 60 points; 0 is complete limitation and 60 no limitation.

We also carried out an analysis of patients' subjective pain and scored it from 0 to 10; 0 being no pain and 10 maximum pain.

The preoperative study included anteroposterior and lateral simple X-rays and lateral dynamic X-rays of the lumbosacral spine During the postoperative period, as well as the X-rays, computed axial tomography (CAT) scans of the lumbosacral spine were performed (6 months before surgery) to determine the presence of solid bone trabeculae between vertebrae.

Based on these studies, we considered there was non-union[14,18] or a space, when bone trabeculae could not be seen or there was mobility greater than 4° on dynamic X-rays of the spine.

Surgical Technique

The patient was placed on the operating table and a posterior midline approach was used. We exposed the spinous processes and lamina of the levels that required fusion. In all cases we performed decompression of the canal and foramen by means of a complete laminectomy; instrumentation was placed between 2 vertebrae. This fixation consisted of pedicle screws at this level with a Poliaxis® (CD Pharma) type fixator. When performing circumferential fusion we carried out complete discectomy and curettage of the

Table 1. Functional questionnaire SF-36 adapted to lumbar pain

The following questions are related to habitual and daily living activities. Does your lumbar pain limit your carrying out of these activities? If so, how much?

Section 1: Mark a number on each line

	No, not at all	Yes, a little	Yes, completely
1. Vigorous activities such as running, lifting heavy objects, etc	2	1	0
2. Moderate activities, playing golf, etc.	2	1	0
3. Lifting or pushing shopping cart	2	1	0
4. Climbing several flights of stairs	2	1	0
5. Climbing one flight of stairs	2	1	0
6. Kneeling, bending, etc	2	1	0
7. Walking more than 1 kilometer	2	1	0
8. Walking 500 meters	2	1	0
9. Walking 100 meters	2	1	0
10. Bathing or getting dressed	2	1	0

Section 2: Choose one number for each statement (from 0 to 5 points)

a) Intensity of pain at this moment		c) Standinge	
I have no pain	5	I can stand for as long as I want	5
My pain is very slight	4	I can stand for as long as I want, but I feel pain	4
My pain is moderate	3	I can stand for less than 1 hour	3
My pain is relatively severe	2	I can stand for less than 30 minutes	2
My pain is very severe	1	I can stand for less than 10 minutes	1
My pain is the worst imaginable	0	I cannot stand due to the pain	0
b) Sleep		d) Travel	
My sleep is never affected by pain	5	I can travel anywhere without pain	5
My sleep is occasionally altered by pain	4	I can travel anywhere, but it causes me pain	4
I cannot sleep more than 6 hours due to the pain	3	I can travel about 2 hours	3
I cannot sleep more than 4 hours due to the pain	2	Pain limits my traveling to less than 1 hour	2
I cannot sleep more than 2 hours due to the pain	1	Pain limits my traveling to 30 minutes	1
Pain does not allow me to sleep	0	Pain does not allow me to travel and I only travel to see my doctor	0

Section 3: Choose one option for each activity:

No difficulty (5); minimal difficulty (4); some difficulty (3); moderate difficulty (2); great difficulty (1); I find it impossible (0).
Driving a car (from 0 to 5)
Remaining seated on a chair (from 0 to 5)
Lifting and carrying a heavy suitcase (from 0 to 5)
Turning in bed (from 0 to 5)

Score: The highest score is 60 points, which is complete wellbeing, whereas a score of 0 points is the greatest degree of pain that makes it impossible to carry out any activityd.

surfaces of the vertebral discs. In this case, we placed a cage filled with bone graft in the interbody space. In about half of the cases we used Moss Titanium Mesh® (Depuy-Acromed) cages and in the other half Ray TFC® (Stryker-Howmedica) type screws. In all the arthrodesis performed we added a bone graft to the transverse processes. During the postoperative period the patients used a rigid corset for 3 months.

The bone graft used was of different origins: in 8 patients we extracted bone autograft from the iliac crest, in 10 patients we used vertebral autograft material obtained from vertebral decompression and laminectomy and in 15 patients we used allograft (morselized cancellous bone) from cadaver donors from the bone bank of our own hospital. The decision as to what type of graft to use was taken by the surgeon during surgery. In group 1 (posterolateral arthrodesis), in 4 patients (26.7%) we used iliac crest autograft, in 6 (40%) we used vertebral autograft and in 5 (33.3%) allograft.

In group 2 (circumferential arthrodesis), in 4 patients (22.22%) we used iliac crest autograft, in 4 (22.22%) we used vertebral autograft and in 10 (55.56%) allograft.

RESULTS

Minimum patient follow-up was 3 years, with a mean of 3.5 years.

Posterolateral arthrodesis was performed in 15 patients (45.4%), in 9 (27.2%) at level L4-L5 and in 6 (18.2%) at level L5-S1. In the remaining 18 patients (54.5%) circumferential arthrodesis was performed, in 7 patients (21.2%) at level L4-L5 and in 11 (33.3%) at level L5-S1.

In the patients that underwent posterolateral arthrodesis (group 1), the mean score obtained using the Low Back SF-36 was 38.4 points (range: 23-60 points); this was considered good to very good in 57% of the patients. In the group of patients that underwent circumferential arthrodesis (group 2), the mean postoperative score using the Low Back SF-36 questionnaire after follow-up was 47.7 points (range: 28-56 points); this was considered good to very good in 80% of the patients. Therefore, there is a difference of 9.3 points in favor of the patients in group 2 (circumferential arthrodesis), which was statistically significant ($p = 0.039$).

The score using a subjective pain score of the patients that underwent posterolateral arthrodesis (group 1) was 5.4 points (range: 2-9 points), and the mean value of the score obtained in patients that underwent circumferential arthrodesis (group 2) was 2.7 points (range: 1-8 points). Therefore, patients in group 1 (posterolateral arthrodesis) had more pain, determined by a subjective score, than the patients of group 2 (circumferential arthrodesis), and this difference was statistically significant ($p = 0.03$).

There were 6 cases of non-union (18.2%) seen on simple X-rays, dynamic X-rays in flexion/extension and in CAT scans of the lumbar spine. In 3 of these patients there was persistent lumbar pain without radiculopathy after surgery, whereas the other 3 had improved and were asymptomatic, in spite of the X-ray findings.

Of these patients, 3 underwent circumferential arthrodesis (in 2 we used bone bank grafts and in 1 an autograft from the iliac crest) and another 3 underwent posterolateral arthrodesis (in 1 we used bone bank grafts and in 2 a vertebral autograft), this difference between the 2 types of arthrodesis was not statistically significant ($p > 0.05$).

We assessed the relationship between the cases of non-union, the type of bone graft used and the type of fusion performed; and we determined that, no matter which type of arthrodesis was performed, the rate of non-unions was greater when bone bank grafts were used than when autografts were used, whether these were vertebral or from the iliac crest, and that this difference is statistically significant ($p = 0.181$).

Amongst the complications seen during treatment, there were 3 cases of superficial infection of the surgical wound (all in patients with circumferential arthrodesis); these responded to antibiotic treatment and more aggressive treatment was not necessary. There were no cases of deep infection, either during the immediate postoperative period or during follow-up.

One patient suffered a fracture of one pedicle (a patient with circumferential arthrodesis) that was diagnosed during postoperative follow-up. The patients wore a rigid corset until consolidation was seen.

We found that 2 patients who continued to suffer pain after surgery had non-unions and that the implanted screws were fractured (patients with circumferential arthrodesis and iliac crest autografts). Additional to these 2 cases, there were 4 more cases of non-union which have already been mentioned.

No cases of root injury were seen after surgery.

We have seen that 16% of the pedicle screws protrude or into the canal or the foramen, without causing clinical signs of root compression.

It was necessary to re-operate 5 patients, a mean time of 1.1 years after surgery, 2 due to painful non-unions, 3 due to pain in the area where there was instrumentation material (2 had undergone circumferential arthrodesis and 1 posterolateral arthrodesis). We withdrew the bars and pedicle screws, and the symptoms ceased.

DISCUSSION

There is much controversy on the subject of treatment of degenerative spondylolisthesis. There are a number of publications in which the advantages and disadvantages of instrumentation to achieve fusion are debated[5,7,8,10,15]. There is also controversy surrounding the fusion technique, whether it should be by anterior approach (anterior lumbar interbody fusion, ALIF) or posterior approach (posterolateral arthrodesis, posterior lumbar fusion, PLF; circumferential arthrodesis, transforaminal lumbar interbody fusion, TLIF; and posterior lumbar interbody fusion, PLIF)[2,4,6,9,11,13].

In 1997, Fischgrund et al[8] published a study of a series of 76 patients with clinically determined stenosis of the canal and degenerative spondylolisthesis, in which posterior decompression and posterolateral arthrodesis were performed with and without instrumentation. Good or excellent results were seen in 76% of the patients in which instrumented arthrodesis was performed, and good to excellent results were seen in 86% in which non-instrumented arthrodesis was performed.

In 1997, Suk et al[15] published a study of a series of 76 patients with degenerative spondylolisthesis. They divided them into 2 groups and carried out PLIF on one group and PLF on the other. The group that underwent PLF had rate of non-union of 7.5% and the group that underwent PLIF 0%. Good or very good clinical results were seen in 90% of the patients in both groups.

In 1999, Booth et al[5] published a study of a series of 41 patients which had undergone PLIF, with a 5 year follow-up, with 0% non-unions, a 2% complication rate and very good clinical results in 83% of the patients.

Our series of patients has at least 3 years of follow-up,

sufficient time to be able to carry out an assessment. Of the total number of patients, 24 (15 patients underwent circumferential arthrodesis) stated they would undergo surgery again if the deformity recurred. Of the remaining 9 (6 underwent posterolateral arthrodesis and 3 circumferential arthrodesis) who would not choose to undergo surgery again, 5 report they are much better than before surgery and the other 4 (who underwent posterolateral arthrodesis) report no improvement or even worsening of their condition.

We found no significant statistical difference between the type of arthrodesis performed (posterolateral or circumferential) as far as achievement of fusion. Nor were there statistical differences in the clinical results seen according to the lumbar level operated on. It is possible that differences may be seen in a larger sample. We obtained better results, based on subjective pain scores, with circumferential arthrodesis.

It would seem that clinical results were better when the patient underwent circumferential arthrodesis[5,10,13,15]. Furthermore, in 2001 Fujibayashi et al[9] presented a series of 32 patients that underwent PLF, with poor clinical results in 86%. However, in 2004 Kai et al[10] presented a series of 42 patients that underwent PLIF with good to very good clinical results in 76% of cases.

In conclusion, circumferential fusion with cages or interbody screws seems to have clinical and subjective results that are better than those seen with posterolateral fusion. We carried out posterior instrumentation in all cases and we did not find any significant differences in rates of union between both types of fusion.

The complication rate is quite low, both for PLIF and for PLF.

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Conflict of interests

The authors have declared that they have no conflict of interests.