Correlation Between Vertebral Endplate Signal Changes And Lumbar Disc degeneration On Magnetic Resonance Imaging.

Haider Najim Aubaid. D.M.R.D , F.I.B.M.S.
Radiodiagnosis. Lecturer in Faculty of Medicine, Kufa University,General Radiologist in MRI and CT unit in Al-Hakeem Hospital, Najaf, Iraq.
Email: haidernajim@yahoo.com.

الخلاصة

إن طبيعة العلاقة بين تغيرات الإشارة في الصفائح الطرفية للفقرة من بين المشاهدات الشائعة في تصوير الرنين المغناطيسي وبين انحلال القرص القطني ما زالت تثير الجدل. هدف الدراسة هو تقييم هذه تغيرات ودراسة الترابط بين مختلف مميزاتها وقسوة الانحلال في القرص القطني.

شملت الدراسة فحوصات الرنين المغناطيسي لـ(٦٠) مريضا (٣٨ ذكر و ٢٢ أنثى) و التي احتوت بجموعها على ٣٠٠ قرص قطني. تم تصنيف الانحلال و تقييم تغيرات الإشارة في الأقراص الطرفية للفقرة أينما وجدت فيما يتعلق بنوعها، امتدادها و عمقها داخل الفقرة دراسة الترابط بنهما.

النتائج: كانت نسبة انتشار التغيرات في المرضى ٥٣.٣ و شوهدت بأعظم نسبة قرب الأقراص القطنية التي كانت مراتب انحلالها متقدمة وشديدة (٣٤.٥% عند المرتبة الخامسة و ٣٩.١% قرب المرتبة الرابعة) و باقتران مهم إحصائيا (قيمة P أقل من ٠.٠٥). أظهرت المراتب المتقدمة من الانحلال اقتران مهم(قيمة P أقل من ٠.٠٥) مع التغيرات ذات النوع الثاني (II)، الأمتداد الشديد و العمق من المرتبة الأولى و الثانية (I-II) .

تستنتج الدراسة وجود علاقة ايجابية وطردية بين وجود وشدة هذه تغيرات من جهة ومرتبة انحلال القرص من جهة أخرى. توصي الدراسة أيضا بإعطاء أهمية خاصة لهذه التغيرات عند مشاهدتها في صور الرنين المغناطيسي و كذلك الحاجة لدراسات إضافية أخرى.

ABSTRACT

The nature of relationship between vertebral endplate signal changes (VESC) with lumbar intervertebral disc (IVD) degeneration is still relatively controversial.

Aim of study is to evaluate VESC in lumbar spine and correlate their characteristics with IVD degeneration. MRI examinations of 60 patients (38 males, 22 females) with a total of 300 IVD were studied retrospectively. IVD degeneration was graded according to system modified by Pfirrmann et al. VESC were assessed regarding type, extent and depth and then correlated with grades of degeneration at affected levels.

VESC were most frequent near lumbar IVD that had advanced degeneration (43.5% in grade IV and 39.1% in grade V) with statistically significant association (P value < 0.05). Higher grades of IVD degeneration showed significant association (P value <0.05) with type II, sever extent, and grade I-II depth of VESC.

As conclusion, VESC seem to be positively related to the lumbar IVD degeneration with more severe characteristics of VESC, particularly extent, are linked to more advanced degeneration, however further clarifying studies are still recommended.

Introduction

Low back pain (LBP) is a common medical condition and the associated disability and medical cost have a significant impact on the community [1, 2, and 3].

Spinal abnormalities are among the commonest causes of LBP and intervertebral disc (IVD) degeneration is postulated as a potential cause for chronic back pain (4)

MRI (magnetic resonance imaging) has significantly advanced the evaluation of the spine and is currently considered as the most accurate noninvasive modality in imaging of degenerative disc disease [5, 6].

IVD anatomy briefly consists of an inner core known as the nucleus pulposus, and a surrounding firm ring of tissue called the annulus fibrosus. During degeneration there are a variety of morphological changes that occur, including lose of both height and hydration of the disc [7 and 8]. It had been shown that a drop in water content of nucleus pulposus and matrix turnover are related to the age and grade of degeneration [9].

The signal characteristics of the disk in T2-weighted sequence reflect changes caused by aging or degeneration and the loss of T2 weighted image brightness in degenerated discs is attributed to a decrease in the water content [10]

According to a Kettler and Wilkes's review[11], many grading systems for evaluation of IVD degeneration implying these characteristics (signal and height of the disc) had been proposed.

Vertebral endplate signal changes (VESC) as seen by MRI were classified according to Modic et al [12] into the so-called Modic types which are I, II and III, representing inflammatory, fatty and sclerotic changes respectively [12].

Although debate has recently focused on VESC as an indicator of symptomatic disk degeneration[13], several studies suggested possible relationship and strong association between these changes and LBP [14, 15, 16, 17].

Aim of study

To evaluate VESC in the lumbar spine and to correlate these changes in terms of type, extent and depth, with presence and degree of disc degeneration.

Patients and methods

MRI examinations of lumbar spines of 60 patients (38 males and 22 females) containing a total of 300 IVD, were included in this retrospective study. Patients were referred to MRI unit in Al-Hakeem General Hospital during the period from Oct 2008 to Aug 2009 because of backache and/or radiculopathy.

All examinations were done by the same MRI device (Siemens Symphony 1.5 T). Non-enhanced T1 and T2-weighted sagittal images were used in evaluation of VESC and grade of disc degeneration.

VESC were assessed in regard to type, extent and depth according to the following criteria: (examples figures 1 and 2)

*Type: included the three Modic types [12] according to signal intensity on T1 and T2 images: I= hypointense T1 and hyperintense T2, II= hyperintense on T1 and intermediate-hyperintense T2, III = hypointense on both T1 and T2.

*Depth: represented the cranio-caudal spread of VESC into vertebral body: grade I= less than 25%, II=25-50%, III= more than 50%.

*Extent: meant the antero-posterior extension of the changes along the endplate margin and divided into: mild=less than 25%, moderate-=25-50% and severe= more than 50% of sagittal diameter of endplate.

Degeneration in IVD was classified according to the grading system used by Pfirrmann et al [8] (table -1-) which is modified from Pearce et al [18].

Table-1-Classification of IVD degeneration on MRI by Pfirrmann et al[8] {modified from Pearce et al [18]}.

Grade	Structure	Distinction of Nucleus and Annulus	Signal Intensity relative to cerebrospinal fluid (CSF)	Disk Height
I	Homogenous, bright white	Clear	Hyperintense to isointense	Normal
II	Inhomogeneous with or without horizontal bands	Clear	Hyperintense to isointense	Normal
III	Inhomogeneous , gray	Unclear	Intermediate	Normal to slightly decreased
IV	Inhomogeneous , gray to black	Lost	Intermediate to hypointense	Normal to moderately decreased
V	Inhomogeneous , black	Lost	Hypointense	Collapsed

If a disc showed signal changes on both sides, the side with higher type, extent and depth was allocated for that level.

The data were subjected for statistical analysis, including Chi square and Fisher exact tests with P value of less than 0.05 is considered significant.

Figure -1: Lumbar MRI, (a) T1 and (b) T2-weighted, of 33 years male. Lumbar grades: L1\2 and L5\S1= II, L2\3 and L3\4 = IV , L4\5=V.

VESC seen at L4\5 with type II (hyperintense T1 and T2), severe extent (anteroposterior >50%) and grade III depth (> 50%) .

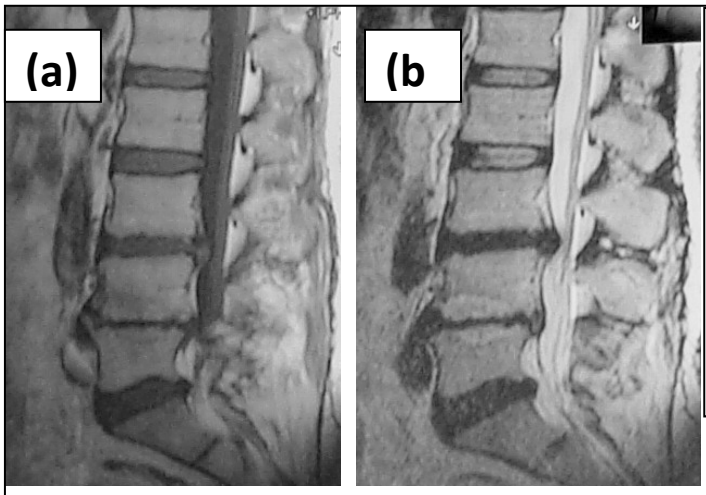

Figure -2: Lumbar MRI, (a) T1 and (b) T2-weighted images, of 38 years male. Lumbar grades:

L1/2 and L2\3= II, L3\4= IV, L4\5=V, L5\S1=III.

VESC seen at L4\5 with type I (hypointense T1 and hyperintense T2), severe extent

Results

The study included 60 patients, 38 males and 22 females (63.3% and 36.7% respectively) with a total of 300 lumbar discs. The mean age of patients was 42.7 years (minimum 20 years, maximum 76years, SD +/- 12.6).

VESC were seen in 46 lumbar levels in 32 patients (32 of 60, 53.3%) with slightly higher rate in females (17 of 32, 53.1%) than males (15 of 32, 46.9%) and regarding age, the highest rate of VESC was seen in 31-40 years age group constituting 40.6% (13 of 32).

As illustrated in figure -3-, lower lumbar levels were more frequently involved by VESC with L4/5 level being the most affected (20, 43.5%).

VESC were most frequently seen with statistically significant association near discs of grades IV and V of degeneration (20, 43.5% and 18, 39.1% respectively, both showed P value < 0.05) while no VESC were seen near discs of grade I and II as shown in Figure-4-.

The distributions of characteristics of Modic changes, namely type, extent and depth according to different grades of disc degeneration are demonstrated in table-2-

Among the three types of Modic changes, type II was the highest, accounting for 82.6% (38 of 46) while 7 levels were of type I and only single case of type III was noted.

Type II was more frequent in grade IV (19, 41.3%) and V (11, 23.9%) of degeneration and showing significant association with both (P value <0.05)

The extent of VESC was of severe degree in large proportion of affected levels (29 of 46, 63%) , higher with equal rate in grade VI and V (both 12 of 46, 26.1%) & showed statistically significant association (P value < 0.05) with grade V of degeneration.

Majority (29, 63%) of the levels affected by VESC were of grade I exceeding depth II (13, 28.2%) and grade III (4, 8.7%) while significant associations was present between grade V of degeneration and VESC depth of grade I and II (both with P value < 0.05).

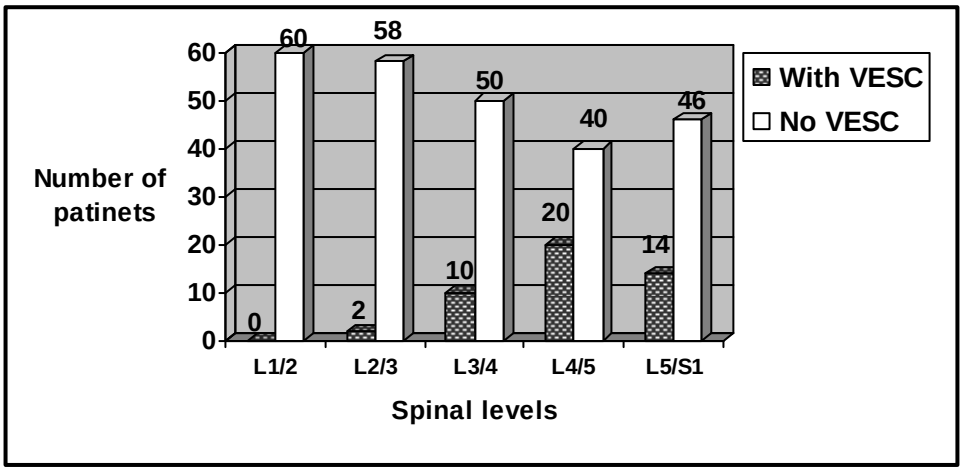

Figure -3-Distribution of VESC according to order of lumbar levels

Table-2-Prevalance of VESC in 300 lumbar levels according to the grade of degeneration.

Grades / VESC	I	II	III	IV	V	Total
With VESC	0	0	8	20	18	46
No VESC	19	108	55	66	6	254
Total	19	108	63	86	24	300

Table -3-Distribution of characteristic of VESC in relation to grade of degeneration in the affected 46 lumbar levels.

Grades / *VESC characteristics*		I (n=0)	II (n=0)	III (n=8)	IV (n=20)	V (n=18)
Type	I (n=7)	0	0	0	1	6
	II (n=38)	0	0	8	19	11
	III (n=1)	0	0	0	0	1
Extent	Mild (n=8)	0	0	2	4	2
	Moderate n=9)	0	0	1	4	4
	Severe (n=29)	0	0	5	12	4
Depth	I (n=29)	0	0	7	12	10
	II (n=13)	0	0	1	6	6
	III (n=4)	0	0	0	2	2
Total =300		19	108	63	86	24

NOTE: Value of (n) between brackets represents number of levels affected by VESC

Discussion:

MRI is the most important method for assessment of degenerative spinal disease and has sufficient reliability in interpretation of general spinal characteristics including disc degeneration and VESC (19).

The prevalence of VESC in our study was 53.3% and falls approximately within upper limit of the reported prevalences which ranged from as low as 19% to as high as 59% ([13, 15, 20, 21 and 22]).

Karchevsky et al [23] and Kuisma et al [24] studies showed an increasing prevalence of VESC with increasing age, while we found that (40.6%) of affected patients were of young ages (31-40 years), which may reflect affection of our people by degenerative changes in earlier age than other populations and/or due to non-intended small number of old age patients included in our study.

The higher prevalence of VESC in females (53.1%) than males (46.9%) in our study was similar to finding of Vitzthum's study[20] but contradicting Karshevski's report of higher male affection [19]. Higher rate of involvement of lower lumbar levels by VESC in our study was consistent with finding of other studies [21, 22, 23, and 25] as being common sites of lumbar spine degeneration

VESC were seen most frequent in levels showing advanced grades of degeneration namely IV (41.3%) and V (23.9%) and the observed significant association (P value < 0.05) suggests that the more severe disc degeneration is, the more VESC are prevalent nearby and that a positive relationship with pathological correlation may be present. This was consistent with other studies [15, 17, 26, 27, and 28] which found similar significant association and supported a more recent study in 2009 by Zhi-Jun et al [29] who

hypothesized that VESC are the possible causes and promotion of lumbar IVD degeneration by structural, biomechanical and nutritional mechanisms.

The predominance of Type II VESC observed in our study (82.6%) over both type I and III, approached findings of previous studies [12, 15, 21 and 23] but at the same time it was contrary to higher rate of type I seen in other studies [22, 15, and 30]

This variance in the reported prevalences of each type of VESC had been attributed to the sampling errors and variations among the studied populations [31] and in our population, the higher rate of type II may be due to the delayed performance of MRI in patients to a such long period after acute onset of pain that at time of MRI examination, most of type I VESC had been changed into type II, a turnover (from type I into II) which was show in several studies [12, 16, 32, and 33].

A recent study in 2009 by Jenson et al [34], found a significant correlation between extent and depth of Modic changes with disc degeneration. We also noted similar statistically significant association (P value < 0.05) between severe extent of VESC and advanced grade (V) of degeneration, while regarding depth of VESC, significant association was present only with early-moderate (I and II) depth of VESC. According to this observation, we can propose that extent seems to be more related to the severity of IVD degeneration than the depth of VESC.

Conclusion and recommendation

VESC seen on MRI are correlated linearly with lumbar disc degeneration with more severe VESC characteristics, particularly the extent are linked to more severe degeneration, hence consolidating the proposed positive pathological interrelationship.

While this study recommends that more light is to be shed on VESC when interpreting lumbar MRI findings, it also encourages more prospective studies stressing on the natural behavior as well as clinical relevance of these changes.

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