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LUMBAR LORDOSIS VARIATION ACCORDING THE TYPE OF POSITIONER USED IN LUMBAR ARTHRODESIS

VARIAÇÃO DA LORDOSE LOMBAR SEGUNDO OS TIPOS DE POSICIONADORES UTILIZADOS EM ARTRODESE LOMBAR

VARIACIÓN DE LA LORDOSIS LUMBAR SEGÚN EL TIPO DE POSICIONADOR UTILIZADO EN ARTRODESIS LUMBAR

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ABSTRACT

Objective: Evaluate the influence of the most used surgical positioners for lumbar lordosis (LL) in asymptomatic individuals. Methods: Cross-sectional study based on demographic data and radiographic parameters of asymptomatic individuals. For this study, 16 volunteers, 15 males, and one female were selected, and the average age was 24.6 years. They were submitted to lateral radiographs of the lumbar spine in orthostasis in use of the following positioners: gel cushion, gel cushion with hip extension, four-point Relton-Hall and Wilson-type positioner. Results: The mean LL in the orthostatic position was 58.76°, whereas in the gel cushion positioner it was 52.51; on the gel cushion with hip extension of 58.23°, Relton-Hall/4points 37.63° and, finally, on the Wilson-type positioner of 40.87°. An average reduction of 5.42° of the LL was observed when positioning on the gel cushion in relation to the orthostasis. In the linear regression analysis, the data presented statistically significant results ($p<0.05$), demonstrating that the L4-S1 segment influences 60% in LL. Conclusion: The positioner with gel cushion and hip extension reproduces an LL similar to physiological values. Relton-Hall and Wilson-type positioners with hip flexion promote hypolordotic positioning compared to basal lordosis in orthostasis. Hip extension alone generated a 5.96° increase in the subject's lordosis. The L4-S1 segment has a 60% influence on the LL when the individuals are in the positioners. ***Level of evidence III; Controlled cross-sectional study.***

Keywords: Spine; Lordosis; Patient Positioning; Quality of Life.

RESUMO

Objetivo: Avaliar a influência dos posicionadores cirúrgicos na lordose lombar (LL) em indivíduos assintomáticos. Métodos: Estudo transversal com dados demográficos e parâmetros radiográficos de indivíduos assintomáticos. Utilizamos 16 voluntários, sendo 15 do gênero masculino e uma do gênero feminino, com idade média de 24,6 anos. Foram submetidos a realização de radiografias em perfil da coluna lombar em ortostase nos seguintes posicionadores: coxim em gel, coxim em gel com extensão do quadril, Relton-Hall em quatro pontos e posicionador tipo Wilson. Resultados: A média de LL na posição ortostática foi de 58,76°, já no posicionador coxim em gel de 52,51; no coxim em gel com extensão dos quadris de 58,23°, Relton-Hall/4pontos 37,63° e, por último, no posicionador tipo Wilson, de 40,87°. Houve redução média de 5,42° da LL ao posicionar no coxim em gel em relação a ortostase, na análise de regressão linear os dados apresentaram resultados estaticamente significativos ($p<0,05$), demostrando que o seguimento L4-S1 apresenta uma influência de 60% na LL. Conclusão: O posicionador coxins em gel e extensão do quadril reproduz uma LL semelhante à fisiológica. Posicionadores do tipo Relton-Hall e Wilson com flexão do quadril promovem um posicionamento hipolordótico comparada a lordose basal em ortostase. A extensão do quadril por si só foi capaz de gerar um aumento de 5,96° na lordose do indivíduo. O seguimento L4-S1 apresenta uma influência de 60% na LL quando os indivíduos estão nos posicionadores. ***Nível de Evidência III; Estudo Transversal Controlado.***

Descritores: *Coluna Vertebral; Lordose; Posicionamento do Paciente; Qualidade de Vida.*

RESUMEN

Objetivo: Evaluar la influencia de los posicionadores quirúrgicos para la lordosis lumbar (LL) en individuos asintomáticos. Métodos: Estudio transversal con datos demográficos y parámetros radiográficos de individuos asintomáticos. Utilizamos 16 voluntarios, 15 hombres y una mujer, edad media de 24,6 años. Sometidos a radiografías laterales de la columna lumbar en ortostasis en los siguientes posicionadores: almohadilla de gel, almohadilla de gel con extensión de cadera, posicionador de cuatro puntos y posicionador tipo Wilson. Resultados: El promedio de LL en posición ortostática fue de 58,76°, en el posicionador de almohadilla de gel fue de 52,51°; en almohadilla de gel con

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extensión de cadera de 58,23°, 4 puntos 37,63° y, por último, en posicionador tipo Wilson de 40,87°. Se observó una reducción promedio de 5,42° de LL al posicionarse sobre la almohadilla de gel en relación a ortostasis. En el análisis de regresión lineal, los datos presentaron resultados estadísticamente significativos (p<0,05), demostrando que el segmento L4-S1 tiene una influencia de 60% en LL. Conclusión: El posicionador con almohadilla de gel y con extensión de cadera reproduce una LL similar a la fisiológica. Relton-Hall y Wilson con flexión de cadera promueven el posicionamiento hipolordótico en comparación con la lordosis basal. La extensión de la cadera por sí sola fue capaz de generar un aumento de 5,96° en la lordosis. El segmento L4-S1 tiene una influencia del 60% en la LL cuando los individuos están en los posicionadores. ***Nivel de evidencia III; Estudio Transversal Controlado.***

Descriptores: *Columna Vertebral; Lordosis, Posicionamiento del Paciente; Calidad de Vida.*

INTRODUCTION

Procedures for spinal arthrodesis are becoming more frequent. There was a 137% increase in the annual number of spinal fusion surgeries between 1998 and 2008 in the US, from 174,223 to 413,171 procedures in 2008.[1]

An optimal sagittal balance is conducive to better arthrodesis results, such as a higher fusion rate and less adjacent-level degeneration.[2]

However, arthrodesis with insufficient lumbar lordosis (LL) predispose to unsatisfactory outcomes such as sagittal plane imbalance (SVA > 5cm), chronic low back pain, and changes in the quality of life scores of these individuals.[3-5]

Measures for optimization of the LL involve knowledge of the individual's previous sagittal parameters, proper surgical technique, and also correct intraoperative positioning. Surgical positioning is critical to maintain LL and prevent iatrogenic *flatback*.[6] Lenke and colleagues observed that patients with deformities in the sagittal plane and reduced LL (average of 25.9°) showed an average gain of 17.2° with surgical placement alone.[7]

Several studies have demonstrated the influence of intraoperative positioning on LL, especially the gain of LL in the prone position with hip extension, showing it to be a valid strategy for optimizing LL.[7-10] These studies evaluated patients positioned mainly on Jackson and Allen tables. However, these surgical tables and positioners are not available in the operational routine of most hospitals. Furthermore, to the authors' knowledge, no work has been published to evaluate the influence of surgical positioners available in our environment on LL.

Thus, this study aimed to evaluate the influence of the most commonly used surgical positioners in our environment on lordosis of the lumbar spine in asymptomatic individuals.

METHODS

After approval by the Research Ethics Committee (CAAE: 55519622.0.0000.0023) and signing the Informed Consent Form (ICF), 16 volunteers aged 18 years or older, asymptomatic, and with no previous history of spinal pathology or surgery were included. Initially, the demographic data of each individual (gender, age, weight, and height) were collected, and lateral radiographs of the lumbar spine were taken in orthostasis and the following positioners: gel cushion, gel cushion with hip extension, Relton-Hall (4 points), and Wilson-type positioner. (Figures 1 to 4)

Figure 1. Positioning in gel cushions with support for face, thorax and pelvis.

Figure 2. Positioning on gel cushion with hip extension.

Figure 3. Relton-Hall positioning - four-point support.

Figure 4. Wilson-type positioner.

The same researcher adjusted the volunteers in the positioners in a standardized way. Then, for a period of 5 minutes, waited for accommodation and relaxation of the paravertebral musculature between successive positions. Then, all radiographs were taken according to technique and in digital format, encompassing the upper L1 plateau and the femoral heads in the same image to allow a correct measurement of the spinopelvic parameters.

The parameters measured in each radiograph were: lumbar lordosis (angle between the upper plateau of L1 and S1), pelvic incidence (PI), pelvic tilt (PT), and sacral slope (SS) (Figure 5), using Surgimap® software (Nemaris Inc., New York, NY, USA). The variables obtained from lateral radiographs of the lumbar spine in orthostasis were compared with those of the radiographs taken with each surgical positioner**.** Continuous variables were expressed as mean and standard deviation for this evaluation and compared between groups using paired Student's t-test. The results and p-values (considering values less than 0.05 as

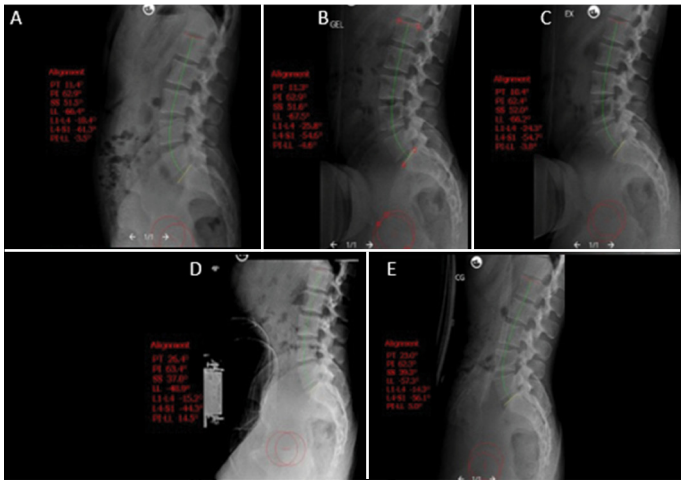

Figure 5. Radiographs in orthostasis (A), gel cushion positioners (B), gel cushion positioners with hip extension (C), Relton-Hall (D) and Wilson (E) positioners.

statistical significance) are listed in Tables 1 and 2. A simple linear regression analysis was also performed to evaluate the effect of lumbar lordosis L4-S1 (dependent variable) on LL (independent variable), that is, the influence of L4-S1 tracking on LL composition and change (Table 3). The analyses were performed in the statistical program IBM® SPSS *Statistics* (version 22.0; SPSS, Chicago, IL, USA).

RESULTS

Of the sample of 16 volunteers, 15 were male and one female, with a mean age of 24.6 years (minimum 19, maximum 39, and standard deviation 5.6), mean height 176 cm (minimum 168, maximum 188, and standard deviation 6.2), and mean body mass 77.4 kg (minimum 49, maximum 102, and standard deviation 14.5).

The mean LL in the orthostatic position ("orthostatism") was 58.76°, in the gel-cushion positioner ("gel") 52.51°, in the gel-cushion positioner with hip extension ("extension") 58.23°, in the Relton-Hall positioner/four-point positioner ("4-point") 37.63° and finally in the Wilson-type positioner ("Wilson") 40.87°. (Table 1)

When performing the t-test, we observed a mean reduction of 5.42° of LL when positioning on the gel cushion to orthostasis, a reduction of 19.74° with the 4-point positioning, and 17.73° with the Wilson-type positioner, all values with statistical significance ($p<0.05$). When comparing the LL in orthostasis with the "extension" group, a mean reduction of only 0.5° in lordosis was observed without statistical significance ($P=0.754$). When comparing the "gel" group with the "extension" group, there was an increase of 5.96°, also with statistical significance ($P<0.05$). Hip extension alone favored a significant increase in LL. (Table 2)

When specifically evaluating the variations in lordosis of the L4-S1 follow-up, we observed a reduction of 3.90° in the "gel" group ($p=0.067$), 0.58° in the "extension" ($p=0.694$), 12.58° in the 4-point ($P=0.000$) and 17.16° ($p=0.000$) in the Wilson positioner relative to the standing position. When analyzing the group positioned on the gel cushion to the group with hip extension, there was a 3.32° increase in lordosis L4-S1; again hip extension alone showed statistical significance ($p<0.05$). (Table 3)

In the linear regression analysis, it was observed with statistical significance that the L4-S1 segment has a 60% influence on the LL when the subjects are in the positioners, even though the L4-S1 segment has only two movable discs (Table 4). For example, hip extension alone promotes a 5.42° increase in LL ("gel" vs. "gel with the extension"), and 3.32° (61%) of this increase occurred in the L4-S1 segment.

DISCUSSION

The mean LL of the 16 volunteers was 58.76° in the standing position, with a significant reduction in the prone position in all positioners studied, except for the gel cushion with hip extension, which reproduced lordosis in the standing position. The linear regression analysis showed the importance of the L4-S1 follow-up in the composition and alteration of the LL, with an influence of up to 60%. Different studies have also evaluated the influence of intraoperative positioning on lumbar lordosis.[7,9,11]

Tan and colleagues analyzed the variation in intraoperative positioning in the LL of 10 volunteers. They found a reduction of up to 57% in the LL of subjects positioned with hip flexion. In contrast, the LL of the standing position was reproduced by positioning the volunteers with pads supporting the thorax and pelvis. In addition, they also reported that the LL change was accompanied by a change in the angles between the vertebral bodies and that most of this change was located in the L4-L5 and L5-S1 segments.[11] These

Table 1. Mean values of the lumbar lordosis in the different positioners.

Positioning	Average (°)	Standard Deviation	Median	Minimum (°)	Maximum (°)
Orthostatism	58.76	7,81	56,55	48,4	71,6
Gel	52.51	11.8	48.4	32	69.2
Extension	58.23	10.16	57	44	75.8
4 points	37.63	11.74	38.1	21	62.4
Wilson	40.87	9.08	40.6	23.3	58.6

Table 2. Comparison of lumbar lordosis (LL) between different positions.

	MV LL (°)	Standard Deviation	Minimum (°)	Maximum (°)	p.
Orthostatism x Gel	5.43	8.46	0.74	10.11	0.026
Orthostatism x Extension	0.54	6.55	-4.17	3.086	0.754
Orthostatism x 4 points	19.75	8.71	14.92	24.57	0.000
Orthostatism x Wilson	17.73	7.89	13.36	22.10	0.000
Gel x Extension	-5.97	6.87	-9.77	-2.16	0.005
Gel x 4 points	14.32	7.52	10.15	18.49	0.000
Gel x Wilson	12.31	8.22	7.75	16.86	0.000
Extension x 4 points	20.29	9.06	15.27	25.31	0.000
Extension x Wilson	18.27	8.54	13.54	23.00	0.000
4 points x Wilson	-2.01	7.58	-6.21	2.18	0.321

MV: Mean L1-S1 variation between positions; p: paired T-test ($p<0.05$). Positive values (MV LL) indicate reduced LL of the second group compared to the first.

Table 3. Comparison of lordosis of L4-S1 between different positions.

	MV L4-S1 (°)	Standard Deviation	Minimum (°)	Maximum (°)	p.
Orthostatism x Gel	3.91	7.63	-0.32	8.13	0.067
Orthostatism x Extension	0.58	5.59	-2.52	3.68	0.694
Orthostatism x 4 points	12.59	9.31	7.43	17.74	0.000
Orthostatism x Wilson	17.17	10.07	11.59	22.74	0.000
Gel x Extension	-3.33	5.93	-6.60	-0.04	0.047
Gel x 4 points	8.68	8.16	4.16	13.19	0.001
Gel x Wilson	3.65	7.064	-0.26	7.56	0.065
Extension x 4 points	12.01	9.28	6.87	17.15	0.000
Extension x Wilson	6.97	8.11	2.48	11.47	0.005
4 points x Wilson	-5.03	7.38	-9.12	-0.94	0.019

MV: Average L4-S1 variation between positions; p: paired T-test ($p<0.05$). Positive values (MV LL) indicate reduced LL of the second group compared to the first.

Table 4. Results of the simple linear regression analysis.

Lumbar Lordosis x Lordosis L4-S1	p.	R	Adjusted R^2
Orthostatism	0.487	0.177	0.038
Gel	0.001	0.586	0.584
Extension	0.003	0.605	0.498
4 points	0.004	0.492	0.605
Wilson	0.006	0.601	0.458

Lumbar lordosis L4-S1 (dependent variable) and LL (independent variable), considered significant $p<0.05$.

data agree with our study, contributing to the understanding of hip extension as a tool to optimize the LL and the need for more attention to the optimization of lordosis of the L4-S1 segment, since this influences the LL in up to 60%.

Just as hip extension showed a gain in LL, hip flexion worsens these values. In the study conducted by Stephens and colleagues,[9] the average LL in 10 asymptomatic volunteers was 51.7°. By positioning them on the Andrews table with 90° of hip flexion, the LL reduced significantly to 17°. When reduced the flexion to 60°, the average LL increased to 27.3º. However, the L1-L4 follow-up accounted for 80% of the change in lumbar lordosis with minimal changes in the L4-L5 and L5-S1 discs, a finding that diverges from our linear regression analysis.

Lenke and colleagues[7] evaluated the effect of intraoperative positioning (prone position with hips extended on a Jackson table) on LL of adults with spinal deformity. They concluded that the patients with the greatest lordosis gain with intraoperative positioning were hypolordotic (LL mean 25.9°) and had worse sagittal balance. While the group with a preoperative mean LL of 54.2° and better sagittal parameters showed no significant change with intraoperative positioning. This study differs from our population by evaluating patients with spinal deformities already with surgical indication, while the present study evaluated asymptomatic patients. The authors believe that the optimization of LL with intraoperative positioning will be even greater in patients with complex deformities who already present with reduced LL and sagittal imbalance. This is precisely the group of patients that require the greatest corrections.

As already described, there was a statistically significant reduction in the LL of individuals in the "4-point" and "Wilson" groups, 19.74° and 17.73°, respectively. The difference in reduction between these positioners was not statistically significant, i.e., both negatively influence the lordosis of the individual similarly. The authors believe that this reduction is mainly the result of greater hip flexion. In spinal arthrodesis surgeries, these positioners may provide a fixation in hypolordosis relative to the patient's baseline, favoring iatrogenic *flatback*, leading to pain, disc degeneration, and future changes in sagittal balance.[4,6]

The main limitations of this study are the small sample size of the volunteers, the fact that it was carried out in only one center, which reduces the generability of the data, and finally, for ethical reasons, it did not evaluate the effect of anesthesia (muscle relaxation) on lordosis gain. However, it is believed that there will be an even greater increase in lumbar lordosis when the patient is anesthetized in the prone position and when hip extension is used as a tool in positioning hypolordotic patients with spinal deformities. Furthermore, to the authors' knowledge it was the only paper to date that evaluated the cushions available in our environment.

CONCLUSION

Positioning with gel pads and hip extension reproduces an LL similar to physiological values. Relton-Hall and Wilson-type hip flexors promote hypolordotic positioning compared to basal lordosis in orthostasis. Hip extension alone was able to generate a 5.96° increase in lordosis for the individual. The L4-S1 segment has a 60% influence on the LL when the subjects are in the positioners. Hip extension is a valid strategy when seeking to optimize LL gain intraoperatively.

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

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