Original Article

Association of Cervical Spine Magnetic Resonance Imaging Abnormalities with Chronic Neck Pain in Southern Nigeria

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Abstract

Objective: This study was done to evaluate the relationship between cervical spine magnetic resonance imaging (MRI) findings and clinical features in adults with chronic neck pain (NP) at our tertiary hospital. **Materials and Methods:** This was a prospective cross-sectional study of the cervical spine MRI of 90 adult patients with chronic NP. The clinical history, biodata, and cervical spine MRI findings were analysed. Statistical tests were considered significant at $P \leq 0.05$. **Results:** The mean age of the participants was 54.72 (13.51) years (range = 28–79 years). There were 52 (58%) males and 38 (42%) females. Cervical disc desiccation and disc herniation were the most prevalent MRI findings. C4/C5 and C5/C6 disc levels were most commonly affected. Disc height reduction correlated with shoulder pain ($r = 0.23$, $P = 0.030$), unsteady gait ($r = 0.27$, $P = 0.010$), and lower limb weakness ($r = 0.23$, $P = 0.029$). Vertebral collapse correlated with shoulder pain ($r = 0.22$, $P = 0.036$), upper limbs burning sensation ($r = 0.33$, $P = 0.001$), and loss of dexterity ($r = 0.22$, $P = 0.037$). Spondylolisthesis correlated significantly with unsteady gait ($r = 0.34$, $P = 0.001$), dizziness/vertigo ($r = 0.29$, $P = 0.005$), painful neck movement ($r = 0.32$, $P = 0.002$), loss of dexterity ($r = 0.37$, $P < 0.001$) and sphincteric dysfunction ($r = 0.23$, $P = 0.031$). Modic changes correlated with loss of dexterity ($r = 0.39$, $P < 0.001$) and upper limbs burning sensation ($r = 0.21$, $P = 0.048$). Cervical canal stenosis did not correlate significantly with any symptom. **Conclusion:** Cervical disc disease (C4/C5 and C5/C6 levels) was the most prevalent finding on MRI. Disc height reduction, vertebral collapse, spondylolisthesis, and Modic changes correlated with various clinical symptoms.

Keywords: *Cervical Spine, cervical spondylosis, chronic neck pain, degenerative disc disease, disc herniation, magnetic resonance imaging*

Introduction

Neck pain (NP) can be defined as the sensation of discomfort in the area of the neck that is bounded by the occiput superiorly, the second thoracic vertebra inferiorly, and the ends of the scapular spines laterally.[1] It can result from disorders of any of the structures in the neck, including the cervical vertebrae and intervertebral discs, spinal cord, nerves, muscles, blood vessels, oesophagus, larynx, trachea, etc.[2] A recent study found an NP prevalence of 65.9% in a rural community in northwest Nigeria.[1] NP is the fourth major cause of disability worldwide.[2] Pain in a radicular pattern in one or both upper extremities, related to compression of one or more cervical nerve roots, is termed cervical radiculopathy.[3]

NP can be classified according to the duration as acute (pain lasting <6 weeks), subacute (6–12 weeks), and chronic (>12 weeks).[4] There are two general aetiologic categories: posttraumatic and degenerative. Posttraumatic aetiologies include gross injuries and whiplash syndrome (injury to the cervical vertebrae and its related soft tissues following sudden jerking). Degenerative causes of NP include spondylosis, acute disc herniation, and degenerative disc disease, as well as previous trauma.[5] The less common causes of NP include tumours, infections, systemic arthropathy, oesophageal reflux disease, and referred pain from cardiac, gastric, and diaphragmatic diseases.[6]

The risk factors for NP include advancing age, female sex, history of neck or back pain, and poor psychological status. Other risk factors are occupation, poor posture, poor physical work environment, and smoking.[2,7] The prevalence of NP is generally higher in women, in high-income countries, and in urban areas.[7]

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Chronic NP (>12 weeks) is multifactorial in origin. Smoking, obesity, sedentary lifestyle, previous NP, trauma, back pain, and poor general health contribute to the development of chronic NP. Mechanical and degenerative factors are more likely with chronic NP.[8-11] Degenerative disease of the cervical spine was the most common cause of chronic NP in multiple studies. Neoplastic, infective, traumatic, inflammatory, vascular, and systemic diseases are less common causes.[12-15]

Plain radiography, discography, ultrasonography, computed tomography, radionuclide imaging, and magnetic resonance imaging (MRI) can be used for evaluating NP.[5,16] Plain radiographs have useful diagnostic values; however, it involves exposure to ionising radiation and has significant limitation in the evaluation of the intervertebral discs, spinal canal stenosis, and neural compression.[5,17,18] MRI is the most sensitive test for detecting soft-tissue abnormalities and to screen out red flags in patients with severe or progressive neurologic deficits. MRI is also useful when referring patients for surgery and for patients with persistent pain that had not responded to conventional managements.[11,19]

Relatively few studies have been done in sub-Saharan Africa to assess the relationship between chronic NP and cervical spine MRI findings. These studies have either been carried out using 0.2T MRI machines or had a retrospective design.[13,14,19-22] This study was done in Southern Nigeria to investigate the cervical spine MRI findings in patients with chronic NP using a 1.5-T MRI machine and associate such findings with the clinical symptoms.

Materials and Methods

This prospective cross-sectional study of 90 adults with a history of chronic NP was conducted at the Radiology Department of Delta State University Teaching Hospital (DELSUTH), Oghara, Ethiope West Local Government Area, Delta State, from November 2019 to April 2020. Ethical clearance (HREC/PAN/2010/046/0328) was obtained from the Health Research and Ethics Committee of the DELSUTH. The subjects were referred for cervical spine MRI from the Neurosurgery, Neurology, Orthopaedics, and Family medicine departments of the hospital. Participants were included consecutively after informed written consent had been granted.[4]

The inclusion criterion was consenting adult patients (>18 years) with chronic NP referred for cervical spine MRI. Patients with a history of acute neck trauma, history of neck surgery, previous diagnosis of spinal tumours, previous history of stroke, pregnancy, claustrophobia, and ferromagnetic implants were not enrolled.

Sociodemographic characteristics (age, sex, marital status, educational status, and occupation), clinical information, and anthropometric measurements (weight, height, and body mass index [BMI]) were recorded in the questionnaire. Weight estimation (kilograms) was done with a weighing scale, and the height (metres) with a metre rule. The BMI was calculated as weight (kg) ÷ height (m^2). The participants were then classified into one of four BMI groups: underweight (BMI < 18.5), normal weight (BMI 18.5–24.9), overweight (BMI 25.0–29.9), or obese (BMI > 30.0).[23] The structured questionnaire also contained questions on the duration of NP, the severity of pain, and associated symptoms like upper and lower limb weakness or paralysis, loss of dexterity, gait abnormality, dizziness/vertigo, and sensory abnormalities.

The severity of NP was assessed using the numerical rating scale, which is a single 11-point numeric scale from 0 to 10, with 0 indicating no pain and 10 being the severe end of the scale; 0 = no pain, 1–3 = mild pain, 4–6 = moderate pain, and 7–10 = severe pain.[24]

The patients were then scanned on a 1.5-Tesla Toshiba Excelart Vantage MRI machine (Toshiba Medical Systems, Otawara, Tochigi, Japan) after ensuring they had taken off all metallic objects on them. Each participant was positioned supine with their neck in the neutral position and the median sagittal plane equidistant to the edges of the table. A radio frequency surface coil was placed to cover the cervical spine. Centering was at C4. The table was then set in motion until the patient was at the isocentre. Principal imaging was performed using conventional spin-echo pulse sequences.[25]

Sagittal T1-weighted spin-echo MRI, repetition time (TR) =500–800 ms and echo time (TE) = 8–12 ms; Sagittal T2-weighted spin-echo sagittal MRI, TR = 2000–3000 ms and TE = 60–120 ms; with or without fat suppression was used. The axial images of T1-weighted and T2-weighted spin-echo MRI with slice thickness, intersection gap, TR, and TE being 6–10 mm, 0.6–1.0 mm, 600–650 ms, and 8–10 ms. For both T1-weighted and T2-weighted spin-echo sagittal MRI, slice thickness, intersection gap, matrix size, and field of view were 3 mm, 0.3–0.4 mm, 256–512 × 192–275, and 27–32 cm, respectively. Matrix size and field of view for axial images were 256 × 256 and 23 cm, respectively, with variations depending on patient size.

The axial images were taken with slices extending from the skull base to C7/T1 intervertebral disc space, while sagittal images included the entire cervical spine, including parasagittal imaging through all of the neural foramina on both sides. Intravenous gadolinium 10 mL (0.5 mmol/L) stat was administered when required.

The Picture Archiving and Communications System server in which the MRI images were stored was accessed, and the studies were reported in a blinded fashion (without reference to patients' clinical history to remove bias on the part of the researcher).

Each cervical intervertebral level was assessed using the modified Matsumoto's classification to evaluate the decrease in signal intensity of the intervertebral disc, posterior disc protrusion, and disc space narrowing.[26] Cervical canal stenosis was classified using a grading system developed by Kang based on MRI findings on T2-weighted (Grade 0 = normal; Grade 1 = obliteration of more than 50% of the cerebrospinal space without any sign of spinal cord deformity; Grade 2 = central canal stenosis with spinal cord deformity but no signal change is seen in the spinal cord; Grade 3 = increased signal intensity of the spinal cord at compressed level).[27] Degenerative marrow (Modic) endplate changes in the cervical spine were classified using Modic's grading system.[28]

The study data were analysed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, New York). Data Normality was tested with Kolmogorov–Smirnov's test. Continuous variables were presented as mean (standard deviation) and ranges, while categorical data were presented as frequencies and percentages. The level of statistical significance for Chi-square, student's *T*-test, and ANOVA was $P \leq 0.05$ at a 95% confidence interval. The relationship between variables was tested using Spearman's correlation coefficient. The strength of the correlation coefficients was graded as follows: $r = 0–0.2$: very low/negligible and probably meaningless correlation; $r = >0.2–0.4$: low correlation; $r = >0.4–0.6$: moderate correlation; $r = >0.6–0.8$: high correlation; $r = >0.8–1.0$: excellent/very high correlation.[29]

Results

Sociodemographics of the study population

There were 52 (58%) male and 38 (42%) female participants giving a male-to-female ratio of 1.36:1. The participants' mean age was 54.72 (13.51) years (range = 28–79 years). The age sub-groups are as follows: 25–34 years (8; 9%), 35–44 years (14; 16%), 45–54 years (21; 23%), 55–64 years (22; 24%), 65–74 years (19; 21%) and ≥75 years (6; 7%). The 22 participants (24%) within the 55–64 years age group constituted the majority of the study population. Twenty-eight (31%), 26 (29%), and 36 (40%) participants had normal weight, overweight, and obesity, respectively.

Clinical features of the participants

The duration of chronic NP in this study was 3–6, 6–12, 12–18, and >18 months in 21 (23%), 23 (26%), 10 (11%), and 36 (40%) participants, respectively. Pain severity was rated as mild by 9 (10%), moderate by 16 (18%), and severe by 65 (72%) subjects. The other clinical features are detailed in Table 1.

MRI findings in participants

Features of degenerative disc disease, vertebral abnormalities, and neural abnormalities were found in the cervical spine MRI of all participants in this study. The most common abnormalities were disc degeneration and posterior disc herniation, seen in 89 (99%) participants each. The other abnormalities seen on MRI were posterior vertebral osteophytes (77; 86%), spinal canal stenosis (68; 76%), reduction of disc height (61; 68%), nerve root

Table 1: Frequency of clinical symptoms in the participants

Clinical symptoms	Frequency (*N*)	Percentage (%)
Type of neck pain		
Sharp	43	48
Dull ache	23	26
Shocking	12	13
Cramping	11	12
Others	1	1
Frequency of neck pain		
Always (throughout the day)	47	52
Weekly	43	48
Neck stiffness	27	30
Headache	37	41
Shoulder pain	33	37
Right	5	6
Left	6	7
Both	22	24
Arm pain	19	21
Right	2	2
Left	2	2
Both	15	17
Hand pain	13	14
Right	0	0
Left	1	1
Both	12	13

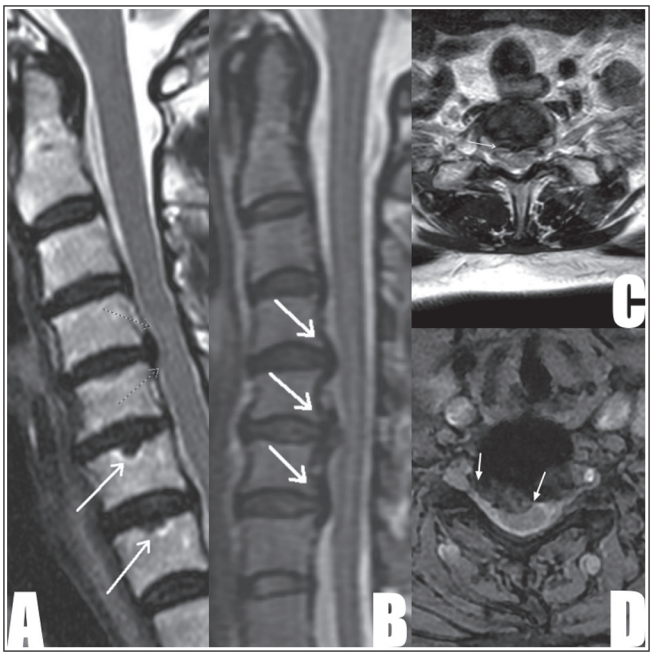

Figure 1: T2-weighted sagittal (A and B) and axial (C and D) MRI images showing generalised disc desiccation and Schmorl nodes at C6 and C7 (A), markedly straightened cervical lordosis and posterior disc bulges (B), and disc desiccation with posterior disc bulges and cervical spinal canal stenoses (C and D)

compression (51; 57%), loss of cervical lordosis (42; 47%), Modic changes (29; 32%), spondylolisthesis (15; 17%), vertebral collapse (17; 19%), Schmorl's node (17; 19%), and myelopathy (17; 19%) **[**Figure 1**].**

The intervertebral disc abnormalities (discopathy) seen on MRI are shown in Table 2. The most severe form of disc degeneration (Grade 2) was most prevalent at C4/C5 (49; 54%) and C5/C6 (49; 54%) levels and least seen at C7/T1 (39; 43%). Grade 2 posterior disc herniation (the most severe form) was most common at C5/C6 (34; 38%) level. The most severe form (Grade 2) of disc height reduction was most common at C6/C7 level (17; 19%) [Table 2].

Cervical spinal canal stenosis (CSCS) was seen in 68 (76%) participants. CSCS grade 3 (with cervical spinal myelopathy [CSM]) was more common at C5/C6 (14; 16%) and C4/C5 levels (12; 13%) [Table 3].

Posterior osteophytes were more at C5 vertebra 75 (83%) and least common at C2 vertebra 15 (17%). Modic changes were most commonly seen at C4/C5 (20; 22%) and C5/C6 (17; 19%) levels. Modic type 2 changes were the dominant type in participants (29; 47%), followed by type 1 (18; 29%). Schmorl's nodes were more commonly seen at C4/C5 (8; 9%) and C3/C4 (6; 7%) levels.

The alignment abnormalities seen were spondylolisthesis (15; 17%) and varying degrees of loss of cervical lordosis, including reduced (30; 34%), straightened (29; 33%), and reversed (15; 17%) cervical lordosis. Grade I spondylolisthesis was the only grade observed in this study. Fifteen participants (17%) had grade I spondylolisthesis which was more prevalent at C5/C6 (8; 9%) and C4/C5 (7; 8%) levels. Nerve root compression (51; 57%) and CSM (17; 19%) were the neural abnormalities depicted in this study. CSM was more common at C5/C6 (14; 16%) and C4/C5 (12; 13%) levels.

Association of MRI findings with sociodemographic and anthropometric parameters

There was a significant correlation between age and posterior osteophytes (r = –0.30, P = 0.004), vertebral collapse (r = 0.41, P < 0.001), Modic changes (r = 0.30, P = 0.004), and disc degeneration (r = 0.37, P < 0.001). The participants' occupation and BMI did not correlate significantly with any of the MRI findings.

Association of MRI findings with clinical features of chronic neck pain

There was a significant correlation between vertebral collapse and shoulder pain (r = 0.22, P = 0.036), burning sensation in the upper limbs (r = 0.33, P = 0.001), and

Table 2: MRI findings of intervertebral disc abnormalities in the study population

Cervical disc level		Disc degeneration *n* (%)	PDH *n* (%)	DHR *n* (%)
C3/C4	Grade 0	11 (12)	25 (28)	72 (80)
	Grade 1	37 (41)	43 (48)	15 (17)
	Grade 2	42 (47)	22 (24)	3 (3)
C4/C5	Grade 0	3 (3)	7 (8)	50 (56)
	Grade 1	38 (42)	51 (57)	36 (40)
	Grade 2	49 (54)	32 (36)	4 (4)
C5/C6	Grade 0	2 (2)	5 (6)	31 (34)
	Grade 1	39 (43)	51 (57)	44 (49)
	Grade 2	49 (54)	34 (38)	15 (17)
C6/C7	Grade 0	7 (8)	15 (17)	38 (42)
	Grade 1	39 (43)	48 (53)	35 (39)
	Grade 2	44 (49)	27 (30)	17 (19)
C7/T1	Grade 0	12 (13)	34 (38)	51 (57)
	Grade 1	39 (43)	46 (51)	34 (38)
	Grade 2	39 (43)	10 (11)	5 (6)

DHR: disc height reduction, MRI: magnetic resonance imaging, PDH: posterior disc herniation

Table 3: Distribution of cervical spinal stenosis

Intervertebral levels	Grade 0		Grade 1		Grade 2		Grade 3	
	n	%	*n*	%	*n*	%	*n*	%
C2/C3	66	74	23	26	0	0	0	0
C3/C4	23	26	45	50	18	20	4	4
C4/C5	6	7	48	53	24	27	12	13
C5/C6	4	4	47	52	25	28	14	16
C6/C7	14	16	47	52	23	26	6	7
C7/T1	34	38	45	50	10	11	1	1

loss of dexterity (r = 0.22, P = 0.037). Spondylolisthesis showed significant association with unsteady gait (r = 0.34, P = 0.001), dizziness/vertigo (r = 0.29, P = 0.005), painful neck movement (r = 0.32, P = 0.002), loss of dexterity (r = 0.37, P < 0.001) and sphincteric dysfunction (r = 0.23, P = 0.031). Modic changes correlated with loss of dexterity (r = 0.39, P < 0.001) and burning sensation in the upper limb (r = 0.21, P = 0.048). Reduction of disc height correlated with shoulder pain (r = 0.23, P = 0.030), unsteady gait (r = 0.27, P = 0.010), and weakness of the lower limbs (r = 0.23, P = 0.029). However, headache, arm pain, and painful neck movement showed no significant association with disc degeneration, posterior disc herniation, and reduction of disc height [Tables 4 and 5]. Cervical canal stenosis did not correlate significantly with any of the clinical features.

Discussion

Ninety participants were recruited for this study, and there were more males than females, with a ratio of 1.36:1. This is similar to findings seen in studies done by Mustapha *et al.*,[19] Ogwumike *et al.*,[1] and Olarinoye-Akorede *et al.*[13] The increased occurrence of NP in men might be due to engagement in more physically demanding activities, but it could also be that more men presented to the hospital for NP than women in this study. In contrast, the meta-analysis by Hoy *et al.*[30] and Balcha *et al.*[15] in Ethiopia

Table 4: Association between clinical features and vertebral bony abnormalities

Clinical features		Posterior osteophytes	Spondylolisthesis	Vertebral collapse	Modic changes	CSC stenosis	Schmorl node
Headache	*r*	−0.038	−0.114	0.170	0.046	0.090	−0.062
	P-value	0.721	0.288	0.111	0.669	0.402	0.564
Shoulder pain	*r*	−0.015	−0.155	0.222	0.166	0.081	−0.014
	P-value	0.886	0.145	0.036	0.118	0.450	0.898
Arm pain	*r*	0.135	0.134	0.168	0.051	0.055	−0.111
	P-value	0.204	0.208	0.114	0.632	0.608	0.300
Hand pain	*r*	0.079	0.071	0.044	−0.013	0.044	−0.037
	P-value	0.460	0.508	0.681	0.905	0.684	0.731
Associated shoulder, arm, or hand complains							
Burning sensation	*r*	0.043	0.055	0.334	0.209	0.066	−0.046
	P-value	0.687	0.604	0.001	0.048	0.538	0.668
Cramps	*r*	−0.085	−0.027	0.028	0.032	0.045	−0.129
	P-value	0.424	0.798	0.794	0.764	0.670	0.226
Tingling sensation	*r*	−0.049	0.011	0.108	0.141	0.062	−0.153
	P-value	0.646	0.915	0.312	0.185	0.561	0.151
Morning neck stiffness	*r*	0.058	0.144	0.168	0.168	0.055	0.029
	P-value	0.589	0.174	0.114	0.114	0.608	0.789
Unsteady gait	*r*	0.198	0.336	0.202	0.153	0.051	0.057
	P-value	0.061	0.001	0.056	0.149	0.632	0.592
Dizziness/vertigo	*r*	0.116	0.292	0.163	0.166	0.081	0.163
	P-value	0.277	0.005	0.125	0.118	0.450	0.125
Difficulty in walking	*r*	0.161	−0.147	−0.022	−0.061	0.042	−0.022
	P-value	0.129	0.167	0.835	0.570	0.697	0.835
Painful neck movement	*r*	0.035	0.315	0.111	0.150	0.146	−0.068
	P-value	0.745	0.002	0.298	0.159	0.169	0.522
Loss of dexterity	*r*	0.013	0.372	0.220	0.388	0.101	0.050
	P-value	0.901	0.0001	0.037	0.0001	0.342	0.641
Numbness of both hands	*r*	0.100	−0.198	0.007	−0.063	0.026	0.007
	P-value	0.350	0.061	0.949	0.553	0.810	0.949
Inability to move the upper limbs	*r*	0.110	−0.055	−0.129	0.006	0.028	−0.015
	P-value	0.303	0.610	0.226	0.953	0.791	0.887
Weakness of the lower limbs	*r*	0.032	−0.106	0.218	0.008	0.035	0.028
	P-value	0.767	0.321	0.039	0.941	0.741	0.791
Inability to move the lower limbs	*r*	0.100	−0.198	0.007	−0.063	0.026	0.007
	P-value	0.350	0.061	0.949	0.553	0.810	0.949
Sphincteric dysfunction	*r*	−0.100	−0.227	−0.090	−0.128	0.020	0.069
	P-value	0.349	0.031	0.401	0.229	0.854	0.521

CSC: cervical spinal canal

Table 5: Association between clinical features and disc abnormalities

Clinical features		Disc degeneration	Posterior disc herniation	Disc height reduction
Headache	*r*	0.090	0.090	0.051
	P-value	0.402	0.402	0.633
Shoulder pain	*r*	−0.139	0.081	0.229
	P-value	0.190	0.450	0.030
Arm pain	*r*	0.055	0.055	0.124
	P-value	0.608	0.608	0.246
Hand pain	*r*	0.044	0.044	0.013
	P-value	0.684	0.684	0.905
Associated shoulder, arm, or hand complaints				
Burning sensation	*r*	0.066	0.066	0.162
	P-value	0.538	0.538	0.127
Cramps	*r*	0.045	0.045	0.165
	P-value	0.670	0.670	0.121
Tingling sensation	*r*	−0.181	0.062	0.077
	P-value	0.088	0.561	0.471
Morning neck stiffness	*r*	−0.205	0.055	0.065
	P-value	0.053	0.608	0.540
Unsteady gait	*r*	0.051	0.051	0.272
	P-value	0.632	0.632	0.010
Dizziness/vertigo	*r*	0.081	0.081	0.081
	P-value	0.450	0.450	0.450
Difficulty in walking	*r*	0.042	0.042	0.131
	P-value	0.697	0.697	0.220
Painful neck movement	*r*	−0.077	0.146	0.051
	P-value	0.472	0.169	0.636
Loss of dexterity	*r*	−0.111	0.101	0.088
	P-value	0.298	0.342	0.408
Numbness of the medial side of both hands	*r*	0.026	0.026	0.167
	P-value	0.810	0.810	0.115
Inability to move the upper limbs	*r*	0.028	0.028	0.184
	P-value	0.791	0.791	0.082
Weakness of the lower limbs	*r*	0.035	0.035	0.230
	P-value	0.741	0.741	0.029
Inability to move the lower limbs	*r*	0.026	0.026	0.167
	P-value	0.810	0.810	0.115
Sphincteric dysfunction	*r*	0.020	0.020	0.128
	P-value	0.854	0.854	0.229

found a higher prevalence of NP among females than males—possibly due to better health-seeking behaviour among the females in those studies.

The majority of the participants had chronic NP of >18 months duration, which is close to the median pain duration of 24 months reported by Elbinoune *et al.*[9] in Morocco. The delayed presentation may be due to prolonged self-medication with analgesics. It may also be because MRI is expensive and not yet widely available in Nigeria.[31-33]

Degenerative disc disease (disc degeneration/desiccation and posterior disc herniation) was the most common finding in this study. In concurrence with the index study, many previous studies also reported cervical degenerative disease as the most prevalent MRI finding in subjects with NP.[13-15,20,34,35]

Multiple disc levels of involvement were seen in this current study, and this is consistent with that seen in the study by Kuijper *et al.*[36] in The Netherlands and Suzuki *et al.*[37] which also reported multilevel disc changes. Disc degeneration/desiccation, the loss of signal intensity on T2W MRI sequence as a result of disc dehydration, was most common at C4/C5 and C5/C6 levels, in keeping with the reports of previous investigators.[14,19,28,37-39]

In addition to NP, CSM in this study presented with weakness or paraesthesia in one or more limbs, difficulty with walking, and unsteady gait. Vertebral collapse, spondylolisthesis, and reduction of disc height are risk factors for CSM.[40] CSM is thought to occur late in the course of cervical spondylosis as a result of static and dynamic factors. Factors that cause mechanical narrowing of the cervical spinal canal are static factors (osteophytes,

disc herniation, spondylolisthesis, and congenital canal stenosis). The dynamic factors occur during normal flexion and extension of the cervical spine under normal physiologic load, which places abnormal forces on the cord and spinal canal. The cervical cord, in the presence of herniated discs and or osteophytes, is susceptible to more compression and stretching during movements of the cervical spine.[41]

In this study, spondylolisthesis showed a significant association with unsteady gait, dizziness/vertigo, painful neck movement, loss of dexterity, and sphincteric dysfunction. This is comparable to the findings by Jiang *et al*.,[42] which documented cervical cord compression features and radiculopathy in patients with degenerative cervical spondylolisthesis.

Cervical canal stenosis was more commonly seen at C5/C6 and C4/C5 levels, similar to the findings by Olarinoye-Akorede *et al.*[41] This observation is likely due to the preponderance of cervical degenerative disc disease at these levels.

This study also found a significant association between vertebral collapse and shoulder pain, burning sensation in the upper limb, and loss of dexterity. Similarly, disc height reduction showed a significant association with shoulder pain, unsteady gait, and lower limb weakness. However, in a similar study by Arana *et al.*[43] in Spain, NP did not correlate with findings on MRI. Degenerative disc disease was the only finding on MRI that was almost significantly associated with pain. No other imaging finding was found to relate to pain. This disparity in findings may be because this current study was on patients with chronic NP, and about half of the cohorts had NP for longer than 12 months.

The loss of normal cervical lordosis is a risk factor for anterior compression of the spinal cord. Reversal of cervical spine curvature was found in 16.9% of patients in this study, which is much higher than the 6.7% of patients in the study by Olarinoye-Akorede *et al.*[14] The difference in findings may be due to the difference in the duration of NP between the studies.

Nakashima *et al.*[44] Japan found that most subjects presented with disc disease, which significantly increased with age in terms of frequency, severity, and number of levels. This is similar to the findings in this study, as the features of degenerative disc disease (disc degeneration, disc herniation, disc height reduction) increased with increasing age. There was a strong association of age with disc degeneration and disc height reduction.

Other less common causes of NP, such as neoplastic, infective, traumatic, and inflammatory causes, were not found in this study, probably because this study focused on chronic NP, and these conditions usually present acutely. This study also excluded patients with a history of trauma and malignancies.

To sum up, cervical disc degenerative changes at C4/C5 and C5/C6 disc levels were the most common MRI finding in this study. Disc height reduction, vertebral collapse, spondylolisthesis, and Modic changes correlated significantly with various clinical symptoms.

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Conflicts of interest

There are no conflicts of interest.

Author contributions

OD Ogholoh: Manuscript editing, manuscript review, approval of the final draft, guarantor. AP Bemigho-Odonmeta: Conception, design, literature search, data analysis, statistical analysis, manuscript review, and approval of the final draft. OI Orhrohoro: Manuscript review, approval of the final draft. JE Ikubor: Manuscript review, approval of the final draft. BM Idowu: Literature search, manuscript preparation, manuscript editing, manuscript review, approval of the final draft. BH Tsebi: Manuscript review, approval of the final draft. N Kogha: Manuscript review, approval of the final draft. NN Nwafor: Manuscript review, approval of the final draft. AO Ogbeide: Manuscript review, approval of the final draft. This manuscript has been read and approved by all the authors, the requirements for authorship as stated in the JWACS author instructions have been met, and each author believes that the manuscript represents honest work.

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