INTER-OBSERVER REPRODUCIBILITY OF THE "LUMBAR FACET HYPERSIGNAL CLASSIFICATION" AND THE CLASSIFICATION OF PFIRRMANN

REPRODUTIBILIDADE INTER OBSERVADORES DA "CLASSIFICAÇÃO DE HIPERSINAL FACETÁRIO LOMBAR" E DA CLASSIFICAÇÃO DE PFIRRMANN

REPRODUCTIVIDAD INTER-OBSERVADORES DE LA "CLASIFICACIÓN DE HIPERSEÑAL FACETARIA LUMBAR" Y DE LA CLASIFICACIÓN DE PFIRRMANN

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ABSTRACT

Objective: To evaluate the inter-observer relationship of the "lumbar facet hypersignal classification" and the correlation with disc degeneration. Methods: Retrospective study of magnetic resonance images obtained from 24 (N=24) patients (9 males and 15 females), aged 35 to 79 years, mean age 48 years and 1 month. The images were reviewed by two spine surgeons, by five orthopedists in training in the specialty of spine surgery and one radiologist to evaluate and quantify the presence of hypersignal lumbar facet and the Pfirrmann Classification for disc degeneration. Results: One hundred and twenty lumbar discs and their joint facets were evaluated by the eight examiners, with data analyzed by the Cronbach test and the Spearman Correlation Analysis with statistically high results, confirming good inter-observer relation for the "Lumbar Facet Hypersignal Classification" and for the classification of Pfirrmann. There was no statistically significant relationship between facet arthrosis and disc degeneration. Conclusions: The results confirm that there is good inter-observer relationship for the classification of Facet Hypersignal and for the Classification of Pfirrmann. However, in spite of a positive relationship, a correlation between facet arthrosis and disc degeneration was not statistically significant. ***Level of Evidence III; Retrospective Comparative Study.***

Keywords: Spine; Synovitis; Intervertebral Disc Degeneration; Join Diseases; Magnetic Resonance Imaging; Low Back Pain.

RESUMO

Objetivo: Avaliar a relação inter observadores da "classificação de hipersinal facetária lombar" e a correlação com a degeneração discal. Métodos: Estudo retrospectivo de imagens de ressonância magnética obtidas de 24 (N= 24) pacientes (nove homens e 15 mulheres) com idade variando de 35 a 79 anos, com média de de 48 anos e um mês. As imagens foram revisadas por dois ortopedistas especialistas em cirurgia de coluna, por cinco ortopedistas em treinamento na especialidade de cirurgia de coluna e um radiologista, para avaliar e quantificar a presença de hipersinal facetário lombar e da Classificação de Pfirrmann para degeneração discal. Resultados: Foram avaliados e classificados 120 discos lombares e suas facetas articulares pelos oito examinadores, com dados analisados pelo Teste de Conbach e da Análise de Correlação de Spearman com resultados estatisticamente elevados, confirmando boa relação inter observadores para a "Classificação de Hipersinal Facetario Lombar" e para a classificação de Pfirrmann. Não foi observada relação estatisticamente significante entre artrose facetária e degeneração fiscal. Conclusão: Os resultados confirmam que existe boa relação inter observadores para a classificação de Hipersinal Facetário e para a Classificação de Pfirrmann. Porém, apesar de relação positiva, não se atingiu de maneira estatisticamente significante, correlação entre artrose facetaria e degeneração discal. ***Nível de Evidência III; Estudo Restrospectivo Comparativo.***

Descritores: *Coluna Vertebral; Sinovite; Degeneração do Disco Intervertebral; Atropatias; Imagem por Ressonância Magnética; Dor Lombar.*

RESUMEN

Objetivo: Evaluar la relación inter-observadores de la "clasificación de hiperseñal facetaria lumbar" y la correlación con la degeneración de disco. Métodos: Estudio retrospectivo de imágenes de resonancia magnética obtenidas de 24 (N = 24) pacientes (9 hombres y 15 mujeres), con edad variando de 35 a 79 años, con promedio de 48 años y 1 mes. Las imágenes fueron revisadas por dos ortopedistas especialistas en cirugía de columna, por cinco ortopedistas en entrenamiento en la especialidad de cirugía de columna y un radiólogo para evaluar y cuantificar la presencia de hiperseñal facetaria lumbar y la Clasificación de Pfirrmann para degeneración de disco. Resultados: Fueron evaluados y clasificados 120 discos lumbares y sus facetas articulares por los ocho examinadores, con datos analizados por el Test de Cronbach y del Análisis de Correlación de Spearman con resultados estadísticamente elevados, confirmando buena relación inter-observadores para la "Clasificación de Hiperseñal Facetaria Lumbar" y para la clasificación de Pfirrmann. No se observó relación estadísticamente significativa entre artrosis facetaria y degeneración de disco. Conclusiones: Los resultados confirman que existe una

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buena relación inter-observadores para la clasificación de Hiperseñal Facetaria y para la Clasificación de Pfirrmann. Sin embargo, a pesar de una relación positiva, la correlación entre la artrosis facetaria y la degeneración de disco no fue estadísticamente significativa. ***Nivel de Evidencia III; Estudio Retrospectivo Comparativo.***

Descriptores: *Columna Vertebral; Sinovitis; Degeneración del Disco Intervertebral; Atropatías; Imagen por Resonancia Magnética; Dolor de la Región Lumbar.*

INTRODUCTION

Today, low back pain has reached epidemic levels, with several studies citing it as one of the main causes of emergency medical care, second only to the common cold.[1,2] The estimated average annual cost in the United States is between $100 and $200 billion dollars.[2]

Facet joint syndrome was first described as one of its causes around 1930.[3,4] Since then, it has been shown that the facet joint has specific innervations and, nevertheless, pain similar to and sometimes indistinguishable from discogenic pain.[3]

The main cause attributed to low back pain would be disc degeneration, whereby the principle current research is attempting to correlate morphological/organic changes with the symptoms. Discogenic pain is present as the result of structural changes in the disc, without the presence of nerve root compression or even changes in disc shape.[5]

Magnetic resonance is the most commonly used examination for disc disorders. The intensity of the signal, particularly in T2, reflects the changes caused by aging or degeneration.[6-8]

Standardization in the comparison of data is paramount for the advancement and correlation of the various investigations of disc disorders, as Pfirrmann et al.[9] have suggested in their classification, with good reproducibility as demonstrated by Ueno and Miller et al.[10]

The facet joint hypersignal, revealed by magnetic resonance as a sign of facet joint arthrosis, was first correlated with chronic low back pain and vertebral disc degeneration by Yang and Yang et al.[11] Later, Longmuir and Conley[12] proposed a classification for the presence of the facet hypersignal and defined this signal as a reactive process of the facet joints.

Given the current evidence, the objective of this study is to analyze whether there is a strong correlation between degenerative disc and facet joint changes, as shown by magnetic resonance, given that both are indicated as important causal agents of low back pain, and to analyze the inter-observer reproducibility of the Pfirrmann classification of lumbar facet joint arthrosis.

METHODS

The lumbar levels between L1 and S1 of 24 patients were analyzed. The study group was comprised of 9 men and 15 women ranging from 35 to 79 years of age with an average age of 48 years and 1 month. T2 weighted magnetic resonance at 1 Tesla was used, with axial and sagittal cuts. The images that were selected and included in this study are part of a database of images obtained from patients in outpatient treatment for degenerative lumbar disease in a study approved by the Institutional Review Board (CAAE: 13842913.5.0000.0082). All patients signed the Informed Consent Form. We used the Longmuir and Conley classification system to grade the degeneration process in the facet joints (Chart 1, Figures 1-4).

Chart 1. Classification of the Facet Hypersignal.

Grade	Definition
o	Normal facet joint
I	Facet joint brilliance responds for less than 50% of the length of the hyaline cartilage in the axial cut
II	Facet joint brilliance responds for more than 50% of the length of the hyaline cartilage in the axial cut
III	Facet joint brilliance responds for the entire length of the hyaline cartilage
IV	Bone erosion

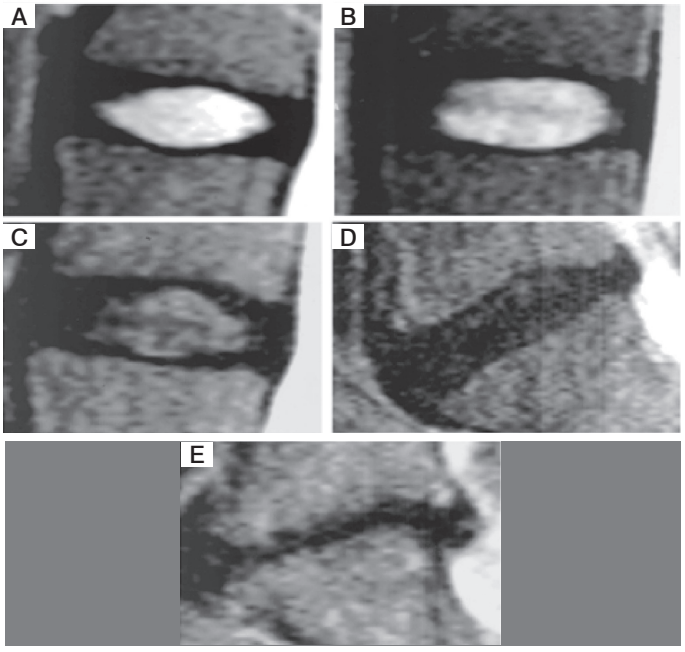

Figure 1. Magnetic Resonance showing disc degeneration according to Pfirrmann. A) Grade I Hyperintense signal, homogeneous disc, height maintained; B) Grade II Hyperintense signal, disc not homogeneous/ horizontal bands; C) Grade III Intermediate signal intensity, loss of the border between nucleus/ annulus, gray disc, height maintained; D) Grade IV Isointense signal, disc not homogeneous, black disc, loss of nucleus/annulus border, loss of height; E) Grade V Hypointense signal, disc not homogeneous, loss of disc/annulus border, collapse of disc height.

Grading of disc degeneration was obtained by means of the Pfirrmann et al. classification system (Chart 2, Figures 1), with each specialist analyzing the images separately from the group. Subsequently, statistical tests were conducted to correlate the two variables and observe to strength of the relationships.

The evaluations were carried out by eight individuals: two spine surgeons, five orthopedists in training for spinal surgery, and one radiologist.

The Statistical Package for Social Science (SPSS) program, version 23, was used for statistical analysis and to obtain the results with a significance level of $p<0.05$.

RESULTS

For the assessment of concordance among observers (Tables 1, 2), the Cronbach's alpha statistical method was used showing that the values are statistically high, from which we can infer, a priori, that the data present internal consistency, i. e., there is concordance among the observers. Therefore, based on what was calculated and exposed, the sample can be considered to have a high degree of reliability, between 0.872 and 0.982, which means that this study is working with an unbiased sample.[13]

Next, we applied Spearman's correlation analysis to determine the degree of correlation between the exposure variables. (Table 2)

We observed that there are three statistically significant relationships between the variables 'Pfirrmann L3-L4' and 'Facet Joints L4-L5', 'Pfirrmann L4-L5' and 'Facet Joints L5-S1', and 'Pfirrmann L5-S1' and 'Facet Joints L5-S1'. For the other pairs of variables, the results showed statistically insignificant relationships. Thus,

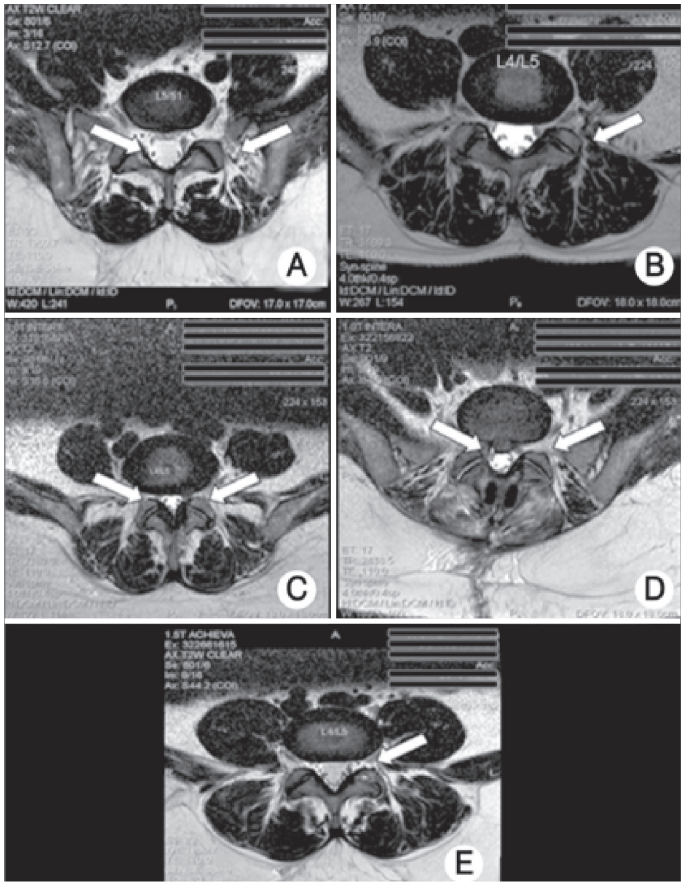

Figure 2. Classification of the facet joint hypersignal. (A): grade 0 (normal facet joint). (B): grade I (facet joint brilliance responds for less than 50% of the facet joint). (C): grade II (facet joint brilliance responds for more than 50% of the facet joint). (D): grade III (facet joint brilliance responds to 100% of the facet joint). (E): grade IV (bone erosion).

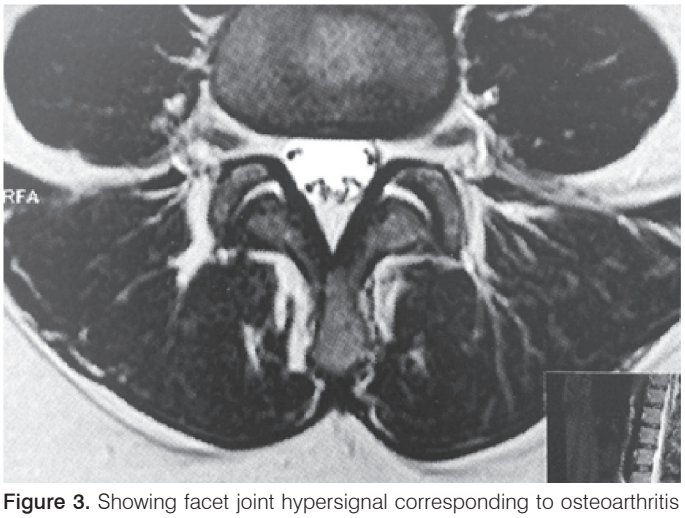

Figure 3. Showing facet joint hypersignal corresponding to osteoarthritis (Grade II).

we can state that the relationships between Pfirrmann and Facet Joints are statistically weak, that is, in general a variable from the Pfirrmann block cannot 'explain' another variable of the Facet Joints block. (Table 3)

DISCUSSION

Facet joint arthrosis is a common finding in radiographs and has long been reported as a source of low back pain.[3,14,15] The facet joint is part of a three-phase complex that corresponds to the segmental motor unit of the spine, directly involved in the development of lumbar stenosis.[16,17] The zygapophyseal joints are the only spinal synovial joints, comprised of hyaline cartilage over the subchondral bone, the synovial membrane, and the joint capsule. Thus, when subjected to excessive movement and increased load,

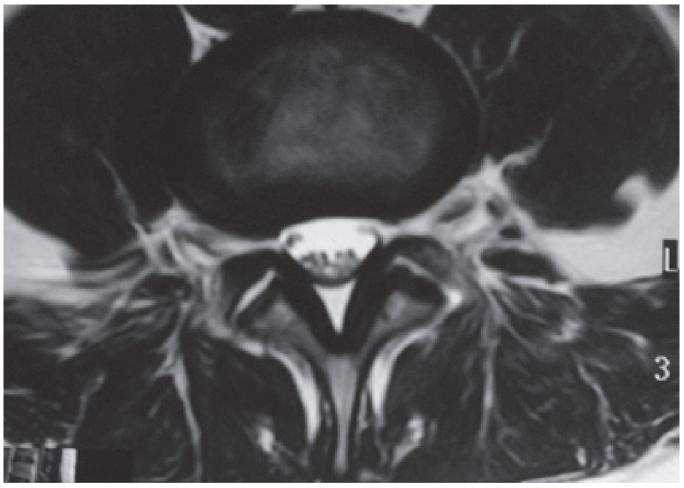

Figure 4. Grade III, facet joint brilliance for the entire extension of the hyaline cartilage

Table 1. Internal Consistency.

Disc degeneration	n	Cronbach's alpha coefficient	Significance (p)
Pfirrmann L1-L2	8	0.934	< 0.001
Pfirrmann L2-L3	14	0.936	< 0.001
Pfirrmann L3-L4	17	0.932	< 0.001
Pfirrmann L4-L5	15	0.960	< 0.001
Pfirrmann L5-S1	13	0.982	< 0.001

Table 2. Internal Consistency faceFAFAArtrose Fa.

Facet joint hypersignal	n	Cronbach's alpha coefficient	Significance (p)
Facet Joints L1-L2	6	0.912	< 0.001
Facet Joints L2-L3	13	0.950	< 0.001
Facet Joints L3-L4	16	0.953	< 0.001
Facet Joints L4-L5	14	0.872	< 0.001
Facet Joints L5-S1	13	0.958	< 0.001

Chart 2. Pfirrmann Disc Degeneration Classification.

Grade	Structure	Nucleus and Annulus Border	Signal Intensity	Disc Height
I	Homogeneous, soft, and brilliant	Distinct	Hyperintense, isointense for cerebrospinal fluid	Normal
II	Not homogeneous, with or without horizontal bands	Distinct	Hyperintense, isointense for cerebrospinal fluid	Normal
III	Not homogeneous, gray	Indistinct	Intermediate	Normal to slightly reduced
IV	Not homogeneous, gray to black	Loss	Intermediate to isointense	Moderately reduced
V	Not homogeneous, black	Loss	Hypointense	Collapsed disc space

Table 3. Correlation Analysis.

Variable	Statistics	[YU] Pfirrmann L1-L2	[YU] Pfirrmann L2-L3	[YU] Pfirrmann L3-L4	[YU] Pfirrmann L4-L5	[YU] Pfirrmann L5-S1
[YU] Facet Joints L1-L2	Correl. Coef. (r)	+0.136	+0.436	-0.149	0.000	-0.455
	Sig. (p)	0.748	0.280	0.725	> 0.999	0.258
	n	8	8	8	8	8
[YU] Facet Joints L2-L3	Correl. Coef. (r)	+0.133	+0.376	+0.430	-0.228	-0.061
	Sig. (p)	0.638	0.167	0.109	0.414	0.828
	n	15	15	15	15	15
[YU] Facet Joints L3-L4	Correl. Coef. (r)	+0.389	+0.339	+0.277	-0.215	-0.297
	Sig. (p)	0.110	0.168	0.266	0.393	0.231
	n	18	18	18	18	18
[YU] Facet Joints L4-L5	Correl. Coef. (r)	+0.250	+0.403	+0.502	0.000	-0.347
	Sig. (p)	0.350	0.122	0.048	> 0.999	0.188
	n	16	16	16	16	16
[YU] Facet Joints L5-S1	Correl. Coef. (r)	-0.495	-0.247	-0.132	-0.649	0.534
	Sig. (p)	0.072	0.394	0.652	0.012	0.049
	n	14	14	14	14	14

degenerative changes tend to develop that potentially cause impairment or disability.[18]

A considerable number of studies point to the intervertebral disc as the zero mark for degenerative spinal changes, among them, facet arthrosis.[18,19] Although some studies show that it may not be an isolated or dominant factor, they definitely mark it as the beginning of the process.[20]

Morphological and cell changes occur as part of the normal aging process[14,19,16] and the changes revealed by resonance are a common finding both in asymptomatic patients and those with low back pain, but there is a strong correlation between low back pain and the presence of disc degeneration.[1,2,5,7,8,19]

A biomechanical study showed that the loss of disc height would increase the pressure on the facet joint at supra-physiological levels.[14] Using an experimental model, Lipson and Muir[21] demonstrated that, following a punctiform disc lesion and posterior degeneration with height loss, the segment evolved with facet joint osteoarthritis.

Classification of facet joint arthrosis, the principal parameter of which is the hypersignal in T2,[11,22] presents good correlation with the pathological changes and good inter-observer concordance.[22] In addition, facet joint degeneration, for example the facet joint syndrome, is an important cause of low back pain[23-25] and the degree of degeneration has been directly and proportionally associated with the degree of pain in some patients.[26] The results of our study showed high Cronbach's alpha coefficients in all the analyses and variables and in relation to the subsequent levels of severity on the scale, showing good concordance among observers and applicability in a general sense, in accordance with the medical literature.

The article by Marcondes and Miller et al., Classification of Facet Joint Hypersignal, also reported results similar to ours, with significance in the inter-observer relationship to the facet joint hypersignal classification, in addition to the non-statistically significant relationship between the facet joint classification and the Pfirrmann classification.[27]

The objective of our study was to correlate the above-mentioned degenerative events using the two classifications existing in the literature, in search of what Pfirrmann et al. suggest in their article, a standardization of the language about the subject, so that we can establish better communications among specialists and in data comparisons[9] towards important advances in treating degenerative changes, which are increasingly prevalent in the aging population.[2,14,19,16]

The Spearman correlation analysis method showed certain significance between disc degeneration at one level and facet joint changes in the subsequent lower lumbar levels, as follows: L3-L4 with L4-L5, L4-L5 with L5-S1, and L5-S1 with L5-S1, respectively. However, from the data we could not infer that the same relationship is valid for all levels.

The association between a cascade of degenerative spinal changes and the presence of low back pain is well described, so the search for a method that can merge the two main marks involved in its genesis, disc degeneration and facet joint arthrosis, is extremely valid.

CONCLUSION

Both classifications demonstrate good inter-observer concordance, showing their easy applicability and objectivity and agreeing with the literature on the subject. However, in the statistical analysis, the direct correlation between facet joint arthrosis and disc degeneration is weak and does not allow us to make any generalizations. Even so, there is a positive trend in the lower lumbar levels.

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

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