Erratum

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When one reads the article CORRELATION BETWEEN DEGENERATIVE DISEASES OF THE LUMBAR SPINE AND TYPES OF LUMBAR LORDOSIS, DOI: http://dx.doi.org/10.1590/S1808-185120212001235427, published in Revista Coluna/Columna V.20 N.1/2021, from the introduction to the conclusion, the figures and references on pages 26-29 should be read from pages 30-33 of the article CORRELATION BETWEEN DEGENERATIVE DISEASES OF THE LUMBAR SPINE AND TYPES OF LUMBAR LORDOSIS, DOI: http://dx.doi.org/10.1590/S1808 185120212001235427, in the errata of Revista Coluna/Columna V.20 N.4/2021.

INTRODUCTION

Low back pain is a significant social and economic problem that leads to the loss of billions of dollars a year worldwide.[1,2] The etiology is multifactorial, but degenerative changes in the lumbar spine are closely associated with this problem[3] and are frequent causes of a reduction in the quality of life in the active population and especially among the elderly.[4] The most common degenerative lumbar spine conditions involve the degeneration of the intervertebral disc, facet joints, capsule, and vertebral ligaments, which leads to diseases such as disc herniation, spondylolisthesis and canal stenosis.[5] Although degenerative conditions are part of the natural progression of aging, it is suspected that in the spine these are related to the load that the vertebrae bear over time. Load distribution in the lumbar region would be directly linked to the anatomy and design of the physiological curves of the spine (lordosis and kyphosis), as well as to the positioning of the pelvis in relation to the vertebral axis.[6]

In 2005, Roussouly et al.,[7] created a classification that addresses the normal variation in the sagittal alignment of the human lumbar spine and pelvis in the orthostatic position in order to quantify and classify common variations in the sagittal alignment of the spine, the sacrum, and the pelvis.

While developing their classification, Roussouly et al.,[7] observed that the types of lordosis could be related to some of the most common degenerative lumbar spine diseases, suggesting that patients with symptomatic disc herniation fit into types 1 and 2 while stenoses were most often seen in cases classified as type 4. Patients classified as type 3 rarely had significant complaints. However, there was no evidence or statistical analysis of this observation. Given this gap in the literature, the objective of this study was to evaluate the relationship between the incidence of the different types of degenerative spine disease and lumbopelvic biomechanics, according to the types of lordosis as classified by Roussouly and their correlation with the treatment performed in these patients.

METHODS

This study was approved by the Institutional Review Board. A retrospective search was conducted of the medical records of patients treated at a private hospital in the city of São Paulo, during the period from 2012 to 2017, who were diagnosed with degenerative lumbar spine disease and had previously received a surgical indication for this reason, but who did not necessarily undergo surgery. The diagnostic and treatment information of these patients was reviewed and the imaging examinations (radiographs and magnetic resonance imaging of the lumbosacral spine) were analyzed to confirm the lumbar lordosis diagnosis and classification. Extraction of patient imaging examinations was performed from the PACS Platform (Carestream Health, Rochester, New York, USA) at the hospital. The radiographs were imported to Surgimap® software (version 2.2.15.1) (Nemaris Inc.™, Audubon, Pennsylvania, USA) for verification of the angles and classification of the lumbar curvature. They were assigned to one of Roussouly's four lordosis curve types according to the radiographic analysis of the lumbar spine. These steps will be described in detail later. Magnetic resonance images of the lumbar spine, together with the medical history on record, were used to define the patient's diagnosis of degeneration. In the presence of two concomitant diseases observed in the magnetic resonance images, the diagnosis of greater clinical severity, which in these patients was the cause of seeking treatment was considered. As such, diagnoses of degenerative discopathy, lumbar disc herniation, spinal canal stenosis, degenerative spondylolisthesis, and facet arthropathy were considered. These data were cross-referenced to correlate the pattern of the curve with the type of lumbar degeneration.

Patients between the ages of 18 and 75 with a diagnosis of degenerative lumbar spine disease who had radiographic and magnetic resonance examinations and complete medical records were included. Patients with prior spine surgery, pediatric spinal deformity, a history of infection or active infection, oncologic diseases or spinal fracture were excluded from the study. In order to divide the groups by the types of lordosis according to the classification of Roussouly et al.,[7] four types of lordosis were defined below and shown in Figure 1. In type 1 the inflection point (the point where there is a change in the orientation of the vertebral bodies) is L3/L4, sacral inclination is less than 35º, the pelvic incidence is small, and long kyphotic and short lordotic curves are present in an 80:20 ratio of the length of the thoracolumbar spine. In type 2, which has more vertebral bodies, the inflection point is above level L1/L2, sacral inclination is less than 35º, pelvic incidence is small, short kyphotic and long lordotic curves are present. They are in a proportion of 60:40 of the total length of the thoracolumbar spine. In type 3, the inflection point is in T12/L4, the sacral inclination is between 35º and 45º, pelvic incidence is high, and the kyphotic and lordotic curves are almost equal in a ratio of 50:50 of the total length of the thoracolumbar spine, and the spine is balanced. In type 4, the inflection point is in T9/T10, the sacral inclination is greater than 45º, pelvic incidence is high, and the lordotic curve is longer than the kyphotic curve in an inverse ratio of 20:80 of the total length of the thoracolumbar spine.

Magnetic resonances of the lumbar spine were used to define the patients' diagnoses. Patients were classified as having disc herniation/degenerative discopathy, spondylolisthesis, spinal canal stenosis, or facet arthrosis. The disc degeneration diagnosis was considered in patients with any degree of degenerative disc changes in the magnetic resonance, without other major changes, complaining of axial pain, especially with trunk flexion. Disc herniation was considered in patients who presented this condition in the magnetic resonance examination, with lumbosciatalgia, paresthesia and/or the loss of strength in the lower limbs. Spinal canal stenosis was considered when viewed in the examination and presenting with neurological claudication. Degenerative spondylolisthesis was considered in patients with vertebral slippage of any degree in the examination, with possible symptoms of axial or root pain. Facet arthropathy was considered in those patients with joint changes without any other findings in the magnetic resonance and with complaints of axial pain.

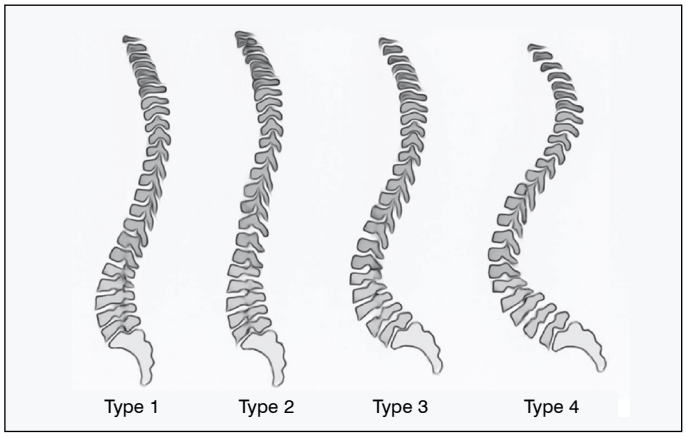

Figure 1. Types of lumbar lordosis, according to Roussouly.

Two observers conducted the analysis of the radiographic and magnetic resonance images of the patients included in the study to define the diagnosis and classify the type of lordosis. A reliability analysis was conducted between the observers resulting in concordance greater than 90%, which was considered acceptable.

General data, such as age, sex, and treatment received were collected from the medical records and analyzed.

For the statistical data analysis, the quantitative variables were described as mean, standard deviation, minimum and maximum values and the qualitative variables as absolute and relative frequencies.

Comparisons between the Roussouly classifications[7] by sex, diagnosis, and type of treatment were verified via the chi-squared test[8] and multinomial logistic regression.[9]

The analyses were conducted using the Statistical Package for the Social Sciences – SPSS, v26.0[10] software (IBM – Armonk – New York – USA) and the level of significance considered was 5%.

RESULTS

The sample consisted of 418 patients with radiographs and magnetic resonance images of the lumbar spine, 203 of whom were women and 215 of whom were men, the equivalent of 48.6% and 51.4%, respectively.

As regards the Roussouly classification[7], 47 (11.2%) patients were classified as type 1 lordosis, 159 (38%) as type 2, 168 (40.2%) as type 3, and 44 (10.5%) as type 4.

The type of treatment performed was proportional, with 50% (209) of the sample undergoing surgical treatment and 50% (209) conservative treatment. Diagnoses of the type of degenerative lumbar spine disease were distributed as follows: 23 (5.5%) patients with facet arthrosis, 92 (22.7%) with degenerative discopathy, 31 (7.4%) with spondylolisthesis, 41 (9.8%) patients with spinal canal stenosis, 219 (52.4%) disc herniation, and 9 (2.2%) patients with no changes in the imaging examinations. Patient characteristics are shown in Table 1.

One of the study objectives was to check possible associations between the type of lordosis, according to the Roussouly classification,[7] and the sex of the patients, the diagnosis, and the type of treatment performed.

We found no evidence of significant association with sex (p value = 0.632). As for the type of treatment performed, patients with type 1 and type 2 lordosis had a higher predominance of surgical treatment (63.8% vs. 36.2%) and type 3 and type 4 lordosis had a higher predominance of conservative treatment (59.1% vs. 40.9%), as observed in Figure 2, representing a significant difference (p value = 0.008). For the purpose of comparison, we grouped diagnoses of degenerative discopathy and disc herniation together, since they are both considered intervertebral disc diseases, and we disregarded the nine cases of patients with normal examinations. Additionally, due to the low contingency table frequencies, we opted for the likelihood ratio test obtained through the multinomial regression model. However, we found no evidence of significant associations (p value = 0.246). The results are shown in Table 2.

We also compared each of the diagnoses with the Roussouly classifications[7] individually. The comparisons were verified using the chi-squared test and we used the Benjamini-Hochberg correction to control type 1 errors, but none of the comparisons were significant (p value > 0.05). The results are presented in Table 3.

Finally, we compared the patients' type of treatment and diagnosis and found evidence of significant association (p value < 0.001). For patients with facet arthrosis and degenerative discopathy, conservative treatment was the most prevalent at 73.9% and 94.7%, respectively. In patients diagnosed with spondylolisthesis, canal stenosis, and disc herniations, surgical treatment was more prevalent, at 64.5%, 58.5%, and 70.3%, respectively. The results are presented in Table 4.

DISCUSSION

Around 50-70% of the population will experience low back pain symptoms for various reasons at least once in their life.[11]

One of the factors that leads to low back pain is degenerative changes that are more common with the increasing life expectancy of the population. In 2005, Roussouly et al.[7] proposed a system to classify types of lumbar lordosis and demonstrated that most asymptomatic individuals were classified as type 3, as was observed in symptomatic individuals in our study. They hypothesized that different types of lordosis could be related to certain pathologies, for example, that patients with type 1 and 2 were liable to present disc herniation. In the present study, no statistically significant result was obtained to confirm this hypothesis.

In 2017, Roussouly[12] conducted a new study of the types of lumbar lordosis, but for patients with degenerative changes, in addition to the 4 already established types, he included type 3 anteverted and type 4 anteverted, which present the same characteristics as the original

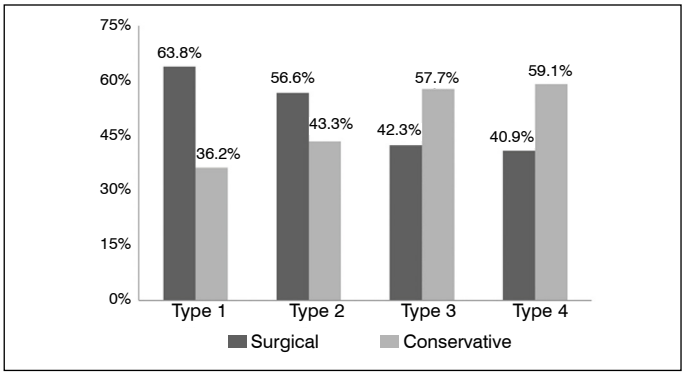

Figure 2. Types of Treatment x Roussouly Classification.

Table 1. Characterization of the sample.

Characteristics of the sample (n = 418)		n	%
Sex			
	Female	203	48.60%
	Male	215	51.40%
Roussouly Classification			
	Type 1	47	11.20%
	Type 2	159	38.00%
	Type 3	168	40.20%
	Type 4	44	10.50%
Diagnosis			
	Facet arthrosis	23	5.50%
	Degenerative discopathy	95	22.70%
	Spondylolisthesis	31	7.40%
	Canal stenosis	41	9.80%
	Disc herniation	219	52.40%
	Normal	9	2.20%
Type of treatment performed			
	Surgical	209	50.00%
	Conservative	209	50.00%

IQR = Interquartile Range

Table 2. Comparisons by Roussouly classification

Factors	Roussouly Classification				p value
	Type 1	Type 2	Type 3	Type 4	
Type of treatment (n=418)					0.008[a]
Surgical	30 (63.8%)	90 (56.6%)	71 (42.3%)	18 (40.9%)	
Conservative	17 (36.2%)	69 (43.4%)	97 (57.7%)	26 (59.1%)	
Sex (n=418)					0.632[a]
Female	19 (40.4%)	77 (48.4%)	86 (51.2%)	21 (47.7%)	
Male	28 (59.6%)	82 (51.6%)	82 (48.8%)	23 (52.3%)	
Diagnosis (n=409)					0.246[b]
Facet arthrosis	2 (4.3%)	11 (7%)	7 (4.3%)	3 (7.3%)	
Degenerative discopathy/ disc herniation	35 (74.5%)	120 (75.9%)	131 (80.4%)	28 (68.3%)	
Spondylolisthesis	3 (6.4%)	9 (5.7%)	11 (6.7%)	8 (19.5%)	
Canal stenosis	7 (14.9%)	18 (11.4%)	14 (8.6%)	2 (4.9%)	

[a] Chi-squared test; [b] Likelihood ratio test.

Table 3. Comparison of diagnoses by Roussouly classification

Diagnosis	Roussouly Type 1		Roussouly Type 2		Roussouly Type 3		Roussouly Type 4	
	No	Yes	No	Yes	No	Yes	No	Yes
Facet arthrosis								
Other diagnosis	380 (87.8%)	53 (12.2%)	276 (63.7%)	157 (36.3%)	254 (58.7%)	179 (41.3%)	389 (89.8%)	44 (10.2%)
Yes	35 (85.4%)	6 (14.6%)	26 (63.4%)	15 (36.6%)	29 (70.7%)	12 (29.3%)	33 (80.5%)	8 (19.5%)
P value	0.657		0.967		0.132		0.067	
Adjusted p value	0.846		0.988		0.66		0.66	
Degenerative discopathy								
Other diagnosis	330 (87.1%)	49 (12.9%)	240 (63.3%)	139 (36.7%)	233 (61.5%)	146 (38.5%)	334 (88.1%)	45 (11.9%)
Yes	85 (89.5%)	10 (10.5%)	62 (65.3%)	33 (34.7%)	50 (52.6%)	45 (47.4%)	88 (92.6%)	7 (7.4%)
P value	0.526		0.725		0.116		0.209	
Adjusted p value	0.846		0.846		0.66		0.789	
Spondylolisthesis								
Other diagnosis	379 (87.7%)	53 (12.3%)	272 (63%)	160 (37%)	257 (59.5%)	175 (40.5%)	388 (89.8%)	44 (10.2%)
Yes	36 (85.7%)	6 (14.3%)	30 (71.4%)	12 (28.6%)	26 (61.9%)	16 (38.1%)	34 (81%)	8 (19%)
P value	0.705		0.276		0.761		0.079	
Adjusted p value	0.846		0.789		0.846		0.66	
Canal stenosis								
Other diagnosis	369 (88.1%)	50 (11.9%)	268 (64%)	151 (36%)	247 (58.9%)	172 (41.1%)	373 (89%)	46 (11%)
Yes	46 (83.6%)	9 (16.4%)	34 (61.8%)	21 (38.2%)	36 (65.5%)	19 (34.5%)	49 (89.1%)	6 (10.9%)
P value	0.349		0.756		0.355		0.988	
Adjusted p value	0.789		0.846		0.789		0.988	
Disc herniation								
Other diagnosis	202 (86.7%)	31 (13.3%)	152 (65.2%)	81 (34.8%)	141 (60.5%)	92 (39.5%)	204 (87.6%)	29 (12.4%)
Yes	213 (88.4%)	28 (11.6%)	150 (62.2%)	91 (37.8%)	142 (58.9%)	99 (41.1%)	218 (90.5%)	23 (9.5%)
P value	0.578		0.498		0.724		0.312	
Adjusted p value	0.846		0.846		0.846		0.789	

Table 4. Type of treatment by diagnosis.

Diagnosis (n = 418)	Type of Treatment		p value
	Surgical	Conservative	
Facet arthrosis	6 (26.1%)	17 (73.9%)	< 0.001[a]
Degenerative discopathy	5 (5.3%)	90 (94.7%)	
Spondylolisthesis	20 (64.5%)	11 (35.5%)	
Canal stenosis	24 (58.5%)	17 (41.5%)	
Disc herniation	154 (70.3%)	65 (29.7%)	
Normal	0 (0%)	9 (100%)	

[a] Chi-squared test

types, but with pelvic inclination < 5 degrees; types 1, 2, 3, and 4 retroverted, which present the same characteristics as the originals but with pelvic inclination > 25 degrees; and lumbar and overall kyphosis. This new classification was not used in the present study since the main objective was to use the classic Roussouly classification.[7]

In absolute numbers, we observed a higher incidence of individuals with intervertebral disc disease in all classifications.

Some studies, like that of Mardare et al.,[13] demonstrated that there is a relationship between sagittal balance and the different pathologies, as in patients with low sacral inclination and increased pelvic incidence and inclination values who tend towards greater disc degeneration. These patients normally have reduced lumbar lordosis leading to flat back syndrome, which we can assume causes increased pressure on the anterior spine, i.e., on the intervertebral discs, for their entire life, leading to a mechanism of constant overload and early degeneration.

Regarding the type of treatment in these individuals, we confirmed a statistically significant result in which individuals classified as type 1 and type 2 had a propensity for surgical treatment and type 3 and type 4 for conservative treatment. A comparison of types of treatment and diagnoses yielded statistical significance. Most patients with canal stenosis, spondylolisthesis, and disc herniation underwent surgical treatment, while most patients with facet arthrosis and degenerative discopathy received conservative treatment, in agreement with Lindsey T,[14] who in 2020 demonstrated that conservative treatment of facet arthrosis and degenerative discopathy should be the initial treatment for patients with low back pain.

The retrospective design of the study itself is one of its limitations. There are others, such as the distribution of the patients into groups where there was a much higher number of individuals with disc herniation than those with other diagnoses. Also, patients were included in the study who had previously been indicated for surgery at another institution, creating a much higher possibility of a real surgical outcome.

Understanding the etiology of lumbar spine degeneration and diseases is of utmost importance in today's world, as these diagnoses contribute to high healthcare costs and a decrease in the productivity of the population. Given the study limitations presented, it was not possible to confirm a relationship between patient diagnosis and lumbar lordosis type. A study with a greater number of individuals is essential such that, if there were a statistically significant difference in the relationship between the diagnosis and the lumbar curvature, specific preventative methods could be established for each type of population to prevent spine diseases.

CONCLUSIONS

We can conclude that the patients classified as Roussouly type 1 and type 2 underwent surgical treatment in higher numbers than type 3 and type 4 patients. We did not observe any statistical correlation between the type of lumbar lordosis and the type of diagnosis presented.

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

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