Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Spl Issue [5] 2022 : 498-505

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

ORIGINAL ARTICLE **OPEN ACCESS**

Role of MRI in Evaluation of Degenerative Disease in C-Spine and Inter Vertebral Disc (IVD) Prolapsed

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ABSTRACT

C-Spine Degenerative Diseases were age related changes commonly and its progression may increase with age. Degenerative changes of the spine commonly affect lower cervical spines. Cross sectional and comparative study. The objective of the study is to evaluate C-Spine degenerative diseases, canal dimension on MRI and to compare degenerative diseases among different age groups and genders. Cross sectional study of 35 patients (avg. age 43.86 ± 12.7 years), with or without radiculopathy who underwent C-Spine MRI scan on 1.5T MRI scanner (Multiva Philips). A total of 210 discs from C2/3 to C7/D1 were studied to evaluate C-Spine degenerative diseases and canal diameter. The canal diameter was evaluated from the mid of the vertebrae to the mid-point of the corresponding transverse process. The evaluation of C-Spine were made by using T2W axial and sagittal images. Statistical analysis was carried out by using software SPSS version 21 and P≤ 0.05 was considered statistically significant. The C-spine degenerative diseases were most commonly found in patients with age ranges from 60-79 years. The prevalence of degenerative diseases were commonly found at lower cervical spine (C5/6 followed by C6/7 and C4/5) and were more commonly prevalent in males as compared to females. Average cervical spine canal diameter was found highest at C1 level (15.17mm) and lowest at C6 level (10.85mm). The average canal diameter was found higher in males (ranges 11.07 –15.9mm) as compared to females (ranges10.65–14.83 mm). The prevalence of cervical spine degenerative diseases was common at lower cervical region (C5/6 followed by C6/7andC4/5) and found mostly in the patients with age ranges from 60-79 years. Thus the MRI play significant role in the evaluation process of C-Spine degenerative diseases.
Keywords: *MRI,C-Spine, Degenerative Disease,Osteophytes,Spinal Canal,DiscBulge*

Received 21.10.2022 Revised 26.11.2022 Accepted 18.12.2022

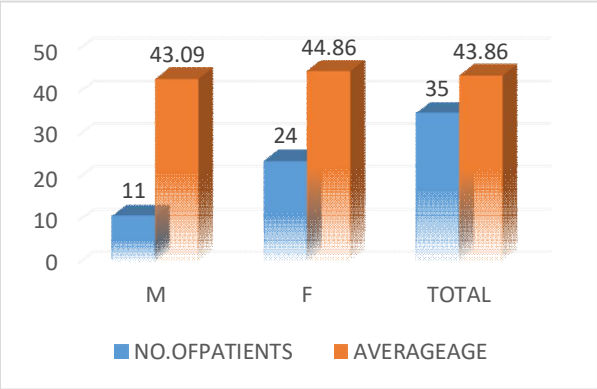
INTRODUCTION

The degenerative diseases of cervical spines are age related changes and in most cases commonly occur due to changes in nucleus pulposus (inner jelly-like substance of the disc). The disc contains about 85% of water in children and with age disc starts losing water. According to some estimation water content falling 70% by age 70 years [1]. The pattern of disc Degenerative disease of C-spine Increases with age in terms of severity & frequency and prevalent mostly at C5/6 level [2]. Xiao-Rong Wang et al. were founded in a study that overall frequency of degenerative changes was high at C5/6 level [3]. The MRI findings including narrowing of disc space and disc degeneration were found in 14% of volunteers with age less than 40 years and 28% over 40 years of age by Boden et al [4]. The disc bulge were found in 49.3% patients, disc herniation in 21.2%, for canal stenosis in 48.4% and cervical cord compression with myelopathic changes were found in 5.7% of patients [5]. Ageing is the main cause of the spine degenerative disease. During the 20 years follow up study progression of degenerative diseases were found in 95% of subjects [6]. The other factors that can cause spine degenerative diseases include smoking, genetic inheritance, impaired nutrition, physical loading history and trauma. The cervical spine degenerative diseases include disc degeneration, osteophytic changes of cervical spine, modic change of cervical spine, disc displacement, spinal canal stenosis, neural for aminal stenosis etc. Disc signal loss on T2W MR Images with/without reduction of height of the disc is called disc degeneration [1]. The degenerative changes usually starts within nucleus pulposus than extends to annulus fibrosus, end plates which may than advanced & eventually leads to osteoarthritis of facet joint, hypertrophy of ligamentum flavum and spinal canal stenosis. To evaluate the disc degeneration of the spine on the basis ofMRI findings different attempts were made to develop comprehensive MRI grading systems [7-11]. The indicative of osteophytosis is the bony outgrowths from the margins of the vertebral bodies (Steinbock 1976) [12]· DAVID EZRA et al. founded the prevalence of osteophytes were highest (48.17%) at motion segment C5/C6 [13]. Disc material displacement beyond the limits of the intervertebral disc space may be

disc bulge or disc herniation [14]. Disc herniation occurs when a part or entire nucleus pulposus is forced through the weak enedortorn out annulus fibrosus [15].The incidence of disc herniation were found highest in 3rdand 4thdecade of life by Tarannum Morshed et al [16]. The spinal canal stenosis is the narrowing of the cervical canal space and lateral recesses as a result of progressive disc degenerative diseases, bone and ligament. The presence of severe grade (grade3) of spinal canal stenosis was commonly found at C3/4 level followed by C5/6 level [17]. MRI is a valuable imaging tool in evaluation of cervical spine degenerative diseases. Tarannum Morshed et al were founded that 96.9%of cases diagnosed as disc herniation were proved to have disc herniation at per-operate level. The objective of the study is to evaluate C-Spine degenerative diseases and spinal canal AP diameter among various age groups and gender.

MATERIAL AND METHODS

A Prospective & Cross sectional study was performed in the Department of Radiology at SGT University Gurugram, Haryana on 1.5T MRI scanner (Multiva Philips) to evaluate C-Spine degenerative diseases in the patients with /without cervical spine radiculopathy.The study include 35 Patients (11M,24F) with mean age 43.86±12.73years(M=43.09±14.81yrs.,F=44.86±
11.99 yrs.) and age ranged from 20 – 79 years. The patients with recent history of trauma, claustrophobia, TB of the spine and metallic implants like aneurysm clips, Cochlear implants, Pacemakers etc. were excluded from the study. MRI scanning of all 35 patients were performed by a well experienced MRI technician on 1.5T MRI scanner (Multiva Philips) by using dedicated cervical spine coil. The scans include axial, sagittal T1WI (TR/TE = 650/15ms, FOV=180mm,Matrix size=276x162,Slice thickness=4mm ,NEX=2),T2WTSE axial, sagittal Images (TR/TE=3000/100, FOV=180 mm, matrix size=276x162, slice thickness=4mm, NEX=2) and STIR images (TR/TE=2500/60,FOV=170mm,matrix size=172x200,slice thickness=4mm,NEX=1). All the patients were divided into three age groups i.e; 20 - 39 years, 40 -59 years and 60-79 years. The demographic distributions of the patients included in the study are shown in fig. 1.1 and 1.2 below



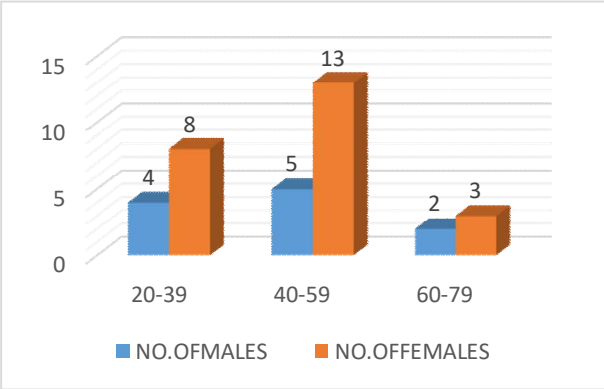


Fig1.1Distribution of frequency &Avg. age of the Pts. Fig.1.2 Distribution of Pts.in various age groups

The evaluations were made byusing T2W axial & Sagittal Images of the C-Spine.The C-Spine of all the 35 patients from C2/C3-C7/D1(210discs) were studied to evaluate Disc degeneration (DD),Discbulge (DB), Dischernіation /Disc protrusion (DH/DP), Osteophytic changes (OC), the calsac indentation(TSI), Spinal canal narrowing/stenosis (SCN/S),cord compression/impingement, Cervical canal AP diameter, Neural canal stenosis/narrowing and Nerve root compression.

Discs were evaluated for degeneration based on difference between nucleus pulposus & annulus fibrosus, signal intensity of nucleus pulpous and disc height as shown in table 1.1.

Table 1. 1. Criteria for evaluation of disc degeneration.

Difference b/w annulus & nucleus	Intensity of nucleus	Disc height	Disc degeneration
Yes	Homogenous hyper intensity or Hyperintense with horizontal dark band	Normal	No disc degeneration
Blurredor loss	Slightly decreased, minor irregularities To Hypointense, with or without horizontal lhyperintense bands	light decreased to collapsed	Disc degeneration Present

IVD prolapse and disc herniation was considered same in this study. All the degenerative diseases included in the study were evaluated for the presence or absence in the patients without dividing them on the basis of severity of degenerative diseases.

Cervical canal diameter was measured fromC1-C7levelonT2W sagittal images. Canal diameter(CSF column) at C1 level was measured from duramater to the most anterior of the posterior Atlantic arch (line from anterior Atlantic arch to posterior arch) as show in fig 1.3. The cervical canal diameter at other levels (up to C7) were measured from the middle point of vertebral body to the middle point of corresponding transverse processasshowinfig.1.4.

T2WITSE Sag. Image of 32y/M pts. Having neck pain

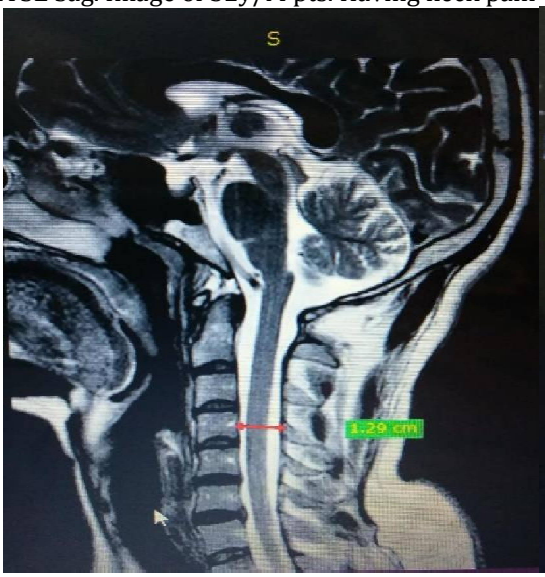


Fig.1.3 Measurement of Canal diameter at C1level.

T2WITSE sagittal image of same patient

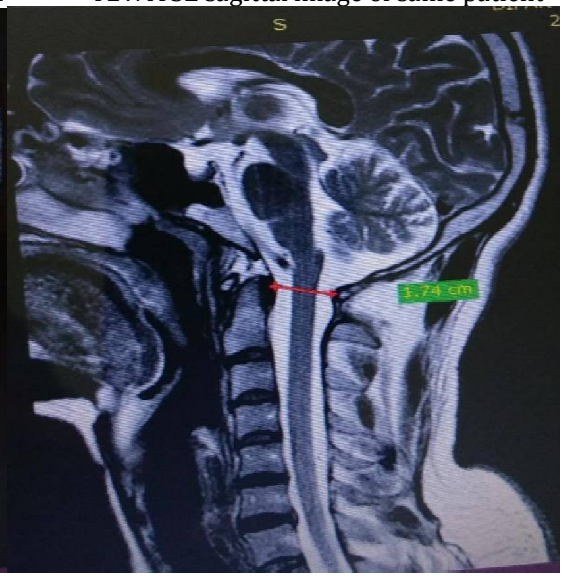


Fig.1.4 Measurement of canal diameter from C2-C7 levels.

Statistical analysis

The descriptive and inferential statistical analysis were carried out by using the software SPSS version 21. Chi square test was used to find out the significance of P-Value. All the statistically appropriate tests were used for data analysis of their search study.

RESULTS AND DISCUSSION

Disc degeneration at one or multiple levels were found in all the 35(100%)patients, followed by osteophytic changes 28 (80%) patients, Discbulge in 24 (68.6%). The calsac indentation in 22 (62.8%), Neural canal narrowing / stenosis in 15 (42.8%). Exiting nerve root compression in 11 (31.4%), Cervical canal narrowing/stenosis 8 (22.8%), Disc herniation in 8 (22.8%) and cervical cord compression/impingement were found in least 6 (17.1%) patients as shown below intable1.2.

Table1.2.Prevalence of degenerative diseases in the patients at one or multiple levels

Degenerative Diseases	DDDB	DH/DP	OC	TSI	CCC	CCN/S	NCN/NFN	ENRC/I
Patients with D. diseases	35	24	8	28	22	6	8	15	11
Total no. of Patients	35	35	35	35	35	35	35	35	35

DD (Disc Degeneration), DB (DiscBulge),DH/DP (Disc Herniation/Disc Prolapse), OC(Osteophytic Changes), TSI (Thecal Sac Indentation), CCC (Cervical Cord Compression), SCN/S (Cervical Canal Narrowing/Stenosis),NCN(Neural Canal Narrowing/ Neural Foramen Narrowing),ENRC/I(Exiting Nerve Root Compression/Indentation)

Prevalence of Cervical spine Degenerative Diseases at various levels

The prevalence of Cervical Spine Degenerative Diseases at various levels of the cervical spines were statistically significant (P≤.05) as shown in the table 1.3.Total 210 discs were evaluated out of which Disc Degeneration were found highest in 144 discs (68.6%), followed by osteophytic changes in 94 discs (44.7%) and cervical cord compression were found rare in 7 discs (3.3%), followed by cervical canal narrowing in 11 discs (5.2%).The prevalence of Disc Degeneration was highest at C5-C6 level with 35 discs (24.3%), followed by C4-C5 level 32 disc (22.2%), C6-C7 level with 31 discs (21.5%) and least at C2-C3 level with 8 discs(5.5%).The prevalence of cervical cord compression & canal narrowing /stenosis were mostly found at C5-C6 level 3 (42.8%) and 4 (36.3%) discs respectively whereas none of the disc at C2-C3, C3-C4 and C7-D1 level having cord compression or canal narrowing /stenosis. The prevalence of cervical spine

degenerative diseases at various levels was shown in the table 1.4 and fig.1.5 below.

Table1.3. P-value at various Cervical Spine level (Chi Square Test)

Level	C2-C3	C3-C4	C4-C5	C5-C6	C6-C7	C7-D1
P-Value	**0.044**	**0.042**	**0.017**	**0.01**	**0.032**	**0.041**

P≤0.05 is considered statistically significant.

Table1.4.Prevalence of degenerative diseases at various levels of C-Spine

LEVEL	DD	DB	DH/DP	OC	TSI	CCC	CCN/CCS	NCN/NFN	ENRC/I
C2-C3	8	0	0	2	1	0	0	0	0
C3-C4	23	6	1	19	7	0	0	2	0
C4-C5	32	13	1	22	16	2	4	4	4
C5-C6	35	17	5	22	12	2	3	7	6
C6-C7	31	12	4	23	10	3	4	7	5
C7-D1	15	1	0	6	0	0	0	0	0
TOTAL	**144**	**49**	**11**	**94**	**46**	**7**	**11**	**20**	**15**

DD (Disc Degeneration), DB (Disc Bulge), DH/DP (Disc Herniation/Disc Prolapse), OC (Osteophytic Changes), TSI (Thecal Sac Indentation), CCC (Cervical Cord Compression), CCN / CCS (Cervical Canal Narrowing / Cervical Canal Stenosis), NCN / NCS (Neural Canal Narrowing/Neural Foramen Narrowing),ENRC/ ENRI(Exiting Nerve Root Compression/Exiting Nerve Root Indentation).

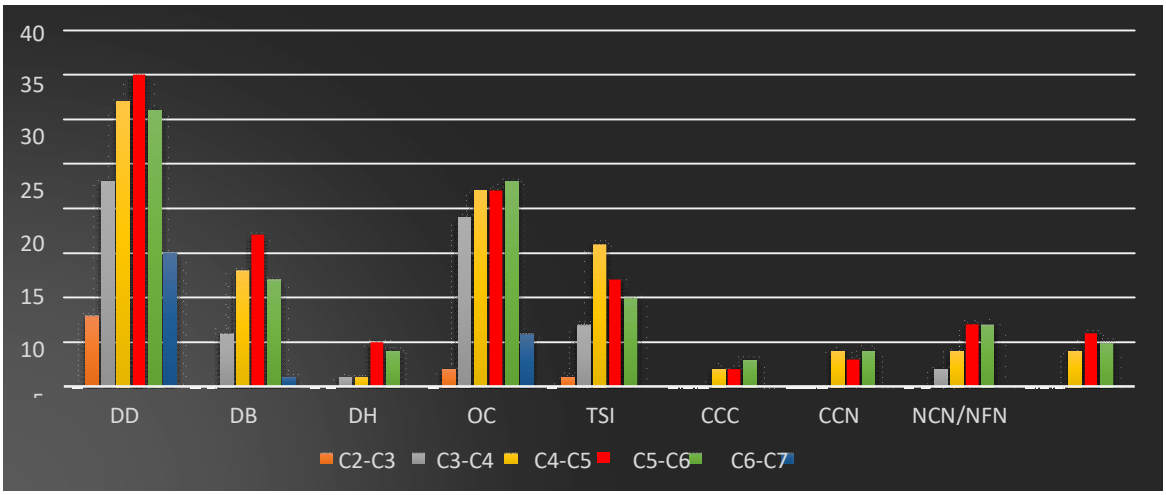


Fig. 1.5 Prevalence of C-Spine degenerative diseases at various levels of the spine

The prevalence of C-Spine degenerative diseases were commonly found in males as compared to females except disc bulge found more common in females (25.7% discs in F, 18.2% discs in M).The percentage of Disc degeneration (DD) were prevalent highest among all degenerative diseases included in the study in both the genders whereas prevalence of cervical cord compression(CCC) were found least.The C-Spine degenerative diseases were commonly found at C5/6 level followed by C4/5 & C6/7 level whereas found least at C2/3 level followed by C7/D1 level in both the genders. The prevalence of C-Spine Degenerative diseases in male and female discs are shown in table 1.5andfig.1.6below.

Table1.5 Distribution of C-Spine degenerative diseases in genders(N=No.of discs)

FINDINGS	TOTAL(N=210)	MALE(N=66)	FEMALE(N=144)
DD	144(68.6%)	51(77.3%)	93(64.6%)
DB	49(23.3%)	12(18.2%)	37(25.7%)
DH/DP	11(5.2%)	7(10.6%)	4(2.8%)
OC	94(44.8%)	40(60.6%)	54(37.5%)
TSI	46(21.9%)	21(31.8%)	25(17.4%)
CCC	7(3.3%)	3(4.5%)	4(2.8%)
CCN/CCS	11(5.2%)	4(6.1%)	7(4.9%)
NCN/NFN	20(9.5%)	12(18.2%)	8(5.6%)
ENRC/I	15(7.1%)	11(16.7%)	4(2.8%)

DD (Disc Degeneration), DB (Disc Bulge), DH/DP (Disc Herniation/Disc Protrusion), OC (Osteophytic Changes), TSI (Thecal Sac Indentation) CCC (Cervical Cord Compression), CCN/CCS (Cervical Canal Narrowing /Cervical Canal Stenosis), NCN/NFN (Neural Canal Narrowing /Neural Foramen Narrowing), ENRC/I (Exiting Nerve Root Compression/Indentation)

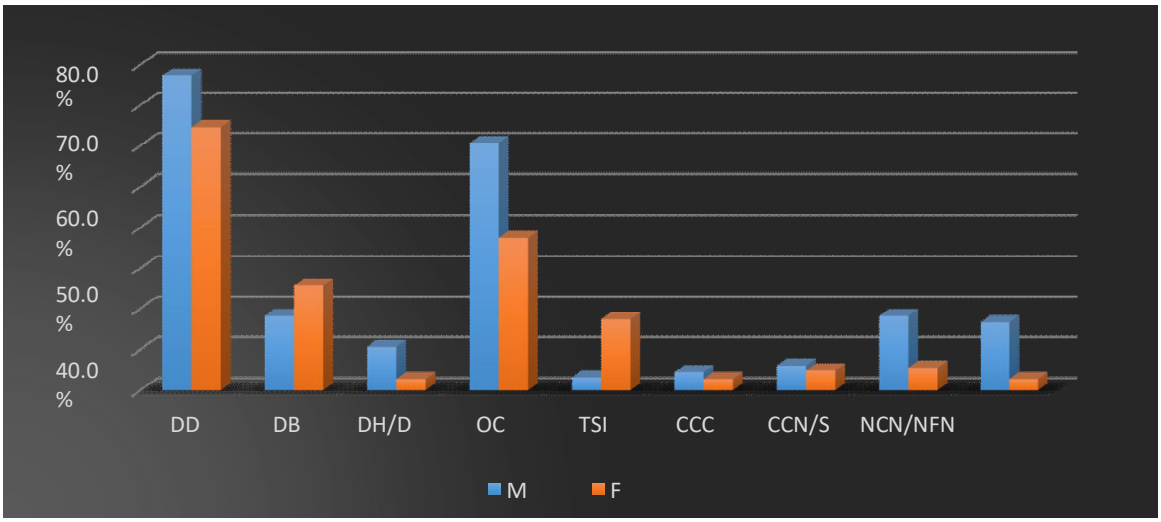


Fig.1.6 Comparison of degenerative diseases in male and female discs (%age)

Comparison of C-Spine Degenerative Diseases among various age groups (20-39, 40-59 and 60-79Yrs.)
The prevalence of cervical spine degenerative diseases were highest found in the age group withagerangesfrom60-79years(P=0.027).Discdegeneration(DD)oftheC-spinewasfoundhighestwhereas spinal cord compression was found lowest in all age groups among all degenerative diseases of the C-Spine included in the study. The comparison of the prevalence of cervical spine degenerative diseases among various age groups is shown in table1.6 and fig 1.7 below.

Table1.6 Comparison of Degenerative Diseases in various age groups(N=No.of discs)

FINDINGS	AGEGROUP INYrs.			TOTALNO.OFDISCS
	20-39(N=72)	40-59(N=108)	60-79(N=30)	(N=210)
DD	45(62.5%)	75(69.4%)	24(80.0%)	144(68.6%)
DB	12(16.7%)	27(25.0%)	10(33.3%)	49(23.33%
DH/DP	4(5.5%)	5(4.6%)	2(6.7%)	11(5.2%)
OC	29(40.3%)	45(41.7%)	20(66.7%)	94(44.8%)
TSI	15(28.8%)	20(18.5%)	11(36.7%)	46(21.9%)
CCC	3(4.2%)	4(3.7%)	0(0.0%)	7(3.33%)
CCN/S	5(6.9%)	4(3.7%)	2(6.7%)	11(5.2%)
NCN/NFN	5(6.9%)	11(10.2%)	4(13.3%)	20(9.5%)
ENRC/I	3(4.2%)	9(8.3%)	3(10.0%)	15(7.14%)

DD(Disc Degeneration),DB (Disc Bulge),DH/DP (DiscHerniation/Disc Protrusion),OC (Osteophytic Changes),TSI (Thecal Sac Indentation)CCC (Cervical Cord Compression), CCN/CCS (Cervical Canal Narrowing/Cervical Canal Stenosis), NCN (Neural Canal Narrowing/ Neural Foramen Narrowing),ENRC/I (Exiting Nerve Root Compression/Indentation

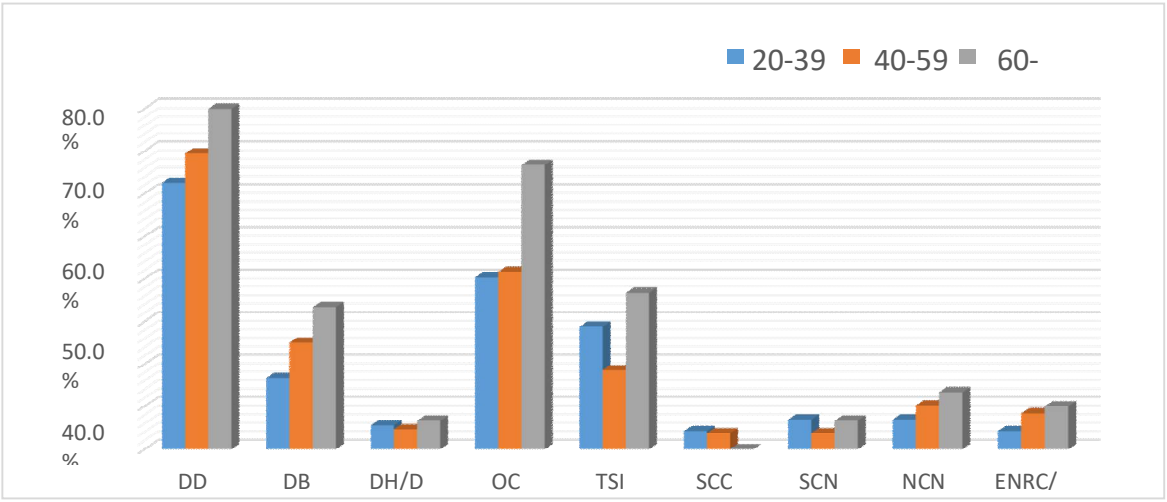


Fig.1.7Comparisonof C-Spine degenerative diseases among various age groups

Spinal canal AP diameter measurement

The spinal canal AP diameter was measured from C1 to C7 in all the 35 patients at the level of mid of the vertebrae. The average cervical spine canal diameter decreases from C1 level to C6 level in both genders and then increases a little at C7 level as shown in fig1.8.The average spinal canal AP diameter ranges from10.85mm to15.17mm.The spinal canal diameter was highest at C1 level (15.17mm)and lowest at C6(10.85mm), followed by C5 level(11.17mm).The spinal canal diameter was higher in males (ranges11.07-15.9mm) as compared to females(ranges10.65-14.83mm).The average spinal canal diameter was highest in males at C1 level (15.9mm) and lowest at C6 level (11.07mm) whereas in females it was 14.83 mm & 10.65 mm at the respective levels. The average canal diameter in males and females are shown in table 1.9 below.

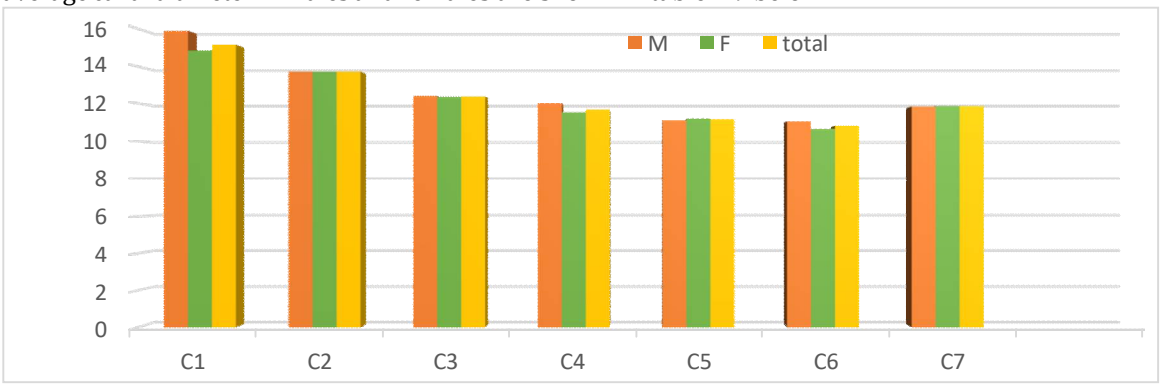


Fig.1.8 Average spinal canal diameter(mm) in the patients

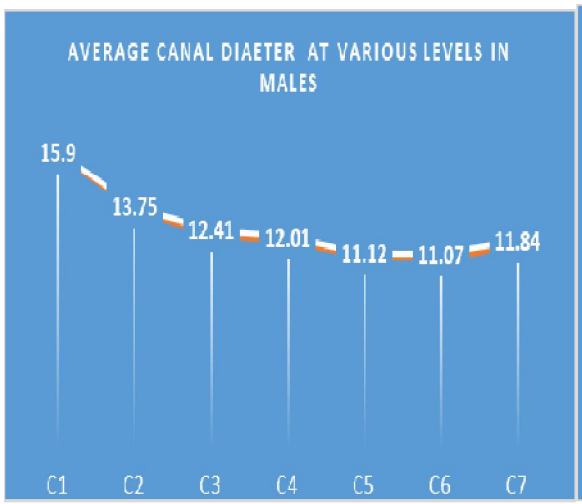


Fig.1.9 A MALES

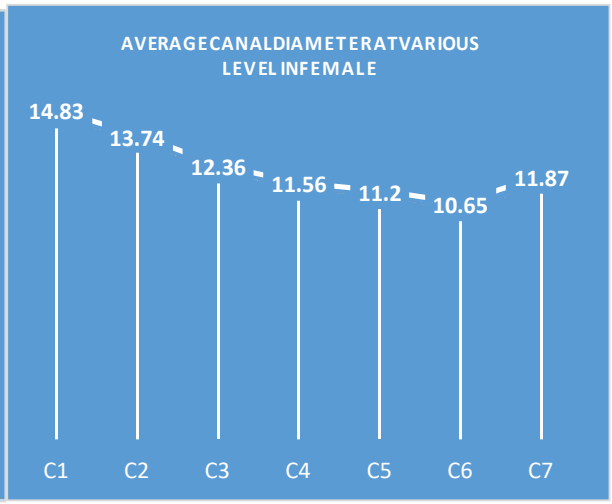


Fig.1.9 B FEMALE

Fig.1.9 Average Spinal Canal AP diameter (mm) in males and females at various levels

DISCUSSION

Degenerative changes in the form of disc desiccation, disc herniation & disc bulge were prevalent in 76.13% of patients [5]. Disc degeneration and disc bulge were more commonly found in 4th and 5th decade of age in the subjects [4, 9]. Disc degeneration (grade 1 or 2) was found in 17% of disc in male & 12% in female with age in 20s which rises to 86% and 89% respectively at age above 60 years [9]. Intervertebral disc degeneration was more commonly found at C5/6, followed by C 6/7 level [18].The prevalence of disc bulge was found highest at C5-C6(36.7%) and C4-C5 level (29.7%) [5].In another study it was found that the osteophytosis, disc degeneration, disc space narrowing & disc bulge was commonly prevalent at C5-C6 [19]. The osteophytes was more commonly prevalent at C5-C6 (48.2%), followed by C4-C5(44.1%)andC6-C7(40.5%)level [5].The disc herniation was found in 21.2% of patients and commonly prevalent at C5-C6 (52.2%), followed by C6-C7 level (38.9%) and 80% of disc herniation was found in patients with age between 3rd and 6th decade [5].Spinal cord compression was found in 5.3% patients and commonly found at C5-C6 level (41%) followed by C6-C7 level (27%) [20]. Neural for aminal stenosis or neural for aminal narrowing was found in 48.4% patients and was prevalent commonly found at C5-C6 followed byC6-C7(40.2%)andC4-C5(29.2%) [5]. Rikke Kruger Jesen et al founded that the for aminal stenosis (74%), disc degeneration (67%)were most common findings and nerve root compression (2%) was least common finding reported on MRI and prevalent commonly at C5-C6,C6-C7 level [21].

In this study cervical spine degenerative diseases were mostly prevalent in the patients with age ranges from60 to 79 years. The most common MRI findings were Discdegeneration68.6%discsfollowedbyosteophytic changes 44.7% and cervical cord compression was rarely found 3.3%. Disc degeneration, disc herniation, osteophytic changes, the cal sac indentation, cervical cord compression, cervical canal narrowing/ stenosis, neural canal narrowing and exiting nerve root compression / indentation were commonly found in Males where as discbulge commonly found in Females. Disc degeneration, disc bulge, disc herniation, neural canal narrowing and exiting nerve root compression were commonly found at C5-C6 where as osteophytic change, cervical cord compression and cervical canal narrowing was more common at C6-C7level.Theaverage cervical canal diameter decreases from C1 to C6 and increases a little at C7.The average cervical canal diameter was highest at C1(15.17mm) and lowest at C6 (10.85mm). The cervical canal diameter was higher in males as compared to females.

There were two limitations in the present study:1].The sample size of the study was less and the results based on small sample may not be generalized. 2].The distribution of samples between male and female patients were unequal. The advantages of the present study are:1].The researcher has attempted to cover more no. of degenerative diseases in the study [2]. The study may enhance knowledge of readers 3]. It will be addition to the existing research in the field 4]. It may help researchers in the department to conduct further relevant researches, and 5]. It has expanded the research knowledge and skills of the researcher to conduct independent research studies.

CONCLUSION

The prevalence of C-Spine Degenerative Diseases on MRI were common at lower end of the cervical region (C5-C6,C6-C7and C4-C5), and found mostly in the patients with age range 60-79 years.The C-Spine degenerative diseases were rarely found at C2-C3 and C7-D1 level .Thus the MRI plays significant role in the evaluation process of cervical spine degenerative diseases and its progression with age.

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CITATION OF THIS ARTICLE

Khursheed Ahmad Ganie, Ashita Jain, Arshad Alam Khan, Komal Priya: Role of MRI in Evaluation of Degenerative Disease in C-Spine and Inter Vertebral Disc (IVD)Prolapsed. Bull. Env. Pharmacol. Life Sci., Spl Issue [5]: 2022: 498-505.