



Contribution of the T2 Turbo Spin Ultrasound Sequence to Low Field Magnetic Resonance Imaging in the Staging of Lumbar Disc Desiccation in Kinshasa Hospitals

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How to cite this paper: Iyoto, D.M.-M., Mukaya, J.T., Tshibasus, F.T., Yanda, S.T., Kikunda, P., Makwanza, L., Ndaie, G., Mawalala, H.M., Nseka, O.Z., Nkodila, A.N., Molua, A.A. and Lelo, M.T. (2024) Contribution of the T2 Turbo Spin Ultrasound Sequence to Low Field Magnetic Resonance Imaging in the Staging of Lumbar Disc Desiccation in Kinshasa Hospitals. *Open Access Library Journal*, 11: e12272.

<https://doi.org/10.4236/oalib.1112272>

Received: September 9, 2024

Accepted: October 25, 2024

Published: October 28, 2024

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Abstract

Background: Grading inter-vertebral disc degeneration (IDD) is important in the evaluation of many degenerative conditions, including patients with low back pain, but data on the pathology in sub-Saharan Africa are limited. The objective of this study is to evaluate the contribution of the T2 turbo spin ultrasound sequence on low-field Magnetic Resonance Imaging (MRI) in the staging of lumbar disc desiccation in hospitals in Kinshasa. **Methods:** Single-center analytical cross-sectional study of lumbar MRI examinations of 81 patients or 405 disc segments, performed over a 16-month period from December 2022 to January 2023 at the Diamant Ngaliema medical center using a 0.4 Tesla MRI. **Results:** A total of 81 patients were examined by MRI for chronic low back pain. Lumbar disc herniation was common in men (50.6%), in an age range between 50 and 59 years (27.2%). Disc desiccation was ubiquitous in all age groups in more than 85% of cases, with a predominance at the lumbosacral junction (91.4%). Pfirrmann grade II was most commonly found in the 50 - 59 age group, followed by grade III in the 60 - 69 age group and for those over 70 years, grade IV. **Conclusion:** Lumbar disc degeneration is the hub of degenerative disc diseases that can affect all disc levels at any age, with a predominance in middle-aged and older adults. MRI remains the modality of choice providing

precision in the study of lumbar disc degeneration.

Subject Areas

Orthopedics

Keywords

Lumbar Disc Herniation, MRI, Disc Desiccation, Pfirrmann, Low Back Pain

1. Introduction a Process of Progressive Deterioration of the Intervertebral Disc

Lumbar disc herniation is a process of progressive deterioration of the intervertebral disc, and it constitutes a global health issue affecting a diverse population across different regions of the globe [1] [2].

Understanding its impact and prevalence is essential for establishing prevention strategies in its management. Lumbar disc herniation (LDH) is counted among the spinal degenerative pathologies whose hub, is disc degeneration [3], the latter is defined as a process characterized by an alteration of the structure and function of the intervertebral disc, often associated with aging, trauma or overuse, which can lead to a loss of disc height, an alteration of its composition and a decrease in its functionality [4].

Also, some African studies have shown that degenerative damage to the lumbar spine, with frequencies ranging from 29.59% to 40%, is far from exceptional [5] [6].

Polymorphic and often multifactorial lumbar disc degeneration (LDD) is expressed sooner or later in 80% of the Western population. Banal spinal pain and radiculalgia with favorable evolution spontaneously or under medical treatment do not justify any recourse to an imaging examination. Nevertheless, it is reserved for painful symptoms not controlled by usual analgesic treatments [3].

Despite knowledge of the structure of the intervertebral disc, LDD is considered one of the main sources of lumbar pain [4]. A certain study, LDH could represent between 1% and 30% of cases of low back pain, with radicular involvement in 25% of patients [7].

Technological advances in medical imaging, including Magnetic Resonance Imaging (MRI), have improved the diagnosis of this condition by providing detailed images of the soft tissues of the spine, thus facilitating the management of patients with lumbar disc herniation. However, despite the importance of MRI in the diagnosis of lumbar disc degenerative pathologies, no study has yet specifically addressed this context in our country. This study aims to evaluate the MRI profile of lumbar disc desiccation, in order to determine the sociodemographic characteristics of Congolese patients with chronic low back pain, to evaluate the diagnostic performance of the T2 TSE sequence on low-field MRI in the staging of lumbar disc desiccation in Congolese patients, and to determine the different

stages of disc desiccation according to disc segments and age. This analysis will allow us to better understand the place of DDL, studied on low-field MRI, in the management of LDH in our environment. The objective of this study is to evaluate the contribution of the T2 turbo spin ultrasound sequence on low-field Magnetic Resonance Imaging (MRI) in the staging of lumbar disc desiccation in hospitals in Kinshasa.

2. Methods

2.1. Study Design, Setting and Period

This descriptive study was conducted at the Diamant Medical Center of Kinshasa (CMD Kinshasa), a private health facility on 2366 Colonel Monjiba Commune of NGaliema 2022 to December 2023, an overall study period of 2 months. Study participants were patients with lumbar disc desiccation, confirmed by lumbar MRI, and initially consulting for chronic low back pain. These patients were referred from various health facilities in Kinshasa to undergo lumbar MRI.

A total of 1000 patients with chronic low back pain (from the CMD or other health facilities) were assessed for their eligibility for the study. Among them, 221 underwent MRI and 81 were confirmed to have a herniated disc by MRI. Of these 81 patients, 405 lumbar disc segments were evaluated in our study. These patients were randomly selected from a list of patients attending the hospital who had undergone the MRI examination.

2.2. Inclusion Criteria

Any patient with chronic low back pain who had undergone an MRI with or without radicular pain in the lower limbs was included in this study. Any patient with a history of spinal trauma, surgery, congenital malformations, inflammatory and tumoral pathologies of the spine was excluded from this study. Any claustrophobic patient, any patient with a metal implant or other contraindications to MRI.

2.3. Image Acquisition

Image acquisition was performed using a HITACHI APARTO lucent 0.4 Tesla MRI with low open field and permanent magnetism. T1-weighted turbo spin echo (TSE), T2-weighted TSE and STIR sequences were performed on sagittal and axial slices with acquisition parameters including sagittal T1-weighted TSE (TR 650 ms, TE 6.3 ms) and T2-weighted TSE (TR 4500 ms, TE 101 ms) sagittal STIR (TR 3800 ms, TE 35 ms, IR 215 ms) and axial T2 (TR 5000 ms, TE 116 ms) with a 4 mm thickness and a 1 mm inter-slice spacing. Sagittal sequences used a 320 mm FOV with an axial axis of 200 mm (Hancock *et al.* 2015); gadolinium injection was mainly used. Image data measurement and processing.

The images were interpreted by MRI diagnosticians who will correlate the sequences obtained with the phenomenon of vertebral disc degeneration, which is a time-dependent dynamic according to the PFIRRMANN classification.

The interpretation was made on the basis of T2-weighted midsagittal slices.

2.4. Observation Indicator

Herniated disc refers to a condition where the gelatinous nucleus of the intervertebral disc extends beyond its normal limits, which can exert pressure on adjacent nerves and cause symptoms such as pain, numbness or weakness [8].

Desiccation or degeneration of the disc or degenerative disc disease is a process characterized by an alteration of the structure and function of the intervertebral disc, often associated with aging, trauma or overuse, which can lead to a loss of disc height, an alteration of its composition and a decrease in its functionality [4].

The PFIRMANN classification is a scoring tool to assess intervertebral disc degeneration based on its structure, signal intensity of the annulus fibrosus and nucleus pulposus, disc height, and the clarity of the boundaries between the intervertebral disc [9]. (Table 1)

Table 1. Characteristics of discs for each grade.

Grade	Structure	Distinction of nucleus and annulus	Signal intensity	Height of intervertebral disc
I	Homogenous bright white	Clear	Hyperintense, isointense to cerebrospinal fluid	Normal
II	Inhomogenous with or without horizontal bands	Clear	Hyperintense, isointense to cerebrospinal fluid	Normal
III	Inhomogenous, grey	Unclear	Intermediate	Normal to slightly decreased
IV	Inhomogenous, grey to black	Lost	Intermediate to hypointense	Normal to moderately decreased
V	Inhomogenous, black	Lost	Hypointense	Collapsed disc space

2.5. Data Collection

Data collection consisted of a documentary review of the medical records of patients who had been referred to the CMD for lumbar MRI. Relevant information was extracted from the patients' medical records using a pre-established form defining the key variables of the study. To ensure data quality, data collection was carried out by two CM Diamant technicians trained in the study methodology, under the supervision of the principal investigator.

2.6. Statistical Analyzes

The data were entered using Excel 2010 software, after checking consistency and quality, they were exported to SPSS 21 for analysis. Descriptive statistics consisted of calculating the mean and standard deviation for quantitative data and percentages for categorical data. The chi-square test was used to compare proportions and the Student's *t* test to compare means. The value of $p < 0.05$ was considered the threshold for statistical significance. The notion of confidentiality was essential for our study, the data were collected anonymously, and were only used for the writing of this work.

2.7. Ethical Considerations

To carry out this study, the protocol was submitted to the scientific committee of the Department of Radiology and Medical Imaging as well as to the ethics committee of the School of Public Health of the University of Kinshasa acting as the national ethics committee (Approval number: ESP/CE/079/2023).

3. Results

Of the 81 patients who underwent MRI for chronic low back pain concluding with a herniated disc following DDL, male gender was predominant, with 41 men (50.6%) with a mean of 55.5 years compared to 40 women (49.4%) with a mean of 52.5 years. The majority of patients were in the age categories between 40 and 69 years, with the 50 to 59 age group (27.2%) being the most affected, followed by the 60 to 69 age group (23.5%). The mean age of all patients included in the study was 54.0 years, with a standard deviation of ± 16.8 years (**Table 2**).

Table 2. Distribution of patients according to age group.

Variables	n (%)
Sex	
Male	41 (50.6)
Female	40 (49.4)
Age range (years)	
<10	2 (2.5)
10 - 19	2 (2.5)
20 - 29	2 (2.5)
30 - 39	9 (11.1)
40 - 49	12 (14.8)
50 - 59	22 (27.2)
60 - 69	19 (23.5)
≥ 70	13 (16.0)
Mean $\pm$ SD of age	54.0 $\pm$ 16.8
Mean $\pm$ SD of age of men	55.5 $\pm$ 18.8
Mean $\pm$ SD of age of women	52.5 $\pm$ 14.4

3.1. Types of Disc Desiccation by Disc Segment of the Lumbar Spine

Of the 405 disc levels of 81 patients who underwent lumbar MRI for chronic low back pain. Disc desiccation was found in all levels, with a more noticeable presence at the L5-S1 level at 91.4%. Desiccation was observed more in the 40 to over 70 age group, with a predominance in the 50 - 59 age group at 27.2% ($p = 0.033$) (**Table 3**).

Table 3. Distribution of patients according to types of disc desiccation by disc segment of the lumbar spine.

Variables	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1
Disc desiccation					
Present	71 (87.7)	72 (88.9)	71 (87.7)	72 (89.9)	74 (91.4)
Absent	10 (12.3)	9 (11.1)	10 (12.3)	9 (11.1)	7 (8.6)
Desiccation grade					
Grade I	6 (7.4)	6 (7.4)	5 (6.2)	4 (4.9)	7 (8.6)
Grade II	37 (45.7)	33 (40.7)	27 (33.3)	17 (21.0)	21 (25.9)
Grade III	20 (24.7)	17 (21)	21 (25.9)	27 (33.3)	22 (27.2)
Grade IV	8 (9.9)	16 (19.8)	18 (22.2)	24 (29.6)	24 (29.6)
Total	71 (87.7)	72 (88.9)	71 (87.7)	72 (88.9)	74 (91.4)

3.2. Age Group and Disc Desiccation

Regarding the grades of disc desiccation observed, it is noted that grade II predominated from the L1-L2 level to the L3-L4 level; at the L4-L5 level, there was a predominance of grade III and the L5-S1 level showed more grade IV. We note that grade V was not found in our study. Pfirrmann grade II was most commonly found in our study for the 50 - 59 age group, followed by grade III for the 60 - 69 age group and for those over 70, grade IV ($p = 0.001$) (**Table 4**).

Table 4. Distribution of patients by age group and disc desiccation.

Age group	Disc desiccation absent	Disc desiccation present				Total
		Grade I	Grade II	Grade III	Grade IV	
<10 years	1 (1.2)	0 (0.0)	1 (1.2)	0 (0.0)	0 (0.0)	2 (2.5)
10 - 19 years	1 (1.2)	1 (1.2)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.5)
20 - 29 years	0 (0.0)	1 (1.2)	1 (1.2)	0 (0.0)	0 (0.0)	2 (2.5)
30 - 39 years	3 (3.7)	0 (0.0)	4 (4.9)	2 (2.5)	0 (0.0)	9 (11.1)
40 - 49 years	3 (3.7)	1 (1.2)	6 (7.4)	1 (1.2)	1 (1.2)	12 (14.8)
50 - 59 years	2 (2.5)	2 (2.5)	12 (14.8)	5 (6.2)	1 (1.2)	22 (27.2)
60 - 69 years	0 (0.0)	1 (1.2)	6 (7.4)	10 (12.3)	2 (2.5)	19 (23.5)
≥70 years	0 (0.0)	0 (0.0)	7 (8.6)	2 (2.5)	4 (4.9)	13 (16.0)
Total	10 (12.3)	6 (7.4)	37 (45.7)	20 (24.7)	8 (9.9)	81 (100.0)

4. Discussion

4.1. Patient Demographics

The prevalence of degenerative disc disease increases linearly with age. And by the age of 70, 80% of lumbar discs deteriorate [10], however the primary cause of disc degeneration is tissue weakening due mainly to aging, poor diet, mechanical stress and even genetics [10] [11]. Our study showed that 54 out of 81 patients were 50 years and older with a mean age ($\pm$ SD) of 54 years ($\pm$ 16.8), ranging from 4 to 83 years, with a male predominance. The age of patients included in our study is similar to those of other studies, namely A. Dubuisson in Sart-Tilman in Belgium in 2012 and Samartzis *et al.* in Hong Kong, China, who reported mean patient ages of 38, 41.1, and 56.4 years, respectively [12] [13]. Combining these data with the previous interpretation, it is clear that degenerative disc disease is a pathology that mainly affects middle-aged adults, with a higher incidence in men than in women. The prevalence of degenerative disc disease appears to increase with age, peaking in patients aged 50 to 69 years. [11] [13]

4.2. Age and Intervertebral Disc Desiccation

In a previous study, the most observed MRI changes in the lumbar spine were intervertebral disc desiccation with 82.5% according to Binit dey *et al.* in Birâtnagar, Nepal in 2022, occurring preferentially in the L5-S1 disc segments in the middle-aged and elderly age groups, *i.e.* the 36 - 55 and 56 - 91 age groups, with a respective prevalence of 43.87% and 32.25%. [14]

Our results were similar to those of this previous study, where our analyses reported a high frequency in the L5-S1 disc segments in 91.4% of cases. The most implicated age groups in our study were those over 40 years old, with a predominance for the 50 - 59 age group at 27.2% of cases. Some studies have reported age-related disc changes, such as decreased disc height, decreased proteoglycan content, and dehydration of the annulus fibrosus [15] [16].

Wei Wang *et al.* report that during the age group of 40 - 50 years, the rate of proteoglycans gradually decreases, which would justify a restriction of the movement of water with a tendency to cracking of the intervertebral disc [11].

4.3. Disc Desiccation and Lumbar Spine Levels

In our study, disc desiccation was present at all levels in more than 85% of cases, with a predominance at the L5 - S1 level (91.4%).

For each vertebral level of the lumbar spine (from L1 to S1), there is variability in the prevalence of the different desiccation grades of the intervertebral discs (Grades I, II, III and IV). We would like to point out that our study was carried out on an African population knowing that the latter is relatively made up of a young population. This hypothesis justifies the absence of Pfirrmann grade 5 in our observations. In our analyses, grade II predominated from the L1-L2 level to the L3-L4 level; at the L4-L5 level, there was a predominance of grade III, and the

L5-S1 level showed more grade IV. This distribution varies from one level to another. For example, at the L1-L2 level, grade II is the most frequent with 52.1%, followed by grade III with 28.2%, while at the L5-S1 level, grade III is the most frequent with 29.7%, followed by grades IV (32.4%) and II (28.4%). Our results corroborate those of and those of Pfirrmann *et al.* in Zurich, Switzerland in 2001 who found 240 cases of grade II and 82 grade II discs, respectively. There is also a trend towards an increasing prevalence of intervertebral disc desiccation grades towards the lower levels of the lumbar spine, with a more balanced distribution between grades I, II, III and IV. Our results support the hypothesis that the upper (L1-L2 and L2-L3) and middle (L3-L4) lumbar levels are less subject to mechanical stress than the distal (L4-L5 and L5-S1) levels [11] [17]. In summary, this analysis provides a better understanding of the distribution of different types of intervertebral disc desiccation in the lumbar spine and provides useful information for assessing degenerative changes associated with this region of the spine.

4.4. Limitation of the Study

The present study showed some limitations such as the small sample size due to the high cost and difficult accessibility of MRI, therefore, further studies with a larger sample size are needed. There is a lack of a gold standard for staging disc desiccation, especially with biochemical and histological methods. Although the PFIRRMANN scoring system presented excellent agreement, this method only provided a morphological and semi-quantitative assessment of disc degeneration. The mono-centric nature of our study means that the results cannot be generalised to the entire province of Kinshasa. In addition, the nature of the cross-sectional study does not allow a causal link to be established.

4.5. Merit of the Study

This study provides significant information on lumbar desiccation in the specific context of the DRC, highlighting its implications on the adult population and emphasizing the need for management strategies adapted to this particular context.

5. Conclusion

Disc degeneration is the hub of degenerative disc diseases that can affect all disc levels at any age with a predominance in middle-aged and older adults. Magnetic resonance imaging remains the modality of choice, providing precision in the study of disc degeneration. Based on the data collected in this study, several findings are worth highlighting: the impact on middle-aged and older adults, particularly those of working age and contributing to the economy. And the presence of various types of desiccation: the results reveal a variability in the types of desiccation of the intervertebral discs, highlighting the complexity of this degenerative disc disease in our environments. This diversity of clinical presentations requires an individualized approach in patient management.

Acknowledgements

We would like to thank all those who accompanied us in the data collection as well as in the writing of this article; especially the doctors of center of Diamant hospital, who willingly approved and supervised the collection of data for this study.

Author Contributions

Design and concept of the study: DMI, JTM and MTL. Acquisition of data: FTT, STY, PK, LM, GN. Manuscript draft: HMM, OZN. Analysis and interpretation of data: ANN and HMM. Final manuscript revision and approval: AAM, JTM and MTL.

Data Availability

Because the consent given by study participants did not include data sharing with third parties, anonymized data can be made available to investigators for analysis at a reasonable request from the corresponding author.

Declarations

Ethics Approval and Consent to Participate

This study was reviewed and approved by the ethics committee of the School of Public Health of the University of Kinshasa acting as the national ethics committee (Approval number: ESP/CE/079/2023), and all included patients provided written informed consent. The rules of confidentiality and ethics were respected according to the 1964 Declaration of Helsinki.

Generative AI and AI-Assisted Technologies in the Writing Process

We certify that no artificial intelligence/large language model was used at any stage of this research manuscript writing.

Competing Interests

The authors declare no competing interests.

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