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Cervical spinal canal body ratio in normal individuals and Stenosis with Cervical Myelopathy: A simple but novel study using a graph paper over a plain X-ray lateral view of the cervical spine

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ABSTRACT

Cervical spine spondylosis is so prevalent in almost all because it is a degenerative disease. Cervical spine spondylosis is a condition caused by the narrowing of the space required for the spinal cord and the nerve roots that pass through the spine to the rest of the body. Suspected cases or warranted cases are advised to avoid trauma or stress to prevent a dreadful complication that is myelopathy. This research is to study and assess the Cervical Spine Canal Body Ratio in healthy individuals and also in patients with myelopathy. The cervical spinal canal and body with disc space ratio are measured using lateral view plain X-ray of the cervical spine, placed over a graph paper. This test was done both in healthy individuals from the age group of twenty-five to thirty-five of female and male. Out of these, twelve patients were with cervical myelopathy. Cervical Spinal canal stenosis may be either congenital or acquired. The content of the canal that is the Spinal cord is more likely to get compromised when the canal is shallow even a minimal trauma or degenerative arthrosis can precipitate myelopathy. In healthy individuals it is unit and when <0.85 it indicates stenosis. This simple, less expensive study can be done even in a peripheral set up. The healthy Canal Body ratio is 0.97 to 1.02. In myelopathy it is about 0.8. Corresponding sagittal diameter is 18 to 21 mm in normal and 9 to 11 mm in cervical stenosis.

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INTRODUCTION

Cervical spine degenerative disease, the spondylosis is almost found in all as age advances. When the canal gets reduced due to spondylosis or if it is a congenital disorder, it is likely to precipitate myelopathy early and even severely. Cervical Spondylosis and Cervical Spine affection, in turn, the cord and nerves affection are not new but millennium old. Galen had explained the results of trauma to the cervical spine at various levels. Gowers in 1892 and Key in 1938 had described the ventral ridges of the disc spaces that had encroached the spinal canal and operated on them. Horsley and Dandy too did a similar surgery (Gowers, 1893). The clinical picture includes pain, weakness, sensory impairment and curvature abnormality. Bailey and Casamajor in the year 1911 had recorded that spondylosis can compress the cord as well the roots just like a tumour (Bailey and Casamajor, 1911). Mixter and Barr preoperatively confirmed a disc prolapse and proved it in surgery in 1932 (Mixter and Barr, 1934). The differential Diagnosis of cervical disc cases are diseases of Thoracic outlet syndrome; brachial neuritis; referred pain in myocardial infection, Quillian Barr Syndrome and carpel tunnel syndrome. In the early part of the 20^{th}-century surgeons were not fully aware of the narrow spinal canal and Spondylotic myelopathy (Mixter and Barr, 1934).

Many cases they encountered had cervical disc prolapsed were soft or firm or hard or even osseous and were extending into the spinal canal, making it to a narrow one impinching the cord. Then surgeons also thought of amyotrophic lateral sclerosis, Multiple Sclerosis, Brown Sequard Syndrome and Syphilis. Now with more tools to diagnose all such other cases are found to have only associated with cervical spondylosis and myelopathy. Payne and Spillane observed that canal stenosis and arthrosis do not go hand in hand always, and sometimes even severe arthrosis did not produce myelopathic like picture (Payne and Spillane, 1957). They explained that preexisting sagittal diameter shortening would build a narrow canal and thereby predispose to myelopathy. More cases were diagnosed with the advent of Myelogram, and now MRI plays a significant role but still at large in the periphery. This study has tried to bring out a novel and simple technique using a very cheap plain X-ray lateral view of the cervical spine to study the alteration in the spinal canal in healthy and stenosis

MATERIALS AND METHODS

In our study, 40 cases of both sexes in the age group 25 to 35 were randomly selected to study the healthy cervical spine canal body ratio. They came with minor complaints like occipital pain, or sprain neck and none of them had any deficit clinically; suggestive of radiculopathy or myelopathy. Spondylitis is common for both sexes. The age group of the subjects were between 25 to 35 may have mild spondylitis, but bony spur may not be jetting into the canal to cause stenosis. For cases of stenosis with myelopathy were selected after ruling out other causes like Tumour, Tuberculosis of Spine, fracture spine due to infection or tumour or trauma.

Inclusion criteria

Patients with the complaints of mild, vague neck pain, strain and shoulder pain were selected for the normal canal body ratio study. Patients with myelopathic signs like paralysis, paraesthesia and bipyramidal signs were taken for the study of pathological canal body ratio in stenosis with myelopathy.

Exclusion criteria

C1 and C2 were excluded because spondylotic myelopathy is extremely rare in this part, and the subarachnoid space is so vast here. Patients with definite evidence of root pain that is radiculopathy with a typical history and myelopathy with weakness were excluded from the canal body ratio in the normal study. Cases with TB spine, Traumatic Fractures were also excluded. The later with myelopathy were subjected to other studies like CT scan and MRI scan, but those findings are outside the scope of this study.

All cases were divided into three groups. 'A' and 'B' constituted the normal group. The former group X-ray lateral view was taken with a Focal Film Distance of 72 inches and the later with 60 inches to study the effect of magnification in different Focal Film Distances. Shorter the focal film distance less will be the magnification effect. Either way because we are exploring only the area of the canal and body magnification will not have any impact. Still, it might affect the Antero Posterior (AP) diameter, which was also studied. The third group that is "C" constitute 12 patients with cervical myelopathy, in whom the Canal Body Ratio and the sagittal diameters were considered.

In all the XRays taken, the four columns were drawn, where the 4^{th} one along the tips of all spinal processes is insignificant. The anterior column runs along the anterior border of the bodies of the cervical vertebrae from C3 to C7. For the same vertebrae, the posterior column runs along the posterior edges of those vertebrae. The 3^{rd} column joins the spino laminar junction, all maintaining the lordotic curvature. Over the plain X-ray lateral view the lines were drawn, from the lower anterior border of C7 to anterior upper border of C3 that forms the 1st column and correspondingly along the posterior inferior border of C7 to the posterior top border of C3 formed the 2^{nd} column and 3rd column along the spino-laminar junction of the same vertebrae. The upper and lower 3 points of these three columns were connected by a transverse line to form a two rectangle like adjacent posterior and anterior structures that represents the areas covered by the vertebral canal and body respectively. A graph sheet was placed over the X-ray with the lines traced with a

Table 1: shows the Canal area in Sq.mmdivided by Body area in Sq.mm with corresponding Sagittal (Antero Posterior)diameter in both groups (A and B) of Normal people.

S.No	Group 'A' FFD 72 inches				Group 'B' 60 inch.			
	CA. Sq.mm	BA. Sq.mm	Ratio	Sg.Di. mm	CA. Sq.mm	BA. Sq.mm	Ratio	Sg.Di. mm
1	1372	1405	0.98	21	1371	1405	0.98	21
2	1346	1402	0.96	20	1346	1402	0.96	20
3	1379	1407	0.98	18	1379	1407	0.98	18
4	1404	1404	0.94	17	1404	1404	0.94	17
5	1378	1406	0.98	19	1378	1406	0.98	18
6	1349	1405	0.96	20	1349	1405	0.96	20
7	1361	1403	0.97	17	1361	1403	0.97	17
8	1336	1406	0.95	16	1336	1406	0.95	16
9	1347	1403	0.96	18	1347	1403	0.96	18
10	1431	1403	1.02	21	1431	1403	1.02	20
11	1377	1405	0.98	20	1379	1405	0.98	20
12	1360	1402	0.97	19	1360	1402	0.97	19
13	1364	1406	0.97	18	1364	1406	0.97	18
14	1377	1405	0.98	17	1377	1405	0.98	16
15	1347	1403	0.96	16	1347	1402	0.96	17
16	1388	1402	0.99	20	1388	1402	0.99	20
17	1377	1405	0.98	17	1377	1405	0.98	17
18	1347	1403	0.96	15	1347	1403	0.96	15
19	1346	1402	0.96	15	1346	1402	0.96	15
20	1375	1403	0.98	17	1375	1403	0.98	17
21	1347	1403	0.96	16	1346	1403	0.96	16
22	1419	1405	1.01	20	1419	1405	1.01	21
23	1376	1404	0.98	19	1376	1404	0.98	20
24	1363	1405	0.97	15	1363	1405	0.97	15
25	1347	1402	0.96	16	1347	1403	0.96	16
26	1345	1403	0.96	17	1345	1403	0.96	17
27	1375	1403	0.98	18	1375	1403	0.98	18
28	1363	1405	0.97	19	1363	1404	0.97	19
29	1347	1403	0.96	17	1347	1403	0.96	17
30	1361	1403	0.97	17	1361	1403	0.97	17
31	1349	1405	0.96	18	1349	1405	0.96	18
32	1375	1403	0.98	19	1375	1403	0.98	18
33	1389	1403	0.99	20	1389	1403	0.99	20
34	1360	1402	0.97	16	1361	1402	0.97	16
35	1349	1405	0.96	15	1349	1405	0.96	15
36	1376	1404	0.98	21	1376	1404	0.98	21
37	1375	1403	0.98	20	1375	1403	0.98	21
38	1361	1403	0.97	17	1361	1403	0.97	17
39	1363	1405	0.97	16	1363	1405	0.97	16
40	1362	1404	0.97	17	1362	1404	0.97	17

Table 2: shows Canal area in Sq.mm divided by Body area in Sq.mm with corresponding Sagittal(Antero Posterior) diameter in both groups of people with Cervical canalStenosis.

			Stenotic cases			
S.No	Age	Sex	CA.Sq.mm	BA.Sq.mm	ratio	Sg.Di.mm
1	60	F	808	1392	0.58	8
2	62	M	899	1406	0.64	11
3	50	M	1011	1403	0.72	12
4	50	M	1108	1403	0.79	12
5	71	M	886	1405	0.63	11
6	49	M	995	1402	0.71	11
7	56	M	1041	1406	0.74	11
8	65	M	1138	1405	0.81	13
9	71	M	1010	1403	0.72	11
10	57	M	967	1402	0.69	9
11	57	F	1096	1405	0.78	10
12	56	M	1067	1403	0.76	9

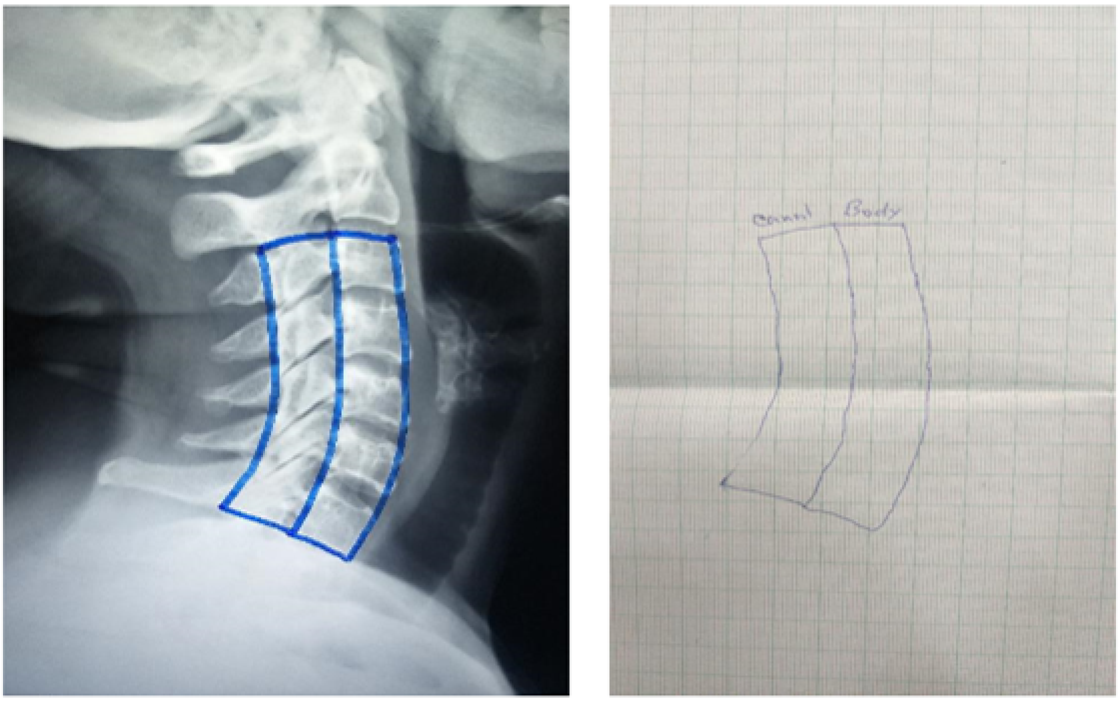

Figure 1: a. shows the Plain XRay Cervical Spine Lateral view with the lines; b. shows the lines superimposed over a graphsheet to measure the Canal and Body areas

sketch pen that gave the two adjacent rectangles like picture over the graph sheet. The number of squares over the canal area (posterior rectangle) and body area (anterior rectangle) were measured separately and is given in Figure 1 a and b.

RESULTS AND DISCUSSION

Canal divided by body gives a value which varied from 0.97 to 1.02. It was done and tabulated that is given in Table 1.

By the same way, it was repeated for patients with cervical myelopathy as per the selection of inclusion criteria with the focal film distance at 5 feet. The values were compared for each patient. The canal body ratio and the sagittal diameter for the patients with the myelopathy who formed the group"C" are given in Table 2.

At the same mid and lower cervical vertebrae mark the midpoint on the posterior border of each vertebra and another point at the corresponding spino-laminar junction. This distance is the sagittal diameter. Over on the X-ray lobby, the anteroposterior or sagittal diameter at each cervical vertebra taken into account was measured in both normal Group A and B and Group C with myelopathy. The X-ray cervical spine lateral view with the three columns drawn over it and the same traced on a graph sheet is shown in Figure 1.

It was found that in both the Focal Film Distance films, the areas for the canal and body did not show any change or variation. In the area study, the magnification effect involves both equally, which is nullified because both the areas have the same effect. The areas remain the same. Similarly, the sagittal diameters did not show much change except for a difference of 1 mm that too only in 7 cases and in all others the diameter matched in both groups. So the magnification effect was nil almost in both the focal film distance healthy groups A and B.

The canal body area ratio in the healthy group varies from 0.94 to 1.02. Magnification is not at all an issue in the area study. The sagittal diameter from C3 to C7 was studied for each patient, and the average is given in the tabular column 1. This was done for both the normal group and the abnormal group that is the patients with myelopathy. The average sagittal diameter s varied from 15 to 21 mms and the average is17.85 mm. in both group A and B with focal film distances 72 and 60 inches respectively in normal cases. In the myelopathic group i.e. C, the Focal Film Distance was kept at 5 feet, the average canal body ratio varied from 0.58 to 0.81 Sq.mm. With an average of 0.71 Sq.mm. In the same group, the sagittal diameter varied from was 8 mm to 13 mm. And the average sagittal diameter in the myelopathic group was 10.6 mm. The average was taken into account just for comparison with the healthy and myelopathic patients' canal body ratio, and the detailed sagittal diameter study is not a part of this study or paper.

Cervical spondylotic disorders constitute about 1 to 2 % of hospital admissions. Moreover, it presents with pathological symptoms and signs in people over the age of 50, and among them, more than 80% are over 65 years. Though spondylosis is common to both sexes, spondylotic myelopathy is common in males. Only 2 or 3 were females in our study. Primary or secondary physicians who happen to treat them mostly comfort themselves as well the patients with the diagnosis of muscle pull or sprain and strain and this study will help them to make an early diagnosis and refer them to respective Neurosurgeons for early aggressive treatment or advise the patients to keep vigil over inadvertent symptoms they might develop later though not necessarily. Multifactorial causes like depth of canal, disc, biomechanics and circulation cause spondylotic myelopathy are to be considered.

In cervical spondylosis, radiculopathy and myelopathy may occur due to osteophytes jetting into the intervertebral foramen or the spinal canal compressing the root or the cord. Shallow canal and foramen may coexist or independent. Fragile disc or superadded osteophytes can compromise the canal. Hypertrophied and buckled ligamentum flavum also can compress the cord. Ehni.G in 1984 said defective functioning of the intraspinal elements could lead to varied symptoms of neurological origin (Ehni, 1984). Taylor.A.R in 1953 has observed that ligamentum flavum, the yellow ligament might bulge into the canal and compress the cord if the canal is already compromised by shallowness or narrowness (Taylor, 1953). Even mild trauma can precipitate a severe neurological deficit. No one can escape spondylosis, but the debilitating crippled life may be avoided. In 1838 Key and later in 1892, Gowers postulated that anterior ridges opposite to disc spaces invaded the spinal canal. In our study, we also found that the canal gets narrowed in such a condition that is common in cervical spondylosis. Bailey and Casamajor in 1911 found that arthrosis can compress the cord and roots like a tumour (Bailey and Casamajor, 1911). About seven patients in our study population had cervical myelopathy due to cord compression because of canal narrowing caused by cervical spondylosis.

Ehni.G in 1984 said that if AP diameter is short and with arthrosis, myelopathy quickly develops whereas if canal is larger even severe spondylosis cannot precipitate myelopathy (Ehni, 1984). Mixter and Barr in 1934 operated on four cervical disc disease cases that were benefited. Before their description, there was a slight argument and confusion among the surgeons if the deficit was due to arthrosis or rupture of the disc (Mixter and Barr, 1934). Chrispin.A.R and Lees. F in 1938 postulated the total area of the mid and lower cervical spinal canal equals that of comprising the corresponding spine bodies together with the disc spaces (Chrispin and Lees, 1963). We took it extensively in our study, selecting 40 healthy patients to assess the typical canal body areas comprising the spinal canal and the body together with the disc space areas. Burrows.E.H in 1963 found that the transverse diameter or the interpedicular distance does not cause myelopathy because it usually is twice that of the sagittal diameter (Burrows, 1963). We measured the average sagittal diameter for the normal as well the myelopathic and not the transverse diameter.

Payne and Spillane in 1957 demonstrated in the X-ray that shallower spinal canal could precipitate myelopathy. They said spondylotic myelopathy results in patients with shallow AP diameter of <14 mm. They were one of the first to demonstrate this shallow spinal canal (Payne and Spillane, 1957). We also found that narrow cervical spinal canal can compress the cord resulting in myelopathy. The sagittal or the anteroposterior diameter we saw in such cases was between 9 mm and 11 mm in the X-ray cervical spine lateral view. We did a canal body ratio study also as described above to assess the stenosis. Before that, we did an extensive survey of 40 patients to know about the canal body ratio in healthy individuals which can tell the clinician, which is normal and which is abnormal. Wolf et al. in 1956 said that cervical myelopathy depends on shallowness and arthrosis in the middle and lower cervical spine. Because the C1 and C2 cervical vertebrae are rare to get involved in spondylosis and the subarachnoid space in that area is so wide that the Spondylotic elements either, the osteophytes or disc and ligamentum flavum cannot narrow the canal to cause so much compression to result in myelopathy. It should also be noted that Ligamentum flavum and discs are absent between C1 and C2. The anteroposterior or sagittal diameter of the spinal canal is more critical in deciding the onset of myelopathy. Wolf.B.S *et al*. in 1956 emphasised the importance of the sagittal diameter in precipitating myelopathy (Wolf, 1956).

Penning.L in 1962 said that depth and anatomical configuration of the canal and foramen permit to diagnose cases with significant pathology in X-rays (Penning, 1962). We also selected the X-ray cervical spine to study this and measured the canal body area ratio primarily and the average AP diameter relatively. Hinck.V.C and Sachdev.N.S in 1966 found that shallow spinal canal does not necessarily conclude that foramen also will be narrowed, resulting in radiculopathy (Hinck and Sachdev, 1966). Our initial study was to measure the Canal Body ratio in healthy and their effect in spondylotic myelopathy. Just for comparison, we studied the average AP diameter also in myelopathic patients. We did not explore the foramen stenosis. Nurick.S postulated that persistent shallowness does not mean that the individual will develop myelopathy later in life (Nurick, 1972). The myelopathic patients in our study who had a narrow canal could not be ascertained if they had a congenital narrowing of the cervical spinal canal. After the onset of myelopathy that too after 50 or 55 years it is very difficult or not possible to ascertain that the individual had developmental canal stenosis prior unless had been screened by his family physician in early years. The possibility is that the premorbid stenosis, that makes the neural elements easily vulnerable to these structures of osteopaths, disc and ligaments flavum. At the same time, it is warned that the presence of stenosis necessarily need not forecast the development of myelopathy in the future.

CONCLUSIONS

By this easy technique of using the simple lateral view of the cervical spine, we have found that the healthy Canal Body ratio varies from 0.94 to 1.02. In myelopathy it is about 0.8. Corresponding sagittal diameter is 18 to 21 mm in healthy and 9 to 11 mm in cervical stenosis. Valuable information like Canal Body Ratio, osteosclerotic spur, disc space, narrowing and AP Diameter can be obtained in the plain X-ray.

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Conflict Of Interest

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REFERENCES

Bailey, P., Casamajor, L. 1911. Osteo-Arthritis Of The Spine As A Cause Of Compression Of The Spinal Cord And Its Roots. *The Journal of Nervous and Mental Disease*, 38(10):588–609.

Burrows, E. H. 1963. The sagittal diameter of the spinal canal in cervical spondylosis. *Clinical Radiology*, 14(1):77–86.

Chrispin, A. R., Lees, F. 1963. The spinal canal in cervical spondylosis. *Journal of Neurology, Neurosurgery & Psychiatry*, 26(2):166–170.

Ehni, G. 1984. Cervical Arthrosis - Diseases of the cervical motion segments spondylosis, Disk rupture, Radiculopathy and myelopathy. Chicago, Year Book Medical book publishers Chapters 1 to 10 and Appendix. Year Book Medical Publishers.

Gowers, W. R. 1893. A manual of diseases of the nervous system. volume 2. J. and A. Chuchill.

Hinck, V. C., Sachdev, N. S. 1966. Developmental Stenosis of the Cervical Spinal Canal. *Brain*, 89(1):27–36.

Mixter, W. J., Barr, J. S. 1934. Rupture of the Intervertebral Disc with Involvement of the Spinal Canal. *New England Journal of Medicine*, 211(5):210–215.

Nurick, S. 1972. The Natural History and the Results of Surgical Treatment of the Spinal Cord Disorder Associated with Cervical Spondylosis. *Brain*, 95(1):101–108.

Payne, E. E., Spillane, J. D. 1957. The Cervical Spine an Anatomico-Pathological Study of 70 Specimens (Using a Special Technique) with Particular Reference to the Problem of Cervical Spondylosis. *Brain*, 80(4):571–596.

Penning, L. 1962. Some aspects of plain radiography of the cervical spine in chronic myelopathy. *Neurology*, 12(8):518.

Taylor, A. R. 1953. Mechanism and treatment of spinal-cord disorders associated with cervical spondylosis. *The Lancet*, 261(6763):717–720.

Wolf, B. S. 1956. The sagittal diameter of the bony cervical spinal canal and its significance in cervical spondylosis. *J Mt Sinai Hosp*, 23(3):283–292.

