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.

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...
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 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.

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" constitutes 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 4th 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 3rd 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 2nd 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.mm divided 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 | CA. Sq.mm | BA. Sq.mm | Ratio |
| 1    | 1372      | 1405       | 0.98   | 21        | 1371      | 1405       | 0.98   |
| 2    | 1346      | 1402       | 0.96   | 20        | 1346      | 1402       | 0.96   |
| 3    | 1379      | 1407       | 0.98   | 18        | 1379      | 1407       | 0.98   |
| 4    | 1404      | 1404       | 0.94   | 17        | 1404      | 1404       | 0.94   |
| 5    | 1378      | 1406       | 0.98   | 19        | 1378      | 1406       | 0.98   |
| 6    | 1349      | 1405       | 0.96   | 20        | 1349      | 1405       | 0.96   |
| 7    | 1361      | 1403       | 0.97   | 17        | 1361      | 1403       | 0.97   |
| 8    | 1336      | 1406       | 0.95   | 16        | 1336      | 1406       | 0.95   |
| 9    | 1347      | 1403       | 0.96   | 18        | 1347      | 1403       | 0.96   |
| 10   | 1431      | 1403       | 1.02   | 21        | 1431      | 1403       | 1.02   |
| 11   | 1377      | 1405       | 0.98   | 20        | 1379      | 1405       | 0.98   |
| 12   | 1360      | 1402       | 0.97   | 19        | 1360      | 1402       | 0.97   |
| 13   | 1364      | 1406       | 0.97   | 18        | 1364      | 1406       | 0.97   |
| 14   | 1377      | 1405       | 0.98   | 17        | 1377      | 1405       | 0.98   |
| 15   | 1347      | 1403       | 0.96   | 16        | 1347      | 1402       | 0.96   |
| 16   | 1388      | 1402       | 0.99   | 20        | 1388      | 1402       | 0.99   |
| 17   | 1377      | 1405       | 0.98   | 17        | 1377      | 1405       | 0.98   |
| 18   | 1347      | 1403       | 0.96   | 15        | 1347      | 1403       | 0.96   |
| 19   | 1346      | 1402       | 0.96   | 15        | 1346      | 1402       | 0.96   |
| 20   | 1375      | 1403       | 0.98   | 17        | 1375      | 1403       | 0.98   |
| 21   | 1347      | 1403       | 0.96   | 16        | 1346      | 1403       | 0.96   |
| 22   | 1419      | 1405       | 1.01   | 20        | 1419      | 1405       | 1.01   |
| 23   | 1376      | 1404       | 0.98   | 19        | 1376      | 1404       | 0.98   |
| 24   | 1363      | 1405       | 0.97   | 15        | 1363      | 1405       | 0.97   |
| 25   | 1347      | 1402       | 0.96   | 16        | 1347      | 1403       | 0.96   |
| 26   | 1345      | 1403       | 0.96   | 17        | 1345      | 1403       | 0.96   |
| 27   | 1375      | 1403       | 0.98   | 18        | 1375      | 1403       | 0.98   |
| 28   | 1363      | 1405       | 0.97   | 19        | 1363      | 1404       | 0.97   |
| 29   | 1347      | 1403       | 0.96   | 17        | 1347      | 1403       | 0.96   |
| 30   | 1361      | 1403       | 0.97   | 17        | 1361      | 1403       | 0.97   |
| 31   | 1349      | 1405       | 0.96   | 18        | 1349      | 1405       | 0.96   |
| 32   | 1375      | 1403       | 0.98   | 19        | 1375      | 1403       | 0.98   |
| 33   | 1389      | 1403       | 0.99   | 20        | 1389      | 1403       | 0.99   |
| 34   | 1360      | 1402       | 0.97   | 16        | 1361      | 1402       | 0.97   |
| 35   | 1349      | 1405       | 0.96   | 15        | 1349      | 1405       | 0.96   |
| 36   | 1376      | 1404       | 0.98   | 21        | 1376      | 1404       | 0.98   |
| 37   | 1375      | 1403       | 0.98   | 20        | 1375      | 1403       | 0.98   |
| 38   | 1361      | 1403       | 0.97   | 17        | 1361      | 1403       | 0.97   |
| 39   | 1363      | 1405       | 0.97   | 16        | 1363      | 1405       | 0.97   |
| 40   | 1362      | 1404       | 0.97   | 17        | 1362      | 1404       | 0.97   |
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 canal Stenosis.

| 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        |

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.

At the same mid and lower cervical vertebrae mark the midpoint on the posterior border of each vertebra and another point at the corresponding spinol
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 nulledified 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 mm and the average is 17.85 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 strain 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 ligament 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 interpediculate 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 spondyloitic 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 Spondyloitic 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 et al. in 1956 emphasised the importance of the sagittal diameter in precipitating myelopathy (Wolf et al., 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 spondyloitic 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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