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SURGEON PREFERENCE AS A KEY FACTOR IN DECISION MAKING IN DEGENERATIVE SPONDYLOLISTHESIS

A PREFERÊNCIA DO CIRURGIÃO COMO FATOR-CHAVE NA TOMADA DE DECISÃO NA ESPONDILOLISTESE DEGENERATIVA

LA PREFERENCIA DEL CIRUJANO COMO FACTOR CLAVE EN LA TOMA DE DECISIONES EN LA ESPONDILOLISTESIS DEGENERATIVA

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ABSTRACT

Objective: This study aims to evaluate the treatment preferences among spine surgeons in Latin America in the management of degenerative spondylolisthesis. Methodology: A questionnaire with 30 clinical cases of patients with degenerative spondylolisthesis, containing images, radiological measurements, and patient data, was sent to 33 spine surgeons in Latin America with fellowship training. The surgeons chose between conservative treatment, isolated decompression, or decompression with fusion. Cluster analyses identified decision-making profiles among the surgeons, and the Kappa coefficient measured the degree of interobserver agreement at the 5% and 1% levels. Results: Four clusters were revealed: A (15.2% – clear preference for fusion), B (39.4% – tendency towards fusion), C (39.4% – tendency towards decompression), and D (6.1% – clear preference for decompression). In a comparison of 528 pairs of assessments, 43% showed significant agreement at the 5% level and 28.2% at the 1% level. Conclusion: The facet angulation, as well as the extent of surgical decompression, were the only relevant factors for decision-making. Individual preference was the strongest factor in decision-making, as revealed by cluster analysis. There is a tendency towards performing fusion rather than decompression among spine surgeons in Latin America, influenced by group polarization and personal bias, more than by the radiological characteristics of each case. ***Level of evidence III; Retrospective study.***

Keywords: Conservative Treatment; Decision Making; Decompression; Observer Variation; Spondylolisthesis; General Surgery.

RESUMO

Objetivo: Este estudo tem como objetivo avaliar as preferências de tratamento entre cirurgiões de coluna da América Latina no manejo da espondilolistese degenerativa. Metodologia: Um questionário com 30 casos clínicos de pacientes com espondilolistese degenerativa, contendo imagens, medições radiológicas e dados dos pacientes, foi enviado para 33 cirurgiões de coluna da América Latina com treinamento em fellowship. Os cirurgiões escolheram entre tratamento conservador, descompressão isolada ou descompressão com fusão. Análises de cluster identificaram perfis de tomada de decisão entre os cirurgiões, e o coeficiente Kappa mediu o grau de concordância interobservador nos níveis de 5% e 1%. Resultados: Foram revelados quatro clusters: A (15,2% – clara preferência por fusão), B (39,4% – tendência à fusão), C (39,4% – tendência à descompressão) e D (6,1% – clara preferência por descompressão). Na comparação de 528 pares de avaliações, 43% apresentaram concordância significativa ao nível de 5% e 28,2% ao nível de 1%. Conclusão: O ângulo das facetas, assim como a extensão da descompressão cirúrgica, foram os únicos fatores relevantes para a tomada de decisão. A preferência individual foi o fator mais forte na tomada de decisão, conforme revelado pela análise de cluster. Há uma tendência à realização de fusão em vez de descompressão entre os cirurgiões de coluna da América Latina, influenciada pela polarização dos grupos e pela tendência pessoal, mais do que pelas características radiológicas de cada caso. ***Nível de evidência III; Estudo retrospectivo.***

Descritores: *Tratamento Conservador; Tomada de Decisão; Descompressão; Variações Dependentes do Observador; Espondilolistese; Cirurgia Geral.*

RESUMEN

Objetivo: Este estudio tiene como objetivo evaluar las preferencias de tratamiento entre cirujanos de columna en Latinoamérica para el manejo de la espondilolistesis degenerativa. Metodología: Se envió un cuestionario con 30 casos clínicos de pacientes con espondilolistesis degenerativa, que incluía imágenes, mediciones radiológicas y datos del paciente, a 33 cirujanos de columna en Latinoamérica con entrenamiento en fellowship. Los cirujanos eligieron entre tratamiento conservador, descompresión aislada o descompresión con fusión.

Study conducted by the Hospital Universitário Cajuru, Curitiba, PR, Brazil.
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Mediante análisis de conglomerados se identificaron perfiles de toma de decisiones entre los cirujanos, y el coeficiente Kappa midió el grado de concordancia interobservador a los niveles del 5% y del 1%. Resultados: Se identificaron cuatro conglomerados: A (15,2% – clara preferencia por la fusión), B (39,4% – tendencia hacia la fusión), C (39,4% – tendencia hacia la descompresión) y D (6,1% – clara preferencia por la descompresión). En una comparación de 528 pares de evaluaciones, el 43% mostró una concordancia significativa al nivel del 5% y el 28,2% al nivel del 1%. Conclusión: El ángulo facetario, así como la extensión de la descompresión quirúrgica, fueron los únicos factores relevantes para la toma de decisiones. La preferencia individual fue el factor más determinante, según reveló el análisis de conglomerados. Existe una tendencia a realizar fusión en lugar de descompresión entre los cirujanos de columna en Latinoamérica, influenciada por la polarización grupal y el sesgo personal, más que por las características radiológicas de cada caso. ***Nivel de evidencia III; Estudio retrospectivo.***

Descriptores: *Tratamiento conservador; Toma de decisiones; Descompresión; Variaciones Dependientes del Observador; Espondilolistesis; Cirugía General.*

INTRODUCTION

Degenerative spondylolisthesis (DS) is a common condition in aging populations that predominantly affects individuals over 50 years old, with a female-to-male ratio of 6:1[1], and L4/L5 being the most affected level[1–4]. Natural progression of DS typically begins with disc degeneration, leading to increased segmental motion[5]. This eventually results in facet joint arthrosis and ligamentum flavum hypertrophy, with further narrowing of the spinal canal. These changes can cause mechanical low back pain and neurologic symptoms[3,6]. Initial evaluation includes physical examination and imaging studies such as MRI and standing/dynamic x-rays[7].

Surgical management of DS remains a controversial subject. Although some studies presented similar results comparing fusion and decompression[8,9], others have emphasized the need for a better definition of subgroups based on several radiographic characteristics, such as sagittal parameters, facet joint angulation, anterior displacement, and degree of disc degeneration[10]. The decision regarding fusion type and approach is even more controversial, ranging from posterolateral fixation to circumferential fusion, with no clear consensus in the literature[11–13].

This study aims to understand the treatment preferences of spine surgeons in Latin America for managing degenerative spondylolisthesis and to identify agreement among specialists regarding optimal treatment strategies. Understanding these preferences could help guide future treatment protocols and clarify decision-making regarding a condition that currently lacks definitive consensus.

METHODOLOGY

Thirty cases of patients with DS who underwent surgery in our department were selected from a prospective database on degenerative spine conditions and organized in a presentation which contained the patient's clinical and radiographic data. All patients had neurogenic claudication as the chief complaint and less relevant back pain (Oswestry disability scale <50%). All of them have undergone at least six months of conservative treatment. The institution's Ethics Committee (386159/2013) approved data use.

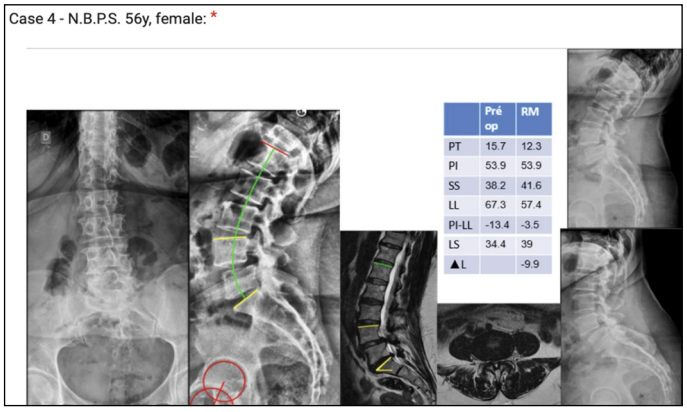
The sample size of 30 cases relies on the fact that one condition is being treated, and two main variables are questioned (surgery with decompression, or surgery with decompression and fusion), following previous strategies for consensus on surgical treatment of spinal pathologies[14,15].

Clinical and Radiographic Data

Each case provided the patient's age, sex, standing, and dynamic X-rays as well as key images from their magnetic resonance. Patient's radiological measurements were taken using Surgimap® version 2.3.2.1,84 Nemaris, Inc. (Methuen, Massachusetts, USA), including pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), lumbar lordosis (LL), mismatch, segmental lordosis, and delta lordosis (*difference between orthostatic x-ray and supine MRI*)[16]. Radiographic features that could influence surgeons' decisions, such as disc height (Pfirmann), presence of symptomatic disc herniation, facet angle (<30° or >30°), vertebral segment mobility, osteophyte, laterolisthesis, scoliosis, uni or bilateral decompression, and sagittal alignment, were considered in our analysis[17].

Survey Design

Based on these cases, a survey was created using Google Forms and sent via email to 33 fellowship-trained spine surgeons from Latin America, selected by convenience sampling. Participants were asked to identify themselves by name and email. Surgeons were asked to choose between maintaining conservative treatment, isolated decompression, or decompression associated with fusion. An alternative "other option" was also available for participants who did not agree with the options provided. Each participant could complete the questionnaire only once. The questionnaire remained open for answers from May 5th to May 29th. Figure 1 shows a complete example of the information received by the participants. The questionnaire underwent one pilot test within the AOSpine Degenerative Study Group. Ten responses were obtained, leading to technical adjustments in the instrument and the questionnaire was approved for final application.



Pelvic Tilt (PT); Pelvic Incidence (PI); Sacral Slope (SS); Lumbar Lordosis (LL); Mismatch (PI-LL); Segmental lordosis (LS); Delta Lordosis (ΔL).

Figure 1. Dynamic and static radiographies as well as MRI images. Data acquired with measures from Surgimap was exposed to the surgeons.

Statistical Analysis

A hierarchical cluster analysis using the Ward method and squared Euclidean distance was applied to identify decision-making profiles among the surgeons. Cluster analysis allows for the identification of similar group patterns with particularities between themselves, starting from the distribution of the three treatments of our sample.

The minimum sample size, at a 95% confidence interval, was calculated as 28 participants.

The overall agreement among the specialists was assessed using the Kappa concordance coefficient. In this study, 33 evaluations resulted in 528 interobserver pairs of comparisons, which were classified according to Landis and Koch[18] in: ≤ 0.19 (poor agreement); ≥ 0.20 and ≤0.39 (weak agreement); ≥ 0.40 and ≤0.59 (moderate agreement); ≥ 0.60 and ≤0.79 (good agreement); ≥0.80 (excellent agreement). It is known that the closer the Kappa is to one, the stronger the agreement between the observers. The significance level was set at 5%, and all statistical analyses were performed using SPSS software version 26[19].

RESULTS

Surgeon Preference - Clusters

Regardless of the case's characteristics, our analysis revealed four clusters (A, B, C, and D) with high grouping quality and significant variation in treatment preferences, as shown in the dendrogram using Ward's combination in Figure 2. Cluster's surgical preferences were formed as follows (Table 1):

- Pattern A: 15.2% (n=5) of the participants showed a high tendency for fusion as a treatment choice, and a low tendency for decompression and conservative treatment.
- Pattern B: 39.4% (n=13) of the participants also showed a high tendency for fusion over decompression, but a mild tendency for decompression and a low tendency for conservative treatment.
- Pattern C: 39.4% (=13) of the participants showed a high tendency for decompression with a mild preference for fusion and a low trend for conservative treatment.
- Pattern D: 6.1% (n=2) of the participants showed a high tendency for decompression, with a mild tendency for conservative treatment, and a low trend for fusion.

Interobserver agreement

An analysis of 528 pairs of comparisons revealed low agreement levels, highlighting significant variability in surgical decision-making among raters. Of those 528 pairs, 43.5% (n=229) reached statistical significance at the 5% level. Within this group, a good agreement rate was observed in only 3.1% (n=7).

Only 28.2% (n=149) of the pairs reached 1% of statistical significance between evaluators. Within this group, interobserver agreement was considered good in just 4.7% (n = 7) of the pairs, revealing that the concordance among surgeons remained low. At 5% and 1% significance, results did not identify any levels of excellent agreement (Table 2).

Influence of Radiographic Variables

When examining the case's characteristics, 33 evaluators identified 11 radiographic variants, resulting in 363 comparisons. For clarity, we have chosen a sample of spine surgeons who represented the decision within the observed clusters (A, B, C or D). It was necessary to have one evaluator as a sample for pattern A (evaluator 8), two evaluators as a sample for pattern B (evaluators 6 and 28), three evaluators as a sample for pattern C (evaluators 11, 12, and 14), and one evaluator as a sample for pattern D (evaluator 2). Tables 3.1 to 3.7 (supplementary file) shows the frequency and percentage of radiographic variables following the treatment proposed by the aforementioned surgeons and the descriptive corresponding level.

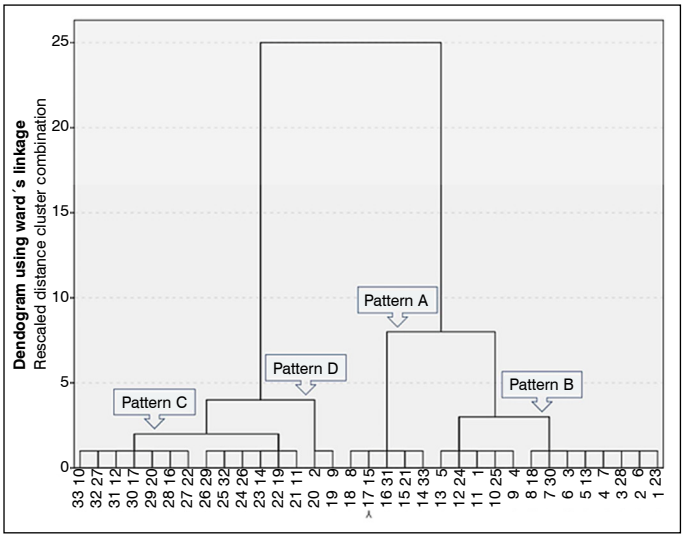


Figure 1. Dendrogram identifying patterns regarding surgeons' preference.

Table 2. Interobserver agreement rate.

Agreement	All		*p value* ≤ 5%		*p value* ≤ 1%	
	n	%	n	%	n	%
Poor	278	52.7	20	8.7	3	2.0
Weak	176	33.3	135	59.0	72	48.3
Moderate	67	12.7	67	29.2	67	45.0
Good	7	1.3	7	3.1	7	4.7
Very good	0	0	0	0	0	0
Total	528	100	229	43.5	149	28.2

Poor agreement: Kappa ≤ 0.19. weak: 0.20 ≤ Kappa ≤ 0.39. moderate: 0.40 ≤ Kappa ≤ 0.59; good: 0.60 ≤ Kappa ≤ 0.79. and very good: Kappa ≥ 0.80.

Table 3.1. Cluster A, evaluator 8.

Variable	Evaluator 8						p value
	Conservative		Decompression		Fusion		
	n	%	n	%	n	%	
Pfirmann							
3/4	3	75.0	0	0.0	23	88.5	0.45
5	1	25.0	0	0.0	3	11.5	
Pfirmann							
3	0	0.0	0	0.0	11	42.3	0.27
4/5	4	100.0	0	0.0	15	57.7	
Disc herniation							
Yes	1	25.0	0	0.0	8	30.8	0.99
No	3	75.0	0	0.0	18	69.2	
Facet Angulation							
< 30°	3	75.0	0	0.0	4	15.4	0.030
> 30°	1	25.0	0	0.0	22	84.6	
Mobility							
<5mm	1	25.0	0	0.0	2	7.7	0.36
>5mm	3	75.0	0	0.0	24	92.3	
Osteophyte							
Yes	1	25.0	0	0.0	12	46.2	0.61
No	3	75.0	0	0.0	14	53.8	
Laterolisthesis							
Yes	1	25.0	0	0.0	1	3.8	0.25
No	3	75.0	0	0.0	25	96.2	
Scoliosis							
Yes	1	25.0	0	0.0	2	7.7	0.36
No	3	75.0	0	0.0	24	92.3	
Decompression							
Uni+bilateral	2	50.0	0	0.0	18	69.2	0.58
No decompression	2	50.0	0	0.0	8	30.8	
Decompression							
Bilateral	2	50.0	0	0.0	15	57.7	0.99
Uni or no decompression	2	50.0	0	0.0	11	42.3	
Sagittal alignment							
Unbalanced	4	100.0	0	0.0	19	73.1	0.55
Balanced	0	0.0	0	0.0	7	26.9	

Data were expressed in frequency (n). percentage (%) and compared using Fisher's exact test.

Table 1. Intensity of treatment.

Pattern	Intensity of treatment choice			Interpretation	n	%
	Conservative	Decompression	Arthrodesis			
A	Low	Low	High	Clear preference for fusion	5	15.2
B	Low	Medium	High	Tendency for fusion over decompression	13	39.4
C	Low	High	Medium	Tendency for decompression over fusion	13	39.4
D	Medium	High	Low	Clear preference for decompression	2	6.1

Table 3.2. Cluster B, evaluator 6.

Variable	Evaluator 6						p value
	Conservative		Decompression		Fusion		
	n	%	n	%	n	%	
Pfirmann							
3/4	3	100.0	7	70.0	16	94.1	0.21
5	0	0.0	3	30.0	1	5.9	
Pfirmann							
3	1	33.3	2	20.0	8	47.1	0.42
4/5	2	66.7	8	80.0	9	52.9	
Disc herniation							
Yes	0	0.0	7	70.0	2	11.8	0.004
No	3	100.0	3	30.0	15	88.2	
Facet Angulation							
< 30°	3	100.0	0	0.0	4	23.5	0.003
> 30°	0	0.0	10	100.0	13	76.5	
Mobility							
<5mm	0	0.0	0	0.0	3	17.6	0.48
>5mm	3	100.0	10	100.0	14	82.4	
Osteophyte							
Yes	1	33.3	8	80.0	4	23.5	0.010
No	2	66.7	2	20.0	13	76.5	
Laterolisthesis							
Yes	0	0.0	1	10.0	1	5.9	0.99
No	3	100.0	9	90.0	16	94.1	
Scoliosis							
Yes	0	0.0	1	10.0	2	11.8	0.99
No	3	100.0	9	90.0	15	88.2	
Decompression							
Uni+bilateral	0	0.0	10	100.0	10	58.8	0.002
No decompression	3	100.0	0	0.0	7	41.2	
Decompression							
Bilateral	0	0.0	8	80.0	9	52.9	0.043
Uni or no decompression	3	100.0	2	20.0	8	47.1	
Sagittal alignment							
Unbalanced	3	100.0	6	60.0	14	82.4	0.35
Balanced	0	0.0	4	40.0	3	17.6	

Data were expressed in frequency (n). percentage (%) and compared using Fisher's exact test.

Table 3.3. Cluster B, evaluator 28.

Variable	Evaluator 28						p value
	Conservative		Decompression		Fusion		
	n	%	n	%	n	%	
Pfirmann							
3/4	2	100.0	9	100.0	15	78.9	0.46
5	0	0.0	0	0.0	4	21.1	
Pfirmann							
3	2	100.0	4	44.4	5	26.3	0.11
4/5	0	0.0	5	55.6	14	73.7	
Disc herniation							
Yes	0	0.0	4	44.4	5	26.3	0.44
No	2	100.0	5	55.6	14	73.7	
Facet Angulation							
< 30°	2	100.0	0	0.0	5	26.3	0.010
> 30°	0	0.0	9	100.0	14	73.7	
Mobility							
<5mm	0	0.0	0	0.0	3	15.8	0.62
>5mm	2	100.0	9	100.0	16	84.2	
Osteophyte							
Yes	0	0.0	6	66.7	7	36.8	0.16
No	2	100.0	3	33.3	12	63.2	
Laterolisthesis							
Yes	0	0.0	0	0.0	2	10.5	0.99
No	2	100.0	9	100.0	17	89.5	
Scoliosis							
Yes	0	0.0	0	0.0	3	15.8	0.62
No	2	100.0	9	100.0	16	84.2	
Decompression							
Uni+bilateral	0	0.0	9	100.0	11	57.9	0.004
No decompression	2	100.0	0	0.0	8	42.1	
Decompression							
Bilateral	0	0.0	7	77.8	10	52.6	0.10
Uni or no decompression	2	100.0	2	22.2	9	47.4	
Sagittal alignment							
Unbalanced	2	100.0	4	44.4	17	89.5	0.027
Balanced	0	0.0	5	55.6	2	10.5	

Data were expressed in frequency (n). percentage (%) and compared using Fisher's exact test.

For pattern A - Clear Preference for Fusion

The facet angle showed a significant association with the chosen treatment, indicating that a facet angle above 30° favors fusion ($p < 0.05$). No significant associations were found between other radiographic variables in this cluster.

Pattern B - Tendency for Fusion Over Decompression

The presence of disc herniation, osteophytes, and the need for unilateral or bilateral decompression were associated with a preference for decompression surgery without fusion ($p < 0.05$). Cases with sagittal imbalance showed a tendency towards fusion ($p < 0.05$).

Pattern C - Tendency for decompression over fusion

Pfirmann grade 3 and facet angle under 30° favored conservative treatment ($p < 0.01$). The presence of osteophytes, unilateral or bilateral decompression, and disc herniation were variables associated with decompression without fusion ($p < 0.05$). The need for bilateral decompression was associated with the choice of fusion ($p < 0.05$).

For pattern D - Clear preference for decompression

Facet angle under 30° was associated with a preference for conservative treatment ($p < 0.05$). Unilateral or bilateral decompression tended towards decompression and fusion ($p < 0.05$). There was a tendency for surgeons to prefer fusion in cases involving bilateral decompression when compared with cases without the need for decompression ($p < 0.05$).

Overall, at a 5% of significance level, when looking at the radiological variables across the four clusters, facet angle under 30°, disc herniation, Pfirmann grade 3, the presence of osteophytes, and

Table 3.4. Cluster C, evaluator 11.

Variable	Evaluator 11						p value
	Conservative		Decompression		Fusion		
	n	%	n	%	n	%	
Pfirmann							
3/4	7	100.0	10	83.3	9	81.8	0.65
5	0	0.0	2	16.7	2	18.2	
Pfirmann							
3	6	85.7	2	16.7	3	27.3	0.008
4/5	1	14.3	10	83.3	8	72.7	
Disc herniation							
Yes	1	14.3	5	41.7	3	27.3	0.54
No	6	85.7	7	58.3	8	72.7	
Facet Angulation							
< 30°	4	57.1	1	8.3	2	18.2	61,000
> 30°	3	42.9	11	91.7	9	81.8	
Mobility							
<5mm	1	14.3	0	0.0	2	18.2	0.32
>5mm	6	85.7	12	100.0	9	81.8	
Osteophyte							
Yes	2	28.6	9	75.0	2	18.2	0.019
No	5	71.4	3	25.0	9	81.8	
Laterolisthesis							
Yes	0	0.0	0	0.0	2	18.2	0.17
No	7	100.0	12	100.0	9	81.8	
Scoliosis							
Yes	0	0.0	1	8.3	2	18.2	0.59
No	7	100.0	11	91.7	9	81.8	
Decompression							
Uni+bilateral	2	28.6	11	91.7	7	63.6	0.018
No decompression	5	71.4	1	8.3	4	36.4	
Decompression							
Bilateral	2	28.6	9	75.0	6	54.5	0.15
Uni or no decompression	5	71.4	3	25.0	5	45.5	
Sagittal alignment							
Unbalanced	6	85.7	8	66.7	9	81.8	0.64
Balanced	1	14.3	4	33.3	2	18.2	

Data were expressed in frequency (n). percentage (%) and compared using Fisher's exact test.

Table 3.5. Cluster C, evaluator 12.

Variable	Evaluator 12						p value
	Conservative		Decompression		Fusion		
	n	%	n	%	n	%	
Pfirmann							
3/4	4	100.0	13	81.3	9	90.0	0.99
5	0	0.0	3	18.8	1	10.0	
Pfirmann							
3	2	50.0	4	25.0	5	50.0	0.43
4/5	2	50.0	12	75.0	5	50.0	
Disc herniation							
Yes	0	0.0	8	50.0	1	10.0	0.052
No	4	100.0	8	50.0	9	90.0	
Facet Angulation							
< 30°	4	100.0	1	6.3	2	20.0	0.0007
> 30°	0	0.0	15	93.8	8	80.0	
Mobility							
<5mm	0	0.0	0	0.0	3	30.0	0.069
>5mm	4	100.0	16	100.0	7	70.0	
Osteophyte							
Yes	0	0.0	10	62.5	3	30.0	0.062
No	4	100.0	6	37.5	7	70.0	
Laterolisthesis							
Yes	0	0.0	1	6.3	1	10.0	0.99
No	4	100.0	15	93.8	9	90.0	
Scoliosis							
Yes	0	0.0	2	12.5	1	10.0	0.99
No	4	100.0	14	87.5	9	90.0	
Decompression							
Uni+bilateral	0	0.0	15	93.8	5	50.0	0.0002
No decompression	4	100.0	1	6.3	5	50.0	
Decompression							
Bilateral	0	0.0	12	75.0	5	50.0	0.022
Uni or no decompression	4	100.0	4	25.0	5	50.0	
Sagittal alignment							
Unbalanced	4	100.0	11	68.8	8	80.0	0.60
Balanced	0	0.0	5	31.3	2	20.0	

Data were expressed in frequency (n). percentage (%) and compared using Fisher's exact test.

unilateral decompression were consistently associated with less aggressive approaches, such as decompression without fusion or conservative treatment. Facet angle above 30°, bilateral decompression, along with sagittal imbalance were radiographic variables associated with the choice of fusion. Table 4 demonstrates significant variables, according to each cluster, in their preoperative decision making.

DISCUSSION

Our study showed significant variability in the surgical management of DS among Latin American spine surgeons, emphasizing the influence of individual preference over objective radiological factors. Despite the radiographic information provided and considering that all cases had the same clinical symptom, there was a clear trend for one specific treatment option for the majority of surgeons, regardless of the radiographic variations in each case.

Decision-making processes can be divided into either a conscious or subconscious way. On a conscious level, the most common among new spine surgeons is to gather as much relevant information as possible to establish a diagnosis and determine the most suitable treatment. This may involve obtaining additional imaging tests, reviewing relevant literature, or engaging in other processes that require time and effort to achieve the optimal treatment plan for the patient. Subconscious decision-making is often automatic and driven by pattern recognition of specific diseases. This enables quicker and more definitive resolutions and is commonly seen in experienced spine surgeons[20].

Neither approach is incorrect for diagnosing or treating a patient because both are part of the surgeon's learning curve. Although they belong to the decision-making process, they can impose risks in some circumstances, like treating specific and complex pathologies

Table 3.6. Cluster C, evaluator 14.

Variable	Evaluator 14						p value
	Conservative		Decompression		Fusion		
	n	%	n	%	n	%	
Pfirmann							
3/4	5	100.0	9	75.0	12	92.3	0.36
5	0	0.0	3	25.0	1	7.7	
Pfirmann							
3	2	40.0	4	33.3	5	38.5	0.99
4/5	3	60.0	8	66.7	8	61.5	
Disc herniation							
Yes	0	0.0	7	58.3	2	15.4	0.020
No	5	100.0	5	41.7	11	84.6	
Facet Angulation							
< 30°	4	80.0	1	8.3	2	15.4	0.009
> 30°	1	20.0	11	91.7	11	84.6	
Mobility							
<5mm	0	0.0	1	8.3	2	15.4	0.99
>5mm	5	100.0	11	91.7	11	84.6	
Osteophyte							
Yes	1	20.0	6	50.0	6	46.2	0.56
No	4	80.0	6	50.0	7	53.8	
Laterolisthesis							
Yes	0	0.0	2	16.7	0	0.0	0.46
No	5	100.0	10	83.3	13	100.0	
Scoliosis							
Yes	0	0.0	3	25.0	0	0.0	0.12
No	5	100.0	9	75.0	13	100.0	
Decompression							
Uni+bilateral	1	20.0	12	100.0	7	53.8	0.002
No decompression	4	80.0	0	0.0	6	46.2	
Decompression							
Bilateral	1	20.0	10	83.3	6	46.2	0.036
Uni or no decompression	4	80.0	2	16.7	7	53.8	
Sagittal alignment							
Unbalanced	5	100.0	8	66.7	10	76.9	0.38
Balanced	0	0.0	4	33.3	3	23.1	

Data were expressed in frequency (n). percentage (%) and compared using Fisher's exact test.

Table 3.7. Cluster D, evaluator 2.

Variable	Evaluator 2						p value
	Conservative		Decompression		Fusion		
	n	%	n	%	n	%	
Pfirmann							
3/4	8	88.9	14	87.5	4	80.0	0.99
5	1	11.1	2	12.5	1	20.0	
Pfirmann							
3	4	44.4	6	37.5	1	20.0	0.78
4/5	5	55.6	10	62.5	4	80.0	
Disc herniation							
Yes	1	11.1	5	31.3	3	60.0	0.15
No	8	88.9	11	68.8	2	40.0	
Facet Angulation							
< 30°	5	55.6	1	6.3	1	20.0	0.012
> 30°	4	44.4	15	93.8	4	80.0	
Mobility							
<5mm	2	22.2	0	0.0	1	20.0	0.13
>5mm	7	77.8	16	100.0	4	80.0	
Osteophyte							
Yes	3	33.3	9	56.3	1	20.0	0.37
No	6	66.7	7	43.8	4	80.0	
Laterolisthesis							
Yes	1	11.1	0	0.0	1	20.0	0.21
No	8	88.9	16	100.0	4	80.0	
Scoliosis							
Yes	1	11.1	1	6.3	1	20.0	0.73
No	8	88.9	15	93.8	4	80.0	
Decompression							
Uni+bilateral	2	22.2	13	81.3	5	100.0	0.003
No decompression	7	77.8	3	18.8	0	0.0	
Decompression							
Bilateral	1	11.1	11	68.8	5	100.0	0.001
Uni or no decompression	8	88.9	5	31.3	0	0.0	
Sagittal alignment							
Unbalanced	9	100.0	10	62.5	4	80.0	71,000
Balanced	0	0.0	6	37.5	1	20.0	

Data were expressed in frequency (n). percentage (%) and compared using Fisher's exact test.

such as DS - which has many variables and even experienced surgeons can overlook some important aspects of this disease during their decision-making process. Polarization of groups can provide a valuable framework to understand this behavior. This theory suggests that individuals often align their beliefs and values with those of their professional or educational group, further reinforcing shared practices and decision-making approaches, which can create a vicious cycle[21].

Some radiographic factors were often influential, while others were rarely taken into consideration. Facet angulation is an important radiographic factor that must be taken into consideration during the radiographic evaluation of the patient[22]. A vertical angulation of the facet (>30°) is a risk factor that brings instability to the segment operated, leading to a poor outcome of the surgery in the long-term, raising reoperation rates. Disc height is also relevant because a Pfirmann 3 or 4 disc is related to a higher segmental motion than

Table 4. Significance variables according to Clusters.

Radiographic variant	Cluster A	Cluster B	Cluster C	Cluster D
Facet Angulation	S	S	S	S
Osteophyte	NS	S	S	NS
Disc Herniation	NS	S	S	NS
Pfirmann 3	NS	NS	S	NS
Pfirmann 4/5	NS	NS	NS	NS
Unilateral or bilateral decompression	NS	S	S	S
Absence of decompression or bilateral decompression	NS	NS	S	S
VSM	NS	NS	NS	NS
Laterolisthesis	NS	NS	NS	NS
Scoliosis	NS	NS	NS	NS
Sagittal alignment	NS	S	NS	NS

NS= Not Significant / S= Significant / VSM = Vertebral Segment Mobility.

a Pfirmann 5 disc[23]. Another important step during patient evaluation is a dynamic lumbar X-ray to analyze segment motion.

Vertebral translation and flexion-extension x-rays[24] were not relevant for decision-making in any of the clusters. Blumenthal et al[25] proposed performing a laminectomy without fusion in symptomatic patients with grade I DS. Their findings revealed that segmental motion >1.25mm resulted in 54% of reoperation rate. When the three factors (facet angle, disc height, and translation) were present in the same patient, the reoperation rate reached up to 75% of the cases.

In the present study, surgeons in cluster A, C, and D valued facet angles as a relevant factor, and only surgeons in cluster C valued disc height in their decision-making. This calls for attention to the possible generalization of DS, rather than to identifying subgroups with possible hypermobility or instability, when deciding whether to fuse the segment or simply decompress it.

The presence of osteophytes can reduce motion segment resistance to compression by 17%, and resistance to bending up to 49%[26]. The stability provided by its growth can allow the surgeon to promote a less invasive surgery in an already stable segment. In our cluster analysis, only clusters B and C considered the importance of osteophyte in their pre-operative planning.

Important considerations were observed in the decision-making process. Ranging from more aggressive treatment (cluster A) to less aggressive treatment (cluster D), surgeons tended to take into account at least three to four radiographic factors when they had a tendency for decompression. In contrast, surgeons with a strong preference for fusion considered few, if any, radiographic factors during preoperative planning.

The CARDS classification[12] established important radiographic parameters during DS evaluation, such as disc height, vertebral translation, and kyphosis, along with leg pain as a modifier. They tried to demonstrate that patients with DS should have an individualized treatment, ensuring that they receive what they truly need rather than what the surgeon prefers. The French Society of Spine Surgery proposed a new classification based on radiographic evaluation of spinopelvic parameters and sagittal balance[10]. This also changed the concept of DS as a localized disorder, giving the correct importance of a global overview of the individual's spine and its compensatory mechanisms for maintaining its balance[27].

Recently, Vialle et al developed a scoring system for DS[17]. The variables include facet angulation, presence of osteophytes, disc height, vertebral translation, spinopelvic parameters, presence of scoliosis, sagittal balance, and the need for unilateral or bilateral decompression. Each variable is assigned a score based on its relevance, according to the current literature and classifications. The final score would indicate whether the patient should undergo decompression alone, decompression with fusion, or decompression followed by interbody fusion.

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CONCLUSION

There is an absence of consensus among spine surgeons from Latin America regarding the management of DS. Four Clusters of treatment preference were identified, with a tendency towards fusion over decompression amongst these spine surgeons

CONFLICT OF INTEREST

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

CONTRIBUTIONS OF THE AUTHORS

All authors collaborated on this manuscript, both in the design and conduct of the systematic review, manuscript writing and critical analysis of the content. Each author contributed individually and significantly to the development of this article. VEN: manuscript design, data analysis, critical review and final approval; SMM: design of the work and data acquisition; FVL: data analysis, manuscript writing and critical review; PLFT: data analysis and manuscript writing; FJVN: Data analysis and manuscript writing; POVA: Data analysis, manuscript writing and Critical review.

DATA AVAILABILITY DECLARATION

The data underlying the research text are available.

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