

Correlation Between Common Carotid Artery Intima-Media Thickness and Lumbosacral Intervertebral Disc Degeneration

Ammar Ahmed Jawad Al-Shamma,^{a1} Haider Najim AL-Tameemi^{2*} and Aws R. Al-Isawi²

¹Department of Radiology, Al-Sader Medical City, Al-Najaf Health Directorate, Al-Najaf, Iraq.

²Department of Radiology/Surgery, Faculty of Medicine, University of Kufa, Al-Najaf, Iraq.

Corresponding author: Haider Najim AL-Tameemi (e-mail: haidern.altameemi@uokufa.edu.iq).

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Abstract Background: Lumbosacral intervertebral disc degeneration (IDD) is a common cause of low back pain and has recently been attributed to ischemic causes. Magnetic resonance imaging (MRI) can accurately assess the presence and degree of IDD, while the common carotid artery (CCA) intima-media thickness (IMT) measured on ultrasound (US) has been accepted as a reliable imaging marker for the presence of atherosclerosis. **Aim of the Study:** To assess the association between CCA-IMT with the presence and grade of lumbosacral IVD as evident on MRI in patients with LBP. **Patient and Methods:** This cross-sectional study was done on 200 patients with LBP (115 females and 85 males) referred for lumbosacral spinal MRI at the MRI unit in AL-Sader Medical City for eight months duration. MRI examination involved L1/L2, L2/L3, L3/4, L4/L5 & L5/S1 intervertebral discs levels. Patients with a history of lumbosacral surgery, trauma, or tumor were excluded. CCA-IMT was measured using a B-mode US scan, while the degree of IDD was assessed on MRI using I-V Pfirrmann's grading system. **Results:** Older age, male gender, higher body mass index, presence of cardiovascular comorbidities, and specific occupations were associated with a higher grade of IDD. However, the mean CCA-IMT was independently associated with the advancing grade of IDD at all levels with a statistically significant difference ($P < 0.001$). A significantly larger mean CCA-IMT was found in relation to grade V (0.946 ± 0.28), and the lowest mean was found in those with grade I (0.468 ± 0.1). The grading of IDD was fair in the prediction of thicker CCA-IMT. **Conclusion:** IDD was directly correlated with CCA-IMT, and patients with higher grades of IDC tend to have thicker mean CCA-IMT. IDD may be a manifestation or predictor of atherosclerosis. However, future long-term cohort studies to assess causal association are recommended.

Key Words lumbar spine, common carotid artery, intima-media, ultrasound, magnetic resonance imaging, spinal degeneration, atherosclerosis

1. Introduction

Worldwide, low back pain (LBP) is considered a leading cause of disability [1], and all ages can be affected [2]. One of the essential causes of LBP, lumbar intervertebral disc degeneration (IDD), has shown increasing prevalence from early adulthood onwards, being highest after the age of 45 years [3]. The predisposition for IDD has been linked to multiple factors, including aging, biomechanical stress [4], obesity [5], and genetic background [6]. Recently, ischemic secondary to atherosclerotic disease of lumbar arteries has gained rising attention as a possible underlying factor for IDD [7].

Imaging is integral in evaluating spinal diseases, and magnetic resonance imaging (inaccurately assesses the presence and grade of intervertebral disc degeneration [8], [9]. On the other hand, being noninvasive, rapid, and straightforward to

measure, the standard carotid artery intima-media thickness (CCA-IMT) measured by B-mode ultrasound is widely used in the assessment of atherosclerosis and overall prediction of cardiovascular risk [10]. Based on a hypothesis, an association is likely present between the grade of lumbar disc degeneration and the thickening of CCA intima-media. The current study assessed the correlation of CCA-IMT with the presence and severity of lumbosacral IDD, which is evident on MRI in patients with low back pain.

2. Patient and Method

This cross-sectional study was conducted on 200 patients (115 females and 85 males) at the MRI Unit of the Al-Sader Medical City, Al-Najaf province, Iraq, over a 10-month period (between January and October 2019). All selected patients were referred to the MRI unit for lumbosacral evalu-

ation because of LBP with or without radiculopathy.

Any adult patient with LBP who had complete lumbosacral MRI examination was included. Patients were excluded when there was a current or history of spinal tumor, trauma, and surgery, incomplete inclusion of all lumbosacral levels, and refusal of carotid ultrasound examination.

The study was approved by the Intuitional Review Committee, and informed consent to participate was obtained directly from all patients.

Demographic and clinical data were obtained directly from the patients and their records.

Imaging protocols and evaluation. All lumbosacral MRI examinations were performed by the same MRI machine (Acheiva 1.5 Tesla, Philips Medical System, 2011) with the following imaging parameters: Sagittal T1 WI. TSE TE=8ms TR=500ms; Sagittal T2 WI. TSE TE=100ms TR=4000ms; Axial T2 WI TE=100ms TR=4000ms.

After reviewing the whole lumbosacral MRI examination for each patient by a single experienced neuroradiologist, the IDD of each intervertebral level was graded from I-V grades using Pfirmann's grading system [9] (Figure 1).

Another general radiologist, blinded to the MRI results, did a carotid ultrasound examination on each patient. The ultrasound device used was Voluson E6 (General Electric, 2014) with a linear 7.5 MHz probe. On the longitudinal B-scan image of CCA, the IMT is represented by the echo-free space between the two echogenic lines, forming the internal interface between the blood pool and intima layer and the external interface between the media and adventitial layers. The IMT of CCA on each side was measured manually at three segments (proximal, middle, and distal), and the average of three readings was taken as the mean CCA-IMT (Figure 2).

Statistical analysis was conducted using SPSS (version 25). Analysis of variances (ANOVA) and students' t test used to compare means under a level of significance of two-tailed $P < 0.05$. Bivariate partial correlation analysis was applied to assess the correlations of CCA-IMT and grade of IDD with adjustment for age, sex, BMI, occupation and comorbidities (including hypertension, diabetes, ischemic heart disease, hyperlipidemia). Receiver operating characteristics (ROC) curve and the area under the curve (AUC) were estimated as an indicator for the IDD grade predictive value.

3. Results

There were 200 participants enrolled in this study, with a mean age of 45.6 ± 14.3 (range: 20 – 80) years. Further distribution of age revealed that the more frequent age group was 31 – 40 years and 41 – 50 years; contributed for 27% and 26.5%, respectively. Males were 85 (42.5%) and females were 115 (57.5%), with a male to female ratio of (0.74:1). These findings and other demographic variables and medical history are summarized in Table 1.

According to the Pfirmann grading of lumber discs at different levels; grade I was less frequent in all levels (10/200 to 14/200); grade II and grade III were more frequent at L1/L2,



Figure 1: A sagittal T2-weighted image of lumbosacral spinal MRI, showing multilevel disc degeneration, with grade III at L1/2 and L2/3, grade IV at L3/4 and L4/5, and grade II at L5/S1 level according to Pfirmann's grading system

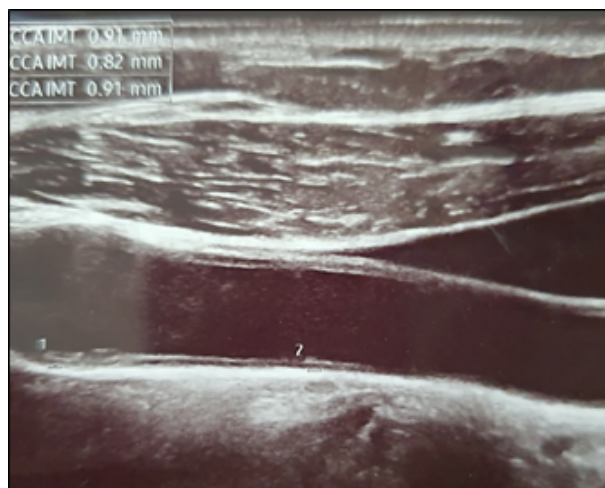


Figure 2: Measuring the intima-media thickness (IMT) of the common carotid artery (CAA) represented by the echofree space between the two echogenic lines (between calipers)

L2/L3 and L3/L4 levels compared to other two levels; grade IV was more frequent at L3/L4 (52/200), L4/L5 (92/200), and L5/S1 (92/200) (Table 2).

As seen in Table 3, the mean CCA-IMT was significantly increased with the advancing grade in all levels. Patients with higher grade showed thicker IMT, while the lowest mean IMT was reported in those with grade I with a highly significant difference ($P < 0.001$).

Further analysis was performed to assess the correlation between CCA-IMT and other demographic variables (Table 4) and revealed that IMT was significantly higher in patients who were older age, overweight and obese, with comor-

Variable		No.	%
Age (year)	≤ 30	31	15.5
	31 - 40	54	27.0
	41 - 50	53	26.5
	51 - 60	26	13.0
	61 - 70	24	12.0
	>70	12	6.0
	Mean (SD*)	45.6 (14.3)	-
Range	20 - 80	-	
Sex	Male	85	42.5
	Female	115	57.5
Occupation	Housewife	75	37.5
	Unemployed	55	27.5
	Employed	43	21.5
	Retired	15	7.5
	Student	12	6.0
BMI category	Normal	62	31.0
	Overweight	82	41.0
	Obese	56	28.0
Comorbidities	Yes	61	30.5
	No	139	69.5

Table 1: Demographic characteristics of the studied group (N = 200)

Spinal Level	Pfirman's grading			
	Grade I	Grade II	Grade III	Grade IV
L1/L2	14	78	79	29
L2/L3	14	80	79	27
L3/L4	16	59	73	52
L4/L5	10	34	64	92
L5/S1	11	40	57	92

Table 2: Grading of intervertebral discs at different lumbar spinal levels

bidities, retired, housewives and unemployed (P<0.05 for all parameters). Males had higher mean IMT than females, but the difference was statistically not significant (P>0.05).

After bivariate partial correlation analysis and adjustment for the demographic variables to control their confounding effect, the correlation between CCA-IMT and IDD grades was still significant on both sides (P. value < 0.05), as shown in Table 5.

ROC curve analysis was performed to assess the value of the grade of disc degeneration in prediction of CCA-IMT (Figure 3) and revealed that at all levels, the grading was fair predictor of thicker CCA-IMT (Table 6) with an AUC ranged between 0.700 to 0.802 in right CCA and 0.700 – 0.743 in left CCA with 81% sensitivity, 82% specificity, and 81% accuracy.

4. Discussion

Noninvasive assessment of IMT of CCA is widely used in observational studies and trials as an intermediate or proxy end point for cardiovascular disease [10], and atherosclerosis was blamed as a possible risk factor for IDD [7] and [4] which is best assessed radiologically by MRI.

The current study found a significant association between IDD and CCA-IMT, soigher mean CCA-IMT was seen in patients with higher IDD grades at all lumbar levels. Risk factors for radiographically apparent lumbar disc disorders, like age, gender, genetic occupational, and BMI, may have

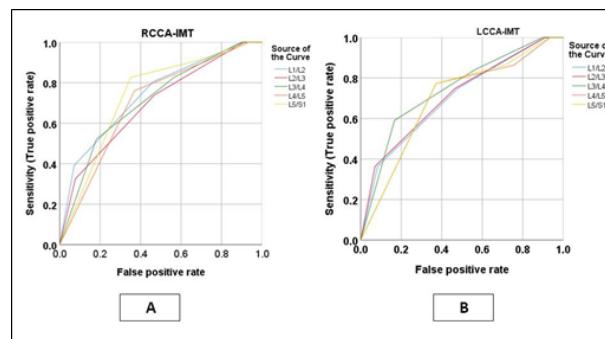


Figure 3: Receiver operating characteristics (ROC) curve for the validity of grading in prediction of right (A) and left (B) CCA-IMT

confounding effects [11]; however, CCA-IMT was independently associated with increasing grade of IDD after adjustment, with fair prediction. To our best knowledge, only a few studies concerned the association between lumbar IDD and atherosclerosis were published, like Estublier C et al. study, which found an association between IDD with atherosclerosis and aortic calcification [12]. A study by Takasu et al. [13] who concluded that people with thicker carotid IMT are more likely to have thoracic aorta atherosclerotic plaques. Another clinically-based study found a positive correlation between clinical signs of sciatica and CCA-IMT and was not utilizing a spinal imaging aspect [14].

Because IDD was a fair predictor of CCA-IMT in this study, we think that patients recently diagnosed with lumbar spinal degeneration may warn further cardiovascular work-up to detect any underlying, possibly unknown atherosclerosis so that an appropriate and timely management can be initiated.

It is thought that atherosclerosis of the feeding lumbar arteries may lead to inadequate nutrition and diminished oxygenation of the intervertebral disc with resultant defective extracellular matrix synthesis [15]. Nutrition to the disc may be further impaired by endplate calcification, which is presumed to develop secondary to the deficient nutrition of the endplate itself [16], [17]. Our preliminary results of a possible association between CCA-IMT and IDD enforce the hypothesis of atherosclerosis as a risk factor for spinal degeneration [4], [7] and pursue further studies to confirm this etiological role in the future.

The study has some limitations. Because of the observational cross-sectional nature of the study and lack of previous or baseline lumbar MRI examinations to compare with, the causal association between IDD and CCA IMT cannot be affirmed. The study was conducted only on those with LBP; hence, the results cannot be generalizable to the asymptomatic individuals. The study did not include many cardiovascular parameters, including coronary angiography, electrocardiography, and lipid profile. Future studies addressing these factors are worthy.

Disc level	CCA-IMT Mean (mm) ± SD				P. value
	Grade I	Grade II	Grade III	Grade IV	
L1/L2	0.47 ±0.1	0.62 ±0.2	0.8 ±0.27	1.0 ±0.27	<0.001
L2/L3	0.47 ±0.11	0.62 ±0.22	0.8 ±0.27	0.99 ±0.29	<0.001
L3/L4	0.47 ±0.11	0.63 ±0.21	0.72 ±0.26	0.96 ±0.29	<0.001
L4/L5	0.46 ±0.07	0.62 ±0.25	0.63 ±0.21	0.89 ±0.27	<0.001
L5/S1	0.47 ±0.12	0.6 ±0.21	0.69 ±0.22	0.89 ±0.28	<0.001
Mean	0.468 ±0.1	0.61 ±0.22	0.728 ±0.25	0.946 ±0.28	<0.001

Table 3: Correlation of mean CCA-IMT with IDD grading at different disc levels

		Mean CCA-IMT (mm)		P. value
		Mean	±SD	
Age (year)	≤ 30	0.45	0.08	<0.001
	31 - 40	0.6	0.18	
	41 - 50	0.77	0.29	
	51 - 60	0.93	0.28	
	61 - 70	1.03	0.23	
	>70	1.1	0.25	
Sex	Male	0.76	0.27	0.388
	Female	0.74	0.28	
Body mass index (BMI)	Normal	0.67	0.30	P= 0.026
	Overweight	0.77	0.26	
	Obese	0.79	0.27	
Comorbidities	Yes	0.92	0.29	<0.001
	No	0.67	0.23	
Occupation	Housewife	0.76	0.28	<0.001
	Unemployed	0.81	0.24	
	Employed	0.63	0.22	
	Retired	1.03	0.25	
	Student	0.43	0.06	

Table 4: Comparison of mean CCA-IMT according to demographic variables

Disc level	Right CCA -IMT	
	R	P. value
L1/L2	0.266	<0.001
L2/L3	0.214	0.003
L3/L4	0.285	0.003
L4/L5	0.266	<0.001
L5/S1	0.269	<0.001

Table 5: Bivariate partial correlation analysis between mean CCA-IMT and degeneration grading after adjustment for other variables

5. Conclusion

Intervertebral DD was directly and significantly associated with CCA-IMT. There were significant risk factors for both IDD and IMT. IDD based on MRI was an independent predictor of thicker IMT after adjustment of older age, larger BMI, occupation, and chronic diseases. IDD may be a manifestation of atherosclerosis as reflected by thicker IMT of

Left CCA-IMT		
Disc Level	AUC	Interpretation
L1/L2	0.752	Fair
L2/L3	0.711	Fair
L3/L4	0.725	Fair
L4/L5	0.702	Fair
L5/S1	0.719	Fair
Average	0.716	Fair

Table 6: Validity of intervertebral disc grading at different vertebral levels in the predicting CCA-IMT

CCA, and patients with high grades of IDD may warrant further cardiovascular assessment to look for any atherosclerotic risk factor. However, the study recommends further evaluating possible role of atherosclerosis in the pathogenesis of IDD and the presence of any causal association.

Conflict of interest

The authors declare no conflict of interests. All authors read and approved final version of the paper.

Authors Contribution

All authors contributed equally in this paper.

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