Spine MRI Patterns And Predictors of Disability In Patients With Lower Back Pain. A Prospective Cross-Sectional Study at University of Gondar Comprehensive Specialized Hospital, North West Ethiopia. 2020.

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Abstract

Background: Low back pain (LBP) has become one of the most serious public health problems with substantial socioeconomic implication. Degenerative disc disease one of the commonest cause of LBP. Magnetic resonance imaging (MRI) is routinely utilized in evaluation patients with degenerative changes of the lumbar spine. However there are contradictors reports with regards to association of MRI findings of lumbar spine and patients' symptoms.

Objective: This study is aimed determine correlation of degree of disability with lumbar spine MRI findings in patients with LBP at University of Gondar comprehensive Specialized Hospital (UoGCSH), North West Ethiopia, 2020.

Methods and Materials. A prospective cross-sectional study was conducted on 72 consecutively enrolled patients with lower back pain who underwent lumbar MRI scan. Degree of disability was measured using Oswestry disability Index (ODI) questionnaire translated to local language. Association between lumbar spine MRI parameters and ODI score and category was tested using Spearman's rank correlation coefficient and Chi square tests.

Results The mean age the study subjects was 43.81 ± 1.88 years (range 22-83 years). 59.7% of the study population were Female. In terms of ODI category, most fell under minimal and moderate disability 33 (45.8%) and 25(34.7%) respectively. Disc bulge (81.9%) and foraminal stenosis were the most frequent MRI abnormalities detected. ODI score showed weak correlation with grade of spinal canal stenosis. Foraminal stenosis grade was not correlated ODI.

Conclusion: The clinical relevance of MRI findings in patients with degenerative disc disease is limited and MRI should be sparingly ordered in evaluation of these patients particularly in resource constrained settings.

Introduction

Lower back pain is a major public health problem globally with life time prevalence reaching 11–84% (1). According to the Global Burden of Disease (GBD) report, the population prevalence of lower back pain for all age groups and gender was estimated to be more than half a billion people per year in 2015 and that figure was 17.3% larger compared to the prevalence in 2005. According to the same report lower back and neck pain were the leading global cause of disability in most countries in 2015.(2)

Numerous disease processes could cause lower back pain and disability of which disc disease is the commonest.(3) Disc degeneration can be defined as an aberrant, cell mediated response to progressive structural failure or simply as a degenerate disc that is painful(4). According to the lumbar disc nomenclature version 2.0 intervertebral disc disease is broadly classified in to degeneration and herniation. Degeneration include disc desiccation, disc space narrowing, disc bulge, mucinous degeneration, intradiscal gas and associated bone and marrow changes like endplate sclerosis and

Modic changes. Herniation is defined as focal displacement of disc material involving less than 25% of the disc dimension on axial plane. A more diffuse disc material displacement is referred as disc bulge(5). These disc changes are known to occur more frequently with increasing age.(6, 7). According to Boden et al. the prevalence of disc degeneration on at least one level was 35% and 100% in the age groups 20–39 and 60–80 years respectively.(8) In a different study, MRI detected degenerative disc changes were present in 40% and 90% of under 30years and 50–55years of age respectively(9).

Imaging plays an important role in the diagnosis, pre-surgical evaluation and follow up of patients with low back pain. Plain radiography, myelography, computed tomography (CT) and MRI have traditionally been used to identify morphological changes in the discovertebral unit. Recent advances in MRI have dramatically improved the ability to evaluate the spinal canal and neural structures with reasonable accuracy. Jung-Ha Kim et al. performed metaanalysis on diagnostic accuracy of MRI and CT in reference to surgical finding. The summary estimates for MRI were 81.3% and 77.1% for sensitivity and specificity respectively.(10)

A number of discal, vertebral and neuronal characteristics can be evaluated on MRI and are routinely included in patients' report. According to a systematic review done to estimate and compare prevalence of lumbar spine MRI in asymptomatic and symptomatic patients, disc degeneration (34.4%), protrusion (19.1%) and central canal stenosis (14%) were the most frequent abnormalities in the asymptomatic group whereas in the symptomatic group central canal stenosis (59.5%), disc protrusion (42.2%) and disc bulge (43.2%) were most prevalent(11). Similarly, a hospital based cross sectional study on MRI patterns of disc disease in Black Lion Specialized Teaching Hospital, Ethiopia found that 70.1% patients had disc protrusion and 18.5% had disc bulge. Central type of disc displacements was seen in 61.2%, posterolateral in 15.8% and lateral in 9.3%. Lumbar degenerative disc disease was most frequently seen at L4-L5 and L5/S1 level. (12).

Although MRI could provide ample information on the discovertebral status of patients with lower back pain, the clinical value of MRI parameters in terms of correlation with clinical severity, guiding treatment and predicting outcome of treatment is not clear. Freyr G et al. based on their cohort of 109 consecutive patients reported that spinal canal stenosis measured on MRI correlated poorly with walking distance, level of leg and back pain, Oswestry disability index (ODI) and other measures of quality of life.(13) Vijay G Goni et al. found no correlation between ODI and anteroposterior diameter or cross-sectional area of the spinal canal.(14) Similarly, a retrospective review of 313 patients found no difference in rates of symptoms in MRI positive and MRI negative individuals. The same study however reported statistically significant difference in rate of surgery in the following year.(15) A prospective study of 200 individuals with baseline MRI aimed to determine association of occurrence of new and serious lower back pain episodes and MRI taken around the time of pain revealed no difference in the baseline and follow up MRI. (16) On the other hand a systematic review of 14 studies (3097 subjects) reported that disc bulge (OR – 7.5), spondylolysis (OR- 5.1), disc extrusion (OR – 4.4), disc protrusion (OR – 2.7) and Modic 1 change (OR – 4) were more prevalent in patients with lower back pain compared to that of asymptomatic patients, whereas prevalence of disc extrusion, annular fissure, spondylolisthesis, Modic 2 & 3 changes

and central canal stenosis were not statistically different between the two groups. The study however included individuals less than 50 years of age.(11) Arpinar et al. using dynamic contrast enhanced MRI reported significant correlation between end plate enhancement and degree of disability based on ODI. (17)

Though there have been previous studies on patterns and prevalence of MRI finding from Africa, their clinical significance in terms of level of pain and disability hasn't been explored sufficiently. In this study we purposed to describe lumbar MRI patterns and their association with degree of disability measured using ODI index in a third world setting.

Objectives

The objective of this research is to determine Lumbar spine MRI patterns and their association with Oswestry disability index in patients with lower back pain who presented to Radiology department of University of Gondar Comprehensive Specialized Hospital, northwest Ethiopia, 2020

Methods And Materials

Study Area

University of Gondar comprehensive specialized Hospital is located in Gondar town, North West part of Ethiopia, 738 km from Addis Ababa. Gondar town is the capital of Central Gondar zone of Amhara Region. The Hospital is a major tertiary teaching Hospital giving service to over five million population across the region.

The Department of Radiology provides diagnostic and basic interventional services. The department is equipped with two multi-detector CT scans (64 and 4 slice CT scans), one 1.5 tesla MRI, multiple multipurpose ultrasound machines and 2 Digital radiography machines.

Study design

Hospital based prospective cross sectional study design was employed for this study.

Study Period.

The study was conducted between June and September 2020.

Source and study population

Study population

All patients with lower back pain referred to the radiology department of UoG CSH for a lumbar spine MRI scan.

Inclusion and exclusion criteria

Inclusion criteria

All patients above 20 years of age who had history of lower back pain who were referred for lumbar spine MRI and consented to be part of the study were included.

Exclusion criteria

Patients with Previous lumbar spine operation, patients with non-degenerative cause of lower back pain and patients with contraindication for MRI or unable to complete lumbar spine exam were excluded.

Variables of the study

Dependent variable:

Oswestry Disability Index (ODI) is the outcome variable. ODI is a questionnaire containing 10 sections with six statements in each sections. The statements are scored from 0 to 5 depending on degree of pain and disability. Functional impairments such as personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and travelling are assessed in the questionnaire. ODI is a simple, condition-specific, and preferred multidimensional tool because patients can easily comprehend the form. Patients with a score of 0–20% disability are considered minimally disabled, meaning patients can cope with most living activities. A score of 21–40% meant patients are classified as moderately disabled, and these patient experience more pain and difficulty with sitting, lifting, and standing. Travel and social life are more difficult, and personal care, sexual activity, and sleeping are not grossly affected. A score of 41–60% meant patients are considered severely disabled. Severely disabled patients have increased pain intensity that impacts routine functions. A score of 61–80% puts a patient in the category of disabled requiring positive intervention. Finally, a score of 81–100% refers to a patient who is bedridden.(18)

Independent variables:

Sociodemographic variables included age and sex. Lumbar spine MRI parameters including but not limited to intervertebral disc desiccation, bulge, protrusion, Modic change, spinal canal narrowing, neural foraminal narrowing and degree of narrowing were recorded for every patient. The highest grade of canal and foraminal stenosis was taken for comparison with ODI. The grading and operational definitions used for the MRI parameters are described next.

Neural foraminal stenosis refers to the narrowing of the bony exit of the nerve root caused by a decrease in the height of an intervertebral disk, osteoarthritic changes in the facet joints, cephalad subluxation of the superior articular process of the inferior vertebra, and buckling of the ligamentum flavum or protrusion of the annulus fibrosus.

Grade 0

refers to normal neural foramen (normal dorsolateral border of the intervertebral disc, normal form of epidural fat, no significant ligamentum flavum hypertrophy or facet joint arthrosis or osteophytes from foraminal margin).

Grade 1

defined as mild foraminal stenosis with partial effacement of perineural fat and preserved nerve root.

Grade 2

defined as moderate foraminal stenosis perineural fat obliteration in both longitudinal and transverse plane without compression of the exiting nerve root.

Grade 3 referred to severe foraminal stenosis showing circumferential effacement of perineural fat and nerve root compression(19)

Spinal canal stenosis was graded from mild to severe as follows:

Grade 0 – No lumbar stenosis

Grade 1 - Mild stenosis with separation of all cauda equina.

Grade 2 - Moderate stenosis with aggregation of some of the cauda equina

Grade 3 - Severe stenosis with none of the cauda equina separately visible.(20)

Modic changes which refers to vertebral end plate signal changes as a result of degeneration was graded as:

Modic type 1

low signal intensity on T1WI and high on T2WI, representing fibrovascular tissue, inflammatory changes and edema.

Modic type 2

high signal intensity on T1WI and iso-intense/high on T2WI, representing bone marrow replacement by fat.

Modic type 3

low signal intensity on both T1WI and T2WI, representing reactive sclerosis.

Disc desiccation: is classified as:-

Focal disc desiccation

involvement of two or less than two discs.

Multifocal disc desiccation

involvement of greater than two discs.

Sample size and sampling procedure

All eligible patients who presented to the Radiology department with in the study period were enrolled consecutively. A total of 72 patients who fulfilled the inclusion criteria were finally included in the study.

Data collection procedure

All the lumbar spine MRI scans were taken using 1.5Tesla Philips Achieva MRI machine by experienced radiographic technicians. Axial and sagittal T1 & T2 weighted and sagittal STIR sequences were taken for the vertebral segments L1 to S1. No contrast was used for the MRI studies. Scanned spine MRI studies were interpreted by a senior general radiologist.

Data on degree of disability was obtained by interviewing patients using an ODI questionnaire translated to local language. A semi-structured questionnaire was used to document all the other relevant socio demographic and imaging variables.

Data processing and analysis

Data was checked for completeness and cleaned before analysis. No missing data was identified in the dataset. Descriptive statistics is presented in the form of frequencies and percentages for categorical variables and summary statistics for continuous variables. The dependent variable (ODI) was tested for normality using the Shapiro-Wilk Test and showed a skewed distribution. Spearman's non-parametric correlation was applied to determine the relationship between MRI parameters and OSI score. Chi square test was applied when comparing ODI category and categorical independent variables. Statistical significance was assumed if calculated p-value was below 0.05. Data entry and analysis was carried out using IBM SPSS Statistics for Windows, Version 19.0 (IBM Corp, Armonk, NY) and Stata, version 16 (Stata Corp) respectively.

ETHICAL CONSIDERATIONS

Ethical approval

was obtained from School of Medicine Ethical Review Committee, College of Medicine and Health Sciences, University of Gondar. Written informed consent was obtained from the study participants before the study. Participants were informed about the purpose of the research and that they have full right to refuse, withdraw or completely reject part or all of their participation in the study. Participants were also assured that their treatment and relation with the hospital and/or other organizations were not be influenced by their withdrawal from the study. Confidentiality were ensured using anonymous checklist

and questionnaire. The study followed the Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) guideline.

Results

Sociodemographic & Clinical Characteristics

Out of the 72 participants 43 (59.7%) were female. Mean age of patients in this study was 43.8 ± 1.9 years (range 22–83years). The median duration of lower back pain among participants was 2years (IQR 0.5–4years). Figure 1

MRI characteristics

Disc bulge (81.9%), Foraminal stenosis (65.3%), disc desiccation (54.2%), Disc herniation (41.7%) and spinal canal stenosis (41.7%) were the most frequent MRI findings in our study in that order. Modic change was identified in 19.4% of the study subjects. L4/L5 and L5/S1 levels were where the above abnormalities most concentrated.

Foraminal Stenosis

Forty seven (65.3%) of total (n = 72) patients showed neural foraminal stenosis ranging from mild to severe stenosis. Mild neural foraminal stenosis was observed in thirty (41.7%), Moderate neural foraminal stenosis in ten (13.9%) and Severe stenosis in seven (9.7%) cases. L4/L5, L5/S1 and L3/L4 levels were involved in forty three (65.3%), twenty three (31.9%) and sixteen (22.2%) respectively.

Spinal canal stenosis

MRI scan of thirty patients (41.7%) demonstrated mild to severe degree of spinal canal stenosis. Mild, moderate and severe stenosis was observed in 13(18.1%), 11(15.3%) and 6(8.3%) of patients respectively. Spinal canal stenosis was most frequent at L4/L5, L5/S1 and L3/L4 levels with frequency of 37.5%, 19.4% and 15.3% respectively.

Disc bulge

Fifty cases (81.9) in the study showed disc bulge. L4-L5 level involvement accounted for 65.3% of all. Fifty five percent at L5/S1 and L3/L4 involvement was seen in twenty 29.2%.

Disc herniation

Thirty cases (41.7%) of the total 72 patients showed disc herniation. Central disc herniation was the commonest type observed in twenty one cases (29.2%); paracentral herniation was seen in nine cases (12.5%). Disc herniation was most frequently observed at L4/L5, L5/S1 and L3/L4 levels with a frequency distribution of eighteen (25%), thirteen (18.1%) and six (8.3%) respectively.

Modic change

Modic change was present in 14 (19.4%) of the studies. Type II Modic change was the predominant type accounting for 86% (12 out of the fourteen). L3-L4 (11.1%) segment was the most frequently involved followed by L2/3 (4/14) & L4/5 (4/14). Summary of the MRI patterns and ODI categories is presented in Table 1

Table 1
Frequency distribution of MRI parameters
and ODI category

Variables	Freq	Percent
Disc bulge	59	81.90%
Foraminal stenosis	47	65.30%
Grade 0	25	34.70%
Grade 1	30	41.70%
Grade 2	10	13.40%
Grade 3	7	9.70%
L1-L2	1	2.10%
L2-L3	2	4.30%
L3-L4	16	34%
L4-L5	43	91.50%
L5-S1	23	48.90%
Spinal canal stenosis	30	41.70%
Grade 0	42	58.30%
Grade 1 13	13	18.10%
Grade 2	11	15.30%
Grade 3	6	8.30%
L1-L2	1	3.30%
L2-L3	1	3.30%
L3-L4	11	36.70%
L4-L5	27	90%
L5-S1	14	46.70%
Disc herniation	30	41.70%
Central	21	70%
Paracentral	9	30%
Modic Change	14	19.40%
Type one	1	7.10%

Variables	Freq	Percent
Type two	12	85.70%
Type three	1	7.10%
ODI GROUP		
minimal disability	33	45.80%
Mod. disability	25	34.70%
Severe disability	10	13.90%
Crippled	3	4.20%
bed ridden	1	1.40%

ODI index

The median score for the ODI index was 22 (IQR 14.5–37). In terms of ODI category, most fell under minimal and moderate disability 33 (45.8%) and 25(34.7%) respectively. Ten patients had severe disability, three were crippled and one patient was bed ridden.

Bivariate analysis using Spearman's rank non parametric correlation test revealed no statistically significant association between ODI score and individual MRI parameters except for grade of spinal canal stenosis. Spearman rank correlation coefficient (r) for Grade of spinal canal stenosis was 0.3 ($p = 0.01$). The association was not maintained when ODI score was categorized and compared with presence of spinal canal stenosis (chi square 4.6, $p = 0.33$). Grade of foraminal stenosis, disc desiccation, bulge, protrusion and Modic change showed no correlation with ODI score. (Table 2)

Table 2
Spearman correlation coefficient between MRI
parameters and ODI index

Variable	r	P-value
Grade Foraminal stenosis	0.17	0.15
Grade of spinal canal stenosis	0.29	0.01
Disc bulge	0.138	0.247
Disc desiccation	0.237	0.054
Disc herniation	0.059	0.625
Modic change	-0.07	0.556

Discussion

Disc bulge and foraminal stenosis were the two most prevalent MRI findings among our study population, followed by disc desiccation, disc herniation and spinal canal stenosis. Most of the patients with foraminal or spinal canal stenosis had mild degree of stenosis and those pathologies tended to concentrate at L4/5 and L5/S1 levels. The prevalence of disc bulge (82%) and foraminal stenosis (65.3%) in the current study is relatively higher than previously reported. Brinjikji et al in their meta-analysis estimated the prevalence of disc bulge to be 43.2%. Whereas a hospital based study from Ethiopia puts the prevalence much lower at 18.5%. On the other hand the distribution of spinal segment involvement in our study was consistent with findings from previous researches (11, 12).

Our study revealed that MRI grades of spinal canal stenosis is weakly correlated with ODI score ($r = 0.3$). (a spearman rank correlation between 0 and 0.4 is considered a weak correlation in most grading systems.(21)) Similar finding is reported in a study conducted in 1990 by Hurri et al. who reported association between spinal stenosis and ODI index (22). However plain radiography instead of MRI was used to estimate spinal canal stenosis in that study and their finding couldn't be substantiated by subsequent studies which tried to explore association between spinal canal area or anteroposterior diameter with that of ODI score.(13, 14, 23). In addition, Categorical ODI groups. Which are more clinically meaningful than absolute scores, failed to correlate with grade of canal stenosis in the current study. Further study is required to conclusively determine association between canal stenosis and degree of disability.

Grade of foraminal stenosis, disc desiccation, disc bulge or herniation, Modic change and disc desiccation didn't predict disability in the current study. This is in agreement with results from previous studies.(11)

Multitude of hypothesis have been forwarded in the literatures for the reported lack of association between MRI parameters and clinical disability. Variation in what is a normal canal size throughout the population and lack of universally accepted grading system combined with over diagnosis of spinal canal/foraminal stenosis on MRI could be the source of discrepancy between MRI reported abnormality and clinical symptom. In addition, spinal canal narrowing is dynamic and changes with posture assumed by the patient. Therefore a measurement taken on MRI in supine position may not be predictive of patient's symptom. And mere presence of spinal canal stenosis unless followed by compression of neural structures is unlikely to lead to clinical diseases. (24, 25) (24, 25) (24, 25) (24, 25)

Routine MRI investigation of patients with lower back pain for the sake of identifying spinal canal or foraminal stenosis therefore should not be encouraged. Previous studies also indicate that up to 41.5% of patients undergo lumbar MRI unnecessarily (15)The treatment delay because of a long waiting list for an MRI study and the financial burden such unnecessary investigations incur are significant. And these effects are likely to be more pronounced in resource limited settings like sub Saharan Africa.

Our study is not without limitations. Small sample size and relatively few cases in the category of severe canal stenosis could have limited the power of the study. The qualitative grading system used for staging

spinal canal and foraminal stenosis could have introduced bias and misclassification. We recommend that our study is interpreted in light of these limitations.

Conclusion

This study tried to investigate the pattern of MRI abnormalities in adult patients with lower back pain and determine their association with Oswestry disability score (ODI). Disc bulge and foraminal stenosis are the two commonest MRI patterns and their prevalence was relatively higher in the current study than previously reported. Spinal canal stenosis grade is weakly correlated with ODI score. Foraminal stenosis and other discal MRI parameters are not correlated with degree of disability.

Abbreviations

CT	Computed Tomography
IVD	Intervertebral Disc
LBP	Lower Back Pain
MRI	Magnetic resonance imaging
ODI	Oswestry Disability Index
OR	Odds Ratio
r	Correlation coefficient
UoG	University of Gondar
UoGCSH	University of Gondar Comprehensive Specialized Hospital

Declarations

Ethics approval and consent to participate

This study has been approved by the institutional review board of the University of Gondar School of medicine. Informed written consent was obtained from all individuals who participated in the study.

Consent for publication

The authors have consented for the publication of this study.

Availability of data and material

All relevant data will be provided up on request to the corresponding author with the commitment to cite this work.

Competing interests

The authors declare that they have no competing interests

Funding statement

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Authors' contribution

YT Analyzed and interpreted the data and did most of the manuscript write up. BT performed the data collection, literature review and contributed in the analysis. Both authors have read and approved the final manuscript.

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Figures

Figure 1

Distribution of cases on the basis of sex and age group.

Supplementary Files

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