LUMBAR ALTERATIONS IN MAGNETIC RESONANCE: CORRELATION BETWEEN MODIC AND PFIRRMANN CLASSIFICATIONS

ALTERAÇÕES LOMBARES NA RESSONÂNCIA MAGNÉTICA: CORRELAÇÃO ENTRE AS CLASSIFICAÇÕES DE MODIC E PFIRRMANN

ALTERACIONES LUMBARES EN LA RESONANCIA MAGNÉTICA: CORRELACIÓN ENTRE LAS CLASIFICACIONES DE MODIC Y PFIRRMANN

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ABSTRACT

Objective: To evaluate the relationship of sex and age with Modic and Pfirrmann classifications and verify the relationship between the two classifications in the group of patients studied. Methods: 300 magnetic resonance scans (MRI) of the lumbar segment of the patients were evaluated; each lumbar segment (L1-L2, L2-L3, L3-L4, L4-L5 and L5-S1) was assessed according to Modic and Pfirrmann classifications. Results: The type III of Pfirrmann was the most prevalent, whereas Modic was absent on most levels analyzed. The Modic signal was present mainly in the lower levels (L4-L5 and L5-S1) and in females. Conclusion: There is a strong correlation between the changes of the endplate and intervertebral discs, evidenced by changes in MRI. The relationship between Pfirrmann and Modic classifications is statistically higher the greater the disc degeneration.

Keywords: Spine, Intervertebral disc, Magnetic resonance imaging.

RESUMO

Objetivo: Avaliar a relação do sexo e idade com as classificações de Modic e Pfirrmann e verificar a relação entre as duas classificações no grupo de pacientes analisados. Métodos: Foram avaliadas 300 ressonâncias magnéticas (RM) do segmento lombar dos pacientes; cada segmento lombar (L1-L2, L2-L3, L3-L4, L4-L5 e L5-S1) foi avaliado de acordo com as classificações de Modic e de Pfirrmann. Resultados: O tipo III de Pfirrmann foi o mais prevalente, enquanto o Modic estava ausente na maioria dos níveis analisados. O sinal de Modic esteve presente, principalmente, nos níveis mais inferiores (L4-L5 e L5-S1) e no sexo feminino. Conclusão: Existe uma forte correlação entre as alterações da placa terminal e dos discos intervertebrais, evidenciadas pelas alterações na RM. A relação entre as classificações de Pfirrmann e Modic é estatisticamente maior quanto maior for a degeneração discal.

Descritores: Coluna vertebral; Disco intervertebral; Imagem por ressônancia magnética.

RESUMEN

Objetivo: Evaluar la relación del sexo y edad con las clasificaciones de Modic y Pfirrmann y verificar la relación entre las dos clasificaciones en el grupo de pacientes analizados. Métodos: Fueron evaluadas 300 resonancias magnéticas (RM) del segmento lumbar de los pacientes; cada segmento lumbar (L1-L2, L2-L3, L3-L4, L4-L5 y L5-S1) fue evaluado de acuerdo con las clasificaciones de Modic y de Pfirrmann. Resultados: El tipo III de Pfirrmann fue el más prevalente, mientras que el Modic estaba ausente en la mayoría de los niveles analizados. La señal de Modic estuvo presente, principalmente, en los niveles más inferiores (L4-L5 y L5-S1) y en el sexo femenino. Conclusión: Existe una fuerte correlación entre las alteraciones de la placa terminal y de los discos intervertebrales, evidenciadas por las alteraciones en la RM. La relación entre las clasificaciones de Pfirrmann y Modic es estadísticamente mayor cuanto mayor sea la degeneración discal.

Descriptores: Columna vertebral; Disco intervertebral; Imagen por resonancia magnética.

INTRODUCTION

Magnetic resonance is the method most often used to specifically assess intervertebral disc degeneration. Based on proton density, water content, and chemical environment, it portrays the morphology and hydration of the intervertebral disc.[1,2] The Modic and Pfirrmann classifications are two known methods used to evaluate degenerative lumbar disease.[3,4]

Dehydration of the nucleus pulposus and changes in the molecular structures of its components start to occur in the third decade of life, at the onset of the disc degeneration process.[5,6]

Pfirrmann established his classification in 2001, basing it on criteria of changes in disc morphology in patient MRIs (intensity of the signal, structure of the disc, distinction between the nucleus and the annulus, and disc height).[7]

This classification has good applicability in differentiating between the degrees of disc degeneration.[8] Changes in the end plate were described by Modic[9,10] in 1988. The studies suggest that changes can progress from one type to another; however, there is limited knowledge about the natural course of the changes reported by Modic.[11]

Despite the structural changes observed in disc degeneration, there is no defined association between the Pfirrmann classification and the changes observed in the vertebral plate used by the Modic classification.

However, both are easy to apply and have high intraobserver agreement.[12] The objective of this study is to better understand degenerative disc disease and its evolution by establishing a parallel between the two classification systems.

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METHODS

We analyzed the MRIs of 300 patients treated between January and December 2011 at the Clinic of Spinal Pathologies of the Hospital Estadual Mario Covas (HEMC), Santo André, SP, Brazil, which is linked to the discipline of Orthopedics and Traumatology of the Faculdade de Medicina do ABC (FMABC). With the patient's consent, a second copy of the MRI exams of the lumbar spine was requested from the Radiology Sector of the HEMC for the study.

The lumbar images (intervertebral discs and end plates from L1 to S1) were analyzed and classified by two doctors of the FMABC Spine Group according to the classifications of Modic and Pfirrmann using the Osirix Image Software (©Antoine Rosset, 2003-2011) program. When there were disagreements, they reevaluated the images until they reached consensus.

To meet the objectives of the study, the variables of sex and age group, and the Modic and Pfirrmann measurements were described for each group of patients using absolute and relative frequencies, and the totals of the classifications of the evaluated levels were presented.

The Pfirrmann and Modic measurements at each vertebral level were described according to sex, then compared between the sexes using Mann-Whitney tests. The scales were also described by age group and compared between the groups using Kruskal-Wallis tests. The Pfirrmann and Modic measurements were described at each vertebral level and the existence of a relationship between the two scales was verified using Spearman correlations. The tests were performed with a significance level of 5%. All the analyses were performed using SPSS for Windows version 15.0.

RESULTS

Table 1 shows that most of the patients evaluated are female (59%) and are in the 40-60 years of age group (53%).

It is observed that Pfirrmann Type III is the most common across all the levels evaluated. (Table 2)

Table 3 shows that the Modic signal is absent in most of the discs evaluated and that Type 2 is more common in discs L3-L4, L4-L5, and L5-S1. There was no Type 3 found.

It was observed that in discs L2-L3 and L3-L4 the Pfirrmann grade is statistically higher in female patients. (Table 4)

It was found that the Modic grade is statistically higher in females and in disc L3-L4. (Table 5)

Table 6 shows that the Pfirrmann grade increases statistically with age group in all discs evaluated ($p < 0.05$), with the exception of disc L5-S1 where the Pfirrmann grade is statistically equal in the three patient age groups ($p = 0.127$).

It was observed that the Modic grade increases statistically with age group in discs L3-L4 and L5-S1. (Table 7)

It was found that the higher the Pfirrmann grade, the higher the Modic grade, and vice-versa, in all the intervertebral discs evaluated. (Table 8)

Table 1. Description of sex and age group of the patients evaluated.

Variable	N	%
Sex		
Female	178	59.3
Male	122	40.7
Age group		
< 40 years	56	18.7
40 to 60 years	160	53.3
> 60 years	84	28.0
Total	300	100

Table 2. Description of Pfirrmann by vertebral levels and the sum of all levels.

Pfirrmann	L12		L23		L34		L45		L5S1		All discs	
	N	%	N	%	N	%	N	%	N	%	N	%
Type I	0	0.0	0	0.0	0	0.0	5	1.7	0	0.0	5	0.3
Type II	124	41.3	83	27.7	53	17.7	36	12.0	35	11.7	331	22.1
Type III	90	30.0	112	37.3	122	40.7	88	29.3	102	34.0	514	34.3
Type IV	58	19.3	73	24.3	87	29.0	99	33.0	93	31.0	410	27.3
Type V	28	9.3	32	10.7	38	12.7	72	24.0	70	23.3	240	16.0
Total	300	100	300	100	300	100	300	100	300	100	1500	100

Table 3. Description of Modic by vertebral discs and the sum of all levels.

Modic	L12		L23		L34		L45		L5S1		All discs	
	N	%	N	%	N	%	N	%	N	%	N	%
Absent	282	94.0	285	95.0	266	88.7	247	82.3	250	83.3	1330	88.7
Type 1	5	1.7	1	0.3	3	1.0	10	3.3	2	0.7	21	1.4
Type 2	13	4.3	14	4.7	31	10.3	43	14.3	48	16.0	149	9.9
Total	300	100	300	100	300	100	300	100	300	100	1500	100

Table 4. Description of Pfirrmann by intervertebral disc according to sex.

	Sex						
Variable	Female		Male		Total		p
	N	%	N	%	N	%	
Pfirrmann L12							0.298
Type II	71	39.9	53	43.4	124	41.3	
Type III	53	29.8	37	30.3	90	30.0	
Type IV	32	18.0	26	21.3	58	19.3	
Type V	22	12.4	6	4.9	28	9.3	
Pfirrmann L23							0.008
Type II	43	24.2	40	32.8	83	27.7	
Type III	62	34.8	50	41.0	112	37.3	
Type IV	49	27.5	24	19.7	73	24.3	
Type V	24	13.5	8	6.6	32	10.7	
Pfirrmann L34							0.008
Type II	31	17.4	22	18.0	53	17.7	
Type III	60	33.7	62	50.8	122	40.7	
Type IV	57	32.0	30	24.6	87	29.0	
Type V	30	16.9	8	6.6	38	12.7	
Pfirrmann L45							0.251
Type I	5	2.8	0	0.0	5	1.7	
Type II	16	9.0	20	16.4	36	12.0	
Type III	58	32.6	30	24.6	88	29.3	
Type IV	46	25.8	53	43.4	99	33.0	
Type V	53	29.8	19	15.6	72	24.0	
Pfirrmann L5S1							0.817
Type II	17	9.6	18	14.8	35	11.7	
Type III	69	38.8	33	27.0	102	34.0	
Type IV	50	28.1	43	35.2	93	31.0	
Type V	42	23.6	28	23.0	70	23.3	
Total	178	100	122	100	300	100	
Results of the Mann-Whitney test							

Table 5. Description of Modic by intervertebral level according to sex.

Variable	Sex						
	Female		Male		Total		p
	N	%	N	%	N	%	
Modic L12							0.873
Absent	167	93.8	115	94.3	282	94.0	
Type 1	3	1.7	2	1.6	5	1.7	
Type 2	8	4.5	5	4.1	13	4.3	
Modic L23							0.261
Absent	167	93.8	118	96.7	285	95.0	
Type 1	1	0.6	0	0.0	1	0.3	
Type 2	10	5.6	4	3.3	14	4.7	
Modic L34							0.001
Absent	149	83.7	117	95.9	266	88.7	
Type 1	3	1.7	0	0.0	3	1.0	
Type 2	26	14.6	5	4.1	31	10.3	
Modic L45							0.420
Absent	144	80.9	103	84.4	247	82.3	
Type 1	6	3.4	4	3.3	10	3.3	
Type 2	28	15.7	15	12.3	43	14.3	
Modic L5S1							0.100
Absent	143	80.3	107	87.7	250	83.3	
Type 1	2	1.1	0	0.0	2	0.7	
Type 2	33	18.5	15	12.3	48	16.0	
Total	178	100	122	100	300	100	

Table 6. Description of Pfirrmann by intervertebral disc according to age group.

Variable	Age group								
	< 40 years		40 to 60 years		> 60 years		Total		p
	N	%	N	%	N	%	N	%	
Pfirrmann L12									<0.001
Type II	38	67.9	70	43.8	16	19.0	124	41.3	
Type III	12	21.4	49	30.6	29	34.5	90	30.0	
Type IV	6	10.7	29	18.1	23	27.4	58	19.3	
Type V	0	0.0	12	7.5	16	19.0	28	9.3	
Pfirrmann L23									<0.001
Type II	35	62.5	42	26.3	6	7.1	83	27.7	
Type III	17	30.4	63	39.4	32	38.1	112	37.3	
Type IV	2	3.6	41	25.6	30	35.7	73	24.3	
Type V	2	3.6	14	8.8	16	19.0	32	10.7	
Pfirrmann L34									<0.001
Type II	27	48.2	24	15.0	2	2.4	53	17.7	
Type III	23	41.1	66	41.3	33	39.3	122	40.7	
Type IV	4	7.1	46	28.8	37	44.0	87	29.0	
Type V	2	3.6	24	15.0	12	14.3	38	12.7	
Pfirrmann L45									<0.001
Type I	3	5.4	0	0.0	2	2.4	5	1.7	
Type II	18	32.1	16	10.0	2	2.4	36	12.0	
Type III	22	39.3	42	26.3	24	28.6	88	29.3	
Type IV	11	19.6	62	38.8	26	31.0	99	33.0	
Type V	2	3.6	40	25.0	30	35.7	72	24.0	
Pfirrmann L5S1									0.127
Type II	11	19.6	20	12.5	4	4.8	35	11.7	
Type III	16	28.6	52	32.5	34	40.5	102	34.0	
Type IV	21	37.5	54	33.8	18	21.4	93	31.0	
Type V	8	14.3	34	21.3	28	33.3	70	23.3	
Total	56	100	160	100	84	100	300	100	
Results of the Kruskal-Wallis test									

Table 7. Description of Modic by intervertebral disc according to age group.

Variable	Age group								
	< 40 years		40 to 60 years		> 60 years		Total		p
	N	%	N	%	N	%	N	%	
Modic L12									0.066
Absent	56	100.0	150	93.8	76	90.5	282	94.0	
Type 1	0	0.0	3	1.9	2	2.4	5	1.7	
Type 2	0	0.0	7	4.4	6	7.1	13	4.3	
Modic L23									0.143
Absent	56	100.0	151	94.4	78	92.9	285	95.0	
Type 1	0	0.0	1	0.6	0	0.0	1	0.3	
Type 2	0	0.0	8	5.0	6	7.1	14	4.7	
Modic L34									0.012
Absent	56	100.0	138	86.3	72	85.7	266	88.7	
Type 1	0	0.0	3	1.9	0	0.0	3	1.0	
Type 2	0	0.0	19	11.9	12	14.3	31	10.3	
Modic L45									0.144
Absent	51	91.1	128	80.0	68	81.0	247	82.3	
Type 1	2	3.6	6	3.8	2	2.4	10	3.3	
Type 2	3	5.4	26	16.3	14	16.7	43	14.3	
Modic L5S1									0.009
Absent	52	92.9	136	85.0	62	73.8	250	83.3	
Type 1	0	0.0	1	0.6	1	1.2	2	0.7	
Type 2	4	7.1	23	14.4	21	25.0	48	16.0	
Total	56	100	160	100	84	100	300	100	
Results of the Kruskal-Wallis test									

Table 8. Description of Pfirrmann and Modic by intervertebral disc.

Disc	Pfirrmann	Modic								
		Absent		Type 1		Type 2		Total		p
		N	%	N	%	N	%	N	%	
L12	Type II	120	42.6	0	0.0	4	30.8	124	41.3	<0.001
	Type III	88	31.2	2	40.0	0	0.0	90	30.0	
	Type IV	56	19.9	0	0.0	2	15.4	58	19.3	
	Type V	18	6.4	3	60.0	7	53.8	28	9.3	
	Total	282	100	5	100	13	100	300	100	
L23	Type II	82	28.8	0	0.0	1	7.1	83	27.7	0.003
	Type III	108	37.9	0	0.0	4	28.6	112	37.3	
	Type IV	68	23.9	0	0.0	5	35.7	73	24.3	
	Type V	27	9.5	1	100.0	4	28.6	32	10.7	
	Total	285	100	1	100	14	100	300	100	
L34	Type II	53	19.9	0	0.0	0	0.0	53	17.7	<0.001
	Type III	115	43.2	0	0.0	7	22.6	122	40.7	
	Type IV	72	27.1	0	0.0	15	48.4	87	29.0	
	Type V	26	9.8	3	100.0	9	29.0	38	12.7	
	Total	266	100	3	100	31	100	300	100	
L45	Type I	5	2.0	0	0.0	0	0.0	5	1.7	<0.001
	Type II	36	14.6	0	0.0	0	0.0	36	12.0	
	Type III	78	31.6	4	40.0	6	14.0	88	29.3	
	Type IV	85	34.4	0	0.0	14	32.6	99	33.0	
	Type V	43	17.4	6	60.0	23	53.5	72	24.0	
	Total	247	100	10	100	43	100	300	100	
L5S1	Type II	33	13.2	0	0.0	2	4.2	35	11.7	<0.001
	Type III	94	37.6	0	0.0	8	16.7	102	34.0	
	Type IV	89	35.6	0	0.0	4	8.3	93	31.0	
	Type V	34	13.6	2	100.0	34	70.8	70	23.3	
	Total	250	100	2	100	48	100	300	100	
Results of Spearman's correlation										

DISCUSSION

This study proposes a correlation between the classifications presented based on analyses of magnetic resonance images, the exam of choice for the visualization of changes in soft tissue (intervertebral disc, ligament, and musculature).

The average age of the patients in this study is between 40 and 60 years, compatible with earlier studies in which the onset of symptoms can be associated with degenerative pathologies, given that disc degeneration is an inevitable consequence of the human aging process. During the evolution of degeneration, the disc becomes more vulnerable to inflammatory processes.[13-15]

Zuo *et al*[16] considered discs with a Pfirrmann grade lower than or equal to type II to be normal, and those with a Pfirrmann grade higher than type II to be degenerated. They also observed greater degeneration in disc L4-L5 compared with the other intervertebral segments, similar to the results of our study.[16] According to the literature, the fact that level L4-L5 has greater mobility may result in greater disc degeneration as compared to the other intervertebral segments.[17,18]

There was also a smaller number of discs classified as type I, due to the patients' age and the fact that they had histories of low back problems.

In relation to the Modic scale, there were no changes at the higher levels (L12 and L23). Where present, changes were observed mainly at the lower levels (L4-L5 and L5-S1), with type 2 being most prevalent, a phenomenon similar to that encountered by Modic *et al*.[4,9,19] This is probably because the lower levels are exposed to higher biomechanical stress loads, resulting in changes in the end plates.[20] In the study, most patients did not present Modic type changes (88.7%). In accordance with the findings of Leite *et al* (88.3%)[21], no Modic type 3 changes were observed, a situation that is uncommon.[9,22,23]

Previous studies demonstrated similar relationships in terms of the frequency and location of Modic changes in the intervertebral discs studied. Kuisma *et al*[24], studying MRI changes in middle-aged manual laborers, showed that 85% of the discs at the lower lumbar levels (L5S1) were affected by some change to the end plate (Modic 1 or 2). They did not find any type 3 changes.[9] Takatalo *et al*[25], who studied changes in the MRIs of young adults, found a low incidence of the appearance of changes, similar to the findings of our study, with higher prevalence in men, and they also noted a higher incidence in the lower discs. The study by Schenk *et al*[26] showed similar results, with an incidence of around 85% of end plates without any changes and a low incidence of Modic type 3 changes in a group of health care workers whose jobs required, or did not require physical labor.

In this study, changes in the end plate were more prevalent in females, and even though there was some disagreement about whether gradation between the different Modic types exists,[4,9] there was a higher prevalence of type 2 changes among females.

In a comparison of the changes in relation to age, it was observed that increasing age coincides with more serious Modic and Pfirrmann type changes. When the two classifications were correlated, the data showed a strong association, showing that the higher the Pfirrmann grade, the higher the Modic changes.

The study was designed to evaluate only the images, without correlating them with the patient's clinical history, symptoms, or social aspects involved. Prior studies suggest a correlation between symptoms and more advanced grades of the classifications studied.[14] Studies correlating the radiographic findings and symptoms could be topics for further research.

CONCLUSION

The ideal classification system for degenerative disc disease should be simple, easily applicable, and highly reproducible. There is a strong correlation between changes in the end plates and the intervertebral discs, as evidenced by changes in the MRI. The greater the level of disc degeneration, the closer the relationship between the Pfirrmann and Modic classification systems.

All authors declare no potential conflict of interest concerning this article.

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