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LUMBAR ARTHRODESIS IN DEGENERATIVE SPINE: POST OPERATIVE RESULTS AND RADIOGRAPHIC EVALUATION

ARTRODESE LOMBAR NAS AFECÇÕES DEGENERATIVAS DA COLUNA: ANÁLISE RADIOGRÁFICA E RESULTADOS PÓS-OPERATÓRIOS

LUMBAR ARTHRODESIS IN DEGENERATIVE SPINE: POST OPERATIVE RESULTS AND RADIOGRAPHIC EVALUATION

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ABSTRACT

Objective: To relate the radiographic fusion rate and the surgical results in patients undergoing posterolateral arthrodesis with instrumentation of the lumbar spine for the treatment of degenerative disorders. Method: A descriptive, retrospective, case series, observational study, based on medical records and imaging studies of 76 patients over 18 years of age (39 to 88 years) who underwent posterolateral lumbar arthrodesis. Data related to the presence of comorbidities were compiled and clinical outcomes were measured using specific questionnaires collected pre-surgical and 1 year after surgery. Fusion quality, as described by Christensen, was assessed from radiographic images by two examiners. The VAS, EQ-5D and Roland Morris questionnaires were used preoperatively and 1 year after surgery to assess pain, quality of life and function, respectively. Result: It was observed improvement in pain, function and quality of life after 1 year post-surgical. Pain, measured by VAS, had a reduction from 7.92 to 3.16 (p-value <0.001), the function evaluated by the Roland Morris score, also showed a reduction from 14.90 to 7.06 (p-value <0.001) . Culminating with the improvement in quality of life, measured by the EQ-5D, where there was a median increase in the score from 0.5672 to 0.7002 (p-value = 0.002). Conclusion: The absence of radiographic fusion has no direct correlation with worse results in clinical outcomes at 01 year after surgery. Most patients showed clinical improvement with no statistical difference in relation to cases in which bone fusion was obtained. ***Level of evidence IV; retrospective observation.***

Keywords: Spinal Fusion; Spondylosis; Pseudoarthrosis.

RESUMO

Objetivo: Relacionar a taxa de fusão radiográfica e os resultados cirúrgicos nos pacientes submetidos a artrodese posterolateral com instrumentação da coluna lombar para tratamento de afecções degenerativas. Método: Estudo observacional retrospectivo descritivo, tipo série de casos, com base em prontuários médicos e exames de imagem de 76 pacientes maiores de 18 anos (39 a 88 anos), submetidos a artrodese lombar posterolateral. Dados relacionados a presença de comorbidades foram compilados e os desfechos clínicos mensurados por meio de questionários específicos coletados no pré-cirúrgico e após um ano pós-cirúrgico. A qualidade da fusão, conforme descrita por Christensen, foi avaliada a partir de imagens radiográficas por dois examinadores. Os questionários de EVA, EQ-5D e Roland Morris foram utilizados no pré-cirúrgico e um ano pós-cirúrgico para avaliar dor, qualidade de vida e função, respectivamente. Resultado: Observou se melhora na dor, função e qualidade de vida após um ano pós-cirúrgico. A dor, mensurada pelo EVA teve uma redução de 7,92 para 3,16 (p-valor <0,001), a função avaliada pelo escore Roland Morris, também apresentou redução de 14,90 para 7,06 (p-valor <0,001). Culminando com a melhora na qualidade de vida, mensurada pelo EQ-5D, onde observou-se um aumento mediano escore de 0,5672 para 0,7002 (p-valor = 0,002). Conclusão: A ausência de fusão radiográfica não tem correlação direta com piores resultados nos desfechos clínicos em um ano de pós-cirúrgico. Majoritariamente, os pacientes apresentaram melhora clínica sem diferença estatística em relação aos casos em que foi obtido fusão óssea. ***Nível de evidência IV; Observacional retrospectivo.***

Descritores: *Fusão Vertebral; Espondilose; Pseudoartrose.*

RESUMEN

Objetivo: Relacionar el índice de fusión radiográfica y los resultados quirúrgicos en pacientes sometidos a artrodesis posterolateral con instrumentación de columna lumbar para el tratamiento de trastornos degenerativos. Método: Estudio descriptivo, retrospectivo, serie de casos, observacional, basado en historias clínicas y estudios de imagen de 76 pacientes mayores de 18 años (39 a 88 años) a quienes se les realizó artrodesis lumbar posterolateral. Se recopilaron datos relacionados con la presencia de comorbilidades y se midieron los resultados clínicos mediante cuestionarios específicos recogidos antes de la cirugía y al año de la cirugía. La calidad de la fusión, según

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lo descrito por Christensen, fue evaluada a partir de imágenes radiográficas por dos examinadores. Los cuestionarios VAS, EQ-5D y Roland Morris se utilizaron en el preoperatorio y 1 año después de la cirugía para evaluar el dolor, la calidad de vida y la función, respectivamente. Resultado: Se observó mejoría en el dolor, función y calidad de vida después de 1 año posquirúrgico. El dolor, medido por EVA, tuvo una reducción de 7,92 a 3,16 (p-valor <0,001), la función evaluada por el puntaje de Roland Morris, también mostró una reducción de 14,90 a 7,06 (p-valor <0,001) . Culminando con la mejora en la calidad de vida, medida por el EQ-5D, donde hubo un aumento mediano en el puntaje de 0,5672 a 0,7002 (p-valor = 0,002). Conclusión: La ausencia de fusión radiográfica no tiene correlación directa con peores resultados en los resultados clínicos al 01 año de la cirugía. La mayoría de los pacientes presentaron mejoría clínica sin diferencia estadística en relación a los casos en los que se obtuvo fusión ósea. ***Nivel de evidencia IV; observación retrospectiva.***

Descriptores: *Fusión Vertebral; Espondilosis; Seudoartrosis.*

INTRODUCTION

Low back pain is a highly prevalent social and economic problem: it is estimated that in the course of a lifetime, at least one crisis of low back pain occurs in 84% of people.[1] In Brazil, 25% of the population over 60 years of age suffer from chronic low back pain,[2,3] which represents a significant number of cases in Brazilian orthopedic offices and emergency rooms. Although the etiology is multifactorial, chronic low back pain is strongly associated with degenerative changes in the lumbar spine.

The most common symptom is back pain. Irradiation to the lower limbs and other neurological symptoms can occur when compromised neural structures. The quality of life, functionality, and degree of independence of these patients can reduce dramatically in the advanced cases of degeneration and neurological compression.[2,3]

Surgical treatment is indicated when conservative treatment fails, characterized by persistent pain with associated functional limitation, and in cases of neurological impairment.[3,4] Its main objective is to decompress affected neural structures, enlarging the space of the vertebral canal and treating previous segmental instability or instability created by the removal of posterior elements, often necessary during the decompression procedure.[5,6]

Among the fusion techniques available, posterolateral arthrodesis with pedicle screws is one of the most used, with the following advantages: it allows a single access route; good capacity for stabilization and correction of deformities; low risk of vascular injury; low relative cost (when compared to other instrumented techniques); and it is familiar to spine surgeons.[7] In terms of quality of life, functionality, and improvement of symptoms, studies report that approximately 60 to 70% of cases have good outcomes.[8]

The analysis of postoperative outcomes in lumbosacral degenerative disorders shows an association between preoperative comorbidities and rates of complications or poor outcomes after surgery.[9-11] However, appreciation of the specific risk factors influence postoperative complications in the setting of spinal arthrodesis remains limited:[12] many studies have limitations regarding the analysis of a single risk factor[13,14] and relatively small sample sizes.[11,15] Few studies address clinical factors related to the surgical procedure,[15] and controversies still exist regarding the influence of the evolution to solid fusion or pseudoarthrosis on postoperative clinical outcomes.[17,18] When considering only the national literature, these gaps become even more evident. This study aimed to determine if there is an association between the radiological outcomes obtained after posterolateral lumbar arthrodesis with pedicle screws and the clinical results observed.

MATERIALS AND METHODS

Design: This is a retrospective, descriptive, observational, case series study, conducted in a private tertiary hospital, approved by the institution's research ethics committee (CAAE/Einstein - 39717120.0.0000.0071). Data were collected from medical records and imaging scans of patients over 18 years of age who underwent posterolateral lumbar arthrodesis between January 2012 and December 2018, with follow-up after surgery of at least one year. Were cases of reoperation, history of infectious disease, oncology, or spinal fracture excluded. Patients who did not have radiographs more than one year after surgery taken in the hospital and cases of loss to follow-up before one year postoperatively were also excluded.

Individual data were collected from each patient regarding the presence of Diabetes *Mellitus* (DM), Systemic arterial hypertension (SAH), and smoking. The clinical evaluation was done using specific questionnaires validated for the Portuguese language, applied preoperatively, and one year after the surgical procedure. Roland-Morris questionnaire[20] for function; Visual Analog Scale (VAS) for low back pain; and EuroQol (EQ-5D)[21] for quality of life were used. Based on the literature, the minimum difference considered clinically relevant(MCID) for the scores was two points on the VAS scale;[22] 0.18 points on the EQ-5D score[22] and five points on the Roland-Morris score[21] between the time before and after one year of the procedure.

To evaluate the spinal fusion, we used radiographic images in anteroposterior incidence (AP) taken one year after the procedure, extracted from the Digital Platform used by the hospital (Carestream Health, Inc. 2020). The analysis of the images was performed using the criteria proposed by Christensen *et al.*[23] using two examiners independently: a radiologist and a trainee orthopedist in the second year of training in spinal surgery. In short, fusion is the presence of a bone bridge joining the transverse processes uni or bilaterally. Fusion is considered indeterminate in the absence of clarity of bone bridge formation, including fusion mass hidden behind instrumentation; the absence of bone bridge between the transverse processes bilaterally is classified as non-union (pseudoarthrosis). The presence of osteolysis greater than two millimeters around the screws, signs of loosening, and/or breaking of the implant will also be considered as having the presence of pseudoarthrosis.

All clinical and radiographic patient information patient was anonymized for the analyses.

The Kappa coefficient of agreement verified the agreement between the evaluators of the radiographic images,[24] with a calculation of the 95% confidence interval and p-values <0.05 for results considered statistically significant (5% significance level). All analyses were performed using *SPSS V20, Minitab 16 and Excel Office 2010* software. The sample was characterized by the means and standard deviations, minimum and maximum, and interquartile measures and ranges for quantitative variables. Absolute frequencies and percentages described qualitative variables. The distributions of the variables were checked using histograms, boxplots, and Shapiro-Wilk normality tests.[25]

The analysis of the clinical outcomes was verified using the Wilcoxon test, depending on the distribution of the data. The comparison of clinical outcomes with the presence of comorbidities and fusion quality was verified from the logistic regression test.

Logistic regression models were fitted to investigate the associations between patient characteristics, fusion quality (pseudoarthrosis or solid fusion), and clinical outcomes after one year of surgery. These models were also adjusted, controlling for patient profile data, smoking, Diabetes *Mellitus*, and hypertension.

RESULTS

One hundred two patients underwent arthrodesis in the analyzed period. Of these, 76 patients contained complete smoking data and radiographs with 01 post-op; 68 with information on EQ-5D, VAS, and Roland-Morris clinical scores at the pre-surgical time point and one-year post-op. Only 11 patients had information about DM and SAH. (Table 1)

Figure 1. Example of anteroposterior radiography for assessment of spinal fusion posterolateral.

Table 1. Characteristics of patients who underwent lumbar arthrodesis between 2012 and 2018.

Age (years)	
Mean (SD)	58.8 (13.9)
Median (Q1; Q3)	58.5 (49. 66.2)
Minimum; maximum	39; 88
Sex	
Female	41 (54%)
Male	35 (46%)
Smoking (n=76)	12 (15.7%)
DM (n=11)	3 (27%)
SAH (n=11)	3 (27%)
IMC (n = 21)	
20-25	8 (38%)
25-30	8 (38%)
>30	2 (10%)
>35	3 (14%)
ASA Severity Criterion	
I	24 (31.5%)
II	46 (60.5%)
III	6 (8.0%)
Hospitalization time (days)	
Mean (SD)	3 (3.5)
Minimum; maximum	1; 9
Number of levels operated	
1 level	67 (88%)
2 levels	9 (12%)
Radiographic Analysis	
Pseudoarthrosis	9 (11.84%)
Indeterminate consolidation	14 (18.42%)
Bone fusion	53 (69.74%)

DM: Diabetes Mellitus; HAS: Hypertension; BMI: Body Mass Index (Kg/m²); ASA: American Society of Anesthesiologists; SD: standard deviation; Q1: first quartile; Q3: third quartile

There were 41 female and 35 male patients, with a mean age of 58 years (39-88 years). In the radiographs analyzed of these patients, pseudoarthrosis was observed in 09 (11.84%), indeterminate consolidation in 14 (18.42%), and bone fusion in 53 (69.74%) patients.

According to Christensen's criteria, the degree of Kappa agreement between the surgeon and the radiologist in analyzing the radiographic images was statistically significant (p-value < 0.001).

Table 2 represents the clinical evolution of patients one year after surgery through the VAS, Roland-Morris, and EQ-5D questionnaires observed preoperatively and one year after the procedure. We observed a statistically significant difference in the three clinical outcomes analyzed by comparing the preoperative moment with one year after the surgical procedure. There was a 60% reduction in pain, as assessed by the VAS scale (7.92 points preoperatively to 3.16 points after 01 year postoperatively; p-value <0.001). There was also a 53% improvement in the patient's physical function after one year of the procedure, as assessed by the Roland Morris score (14.90 points preoperatively to 7.06 points postoperatively; p-value <0.001). Improvement in pain and physical function promoted improvement in the patient's quality of life, as assessed by the EQ-5D score (0.5672 points pre to 0.7002 points post; p-value = 0.002).

Considering the MCID values for the analyzed scores, a statistically significant difference was found in the three clinical outcomes in the preoperative period and one year after surgery, as shown in Table 3. As assessed by the VAS scale, a clinically relevant reduction in pain was observed in 91% of the patients. An improvement in the patient's physical function was also observed after one year of the procedure, as assessed by the Roland Morris score (71%). Improvement in pain and physical function promoted improvement in the patient's quality of life, as assessed by the EQ-5D score (62%).

The distribution of the patients' scores about the analyzed moments is illustrated in Figure 2.

On average, a 60% reduction in pain was observed: VAS (7.92 at the time pre to 3.16 after one-year post-surgery; p-value <0.001). 53% improvement in the patient's physical function after one year of the procedure: Roland Morris (14.90 pre to 7.06 post; p-value <0.001). Improved quality of life: EQ-5D (0.5672 pre to 0.7002 post; p-value = 0.002). (Figure 2)

The association between the radiographic outcome after 01 year of surgery with the qualitative factors of DM, HSD, and Smoking, absolute and percentage values were used. The data are presented with the joint distribution of the variables for absolute values and their percentages among all combinations of the levels of these two variables. The analysis shows no association between radiographic analysis and the diagnosis of DM, SAH, and smoking, i.e., these factors are considered statistically independent of the radiographic analysis. However, since the sample number is low, the result has a low statistical value.

Table 4 compares the radiographic analysis with the clinical outcomes one-year post-surgery. It is possible to conclude there is no statistically significant difference between the group that evolved with pseudoarthrodesis about the indeterminate group and the group with bone fusion.

Table 2. Evolution of clinical outcomes.

		N	Average	Median	DP	Q1	Q3	IC	P-value
EVA	Pre-op	64	7.92	8	1.44	7	9	0.35	<0.001
	one year	64	3.16	3	2.68	0	6	0.66	
Roland Morris	Pre-op	67	14.9	15	5.04	12	18	1.21	<0.001
	one year	67	7.06	4	6.41	2	12	1.54	
EQ-5D	Pre-op	67	0.567	0.667	0.187	0.434	0.684	0.045	0.002
	one year	67	0.700	0.690	0.245	0.541	1.000	0.059	

SD: standard deviation; Q1: first quartile; Q3: third quartile; CI: confidence interval. P-value: Statistical test: Wilcoxon.

Table 3. Minimum difference considered clinically relevant for pain, function, and quality of life (n= 69).

VAS (pain)	
With MCID	63 (91%)
No MCID	6 (9%)
Roland Morris (role)	
With MCID	49 (71%)
No MCID	20 (29%)
EQ-5D (quality of life)	
With MCID	43 (62%)
No MCID	26 (38%)

MCID: minimum clinically important difference after one year of the procedure. EVA: 2 points; Roland Morris: 5 points; EQ-5D: 0.18 points.

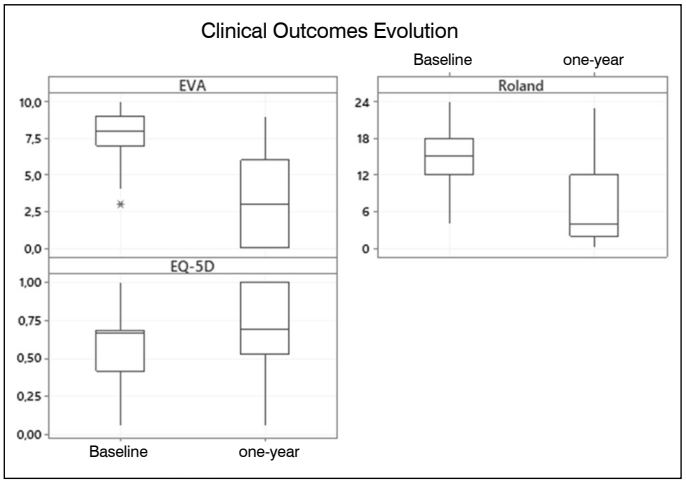

Figure 2. Evolution of pre-surgical (Baseline) and one-year post-surgical clinical outcomes surgical.

Table 4. Comparison of radiographic analysis with clinical outcomes one-year post-surgery.

Radiography 1 year		Average	Median	DP	Q1	Q3	N	IC	P-value
EVA (N=64)	Undetermined	2.86	3	2.66	0	4.75	14	1.39	0.818
	Pseudoarthrosis	3.25	3	2.05	2	5	8	1.42	
	Fusion	3.39	3	2.9	0	6	44	0.86	
Roland Morris (N=67)	Undetermined	4.64	2	5.67	1	6.75	14	2.97	0.181
	Pseudoarthrosis	7.13	4.5	6.71	2.75	9.25	8	4.65	
	Fusion	7.78	5	6.46	2.25	12.75	46	1.87	
EQ-5D (N=67)	Indeterminado	0.77	0.76	0.21	0.64	1	14	0.11	0.548
	Pseudoartrose	0.70	0.69	0.15	0.61	0.714	8	0.10	
	Fusão	0.69	0.71	0.27	0.49	1	46	0.08	

P-value: Kruskal-Wallis test.

DISCUSSION

This study found no association between radiographically observed arthrodesis and worse clinical outcomes when evaluated one year after the surgical procedure.

Pseudarthrosis rates vary in the literature, around 5-35% in cases of surgery for lumbar arthrodesis, as shown.[26] In the study by Grubb et al.[27] evaluating 28 patients undergoing arthrodesis for scoliosis, a total of 17.5% pseudoarthrosis was found, and in all of these, the fusion extended to the pelvis. In this study, the pseudoarthrosis rate was 11.84%.

Studies with prolonged clinical and radiological follow-up show that patients who did not obtain bone fusion, demonstrated in imaging studies in the first year after surgery, mostly obtain fusion in about two years postoperatively.[28] As the follow-up in this study was one year postoperatively; bone fusion may be observed in patients in whom it is still undetermined or absent.

It is estimated that the number of cases that evolve with pseudoarthrosis is underestimated in the medical literature due to the absence of clinical symptoms that stimulate the investigation. Still, it is expected that the patient will present symptoms up to 10 years after surgery with consolidation failure.[29]

CT scanning is now considered the gold standard in the noninvasive evaluation of bone fusion.[30] Still, this method leads to higher radiation exposure, longer scanning time, and higher cost, and many surgeons prefer to request this scan only for symptomatic patients. Employing CT scanning in the sample studied would likely reduce the number of patients classified as undetermined bone fusion.

For patients who evolve to symptomatic pseudoarthrosis after posterolateral arthrodesis, complementation with circumferential arthrodesis of the spine is indicated, most often with anterior cages, showing optimal results for obtaining bone fusion with positive results in about 90 to 100% of cases.[31]

The negative influence of smoking[32,33] and other clinical conditions such as vitamin D deficiency,[34] and corticosteroid use[35] are described in the literature. However, in this study, the same negative influence was not observed for smoking patients or patients with DM and SAH, a limitation of the analysis due to the small number of patients with this information.

The study also brings data that are still little available in the national literature, such as postoperative hospitalization time, ASA classification, number of levels operated on, and preoperative BMI of the patients. Data contributing to the national characterization of the procedure's clinical practice reveals that the average age of the patients is 58.8 years, 54% are female, and most reveal have a BMI of up to 30 Kg/m^2. Most procedures were single-level, with an average length of stay of three days.

The development of pseudoarthrosis is a common complication of lumbar arthrodesis surgeries. Often these cases are asymptomatic and do not require surgery for revision.[36,37]

The study by Kornblum et al.[36] evaluated 47 patients with spondylolisthesis who underwent posterolateral arthrodesis with a minimum follow-up of 5 years and found 86% of good clinical results in patients who presented radiological evidence of arthrodesis versus 56% of good results in patients who developed pseudoarthrosis, with both groups presenting similar results in postoperative satisfaction.

The improvement in clinical outcomes after the surgical procedure in virtually all the patients observed in the present study is probably related to the spinal decompression and lumbar stabilization procedure performed during the surgical procedure. The executions of these procedures are described as more important for clinical improvement in the patient's recent postoperative period than achieving bone fusion.[36,37]

Limitations of the study are shown by the number of the sample and the follow-up time. The authors hypothesize that patients with asymptomatic pseudoarthrosis may progress to bone healing or develop clinical symptoms with longer follow-up.

CONCLUSION

The present study demonstrated that the absence of radiographic fusion does not correlate with worse clinical outcomes at one-year post-surgery. Most patients showed clinical improvement with no statistical difference from the cases in which bone fusion was obtained.

The presence of comorbidities such as Diabetes *Mellitus*, Hypertension, and smoking did not show any impact on the clinical outcome or the radiographic evaluation after 01-year post-surgery.

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