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Correlation of MRI Findings of Intervertebral Disc Water Content and Disc Height with Self-rated Quality of Life, Pain and Disability

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Authors' contributions

This work was carried out in collaboration between all authors. Author BCB designed the study, wrote the protocols, performed the clinical assessments, entered the data and revised the manuscript. Authors AC, CC and ES performed the statistical analysis, wrote the first draft of the manuscript and updated the literature search. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: To investigate (1) the correlation between MRI findings of Intervertebral disc water content and disc height, with self-rated quality of life (QoL), pain, and disability respectively, and (2) the correlation between QoL and pain, and QoL and disability respectively.
Study Design: Clinical diagnostic study.
Place and Duration of Study: Ersta hospital radiological department, Stockholm, between February and september 2004.
Methodology: Eighty-eight patients referred for MRI of the spine due to suspect spine-related discomfort and with no previous surgery of the affected spinal region, were included. In conjunction with the MRI examination, the patients filled out questionnaires to assess QoL, pain and disability. QoL was assessed with Euro-QoL-5D (EQ), pain was self-assessed with a Visual Analogue Scale (VAS), neck-related disability with Neck Disability Index (NDI), and low back-related disability with Oswestry Disability Index (ODI).
Results: Correlations between disc water content and EQ, VAS, NDI and ODI were -

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0.09,0.13, -0.23 and 0.18, respectively. Correlations between disc height and EQ, VAS, NDI and ODI were 0.05, -0.11, -0.23 and -0.05, respectively. Correlation between EQ and VAS was -0.17, correlation between EQ and NDI was -0.5, and correlation between EQ and ODI was -0.49.

Conclusion: No correlation was found between MRI findings of reduced Intervertebral disc water content and disc height with QoL, pain and disability. Other variables may be sought to explain self-rated QoL, pain, and disability among patients referred to MRI of the spine. In our study, the correlation between QoL and pain was not significant. However, the correlation between QoL and disability was significant, indicating that disability may have a greater impact on self-perceived QoL than pain.

Keywords: Spine; magnetic resonance imaging; intervertebral disc; quality of life; pain; disability.

1. INTRODUCTION

Suspect spine-related discomfort is a common reason for investigation with magnetic resonance imaging (MRI) [1-3], and Intervertebral disc pathology is often seen[4]. Some consider such pathology a major contributor to decreased quality of life (QoL), back pain and disability [4-6]. However, the clinical importance and correlation of reduced disc water content and disc height with QoL, pain and disability has been disputed [7-11]. The correlation between self-rated QoL and pain, and between QoL and disability has been previously investigated [12-15], though not specifically in a group of patients referred to MRI of the spine who have not undergone back surgery. This group of patients represents a large group of patients with spine-related discomfort seeking for an explanation of their pain and/or disability [12]. Due to the increasing use of MRI as a diagnostic tool in diagnosing spine-related discomfort, this is an important patient population to study.

The aim of our study on patients referred to MRI of the spine due to spine-related discomfort was to *Investigate* (1) the correlation between MRI findings of Intervertebral disc water content and disc height with self-rated QoL, pain and disability respectively, and (2) the correlation between QoL and pain, and QoL and disability respectively.

2. MATERIAL AND METHODS

Our study is based on material from a clinical study performed in 2004 by Bertilson et al. [16]. All consecutive patients, between 18 and 80 years of age, referred for MRI of the spine to Ersta radiological clinic in Stockholm between February and September 2004 due to suspect spine-related discomfort were invited to take part in the study. All 123 patients accepted to participate. Exclusion criteria were previous surgery of the affected spinal region, life-threatening disease, inability to speak Swedish, or patient known by the conductor of the physical examination. Due to the exclusion criteria, twenty patients were excluded from the study. Three additional patients were excluded, one due to claustrophobia, one due to not having time to participate and one being outside the age limit. Consequentially, 100 patients were included in the study. Sixty-one were examined with MRI of the lumbar spine, 37 with MRI of the cervical spine and 12 with MRI of the thoracic spine. Nine of the 100 patients were examined with MRI of more than one part of the spine.

In our study we also excluded patients with MRI scans of more than one part of the spine, and patients who had filled out questionnaires regarding more than one part of the spine Fig. 1. The exclusion was made to avoid inclusion of the same patients twice when analysing disability. Moreover, MRI of more than one part of the spine indicate discomfort from both neck and lower back, and the rated overall disability might not be representative of disability of one part of the spine. The exclusion of patients with MRI scans of more than one part of the spine lead to our study consisting of 32 patients with MRI of the cervical spine and 56 patients with MRI of the lumbar spine and no patients with MRI of the thoracic spine.

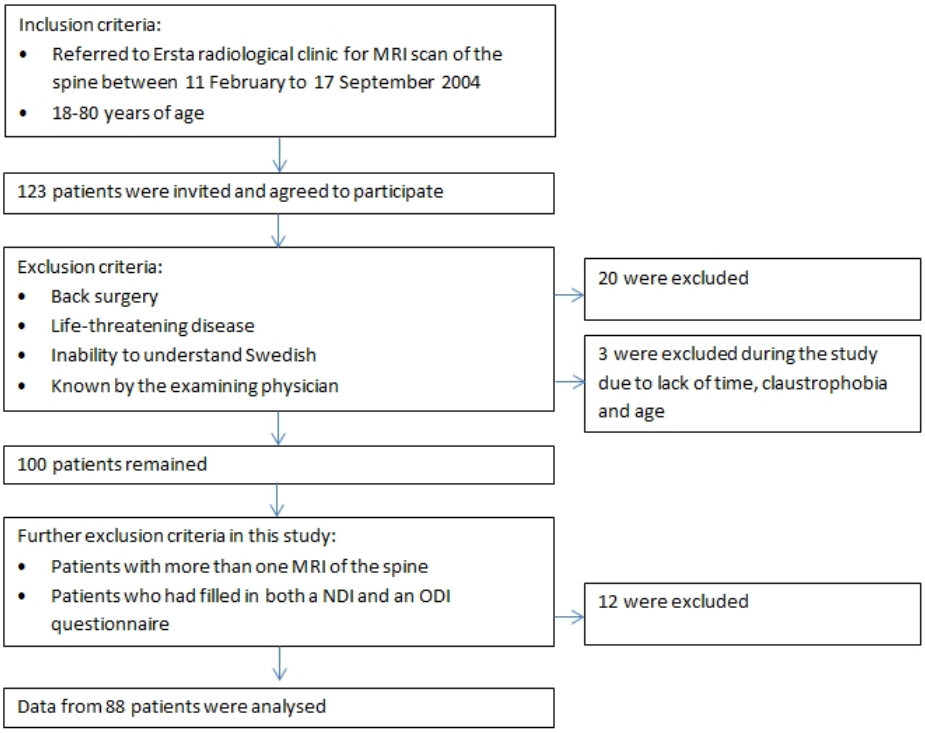

Fig. 1. Inclusion and exclusion of the patients

2.1 Procedure

The examination procedure consisted of three different assessments made within about 1.5 hour from that the patient arrived to the radiological clinic. First, a number of questionnaires, filled in by the patients. The questionnaires included patient characteristics, a pain drawing, a visual analogue scale (VAS), Euro-Qol-5D (EQ-5D), Neck disability index (NDI) and/or Oswestry disability index (ODI). Second, a thorough structured physical examination made and assessed by an experienced orthopedic medicine physician. Third, MRI scans of the spine assessed by two independent neuroradiologists. The radiologists made a first assessment of the images before having read the patient referrals to obtain an unbiased assessment, and then made a final assessment after having read the referrals. Assessments by the radiologist with the larger amount of MRI findings were used in the study.

2.1.1 Questionnaires

2.1.1.1 Visual Analogue Scale (VAS)

A standard horizontal VAS, 0 to 100mm, was used to assess patients' perceived pain [17-19].

2.1.1.2 European Quality of Life (EQ-5D)

EQ-5D was used to assess patients' perceived health-related QoL [20]. In our study, only one part of the EQ-5D, the EQ was used, which measures General State of Health (GSH).

2.1.1.3 Neck Disability Index (NDI)

NDI was used to assess patients' perceived neck-related disability [21]. The scores from each of the ten sections (pain intensity, personal care, lifting, reading, headaches, concentration, work, driving, sleeping and recreation) were summarised, and divided by the number of sections answered. To present NDI as a percentage, we then multiplied by 100 [22].

2.1.1.4 Oswestry Disability Index (ODI)

ODI was used to assess patients' perceived low back-related disability [22]. The scores from each of the ten sections (pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life and travelling) were summarised, divided by the number of sections answered, and multiplied by 100 [22].

2.1.2 Magnetic resonance imaging (MRI)

The MRI apparatus used was a 1.0 Tesla scanner (Philips Intera) with dedicated phased array spinal coil to produce sagittal and axial T1 and T2 spin echo sequences (slice thickness 3mm, interslice gap 0.3mm, fields of view 25cm for sagittal and 16cm for axial images) [16]. Each Intervertebral disc was assessed according to the classification used by the neuroradiologists at Ersta radiological clinic at the time of the study (Appendix 1-3). The following was assessed: disc height, water content, presence of rim sign, and protuberance grade into various anatomic structures (extra for a minal, for a minal, lateral recess and medial). Disc water content was assessed for each disc in reference to surrounding discs and was classified as 0 (normal), 1 (slight reduction) or 2 (significant reduction). The same grading system was used for disc height. Disc water content was assessed as slightly reduced if the disc was grey or light dark on the MRI scan, and significantly reduced if the disc was very dark or black. Reduction in disc height less than 50% was assessed as slight, and reduction more than 50% was assessed as significant (Appendix 4).

2.2 Data Analysis and Statistics

The disc water content grade for the cervical (C1-Th1) and lumbar (L1-S1) spinal segment was summarised for each patient, and the sum was subsequently correlated to ratings of EQ, VAS, NDI and ODI. This method of summarising the disc water grades and disc height was created specifically for this study, with the purpose of assessing the total reduction in disc water content and disc height. With this grading system, a higher sum corresponded to greater reduction of disc water content. The same method was used for disc height.

Spearman rank correlation was used to determine the correlation of disc water content/disc height with rating scales, since the variables are ordinal. The correlation of EQ with VAS and NDI/ODI was also analysed using Spearman rank correlation. The correlation coefficients (ρ) were classified as "very strong" (ρ> 0.8), "moderately strong" (ρ = 0.6-0.8), "fair" (ρ = 0.3-0.5) and "poor" (ρ< 0.3) [23].Statistical analyses were made with Stata/IC 10. *P*-values < .05 were considered significant.

3. RESULTS

3.1 Patient Characteristics

After exclusion, 88 patients remained, 41 were women and 47 men Table 1. The mean age was 55 years, and the mean pain duration was 15 years. Eight patients had pain duration less than six months and the rest were chronic pain patients, having a pain duration surpassing six months [24]. The mean rated EQ among the patients was 51. All 88 patients expressed that MRI would provide the explanation of their pain.

Table 1. Patient characteristics (n = 88)

Characteristics	Value
Women, n (%)	41 (47)
Mean age, years ±SD (range)	55±13 (27-80)
Mean duration of pain ±SD years (range)	15 ±14(0-50)
Smokers, n (%)	21 (24)
Patients with spinal nerve involvement†, n (%)	76 (86)
Patients with disc protrusion*, n (%)	78 (89)
Mean BMI (range)	26.5 (19-40)
Mean EQ±SD	51±23
Mean VAS±SD	58±30
Mean NDI±SD	39±16
Mean ODI±SD	36±19

*SD = Standard Deviation, BMI = Body Mass Index, EQ = the VAS part of Euro-Qol-5D, VAS = Visual Analogue Scale, NDI = Neck Disability Index, ODI = Oswestry Disability Index, †assessed by affected sensibility of touch and pin prick, *irrespective of grade*

3.2 Correlation between Disc Water Content and Quality of Life, Pain and Disability

No correlation was found between reduced disc water content and QoL, pain, or disability Table 2.

3.3 Correlation between Disc Height and Quality of Life, Pain and Disability

No correlation was found between reduced disc height and QoL, pain, or disability Table 2.

Table 2. Correlation between disc water content/height and quality of life, pain and disability among the patients referred to MRI of the spine

Correlation	n	Spearman's ρ	*P*
Water content - EQ	88	0.09	.41
Water content - VAS	88	-0.13	.24
Water content - NDI	32	-0.23	.22
Water content - ODI	56	0.18	.18
Height - EQ	88	0.05	.67
Height - VAS	88	-0.11	.30
Height - NDI	32	-0.23	.20
Height - ODI	56	-0.05	.73

Water content = reduction in disc water content, EQ = Euro-Qol-5D Visual Analogue Scale, VAS = Visual Analogue Scale, NDI = Neck Disability Index, ODI = Oswestry Disability Index, Height = reduction in disc height, = P < .05*

3.4 Correlation between EQ and VAS, and between EQ and NDI/ODI

No correlation was found between EQ and VAS (Table 3). Between EQ and NDI a fair negative correlation was found with ρ = -0.50 (*P* = .004). Between EQ and ODI a fair negative correlation was found with ρ = -0.49 (*P*< .001).

Table 3. Correlation between quality of life, pain and disability among patients referred to MRI of the spine

Correlation	n	Spearman's ρ	*P*
EQ - VAS	88	-0.17	.10
EQ - NDI	32	-0.50	.04*
EQ - ODI	56	-0.49	< .001*

EQ = the VAS part of Euro-Qol-5D, VAS = Visual Analogue Scale, NDI = Neck Disability Index, ODI = Oswestry Disability Index, = P<.05*

4. DISCUSSION

Patients with spine-related discomfort represents a large patient group, and many of these patients believe that MRI will present the explanation to their discomfort [25]. Our study found that MRI assessed reduced Intervertebral disc water content and disc height cannot alone explain reduced QoL, pain or disability in patients with spine-related discomfort. This finding is consistent with several previous studies [8,9,26,27]. We also found a tendency that QoL correlated stronger with disability than pain, suggesting that disability may have a greater impact than pain on self-perceived QoL.

The correlation between QoL and pain was not significant, however a fair correlation was found between QoL and disability. Disability correlated inversely to QoL, i.e. a higher degree of disability correlated to a lower rating of QoL. The inverse correlation between QoL and disability suggests that QoL and disability are related to each other and that improvement of one of them might lead to improvement of the other. Since no correlation was found between QoL and pain, the fair correlation between QoL and disability might indicate that it is more important to improve disability than pain in order to improve QoL among patients referred to MRI of the spine.

The lack of correlation between QoL and pain in our study contradicts the findings of Kovacs et al. [28]. However, the study by Kovacs et al., consisted of acute or subacute pain patients whereas the majority of the patients in our study suffered from chronic pain. The difference in correlation between QoL and pain in our studies might indicate that QoL and pain correlate more strongly to each other in the initial phase than in a chronic phase. It would be motivated to investigate which sections of NDI/ODI correlate most to QoL, in order to enable the clinician to focus on these sections in the treatment plan.

The correlation between QoL and disability in our study was weaker than in some previous studies [29,30]. In a study by Kovacs [29], disability was measured with Roland-Morris Questionnaire (RMQ), whereas in our study NDI and ODI was used. Both RMQ and ODI are condition-specific measures for back pain and correlate well with each other [31], therefore the strength of the correlation between QoL and disability should not depend on whether RMQ or ODI is used. However, the study by Kovacs et al. included patients with acute or subacute pain whereas in our study all patients except eight suffered from chronic pain. The weaker correlation between QoL and disability in our study compared to the study by Kovacs et al. might indicate that the correlation between QoL and disability is stronger in the initial phase and may weaken over time. If the correlation between QoL and disability weakens over time, one theory may be that the patients find coping strategies which permit them to consider their QoL as good despite a high degree of disability.

All patients in our study expected an explanation of their discomfort through MRI. This mindset among patients with spine-related discomfort may cause physicians to refer for image diagnostics in order to achieve patient satisfaction. This becomesa difficulty if the physician lacks knowledge on how to assess the information gathered through imaging methods. A study on patients with acute low back pain or radiculopathy showed that imaging of the spine did not alter patient care, and patients with knowledge of MRI findings had a sense of decreased well-being [32]. The lack of correlation between disc water content and disc height with QoL, pain and disability respectively in our study indicate that the clinical importance of MRI findings of reduced disc water content and disc height may be questioned. This questioning would be consistent with the conclusions of Jarvik et al. [8] and the implication would be that radiologists and clinicians should continue to regard reduced disc water content and reduced disc height as of low clinical importance [7].

A possible explanation to the lack of correlation between MRI findings of reduced disc water content and disc height and QoL, pain and disability might be that these findings are of lower relative clinical importance when they coexist with other MRI findings that may have a higher impact on QoL, pain and disability. This theory is supported by Jarvik et al. who found that disc protrusions have greater clinical importance than reduced disc water content or reduced disc height [8]. Since it is the total amount of QoL, pain, and disability that patients rate, these ratings may not correlate well with reduced disc water content and disc height. Furthermore, damaged discs release chemical factors that may induce pain [33,34] and this may not be visible on MRI. Consequently, physicians should not rely solely upon MRI findings in their assessment of the patient, but try to find other explanations for the patient's discomfort.

A strength four study was that we had no missing data on any single patient, which is otherwise common in clinical studies. A limitation of our study is the relative small number of patients, and another limitation may be that the patient population was not well defined other than that all patients were referred for an MRI of the spine. The patient referrals came from different types of clinics, from general practitioners, orthopedic surgeons and pain

specialists [16]. However, patients suffering from spinal discomfort are a heterogeneous group, and therefore the results of our study may apply to a population of patients referred for MRI of the spine

5. CONCLUSION

No correlation was found between reduced disc water content respectively disc height, and self-rated QoL, pain and disability among patients referred to MRI of the spine. Other variables are therefore needed to explain self-rated QoL, pain, and disability. However it may be important to consider the self-perceived disability of the patients, since disability seems to have a greater impact than pain on self-perceived QoL.

CONSENT

All authors declare that written informed consent was obtained from the patients prior to being included in the study.

ETHICAL APPROVAL

The southern ethical board of the Karolinska Institutet approved the study on 8 December 2003.

ACKNOWLEDGEMENTS

Neuroradiologists Eva Brosjö and Hans Billing made all MRI assessments. Professor Sven-Erik Johansson provided valuable help with the statistical analysis. The Stockholm County Council provided founding for this project.

COMPETING INTERESTS

Authors declare that they have no competing interest exits.

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Appendix 1
MRI protocol, cervical spine

MRI PROTOCOL CERVICAL SPINE **Patient id:**_____ **Patient name:**_____ **Date:**_____

Examination quality: ☐ Good _____
☐ Suboptimal _____
☐ Not conclusive _____

☐ Before reading patient history
☐ After reading patient history

LEVEL	SPINE	DISC			ME-DULLA	SPINAL CANAL	PROTRUSIO / PROTUBERANCE GRADE							RESTRICTION TYPE	
		Water content	Height	Rim sign	signal	Spinal-stenosis	dx extra-foraminal	dx foraminal	dx lat recess	MEDIAL paramedial	sin lat recess	sin foraminal	sin extra-foraminal	Disk Ligament	Bone
C 1-2															
C 2-3															
C 3-4															
C 4-5															
C 5-6															
C 6-7															
C7-Th1															
Th 1-2															
Th 2-3															
Th 3-4															
Grading:		- normal decreased: 1 slight 2 significant	- normal decreased: 1 slight 2 signif.	- absent 1 present	- normal 1 increa.	- absent 1 slight 2signif.	- normal 1 slight 2 significant	- normal 1 slight 2 significant	- normal 1 slight 2 to nerve 3 deranging nerve	- normal 1 slight 2 to dura/ medulla 3 deranging dura med.	- normal 1 slight 2 to nerve 3 deranging nerve	- normal 1 slight 2 significant	- normal 1 slight 2 significant	- normal 1 bulging 2 hernia 3 sequest	- normal 1 vertebra 2 interver-tebral

COMMENT:

A deg. SI change
B infection (spondylitis)
C fracture
D intra osseous disc hernia
E hemangioma
F met / destruction
G olisthesis
H scoliosis
X other (see comment)

1 insignif. (inative)
2 significant (active)
- not applicable

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Radiologist name: .....

Appendix 2
MRI protocol, thoracic spine

MRI PROTOCOL **Patient id:**_____ **Patient name:**_____ **Date:**_____
THORACAL SPINE

Examination quality: □ Good _____
□ Before reading patient history □ Suboptimal _____
□ After reading patient history □ Not conclusive _____

LEVEL	SPINE	DISC			MEDULLA	SPINAL CANAL	PROTRUSIO / PROTUBERANCE GRADE							RESTRICTION TYPE	
		Water content	Height	Rim sign	signal	Spinal-stenosis	dx extra-foraminal	dx foraminal	dx lat recess	MEDIAL paramedial	sin lat recess	sin foraminal	sin extra-foraminal	Disk Ligament	Bone
C 6-7															
C7-Th1															
Th 2-3															
Th 3-4															
Th 4-5															
Th 5-6															
Th 6-7															
Th 7-8															
Th 8-9															
Th 9-10															
Th10-11															
Th 11-12															
Th12-L1															
L1-2															
Grading:		- normal decreased: 1 slight 2 significant	- normal decreased: 1 slight 2 signif.	- absent 1 present	- normal 1 increa.	- absent 1 slight 2signif.	- normal 1 slight 2 significant	- normal 1 slight 2 significant	- normal 1 slight 2 to nerve 3 deranging nerve	- normal 1 slight 2 to dura/ medulla 3 deranging dura/med.	- normal 1 slight 2 to nerve 3 deranging nerve	- normal 1 slight 2 significant	- normal 1 slight 2 significant	- normal 1 bulging 2 hernia 3 sequest	- normal 1 vertebra 2 interver-tebral

COMMENT:

A deg. SI change
B infection (spondylitis)
C fracture
D intra osseous disc hernia
E hemangioma
F met / destruction
G olisthesis
H scoliosis
X other (see comment)

1 insignif. (inative)
2 significant (active)
- not applicable

.....
.....
.....

Radiologist name:.....

Appendix 3
MRI protocol, lumbar spine

MRI PROTOCOL LUMBAR SPINE **Patient id:**_____ **Patient name:**_____ **Date:**_____

□ Before reading patient history
□ After reading patient history

Examination quality: □ Good _____
□ Suboptimal _____
□ Not conclusive _____

LEVEL	SPINE	DISC			MEDULLA	SPINAL CANAL	PROTRUSIO / PROTUBERANCE GRADE							RESTRICTION TYPE	
		Water content	Height	Rim sign	signal	Spinal-stenosis	dx extra-foraminal	dx foraminal	dx lat recess	MEDIAL paramedial	sin lat recess	sin foraminal	sin extra-foraminal	Disk Ligament	Bone
Th 9-10															
Th 10-11															
Th 11-12															
Th12-L1															
L1-2															
L2-3															
L3-4															
L4-5															
L5-S1															
(L5-6)															
Grading:		- normal decreased: 1 slight 2 significant	- normal decreased: 1 slight 2 signif.	- absent 1 present	- normal 1 increa.	- absent 1 slight 2signif.	- normal 1 slight 2 significant	- normal 1 slight 2 significant	- normal 1 slight 2 to nerve 3 deranging nerve	- normal 1 slight 2 to dura/ medulla 3 deranging duramed.	- normal 1 slight 2 to nerve 3 deranging nerve	- normal 1 slight 2 significant	- normal 1 slight 2 significant	- normal 1 bulging 2 hernia 3 sequest	- normal 1 vertebra 2 interver-tebral

A deg. SI change
B infection (spondylitis)
C fracture
D intra osseous disc hernia
E hemangioma
F met / destruction
G olisthesis
H scoliosis
X other (see comment)

1 insignif. (inative)
2 significant (active)
- not applicable

COMMENT:

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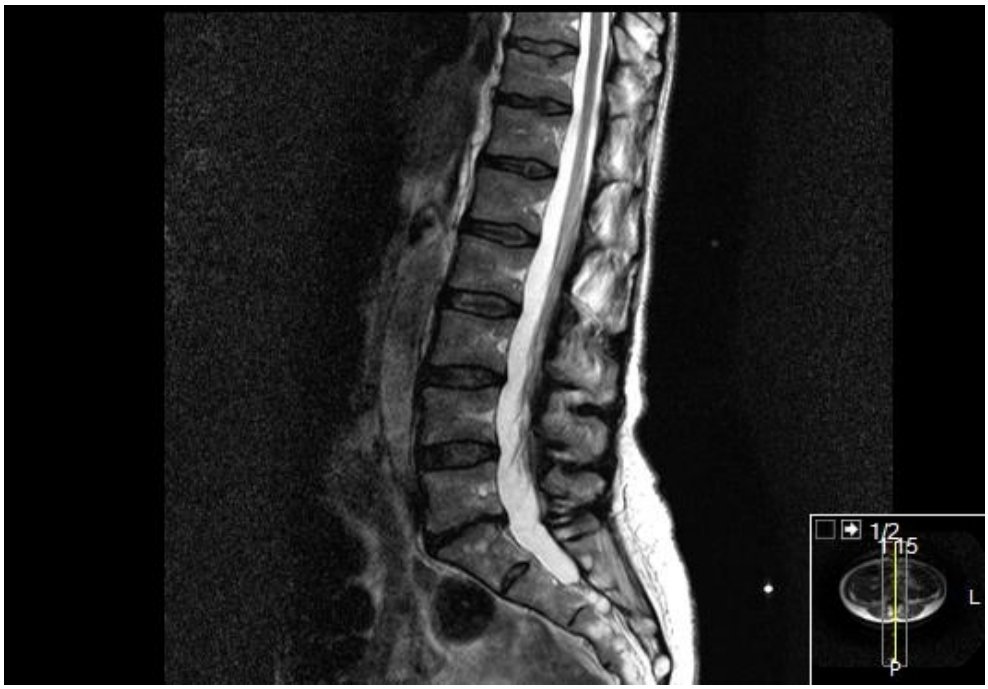
Appendix 4

MRI lumbar spine, sagittal T2 weighted image. Disc water content and height of disc L5-S1 was assessed as grade 2 (significantly decreased).



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