Journal of Medical and Surgical Practice (JMSP)
Vol. 08, No. 01, January-March, 2022

Correlation between new MRI Grading for Cervical Spinal Canal Stenosis and clinical symptoms in Sulaimani

Dr. Haitham Enad Dhari[1*], Dr. Khudher Abed Saleh [2]

1. *M.B.Ch.B, Diploma in Radiology. Dujail emergency and maternity hospital*
2. *M.B.Ch.B, Diploma in Radiology. Sallah adden teaching hospital*

**Corresponding Author* , contact email : *dhari_hedmrd78@gmail.com*

Original Article

Summary

Acquired Cervical canal stenosis is most common degenerative disease defined as a narrowing of the spinal canal by both bone and soft tissues, capable of causing mechanical compression of the spinal canal and nerve roots. The compression of these nerve roots can be asymptomatic, but it can also result in weakness, alteration in reflexes, motor and sensory changes, radicular pain, or atypical arm pain. This study aimed to assess the correlation between new MRI grading of cervical spinal canal stenosis and clinical symptoms in Sulaimani. We performed a cross sectional study carried out in Shar Teaching Hospital and Shaheed Aso teaching Hospital for period from 1st of December, 2014 to end of August, 2015. All patients suspected with cervical spinal stenosis presented to Consultancy Clinics of Shar Teaching Hospital and Shaheed Aso teaching Hospital was study population. We found no significant differences between cervical stenosis patients with different grades regarding their age and gender ($p>0.05$). There a significant association between pain and patients with grade I, on other hand, there was a significant association between parasthesia and patients with grade III ($p<0.001$).

In conclusion, MRI is more common diagnostic technique for diagnosing and grading of cervical spinal canal stenosis.

Keywords: *MRI Grading, Cervical Spinal Canal Stenosis, Sulaimani*

Article information*: Received: January, 2022, Accepted and Published online March, 2022*

How to cite this article*: Dhari H.E. and Saleh K.A. Correlation between new MRI Grading for Cervical Spinal Canal Stenosis and clinical symptoms in Sulaimani. JMSP 2022; 8(1): 89*

1. INTRODUCTION

Acquired Cervical canal stenosis is most common degenerative disease defined as a narrowing of the spinal canal by both bone and soft tissues, capable of causing mechanical compression of the spinal canal and nerve roots. The compression of these nerve roots can be asymptomatic, but it can also result in weakness, alteration in reflexes, motor and sensory changes, radicular pain, or atypical arm pain . Cervical spondylotic myelopathy is a common degenerative disorder associated with the narrowing, or stenosis, of the spinal canal that frequently affects elderly patients. Narrowing of the spinal canal may be caused by various factors, including the herniation or bulging of intervertebral disc, osteophytes, and ossification of the posterior longitudinal ligament. The progressive compression of the cord by these factors may lead to spinal cord ischemia, resulting in histopathologic changes of the cervical spinal cord. Previous studies have described various methods of assessing the degree of cervical canal stenosis. Early studies were based on radiographs; Edwards and Larocca 3 measured the sagittal diameter of the cervical spinal canal on a plain lateral radiograph, whereas Pavlov et al. and Torg et al. used the ratio of the sagittal diameter of the cervical canal divided by the corresponding diameter of the vertebral body. (1-5). However, MRI is currently by far the most commonly used imaging method for the accurate evaluation of spinal canal stenosis. MRI visualizes not only the width and length of the spinal canal but also depicts in detail the spinal cord, intervertebral disc, osteophytes, and ligaments, all of which are potential causes of spinal canal stenosis (2).

Despite the various assessments made in previous studies, grading systems for cervical canal stenosis based on MRI and corresponding reproducibility studies are currently sparse. Moreover, there is no universally used grading system. A standardized grading system in the assessment of cervical canal stenosis is a prerequisite for the comparison of data from different investigations and for the improvement of communication between radiologists and clinicians. Muhle et al. (6) classified cervical canal stenosis according to the following grading system: grade 0, normal; grade 1, partial obliteration of the anterior or posterior subarachnoid space; grade 2, complete obliteration of the anterior or posterior subarachnoid space; and grade 3, cervical cord compression or displacement, there are several limitations to the grading system of Muhle et al. (6) , First, the definition of partial obliteration is unclear. Second, we encountered cases in which CSF clefts were notable around the spinal cord, even when there was severe canal compromise or spinal cord deformity. In turn, the definition of complete obliteration is also impractical. Third, no consideration is given to the signal change of the spinal cord, which is known as a good sign of compressive myelopathy (7). Recently, Kang et al. (8) reported a new MRI grading system for cervical canal stenosis. They classified cervical canal stenosis into the following grades based on T2- weighted sagittal images: grade 0, absence of canal stenosis (subarachnoid space obliteration ≤ 50%); grade 1, subarachnoid space obliteration > 50%; grade 2, spinal cord deformity (compressed); and grade 3, spinal cord signal change. Kang et al. suggested that this new grading system provides a reliable assessment of cervical canal stenosis. The purpose of this study was to evaluate whether the new MRI grading system for cervical canal compression correlates with symptoms and neurologic signs and to evaluate whether each grade represents clinical. significance.

Cervical canal stenosis

Cervical spondylosis is common and progresses with increasing age. It is the result of degenerative changes in the cervical spine, including disc degeneration, facet arthropathy, osteophyte formation, ligamentous thickening . Spinal stenosis, or narrowing of the spinal canal, may occur as a result of progression of spondylotic changes. Spinal cord or nerve root function may be affected, resulting in symptoms of myelopathy or radiculopathy (9).

Natural History and Epidemiology

Spinal cord compression resulting from spondylotic changes is usually a slow and progressive process. Many patients have evidence of significant compression on imaging studies but are asymptomatic. Most cases of myelopathy develop in a stepwise fashion described by episodes of exacerbation of symptoms and worsening function followed by long periods of static function. Fewer patients have steady progressive deterioration. With vascular insufficiency, acute onset may occur with devastating, irreversible ischemic changes occurring within the cord (10). Approximately 25% of individuals younger than forty years of age, 50% of individuals over forty years of age, and 85% of individuals over sixty years of age have some degree of disc degeneration (10,11).

Assessment of Sagittal Diameter of the Spinal Canal

The size of the cervical spinal canal is clinically important (12,13). The spinal canal is narrowed with central stenosis, and this can lead to cervical myelopathy. The role of the narrow cervical spine in the expression of clinical syndromes was evaluated(by plain x-ray)

Edwards and LaRocca (14). They predicted that patients with a canal size of <10 mm had myelopathy, those with a canal size of 13 to 17 mm were less prone to myelopathy but were more prone to symptomatic cervical spondylosis, and those with a canal size of greater than 17 mm were asymptomatic (14). MRI studies which take into account soft tissue structures, a congenital sagittal diameter of <13 mm is a significant risk factor for development of stenosis (12). However, a number of authors have reported an incidence of asymptomatic stenosis of between 16 and 19% 15, 16. With MRI scanning becoming more routinely available the best management of this group of individuals will be challenging. There are numerous ways to evaluate the diameter of the spinal canal. Although traditionally determined on a lateral plain film such measurements have shown to be inaccurate. Inaccuracy has also been attributed to variation in the distance from the X-ray source and rotation of the subject (12,13). In order to improve accuracy of this measurement on plain film a number of authors have described the use of a ratio between the sagittal diameter of the vertebral body and the diameter of the canal (17,18). Pavlov’s ratio was considered normal when >1 and stenotic when <0.8. However, some authors have reported a poor correlation between the space available for the cord and the Pavlov ratio (19,20). The most accurate measurement of spinal canal diameter is obtained using MRI. Unlike other modalities MRI takes into account both osseous and soft tissue structures when calculating the canal diameter. This is important as central stenosis is often due to a combination of degenerative hypertrophy of the facet joints, osteophytic spurring, ligamentum flavum thickening, ossification of the posterior longitudinal ligament, posterior disc protrusion, and translation of one anatomical segment on the next (21). The examination should be performed using thin sections .Spinal MRI should include imaging sets obtained in the axial and sagittal planes using T1-weighted, and T2-weighted techniques. In addition, pulse sequences that provide high signal from cerebrospinal fluid (myelographic effect) help delineate epidural pathological processes such as disc fragments and osteophytes (22). The bony and osteophytic components of the spinal stenosis pattern are seen best using a T2-weighted gradient-echo technique.

2. PATIENTS and METHODS

A cross sectional study carried out in Shar Teaching Hospital and Shaheed Aso teaching

Hospital for period from 1st of December, 2014 to end of August, 2015.

Study Population

All patients suspected with cervical spinal stenosis presented to Consultancy Clinics of Shar Teaching Hospital and Shaheed Aso teaching Hospital was study population.

Inclusion criteria: 1. Adult age (≥25 years), 2. Suspected cervical canal stenosis.

Exclusion criteria: Infections, tumors, acute trauma, surgical history, neural foraminal stenosis, combined brain infarction or other intracranial lesion, and peripheral neuropathy, such as carpal tunnel syndrome.

Sampling

A convenient sample of 50 suspected patients with cervical canal stenosis were selected from patients presented to Consultancy Clinics of Shar Teaching Hospital and Shaheed Asso Hospital.

Data collection

The data were collected by the researcher through direct interview and fulfilling a prepared questionnaire. Neurologic examinations were performed and clinical manifestations were acquired by the same physician. We considered positive neurologic manifestations as observed paresthesias, extremity weakness, numbness, and funicular or radicular pain. The patients were referred from neurosurgeon or orthopedic specialist . Final diagnosis of stenosis and grading was done by Radiology specialist. The questionnaire included the followings:

Demographic characteristics (age and gender), clinical symptoms, causes of stenosis.(by MRI finding), MRI Grading at level of stenosis.

MRI imaging

All MRI examinations were performed using the same protocol on GE 1.5 Tesla in Shar hospital & Siemens 1.5 Tesla in Shaheed Aso hospital using (GE cervical coil) &(Siemens neck matrix coil) and fast spin-echo imaging. T2weighted images were obtained in the axial plane and T2-weighted images in the sagittal plane in the supine position with the following parameters: FOV, (210*210 in GE)& (220*220 in Siemens) , ; slice thickness, 3 mm; interslice gap, 0.3 mm (sagittal image); and slice thickness, 3 mm; interslice gap, 0.3 mm (axial image). The GE MRI sequences in Shar hospital were as follows: (sagittal T2weighted spin echo TR/TE, 1980/111 & sagittal T1weighted spin echo TR/TE 320/7.1 and axial T2-weighted Gradient echo TR/TE, 249/11.2). The Siemens MRI sequences in Shaheed Aso hospital were as follows: (sagittal T2weighted spin echo TR/TE, 3000/89 & sagittal T1weighted spin echo TR/TE 510/11 and axial T2-weighted Gradient echo TR/TE, 400/18).

A total of five sequential levels (C2-C3, C3–C4, C4–C5, C5–C6, and C6– C7) were qualitatively analyzed. The radiologists assessed the presence and grade of cervical spinal canal stenosis at the maximal narrowing point, in accordance with the new MR grading system suggested by Kang et al. 8; hereafter, we refer to this grading system as the Kang system. Cervical canal stenosis was classified into the following grades on the basis of T2-weighted midsagittal images: grade 0, subarachnoid space obliteration ≤ 50%(fig 4) ; grade 1, subarachnoid space obliteration > 50% without cord compression(fig 5); grade 2, spinal cord compression without cord signal change (fig 6); and grade 3, spinal cord compression with cord signal change near the compressed level (fig 7).

Statistical analysis

All patients' data entered using computerized statistical software; Statistical Package for Social Sciences (SPSS) version 17 was used. Descriptive statistics presented as (mean ± standard deviation) and frequencies as percentages. Kolmogorov Smirnov analysis verified the normality of the data set. Multiple contingency tables conducted and appropriate statistical tests performed, Chi-square used for categorical variables (Fishers exact test was used when more than 20% of the cells less than 5). In all statistical analysis, level of significance (p value) set at ≤ 0.05 and the result presented as tables and/or graphs. Statistical analysis of the study was done by the community medicine specialist.

3. RESULTS

Total of 50 cervical stenosis patients were included in present study with mean age of 50±12 years, 34% of them were aging 50-59 years. Females were more than males with male to female ratio as 0.8:1. The common symptoms of studied patients were pain (34%) pain radiating to upper extremities (34%) and parasthesia (32%). All studied patients were graded by T2 sagital MRI. All these findings were shown in table 1.

More than half (55.3%) of cervical stenosis patients were at grade I, 24.7% of them were at grade II, 18.8% of them were at grade III and only one patient was at grade 0. More than half of studied patients had single grading and 42% of them had multiple grades. All these findings were shown in table 2.

The levels of cervical stenosis was distributed as followings; 45.3% at C5-6, 21.4% at C6-7, 19% at C4-5, 11.9% at C3-4 and only two patient at C2-3. More than half (57.1%) of cervical stenosis were at single level and 42.9% of them were at multiple levels. All these findings were shown in table 3.

No significant differences were observed between cervical stenosis patients with different grades regarding their age and gender ($p>0.05$), table 4. There a significant association between pain and patients with grade I, on other hand, there was a significant association between parasthesia and patients with grade III ($p<0.001$), (Table 5.)

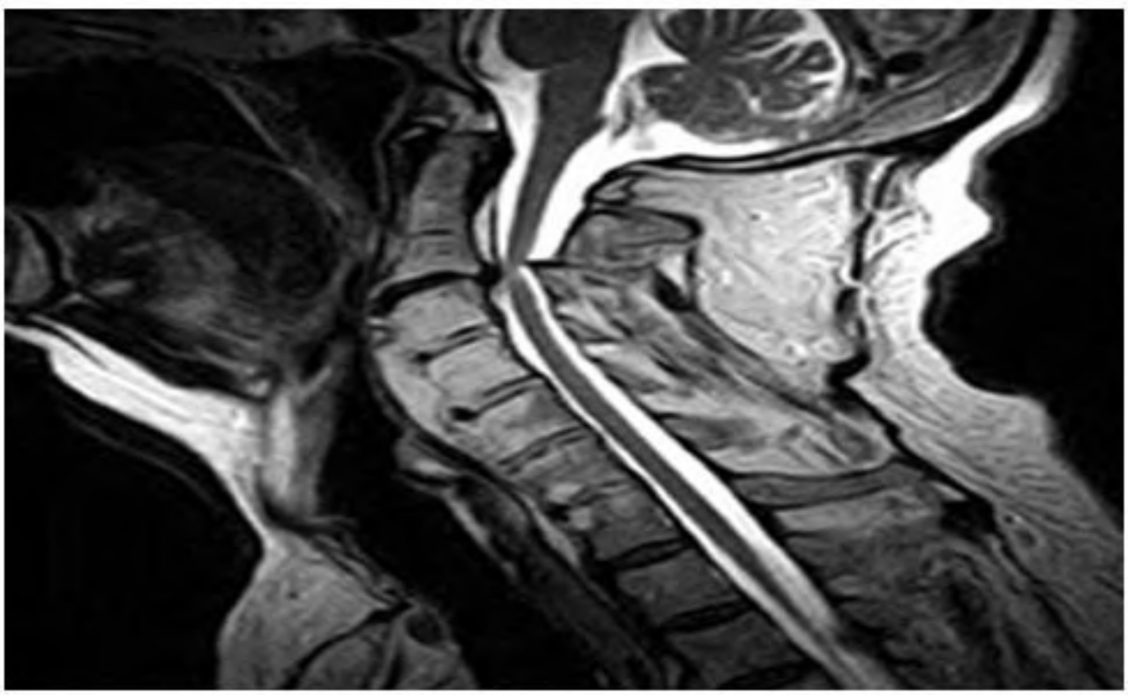

Figure 1: MRI of high grade cervical stenosis.

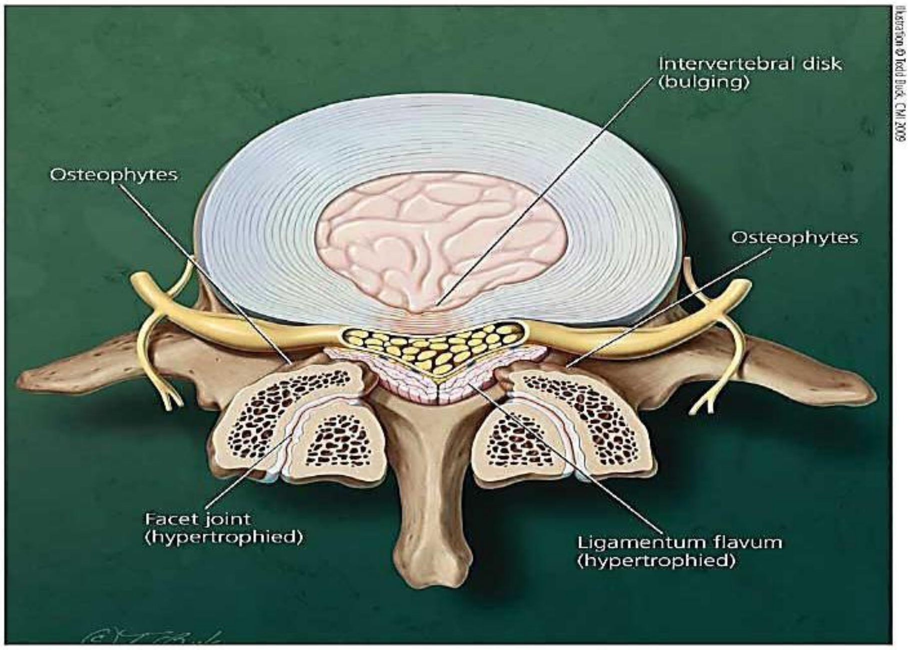

Figure 2: Cervical canal stenosis.

Figure 3: MRI of cervical canal stenosis.

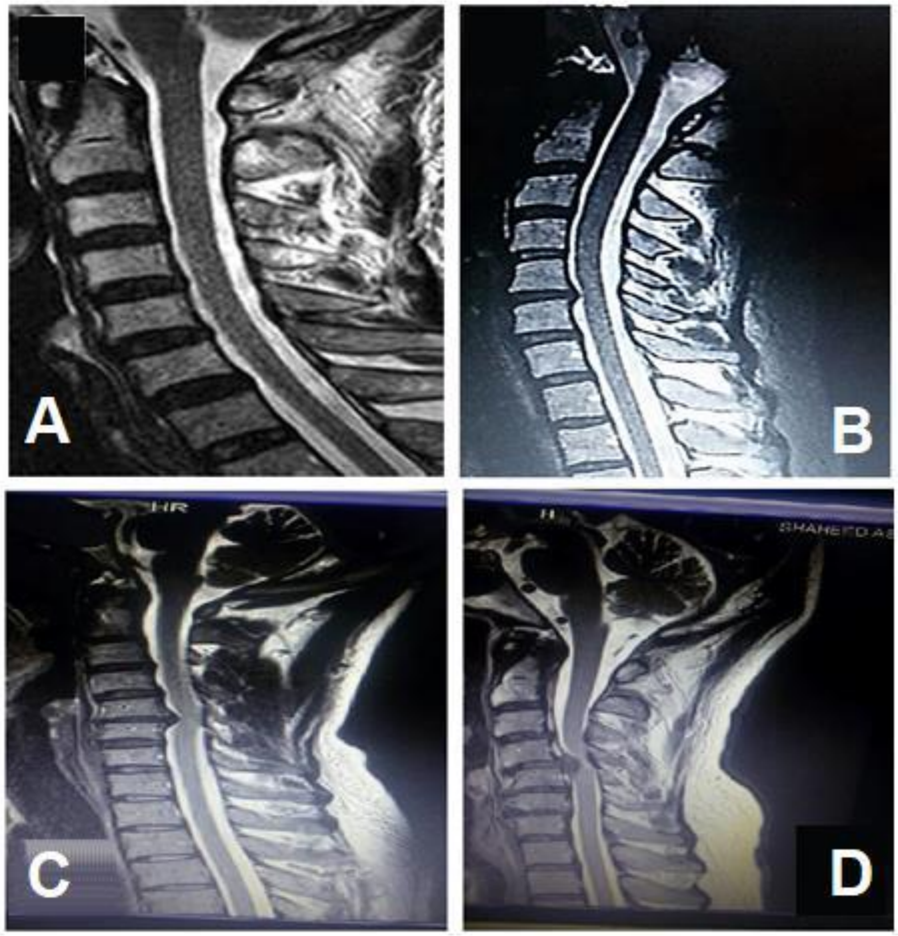

Figure 4: (A): Grade 0. (B): Grade I., (C): Grade II, (D): Grade III.

Table 1: Clinical symptoms and MRI plane of studied patients.

Variable		No.	%
Clinical symptoms	Pain	17	34
	Radiculopathy	17	34
	Parasthesia	16	32
MRI plane / T2 sagittal		50	100

Table 2: Grading of cervical stenosis among the fifty patients

Variable		**No.**	**%**
Grading	Grade 0	1	1.2
	Grade I	47	55.3
	Grade II	21	24.7
	Grade III	16	18.8
Total		85	100
Grading frequency	Single	29	58
	Multiple	21	42
Total		50	100

Table 3: Level of cervical stenosis.

Variable		**No.**	**%**
Level	C2-3	2	2.4
	C3-4	10	11.9
	C4-5	16	19
	C5-6	38	45.3
	C6-7	18	21.4
Total		84	100
Level frequency	Single	28	57.1
	Multiple	21	42.9
Total		49	100

Table 4: Distribution of demographic characteristics according to grades of cervical stenosis.

Variable	Grade I		Grade II		Grade III		χ^2	P. value
	No.	%	No.	%	No.	%		
Age							6.7*	0.3
< 40 years	5	17.8	2	18.2	1	9.1		
40-49 years	10	35.7	4	36.4	1	9.1		
50-59 years	10	35.7	2	18.2	5	45.4		
≥ 60 years	3	10.8	3	27.2	4	36.4		
Gender							4.9*	0.08
Male	15	45.5	3	27.3	5	83.3		
Female	18	54.5	8	72.7	1	16.7		

**Fishers exact test.*

Table 5: Distribution of clinical symptoms according to grades of cervical stenosis.

Clinical symptoms	Grade I		Grade II		Grade III	
	No.	%	No.	%	No.	%
Pain	17	77.3	0	0.0	0	0.0
Radiculopathy	5	22.7	8	100.0	4	20.0
Parasthesia	0	0.0	0	0.0	16	80.0
P. value < 0.001, significant						

4. DISCUSSION

Females with cervical spinal stenosis in our study were more than males. This is similar to results of Park CH, et al study in South Korea (2013) (23). Some studies reported that females sustained cervical spinal canal narrowing more easily than males due to its smaller size. Because of the developmental morphological structure in females, the cervical spine canal is prone to degeneration and has less capability to withstand trauma (24).

Symptoms of cervical canal stenosis reported by our patients were pain, pain radiating to shoulders and parasthesia. These findings agreed with results of Green G, et al study in Ireland (2011) (25). At least 10% of the population recalls having pain in the neck at least three times within the past year and at least 35% of the adult population can recall at least one episode of neck pain. Rothman stated that "it does not appear that cervical disc degeneration is a brief, self-limiting disorder but rather a chronic disease, productive of significant pain and incapacity over an extended period of time". Gore studied 205 patients for a minimum of 10 years and found that over one third of the patients studied had moderate to severe neck pain at final evaluation, thus confirming Rothman's hypothesis. Fifty-one percent of the adult population will experience neck and arm pain at some point in their lifetime (26).

Disc bulge was the common cause of cervical spinal canal stenosis in present study. This finding agreed with results of Malcolm GP study in UK (2002) (27).

MRI grading of cervical canal stenosis in present study showed that 55.3% of cervical canal stenosis patients had grade I stenosis, 24.7% of them had grade II stenosis, 18.8% of them had grade III stenosis and 1.2% of them had grade 0 stenosis. This finding is consistent with results of Kang Y, et al study in South Korea (2011) (8) which found grade I is more common and grade 0 is the least common. This is inconsistent with results of Park HJ, et al study in South Korea (2012) (28) which found grade 0 is more common and grade III is least common. This inconsistency might be attributed to difference in sample size, study designs and patients' selection methods.

The prevalent cervical spinal stenosis level affected was at C5-6 (45.3%), followed by; C6-7 (21.4%), C4-5 (19%), C3-4 (11.9%) and C2-3 (2.4%). These findings are similar to reports of Epstein NE and Hollingsworth R study in USA (2015) (29), on other hand, it is inconsistent with results of Kang Y, et al study in South Korea (2011) (8) which found that C6-C7 was the more common level.

5. CONCLUSIONS

MRI is more common diagnostic technique for diagnosing and grading of cervical spinal canal stenosis. Grade I cervical canal stenosis was the most common and grade 0 was least common. Cervical spinal canal stenosis was more prevalent at cervical level C5-C6. Elderly females were more likely to be affected by cervical canal stenosis. Hence, we recommend adaptation of MRI grading system of cervical canal stenosis by Radiologist is important to provide united picture of cervical canal stenosis clinically. Encouraging the availability of MRI in all national hospitals and Specialized Health centers for early detection of cervical canal stenosis, however, further national large size studies are highly suggested.

Ethical Clearance: Ethical clearance and approval of the study are ascertained by the authors. All ethical issues and data collection were in accordance with the World Medical Association Declaration of Helsinki 2013 of ethical principles for medical research involving human subjects. Data and privacy of patients were kept confidentially.

Conflict of interest: Authors declared none

Funding: None, self-funded by the authors

References

1. Lamothe G, Muller F, Vital JM, Goossens D, Barat M. Evolution of spinal cord injuries due to cervical canal stenosis without radiographic evidence of trauma (SCIWORET): A prospective study. Ann Phys Rehabil Med 2011; 54:213-224.

2. Cook C, Braga-Baiak A, Pietrobon R. Observer agreement of spine stenosis on magnetic resonance imaging analysis of patients with cervical spine myelopathy. J Manipulative Physiol Ther 2008; 31:271–276.

3. Edwards WC, Larocca H. The developmental segmental sagittal diameter of the cervical spinal canal in patients with cervical spondylosis. Spine (Phila Pa 1976) 1983; 8:20–27.

4. Pavlov H, Torg JS, Robie B, Jahre C. Cervical spinal stenosis: determination with vertebral body ratio method. Radiology 1987; 164:771–775.

5. Torg J, Pavlov H, Genuario S. Neuropraxis of the cervical spinal cord with transient quadriplegia. J Bone Joint Surg Am 1986; 68:1354–1370.

6. Muhle C, Metzner J, Weinert D. Classification system based on kinematic MR imaging in cervical spondylitic myelopathy. AJNR 1998; 19:1763–1771.

7. Yukawa Y, Kato F, Yoshihara H, Yanase M, Ito KMR. T2 image classification in cervical compression myelopathy. Spine (Phila Pa 1976) 2007; 32:1675–1678.

8. Kang Y, Lee JW, Koh YH, et al. New MRI grading system for the cervical canal stenosis. AJR 2011; 197:193; W134–W140.

9. McDonnell M, Lucas P. Cervical Spondylosis, Stenosis, and Rheumatoid Arthritis. Medicine &

Health 2012; 95 (4): 105-109.

10. *Emery, SE. Cervical Spondylotic Myelopathy: Diagnosis and Treatment. J Am Acad Orthop Surg. 2001; 9(6):376–88.*
11. *Lee MJ, Cassinelli EH, Riew KD. Prevalence of cervical spine stenosis: Anatomic study in cadavers. J Bone Joint Surg (Am). 2007; 89(2):376–80.*
12. *Morishita Y, Naito M, Hymanson H, Miyazaki M, Wu G, Wang JC. The relationship between the cervical spinal canal diameter and the pathological changes in the cervical spine. European Spine Journal 2009; 18 (6): 877–883.*
13. *Lee MJ, Cassinelli H, Riew KD. Prevalence of cervical spine stenosis: anatomic study in cadavers. Journal of Bone and Joint Surgery 2007; 89 (2): 376–380.*
14. *Edwards WC, LaRocca H. The developmental segmental sagittal diameter of the cervical spinal canal in patients with cervical spondylosis. Spine 1983; 8 (1): 20–27.*
15. *Boden SD, McCowin PR, Davis DO, Dina TS, Mark AS, Wiesel S. Abnormal magnetic-resonance scans of the cervical spine in asymptomatic subjects. A prospective investigation. Journal of Bone and Joint Surgery 1990; 72 (8): 1178–1184.*
16. *Teresi LM, Lufkin RB, Reicher MA. Asymptomatic degenerative disk disease and spondylosis of the cervical spine: MR imaging. Radiology 1987; 164 (1): 83–88.*
17. *Pavlov H, Torg JS, Robie B, Jahre C. Cervical spinal stenosis: determination with vertebral body ratio method. Radiology 1987; 164 (3): 771–775.*
18. *Torg JS, Pavlov H, Genuario SE. Neurapraxia of the cervical spinal cord with transient quadriplegia. Journal of Bone and Joint Surgery 1986; 68 (9): 1354– 1370.*
19. *Blackley HR, Plank LD, Robertson PA. Determining the sagittal dimensions of the canal of the cervical spine. Journal of Bone and Joint Surgery 1999; 81 (1): 110–112.*
20. *Prasad SS, O'Malley M, Caplan M, Shackleford IM, Pydisetty RK. MRI measurements of the cervical spine and their correlation to Pavlov's ratio. Spine 2003; 28 (12): 1263–1268.*
21. *Gundry CR, Fritts HM. Magnetic resonance imaging of the musculoskeletal system: part 8. The spine, section 2, Clinical Orthopaedics and Related Research 1997; 343: 260– 271.*
22. *Melhem ER, Itoh R, Folkers PJM. Cervical spine: three-dimensional fast spin-echo MR imaging—improved recovery of longitudinal magnetization with driven equilibrium pulse. Radiology 2001; 218 (1): 283–288.*
23. *Park CH, Lee SH, Lee SC. Preliminary Results of the Clinical Effectiveness of Percutaneous Adhesiolysis Using a Racz Catheter in the Management of Chronic Pain Due to Cervical Central Stenosis. Pain Physician 2013; 16:353-358.*
24. *Ling Z, Hai-bin C, Yi W, Li-ying Z, Jing-chengand L, Zheng-guo W. Cervical spinal canal*

narrowing and cervical neurological injuries. Chin J Traumatol. 2012; 15(1):36-41.

25. *Green C, Butler J, Eustace S, Poynton A, O'Byrne JM. Imaging Modalities for Cervical Spondylotic Stenosis and Myelopathy. Advances in Orthopedics 2012; 2012:908324.*
26. *McKechnie B. Cervical Degenerative Disc Disease and Cervical Spondylotic Myelopathy.BMC 2008; 3 (1): 234-239.*
27. *Malcolm G. Surgical disorders of the cervical spine: Presentation and management of common disorders. Journal of Neurology, Neurosurgery, and Psychiatry 2002; 73(1):i34-i41.*
28. *Park HJ, Kim SS, Lee SY, Park NH, Chung EC, Rho MH, et al. A practical MRI grading system for cervical foraminal stenosis based on oblique sagittal images. The British Journal of Radiology. 2013; 86(1025):20120515.*
29. *Epstein NE, Hollingsworth R. Diagnosis and management of traumatic cervical central spinal cord injury: A review. Surg Neurol Int 2015; 6 (4): S140-S153.*