RADIOGRAPHIC ANALYSIS OF THE RESULTS OF ANTERIOR INTERNODY ARTHRODESIS ON THE SAGITTAL LUMBOPELVIC PARAMETERS

ANÁLISE RADIOGRÁFICA DOS RESULTADOS DA ARTRODESE INTERSOMÁTICA ANTERIOR SOBRE OS PARÂMETROS LOMBOPÉLVICOS SAGITAIS

ANÁLISIS RADIOGRÁFICO DE LOS RESULTADOS DE LA ARTRODESIS INTERSOMÁTICA ANTERIOR SOBRE LOS PARÁMETROS LUMBOPÉLVICOS SAGITALES

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ABSTRACT

Objective: The objective of this study is to analyze the radiographs of patients who underwent anterior lumbar interbody fusion (ALIF), to compare the values of the lumbopelvic measurements, and to quantify improvements in these parameters achieved through this technique. Methods: The radiographs of 42 patients, all submitted to ALIF with a 12° interbody device, were evaluated from a database at a single center. The pelvic incidence, pelvic tilt, sacral slope, lumbar lordosis, segmental lordosis, and regional lordosis angles of each patient were measured in pre- and postoperative radiographs. Results: We observed a discreet change in the pelvic parameters and a marked increase in regional lordosis with a mean increase of 5.8° ($p>0.001$). Segmental lordosis also showed a mean increase of 2.43°. The gain in segmental lordosis was even higher in patients with degenerative spondylolisthesis and when the operated level was L5-S1. Conclusions: The ALIF technique in the lumbar spine is capable of significantly increase the lordosis of a segment, whether at one or two levels. Greater improvement in the lumbopelvic parameters was observed it the procedures performed in level L5-S1 and in cases that presented spondylolisthesis.

Keywords: Lordosis; Arthrodesis; Radiography.

RESUMO

Objetivo: O presente estudo tem por objetivo analisar as radiografias de pacientes submetidos à artrodese intersomática via anterior (ALIF), comparar os valores das medidas lombopélvicas e quantificar a melhora nesses parâmetros oferecida através dessa técnica. Métodos: Foram avaliadas as radiografias de 42 pacientes de um banco de dados de um único centro, todos submetidos à ALIF com dispositivo intersomático de 12º. Foram aferidos os valores dos ângulos de incidência pélvica, inclinação pélvica, inclinação sacral, lordose lombar, lordose segmentar e lordose regional na radiografia pré- e pós-operatória de cada paciente. Resultados: Observou-se uma alteração discreta nos parâmetros pélvicos e um aumento expressivo na lordose regional com um aumento médio de 5,8º ($p>0,001$). A lordose segmentar também demonstrou aumento com uma média de acréscimo de 2,43º. O ganho da lordose segmentar foi ainda maior nos pacientes com espondilolistese degenerativa e quando o nível operado era L5-S1. Conclusões: A técnica de ALIF na coluna lombar é capaz de aumentar significativamente a lordose de um segmento, seja em um ou dois níveis. Uma melhora mais expressiva nos parâmetros lombopélvicos foi observada nos procedimentos realizados no nível L5-S1 e em casos que apresentavam espondilolistese.

Descritores: *Lordose; Artrodese; Radiografia.*

RESUMEN

Objetivo: El presente estudio tiene por objetivo analizar las radiografías de pacientes sometidos a la artrodesis intersomática vía anterior (ALIF), comparar los valores de las medidas lumbopélvicas y cuantificar la mejora en esos parámetros ofrecida a través de esa técnica. Métodos: Fueron evaluadas las radiografías de 42 pacientes de un banco de datos de un único centro, todos sometidos a la ALIF con dispositivo intersomático de 12º. Fueron medidos los valores de los ángulos de incidencia pélvica, inclinación pélvica, inclinación sacral, lordosis lumbar, lordosis segmentaria y lordosis regional en la radiografía pre y post operatoria de cada paciente. Resultados: Se observó una alteración discreta en los parámetros pélvicos y un aumento expresivo en la lordosis regional con un aumento promedio de 5,8º ($p>0,001$). La lordosis segmentaria también demostró aumento con un promedio de incremento de 2,43º. El aumento de la lordosis segmentaria fue aún mayor en los pacientes con espondilolistesis degenerativa y cuando el nivel operado era L5-S1. Conclusiones: La técnica de ALIF en la columna lumbar es capaz de aumentar significativamente la lordosis de un segmento, ya sea en uno o dos niveles. Fue observada una mejora más expresiva en los parámetros lumbopélvicos en los procedimientos realizados en el nivel L5-S1 y en casos que presentaban espondilolistesis.

Descriptores: *Lordosis; Artrodesis; Radiografía.*

Study conducted at the Spine Surgery Group, Orthopedics and Traumatology Service of the Hospital Cajuru and at the Pontifícia Universidade Católica do Paraná, Curitiba, PR, Brazil.
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http://dx.doi.org/10.1590/S1808-185120201902224026

Received on 05/15/2019 accepted on 09/03/2019

INTRODUCTION

Reestablishing sagittal balance is essential for a good outcome from lumbar spine surgery in many cases. Current advances in knowledge about lumbopelvic parameters have only reinforced this requirement, proving that many patients benefit from an increase in lumbar lordosis to restore sagittal balance[1] and the surgeon's lack of success in providing this gain in lumbar lordosis often results in a poor functional outcome[2] and failure of the proposed treatment.

The various arthrodesis techniques available today have their own characteristics and there is still no consensus around what is the best technique to be used.

Minimally invasive techniques have become an increasingly common option and one technique that has been promising is anterior lumbar interbody fusion (ALIF), which demonstrates good fusion capability[3] and a significant improvement in lumbar parameters[4,5] if performed properly.

This study aims to show the improvement in lumbopelvic radiographic parameters by evaluating a series of cases of ALIF performed in a single center.

METHODS

This study is a retrospective analysis of radiological images from a single center database collected between 2013 and 2019. This study was approved by the Institutional Review Board where it was conducted (089852/2013).

The selection of patients who presented degenerative lumbar pathology treated with anterior interbody arthrodesis at one or two levels was conducted.

Forty-two patients were found, all of whom had lumbar spine radiographs taken preoperatively at the outpatient clinic and in the immediate postoperative period at the hospital.

In all selected cases, interbody lordotization devices with 12º angulation were used.

Cases with prior lumbar surgery or with anterior interbody arthrodesis at more than two levels were excluded from the study.

Pre- and postoperative radiographic analysis included lateral orthostatic radiographs, which were evaluated by a single surgeon in a standardized manner by measuring pelvic incidence, pelvic tilt, sacral slope, lumbar lordosis, segmental lordosis (L4-S1), and regional lordosis (the vertebral plate above and below the cage) (Figure 1).

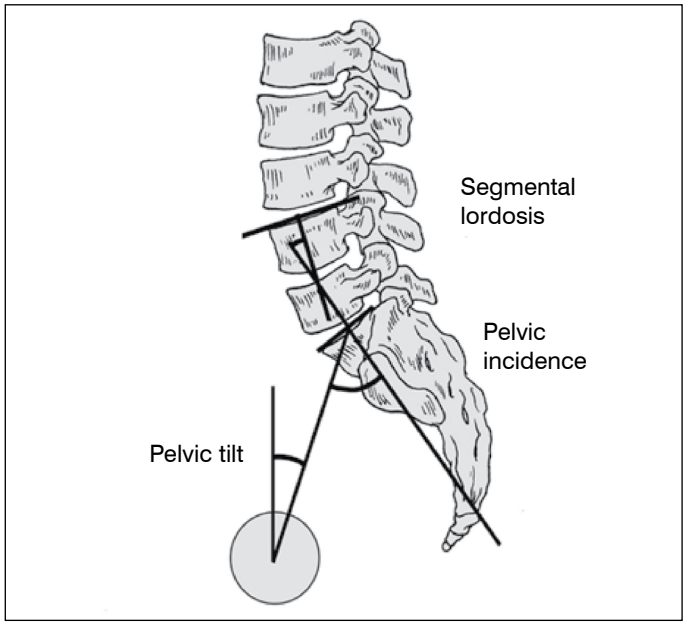

Figure 1. Example of segmental lordosis, pelvic incidence, and pelvic tilt.

The data were then evaluated by comparing the mean pre- and postoperative values of each parameter.

The patients were then divided into subgroups for the comparison of specific data and the results of the intervention between the groups with surgery at level L4-L5 or L5-S1, between the groups that previously had degenerative disc disease (DDD) or spondylolisthesis, and between the groups that had undergone anterior interbody arthrodesis standalone or associated with posterior fixation were compared.

RESULTS

Among the 42 patients selected for the study, 36 were submitted to anterior arthrodesis at one level and 6 at two levels.

The mostly frequently observed level in the sample was L5-S1, with 24 cases (57.1%).

Pelvic tilt decreased slightly by an average of 1.56º (p=0.183), while sacral slope decreased by an average of 1.7º (p=0.226). The mean pelvic incidence did not change in the sample, remaining with an average of 51.3º pre- and postoperatively.

Regional lordosis showed a marked and statistically significant improvement (p=0.0016), increasing from an average of 21.13º to 26.93º. (Table 1)

Segmental lordosis showed a less significant improvement, increasing from a mean preoperative value of 32.41º to 34.84º in the postoperative period (p=0.0912).

Lumbar lordosis experienced a more discreet average change (p=0.1696), but unequal among the cases when evaluated individually. We observed that in several patients, despite the significant improvement in regional and segmental lordosis, the same improvement was not observed in lumbar lordosis. (Table 2)

Of the 42 study patients, 57% (24) had a decrease in lumbar lordosis in the immediate postoperative period. Among these, 16 had an increase in regional lordosis and 5 had an increase in segmental lordosis.

By dividing the cases between DDD and spondylolisthesis, a significant difference was observed in the outcomes of both groups, with an increase in lumbar, segmental, and regional lordosis, with regional lordosis presenting the most significant average increase at 11.15º in the spondylolisthesis group as compared to 5.2º in the DDD group. (Table 3)

In the comparison of the outcomes of patients treated with ALIF accompanied by posterior fixation and those treated with ALIF alone, no significant difference was observed between the techniques, although the group of patients treated with ALIF associated with posterior fixation had slightly better results. (Table 4)

The analysis of the outcomes of anterior interbody arthrodesis

Table 1. Overall pre- and postoperative lumbopelvic parameters.

	Preoperative	Postoperative	Difference
PT	I	18.35	1.56
PI	51.3	51.3	0
SS	34.86	33.16	-1.7
LL	48.58	46	-2.58
LReg	21.13	26.93	5.8
LSeg	32.41	34.84	2.43

PT (pelvic tilt), PI (pelvic incidence), SS (sacral slope), LL (lumbar lordosis), LReg (regional lordosis), LSeg (segmental lordosis).

Table 2. Qualitative results.

	Increase	Decrease	No change
LL	15	24	3
LReg	34	5	3
LSeg	24	15	3

LL (lumbar lordosis), LReg (regional lordosis), LSeg (segmental lordosis).

at level L4-L5 and level L5-S1 revealed a significant improvement in the L5-S1 group, with better lumbopelvic parameter results.

There was improvement mainly in the segmental lordosis of the L5-S1 group, which presented a much higher statistical significance than group L4-L5 ($p < 0.001$ versus $p=0.059$). (Table 5)

DISCUSSION

Anterior lumbar fusion is a safe technique[6] that has been gaining ground among surgeons in the treatment of degenerative lumbar spine diseases.

Table 3. Comparison between the degenerative disc disease and spondylolisthesis groups.

	LL	LReg	LSeg
DDD Pre	46.25	21.01	32.27
DDD Post	42.85	26.21	34.2
Difference	-3.4	5.2	1.93
p	0.127939	0.014089	0.198161
Sp Pre	54.1	19.72	32.3
Sp Post	56.36	30.87	38.31
Difference	2.26	11.15	6.01
p	0.370198	0.004852	0.091288

DDD (degenerative disc disease), Sp (spondylolisthesis), LL (lumbar lordosis), LReg (regional lordosis), LSeg (segmental lordosis).

Table 4. Comparison between the ALIF associated with posterior approach arthrodesis and standalone ALIF groups.

	LL	LReg	LSeg
PPA Pre	51.57	22.54	33.51
PPA Post	50.29	29.11	36.48
Dif	-1.28	6.57	2.97
p	0.379456	0.021367	0.155232
SA Pre	46.33	20.07	31.58
SA Post	42.79	25.29	33.61
Dif	-3.54	5.22	2.03
p	0.148423	0.015931	0.192841

PPA (ALIF associated with posterior approach arthrodesis), SA (standalone ALIF), LL (lumbar lordosis), LReg (regional lordosis), LSeg (segmental lordosis).

Table 5. Comparison between the level L4-L5 and level L5-S1 groups.

	LL	LReg	LSeg
L4-L5 Pre	50.72	21.47	33.57
L4-L5 Post	48.25	27.6	36.43
Dif	-2.47	6.13	2.86
p	0.3249646	0.0590005	0.238893
L5-S1 Pre	46.79	17.32	31.14
L5-S1 Post	45.54	24.88	34.2
Dif	-1.25	7.56	3.06
p	0.3569331	< 0.001	0.094669

LL (lumbar lordosis), LReg (regional lordosis), LSeg (segmental lordosis).

The anterior retroperitoneal approach ensures wide access with full exposure of the ventral face of the intervertebral disc, thus allowing an ample discectomy and the insertion of interbody lordotization devices that would be difficult to insert from other approaches.

Anterolateral access in indicated mainly for levels L5-S1 and L4-L5 and can be used for higher levels depending on the vascular anatomy of the patient. Comparative studies have shown that ALIF is superior to transforaminal lumbar interbody fusion (TLIF) in the correction of kyphotizing deformities, increase of the height of the intervertebral space, segmental lordosis[7-9], and even adjacent level degeneration.[10]

A good fusion rate is associated with the ALIF technique,[3] with signs of complete fusion in 100% of the cases in a published study of 36 patients.[11]

In this study, the results indicate a significant improvement in regional lordosis, which is directly related to the size of the interbody devices allowed by this technique and to their placement with good anterior support and their wedge shape, often impossible to perform in other techniques.[5,12,13]

Lumbar lordosis in turn showed a decrease, going from a mean of 48.5° to 46°, without statistical significance ($p=0.169$). However, when we compared the results of standalone ALIF and ALIF associated with posterior fixation (Table 4), we observed a smaller loss of lumbar lordosis in the group with associated posterior fixation, with a mean loss of 1.28° versus 3.54° in the standalone anterior approach group, suggesting that an antalgic posture mechanism may be present in the postoperative radiographs, since some of the radiographs were taken on the first postoperative day, when the patient tends to have more significant pain. This antalgic posture may lead to kyphotization of the non-fixed levels, explaining the incongruity that exists in cases of significant improvement of regional lordosis without the same improvement in lumbar lordosis (Table 2).

When compared to the earlier study of transforaminal lumbar interbody fusion (TLIF),[14] we can see that the loss of lumbar lordosis was more significant in the patients that underwent TLIF, decreasing from 59° to 39° postoperatively ($p=0.01$) as compared to those who underwent ALIF who went from a preoperative lordosis of 46.3° to 42.7° following surgery ($p=0.14$).

However, segmental lordosis increased significantly, from 20° to 25.2° ($p=0.01$) in the present study as compared to a decrease from 11.4° to 11.06° ($p=0.85$) following surgery in the group of TLIF patients in the previous study.

CONCLUSION

From the data obtained through a prospective evaluation of the image, we observed that anterior lumbar interbody fusion in one or two levels of the lumbar spine is able to significantly increase segmental lordosis.

A more significant improvement in the lumbopelvic parameters was observed in the procedures performed at level L5-S1 and in cases with spondylolisthesis.

A study with late postoperative radiographs should be conducted for more accurate measurements of the lumbopelvic parameters obtained through surgical intervention in the long term.

All authors declare no potential conflict of interest related to this article.

CONTRIBUTION OF THE AUTHORS: Each author made significant individual contributions to this manuscript. FNN: writing of the article, selection of the cases from the database, measurement of the lumbopelvic parameters, analysis of the results; ENV: intellectual concept, statistical analysis, data analysis, and writing of the article; MDB: selection of cases from the database, bibliographical review.

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