

POSTEROLATERAL ARTHRODESIS VS. INTERBODY FUSION IN TREATMENT OF DEGENERATIVE SPONDYLOLISTHESIS. CLINICAL EVALUATION AND IMPACT OF BMI ON OUTCOMES

ARTRODESE POSTEROLATERAL VS ARTRODESE CIRCUNFERENCIAL NO TRATAMENTO DA ESPONDILOLISTESE DEGENERATIVA. AVALIAÇÃO CLÍNICA E IMPACTO DO IMC NOS RESULTADOS

ARTRODESIS POSTEROLATERAL VS ARTRODESIS CIRCUNFERENCIAL EN EL TRATAMIENTO DE LA ESPONDILOLISTESIS DEGENERATIVA. EVALUACIÓN CLÍNICA E IMPACTO DEL IMC EN LOS RESULTADOS

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ABSTRACT

Objective: The surgical treatment of degenerative spondylolisthesis has proved to be better when compared with nonsurgical treatment. Current surgical techniques evolved to improve the vertebral fixation devices aiming to increasing the bone fusion rate. The transpedicular fixation associated with interbody fusion allows an increased bone surfaces contact, and in this way achieve a better fusion rate. But will the clinical and functional outcomes be better? **Methods:** Retrospective study with 51 subjects submitted to PLA (n=19) and 360° (n=32) from 1996 to 2009. Only single level decompressions were included. Mean age 61,2 years old. Mean follow-up 5.8 years (de 2 a 14 anos). Clinical evaluation with Visual Analog Scale (VAS), global satisfaction and functional evaluation with Oswestry disability Index (ODI). Comparison of clinical and functional results based on BMI (BMI ≥ 30 vs BMI < 30). Statistical analysis with SPSS 19[®]. **Results:** In our study, the results clearly show a good outcome after surgery. There was a clinical and functional improvement with both techniques used (p<0,05). The satisfaction rate after surgery was also high. After several years of follow-up there were no statistically significant differences between the two fusion groups. Regarding BMI, non-obese patients has better clinical outcomes (p<0,05), although no differences were found in functional outcomes depending on weight. **Conclusion:** Decompression and instrumented vertebral fusion is a current and accepted treatment for degenerative spondylolisthesis. The fusion technique used does not affect the clinical or functional outcomes at long term follow-up.

Keywords: Spondylolisthesis; Spinal fusion/instrumentation; Spinal fusion/methods; Lumbar vertebrae/injuries; Obesity.

RESUMO

OBJETIVO: O tratamento cirúrgico da espondilolistese degenerativa (ED) apresenta vantagens quando comparado com o tratamento conservador. As técnicas cirúrgicas evoluíram no sentido de otimizar a fixação vertebral após descompressão, com o intuito de aumentar a taxa de artrodese. A fixação pedicular associada à fusão intersomática permite aumentar a área de contacto ósseo e assim a taxa de fusão, mas serão os resultados clínicos e funcionais superiores? **Métodos:** Estudo retrospectivo incluindo 51 indivíduos (idade média de 61,2 anos) submetidos a artrodese posterolateral (APL) (19) e artrodese circunferencial (360°) (32) de 1996 até 2009 com acompanhamento médio de 5,8 anos (2 a 14 anos). Incluídas apenas descompressões de um nível. Avaliação clínica (VAS - Visual Analogue Pain Score), satisfação global e avaliação funcional (Oswestry disability Index modificado). Cálculo do IMC (índice de massa corporal) – avaliação clínica e funcional IMC ≥ 30 vs IMC < 30 . Estudo estatístico com SPSS[®]. **Resultados:** Os resultados mostram franca melhoria clínica e funcional no tratamento cirúrgico da espondilolistese degenerativa, independentemente das técnicas estudadas. A taxa de satisfação é igualmente elevada. No confronto entre as duas técnicas de fixação não houve diferenças estatisticamente significativas. Relativamente ao IMC, os pacientes não obesos tiveram melhores resultados clínicos (p<0,05), não havendo diferenças relativas à função entre os dois grupos. **Conclusão:** A descompressão seguida de instrumentação vertebral é um tratamento eficaz para os pacientes com espondilolistese degenerativa. A técnica de artrodese utilizada não influencia os resultados clínicos e funcionais.

Descritores: Espondilolistese; Fusão vertebral/instrumentação; Fusão vertebral/métodos; Vértebras lombares/lesões; Obesidade.

RESUMEN

Objetivo: El tratamiento quirúrgico de la espondilolistesis degenerativa (ED) presenta ventajas cuando se lo compara con el tratamiento conservador. Las técnicas quirúrgicas evolucionaron en el sentido de optimizar la fijación vertebral después de descompresión, con la finalidad de aumentar la tasa de artrodosis. La fijación pedicular, asociada con la fusión intersomática, permite aumentar el área de contacto óseo y así la tasa de fusión, pero, ¿serán mejores los resultados clínicos y funcionales? **Métodos:** Estudio retrospectivo incluyendo a 51 individuos (edad promedio de 61,2 años), sometidos a artrodosis posterolateral (APL) (19) y a artrodosis circunferencial (360°) (32),

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desde 1996 hasta 2009, con acompañamiento promedio de 5,8 años (de 2 a 14 años). Se incluyeron solamente descompresiones de un nivel. Evaluación clínica (VAS - Visual Analogue Pain Score), satisfacción general y evaluación funcional (Índice de Incapacidad de Oswestry modificado). Cálculo del IMC (índice de masa corporal) – evaluación clínica y funcional IMC ≥ 30 vs IMC < 30 . Estudio estadístico con SPSS®. Resultados: Los resultados muestran franca mejoría clínica y funcional en el tratamiento quirúrgico de la espondilolistesis degenerativa, independientemente de las técnicas estudiadas. La tasa de satisfacción también es alta. En la comparación, entre las dos técnicas de fijación, no hubo diferencias estadísticamente significativas. Con respecto al IMC, los pacientes no obesos obtuvieron mejores resultados clínicos ($p < 0,05$) y no hubo diferencias referentes a la función entre los dos grupos. Conclusión: La descompresión, seguida de instrumentación vertebral es un tratamiento eficaz para los pacientes con espondilolistesis degenerativa. La técnica de artrodesis utilizada no tiene influencia en los resultados clínicos ni funcionales.

Descriptores: Espondilolistesis; Fusión vertebral/instrumentación; Fusión vertebral/métodos; Vértebras lumbares/lesiones; Obesidad.

INTRODUCTION

Degenerative spondylolisthesis (DS) is a condition that affects intervertebral discs and facet joints, causing slippage of adjacent vertebrae. Surgical treatment commonly includes assisted lumbar decompression by spinal arthrodesis with or without instrumentation in an attempt to restrict mobility and thus correct the associated instability.¹

Surgical outcomes are dependent on a number of factors, such as the rate of recurrent lumbar stenosis, instability, nonunion, and decompensation of the adjacent segment.² Recognition of the advantage of performing arthrodesis after decompression of the affected levels^{3,4} generated a surge in the globalization of this procedure as well as the creation of several surgical techniques to promote lumbar fusion. The creation of surgical material and techniques for its instrumentation increased greatly, followed by an exponential increase in spending on these procedures, with spine surgery accounting for 42% of total spending in the U.S. in 2003.⁵

In 1991, a prospective study conducted by Herkowitz and Kurz³ showed the advantage of (uninstrumented) fusion in the treatment of degenerative spondylolisthesis compared with decompression alone. In this study, the high rate of nonunion (36%) had no clinical consequences. Later, in 1997, Fischgrund et al.⁶ showed there to be no benefit with instrumented fusion when compared with uninstrumented posterolateral arthrodesis, although the rate of vertebral bone fusion was clearly superior to the instrumented group.

Thus, the rate of bone fusion does not seem to correlate with better clinical results and the controversy arose regarding the need for instrumentation. In 2004, Kornblum et al.⁷ reviewed the patients initially included in the 1991 study and concluded that 36% of patients with nonunion had more pronounced and significant clinical deterioration compared with the group with solid fusion. However, no control group (with instrumentation) was included in this study, and therefore the role of instrumentation remains controversial.

At present, the strength of spinal fusion is part of the objectives of the surgeon and despite efforts to optimize and enhance the rate of arthrodesis, no evidence of the effectiveness or superiority of the various techniques available⁸ (uninstrumented, instrumented, or circumferential posterolateral arthrodesis) has been found. Surgical costs, complications, results, and learning curves are inherent to the various techniques, which make the comparison of the various methods important and logical in the range of accuracy of indications and benefits to the patients.

Besides comparing the results between surgical techniques, this study also evaluated the impact of obesity on the clinical and functional results by measuring BMI (body mass index) for each patient.

MATERIAL AND METHODS

Retrospective cohort: Evaluation of patients undergoing decompression and instrumented posterior lumbar fusion between 1996 and 2009 at Hospital São João.

A total of 83 patients were selected by the following inclusion criteria: 1) Degenerative listhesis at only one level; 2) Surgical treatment via a posterior approach (posterolateral or circumferential arthrodesis); 3) A duration of symptoms greater than 24 months before surgery; 4) Minimum 2 years of follow-up.

Exclusion criteria were: 1) More than one level instrumented; 2) Spondylolysis and isthmic spondylolisthesis; 3) Patients undergoing uninstrumented posterolateral arthrodesis; 4) Nonunion; 5) Patients with a history of previous surgery to the lumbar spine; 6) Patients with concomitant deformities of the spine (scoliosis, tumor, or trauma).

Of the 83 patients initially selected, 51 patients were reviewed, and the remainder did not accept to participate in the study, did not attend the follow-up consultation, died, or could not be contacted. Thirty were female and 21 were male. The mean age was 61 years (between 47 and 75 years). Mean follow-up was 5.8 years (range two to 14 years). Level involved: L3-L4 in three, L4-L5 in 37 patients, and L5-S1 in 11 patients. Clinical signs of neurogenic claudication were observed in 21 patients, lumbosciatica was observed in 21 patients, and low back pain alone was observed in nine patients.

All patients underwent surgery performed by the Spine Group of the Department of Orthopedics of Hospital São João. The surgeries performed were: 1) Decompression and instrumented posterolateral fusion with transpedicular screws without discectomy, or 2) Decompression, interbody fusion and posterior instrumentation with transpedicular screws (360°). Autologous bone graft was used in both techniques.

Variables measured: All patients were evaluated preoperatively and after surgery in regular consultations. Clinical evaluation of pain consisted of the completion of the Visual Analogue Pain Score (VAS) and patients answered the Oswestry disability index (ODI) questionnaire in relation to the impact of the disease on their quality of life.⁹ The degree of satisfaction was also measured on a scale from 1 (not satisfied) to 10 (very satisfied).

The clinical and functional results were translated by the difference between the preoperative VAS and ODI with the data collected in the final consultation and translated into a percentage, i.e. VAS improvement (Δ VAS = preoperative VAS - current VAS) and ODI improvement (Δ ODI = preoperative ODI - current ODI).

Weight and height was asked of all patients preoperatively, thus the body mass index (BMI) was calculated using the formula BMI = height/weight.²

All patients involved in the study were followed up on routine visits and control radiographs were taken postoperatively. The strength of bone fusion was assessed in AP and profile radiographs and excluded patients with signs of nonunion or uncertainties in the evaluation of the images. No standardized protocol was used in this assessment or other diagnostic exams.

Clinical study

Patients were divided into two groups according to the type of surgery they underwent: instrumented posterolateral arthrodesis (PLA) or circumferential arthrodesis (360°). Statistical comparison of clinical and functional results between the two groups.

In other regards, after the calculation of BMI, patients were divided according to whether their BMI was less than 30 or greater than or equal to 30. Statistical comparisons of the results were performed based on BMI.

Statistical study

Statistical analysis was performed with SPSS 19® software. Descriptive and epidemiological analysis of study sample, as well as

the analysis of the results obtained after surgery and influence of BMI were performed.

The Wilcoxon signed-rank test was used to compare the preoperative data with current results. The Mann-Whitney U-test was used to compare the two groups at the clinical (VAS) and functional (ODI) level.

RESULTS

Thirty-two patients underwent circumferential arthrodesis (360°) and 19 patients were included in the posterolateral arthrodesis (PLA) group. The group with BMI < 30 contained 36 patients and the group with BMI ≥ 30 included 15 patients. The general demographics are summarized in Table 1.

Some statistically significant differences were found in the analysis of the population according to the type of surgery, notably a higher proportion of males in the PLA group ($p = 0.02$) and a greater proportion of patients undergoing surgery at L5-S1 in the same group ($p = 0.01$).

Table 1. Epidemiological and preoperative data.

Variable	Group		p
	360° Group (n=32)	PLA Group (n=19)	
Sex (M:F)	12:20	9:10	0.02
Mean age	62.7 ± 8.1	58.8 ± 7.1	ns
BMI – Body Mass Index	28.5	26.9	0.002
L3-L4	2	1	ns
L4-L5	23	14	ns
L5-S1	5	6	0.01

Statistics

In general, surgery was beneficial for patients, obtaining good results both on a clinical level – improved VAS and high satisfaction, as well as on a functional level – improved ODI scores.

Overall, the preoperative mean VAS was 8.5 (± 0.7) and the mean during the last consultation was 3.8 (± 1.1), corresponding to a 56% improvement of the VAS (in percentage) on average. The preoperative overall mean ODI was 49.9% (± 4.7). This score improved to 23.3% (± 3.9) on average in the last visit, an improvement of 53.7% (± 8.5).

The degree of patient satisfaction, another variable that was investigated, also showed good results, with an average value of 8.4 (range 1-10).

The functional and clinical results of the comparison of the two groups are summarized in Table 2. For the current VAS, ODI, and satisfaction, there were no statistically significant differences between the two groups. The PLA group had a mean VAS value of 3.3 (± 0.6) while the 360° group averaged 4.1 (± 0.8), and this difference was not statistically significant. Also, no significant difference was found in the mean ODI, in the PLA group it was 22.5% (± 6.9) and in the 360° group it was 23.8% (± 7.1). The degree of satisfaction for the PLA and 360° groups was identical on average.

Table 3 shows the differences regarding the improvement of VAS and ODI, i.e., the difference between the current values and the preoperative values.

As shown in Table 3, both groups presented preoperative VAS and ODI scores without statistically significant differences, homogenizing the study sample. Similarly, the improvement observed after surgery compared to preoperative values did not show significant differences from the statistical point of view for both clinical and functional parameters.

Results based on BMI: Patients were divided into two groups according to BMI – the < 30 group and the ≥ 30 group. The clinical and functional results were compared between the two groups. (Table 4)

The < 30 BMI group comprised a total of 36 patients with a mean BMI of 26.4, while the ≥ 30 group comprised 15 patients with a mean BMI of 31.5.

When evaluating the (current) results after surgery, there were differences regarding the VAS score between the two groups, with the BMI < 30 group obtaining better results compared to those with a BMI ≥ 30 ($p = 0.012$). Similarly, the satisfaction of patients with a lower BMI was statistically higher ($p = 0.024$). There were no functional differences (ODI score) between groups.

Table 2. Comparison of clinical and functional results between PLA and 360°.

	PLA			360°			p	
	Mean	SD	%	Mean	SD	%		
Current VAS	3.3	0.6	Mild ≤ 3	4.1	0.8	Mild ≤ 3	ns	
			63%			Moderate 3-7		63%
			26%			Intense ≥ 7		0%
Current ODI	22.5	6.9	Excellent	23.8	7.1	Excellent	ns	
			52%			Good		53%
			37%			Unchanged		6%
Satisfaction	8.4	0.6	8.4	8.4	0.6	8.4	ns	
			8.4			8.4		
			8.4			8.4		

Table 3. Preoperative VAS and ODI scores and their respective improvements.

	PLA		360°		p
	Pre-op	Improvement	Pre-op	Improvement	
VAS	7.9	58.7%	8.8	54.4%	ns
	8.5	56%	4.1	53.7%	
ODI	46.9	52.8%	51.7	54.3%	ns
	49.9%	53.7%	23.3%	53.7%	

Results regarding the clinical and functional improvement after surgery are shown in Table 5. The results show no differences in the preoperative VAS level between the two groups; however, the group with a lower BMI showed more pronounced improvement in VAS than the group with higher BMI ($p = 0.003$). There were no statistically significant differences between the two groups regarding the ODI.

Table 4. Comparison of current clinical and functional results based on BMI.

		BMI < 30 (n=36)		BMI ≥ 30 (n=15)		p	
Current VAS	3.5	Mild ≤ 3	50%	4.5	Mild ≤ 3	40%	0.012
		Moderate 3-7	50%		Moderate 3-7	47%	
		Intense ≥ 7	0%		Intense ≥ 7	13%	
Current ODI	21.3	Excellent	47%	28	Excellent	40%	ns
		Good	50%		Good	40%	
		Unchanged	3%		Unchanged	20%	
Satisfaction		8.4 ± 1.3		7.7 ± 1.5		0.024	

Table 5. Preoperative VAS and ODI values and their respective improvements.

		BMI < 30		BMI ≥ 30		p
VAS	Pre-op	8.56	Pre-op	8.4	ns	
	Difference	5.03	Difference	3.93	0.003	
ODI	Pre-op	49.19	Pre-op	51.67	ns	
	Difference	27.86	Difference	23.67	ns	

DISCUSSION

The main purpose of surgical treatment of degenerative spondylolisthesis is to improve the prognosis of the disease and obtain better results in light of the cost/benefit ratio and complications associated with the use of the implant material.

A systematic review¹ from 2007 encompassing the various studies available about decompression alone versus decompression with instrumented or uninstrumented arthrodesis has highlighted the benefit of bone fusion in clinical and functional results after the surgical treatment of degenerative spondylolisthesis. In fact, this evidence has become more overt with randomized controlled trials, of which the highest statistical significance was that of Fischgrund et al.⁶

However, evidence has still not been reported that allows for the discrimination between the advantages of instrumented versus uninstrumented arthrodesis.¹ If it is true that the former allows for superior bone fusion rates than the latter, the clinical and functional

relevance of this fact remains controversial.¹⁰ As already stated, the association between the quality or rate of bone fusion and clinical outcomes can have long-term relevance, as demonstrated by Kornblum et al.⁷ when reviewing patients with 5-14 years of follow-up. The reduction of pain and improved function was correlated with the strength of the bone fusion; however, infer the advantage of long-term instrumentation from this can be misleading because only uninstrumented fusion was performed in the study.

In this study, only the clinical and functional results of patients who underwent instrumented arthrodesis were compared. They were separated by the use or not of interbody fusion, under the premise of more solid bone fusion being obtained using this technique.

The results showed no differences on the clinical or functional level between the two techniques. From this it should already be apparent that an important parameter makes the sample heterogenous and somewhat limits the interpretation of the results. Indeed, the two groups had statistically significant differences in BMI, with the 360° group having a BMI superior to that of the PLA group. In the statistical analysis, there were no statistical regressions in order to homogenize the sample for this variable, which is a limitation of the present study.

Nevertheless, the concomitant use of an interbody spacer added costs and complications, and according to the results obtained, did not result in better outcomes. These results coincide with those published in other studies, in particular Abdu et al.,¹¹ who compared three arthrodesis surgical techniques, including uninstrumented *in situ* posterolateral arthrodesis. The same authors did not demonstrate the superiority of one technique over the others over four years of follow-up; however, they point out the need to continually monitor these patients and eventually review the results, in order to assess possible differences in the long term. In fact, the postoperative time of evolution can be decisive in the recognition of the benefits of instrumentation. Videbaek et al.,¹² in a randomized trial for degenerative diseases of the lumbar spine (though not including degenerative spondylolisthesis), showed benefits of using 360° arthrodesis in a follow-up period of five to nine years. This difference was not observed at two years of follow-up.

Another aspect of this study was to analyze the influence of obesity, here translated by BMI, in the results after surgery for degenerative spondylolisthesis. Several published studies reported a greater incidence of complications and comorbidities after surgery in obese patients. In the case of lumbar stenosis, Gepstein et al.¹³ found that obesity did not constitute a contraindication for surgery, presenting results that were overlapping with non-obese patients. In another study, Djurasovic et al.¹⁴ studied the influence of obesity (BMI) on outcomes after lumbar fusion and although the complication rate was higher, no differences with regard to clinical and functional results were observed.

In the present study on degenerative spondylolisthesis, results showed worse clinical outcomes (VAS) in patients with a BMI ≥ 30, showing a higher current VAS score for these patients, as well as a smaller improvement in this score. Overall satisfaction with surgery was also lower for patients with a higher BMI. Although ODI score differences were not registered, the indication for surgery should be considered in these patients, this information should be valued preoperatively and measures aimed at weight loss should be encouraged.

The present study has some limitations. Besides the sample not being homogeneous in regards to BMI, patients included also varied in the follow-up duration, the inclusion of patients with two years follow-up may have influenced the results in a context in which the literature suggests that there is a possible long-term advantage of greater strength obtained with instrumentation. Moreover, this study did not aim to determine the rate of bone fusion and thus correlate it with the results obtained. The complications associated with each procedure were also not accounted for.

The discussion that has been generated around the surgical instrumentation in degenerative spondylolisthesis and what is the most appropriate technique needs further investigation. Currently,

further studies are needed particularly in the long term to confirm the trend of obtaining higher lumbar fusion rates, and thus better results.

CONCLUSION

The surgery is a therapeutic method with good results in the treatment of degenerative spondylolisthesis. In the present study, the results were independent of the instrumented arthrodesis technique used, leading us to consider the cost/benefit as well as the

complexity and complications associated with each technique. BMI has an impact on outcomes after lumbar fusion in degenerative spondylolisthesis and one should inform the patient of this fact and encourage pre- or postoperative weight loss measures.

All authors declare no potential conflict of interest concerning this article.

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