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

REPRODUCTIVIDAD INTER- OBSERVADORES DE LA “CLASSIFICACIÓN DE HIPERSEÑAL FACETARIA LUMBAR” Y DE LA CLASIFICACIÓN DE PFIRRMANN

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 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; Joint 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, conferindo boa relação inter observadores para “Clasificación de Hipersinal Facetario Lombar” e para a classificação de Pfirrmann. Não foi observada relação estatisticamente significante entre artrose facetária e degeneração discal. 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.
**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. The estimated average annual cost in the United States is between $100 and $200 billion dollars. Facet joint syndrome was first described as one of its causes around 1930. Since then, it has been shown that the facet joint has specific innervations and, nevertheless, pain similar to and sometimes indistinguishable from discogenic pain. 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. 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.

Standardization in the comparison of data is paramount for the advancement and correlation of the various investigations of disc disorders, as Pfirrmann et al. have suggested in their classification, with good reproducibility as demonstrated by Ueno and Miller. 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. Later, Longmuir and Conley 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 T esla 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).

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.

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, the changes caused by aging or degeneration.

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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,
Degenerative changes tend to develop that potentially cause impairment or disability. A considerable number of studies point to the intervertebral disc as the zero mark for degenerative spinal changes, among them, facet arthrosis. Although some studies show that it may not be an isolated or dominant factor, they definitely mark it as the beginning of the process.

Morphological and cell changes occur as part of the normal aging process 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. A biomechanical study showed that the loss of disc height would increase the pressure on the facet joint at supra-physiological levels. Using an experimental model, Lipson and Muir 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, presents good correlation with the pathological changes and good inter-observer concordance. In addition, facet joint degeneration, for example the facet joint syndrome, is an important cause of low back pain and the degree of degeneration has been directly and proportionally associated with the degree of pain in some patients. The results of our study showed high Cronbach’s alpha coefficients in all the levels, showing their easy applicability and objectivity and agreeing with the literature on the subject. However, in the statistical analysis, 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 literature suggests 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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REFERENCES

1. Brodie DS, Ritter SM. Nonoperative management of low back pain and lumbar disc degeneration. J Bone Joint Surg Am. 2004;86:1810–8.

2. Katz JN. Lumbar disc disorders and low back pain: socioeconomic factors and consequences. J Bone Joint Surg Am. 2006;88 (Suppl 2):21 – 4.

3. Mooney V, Robertson J. The facet syndrome. Clin Orthop. 1976;(115):149–56.

4. Eisenstein SM, Parry CR. The lumbar facet arthrosis syndrome. J Bone Joint Surg Br. 1987;69(1):3–7.

5. Crook HV. Internal disc disruption: A challenge to disc prolapse fifty years on. Spine (Phila Pa 1976). 1986;11(6):650-3.

6. Modic MT, Masaryk TJ, Ross JS, Carter JR. Imaging of degenerative disk disease. Radiology. 1988;168(1):177–86.

7. Modic MT, Steinberg PM, Ross JS, Masaryk TJ, Carter JR. Degenerative disk disease: assessment of changes in vertebral body marrow with MR imaging. Radiology. 1988;166(1 Pt 1):193–9.

8. Pearce RH, Thompson JP, Bebault GM, Flak B. Magnetic resonance imaging reflects the chemical changes of aging degeneration in the human intervertebral disk. J Rheumatol Suppl. 1991;27:42–3.

9. Pfirrmann CW, Metzdorf A, Zanetti M, Hodler J, Boos N. Magnetic resonance classification of lumbar intervertebral disc degeneration. Spine (Phila Pa 1976). 2001;26(17):1873-8.

10. Ueno FH, Rodrigues LMR, Valesin Filho ES, Puertas EB. Reproducibilidade intra e inter-ob servadores da classificação de Pfirrmann para degeneração discal por meio da ressonância magnética. Coluna/Columna. 2008;7(4):330-3.

11. Yang SC, Yang PH. Significance of the bright facet sign on T2W MRI of lumbar facet joint. Mid Taiwan J Med. 2005;10(3):150-4.

12. Longmire GA, Conley RN. Interexaminer reliability of T2-weighted magnetic resonance imaging for lumbar bright facet sign. J Manipulative Physiol Ther. 2008;31(8):593-601.

13. Perrin EB. SAC Instrument Review Process: Medical Outcomes Trust Bulletin. 1995;5(3):1.

14. Dunlop RB, Adams MA, Hutton WC. Disc space narrowing and the lumbar facet joints. J Bone Joint Surg Br. 1984;66(6):706–10.

15. Revell ME, Listrat VM, Chevalier XJ, Dougados M, N guen MP, Vallee C, et al. Facet joint block for low back pain: identifying predictors of a good response. Arch phys Med Rehabil. 1992;73(9):824-8.

16. Kirkaldy-Willis WH, Wedge JH, Yong-Hing J, Reilly J. Pathology and pathogenesis of lumbar spondylosis and stenosis. Spine (Phila Pa 1976). 1978;3(4):319-28.

17. Farfan HF, Sullivan JB. The relation of facet orientation to intervertebral disc failure. Can J Surg. 1967;10(2):179-85.

18. Yang KH, Kink AI. Mechanism of facet load transmission as a hypothesis for low- back pain. Spine (Phila Pa 1976). 1984;9(6):557-65.

19. Vernon-Roberts B, Pine CJ. Degenerative changes in the intervertebral discs of the lumbar spine and their sequelae. Rheumatol Rehabil. 1977;16(1):13–21.

20. Lewin T. Osteoarthritis in lumbar synovial joints: a morphologic study. Acta Orthop Scand. 1964;73(Suppl 73):1–112.

21. Lipson SJ, Mur H. Experimental intervertebral disc degeneration: morphologic and proteoglycan changes over time. Arthritis Reum. 1981;24(1):12-21.

22. Bogduk N, Twomey L. Clinical Anatomy of the Lumbar Spine. Melbourne: Longman Group UK Limited. 1991. p.151-3.

23. Schwarzer AC, April C, Derby R, Fortin J, Kine G, Bogduk N. Clinical features of patients with pain stemming from the lumbar zygapophysial joints: Is the lumbar facet syndrome a clinical entity? Spine (Phila Pa 1976). 1994;19(10):1132-7.

24. Manchikanti L, Pampati V, Fellows B, Baldev CE. Prevalence of facet joint pain in chronic low back pain. Pain Physician. 1999;2(3):59–64.

25. Kalichman L, Hunter DJ. Lumbar facet joint osteoarthritis: a review. Semin Arthritis Rheum. 2007;37(2):69–80.

26. Suri P, Hunter DJ, Ranville J. Presence and extent of severe facet joint osteoarthritis are associated with back pain in older adults. Osteoarthritis Cartilage. 2013;21(9):1199–206.

27. César AEM, Yonezaki AM, Ueno FH, Valesin Filho ES, Rodrigues LMR. Intraobserver and Interobserver Reproducibility of Lumbar Facet Hypersignal Rating and Correlation With Disc Degeneration By Magnetic Resonance Imaging. Coluna/Columna. 2011;10(3):179-82.