SPINAL CANAL DIAMETERS AND THEIR RELATIONSHIP TO CERVICAL SPINE GLIOSIS IN MAGNETIC RESONANCE IMAGING

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ABSTRACT

To determine the most frequent levels of atraumatic cervical spine cord gliosis in cervical spondylosis and relationship, if any, between cervical spine gliosis and the degree of adjacent cervical stenosis on Magnetic Resonance Imaging (MRI). Preliminary results of post-surgical outcome was obtained for patients with pre-op cervical cord gliosis.

MATERIAL AND METHODS

89 MRI examinations of the cervical spine performed in a hospital setting over a period of 1 year from June 93 to May 94 were reviewed. Magnetic Resonance Imaging examination showing cord changes consistent with gliosis without a history of trauma were selected for analysis. 13 patients with MRI features of gliosis were studied. MRI features of gliosis include high intensity signals on T2 weighted and proton density sequence which is usually well defined and with no mass effect.

Using the sagittal and axial SE T1W and FSE T2W images acquired on a GE Signa Horizon 1.5 T Echospeed, measurements were made of the relevant spinal canal diameters. The cranio-caudal extent of gliosis of the cervical cord was also recorded.

Additionally, the causes of the spinal canal stenosis were determined and the subsequent treatment including operative findings and followup management were determined from the patient's clinical notes.

At each intervertebral junction from C1-2 to C7-T1 levels, the mid sagittal diameter was measured in the sagittal and axial planes of the MRI examination. At each level, two measurements were taken. The actual diameter (AD) is the actual diameter of the spinal canal and the expected diameter (ED) is measured by extending an imaginary border of the where the canal margins should be, if there was no pathology present (Figure 1a &1b). A ratio of the actual diameter over the expected diameter was then calculated and an attempt was made to correlate these ratios with presence or absence of adjacent gliosis and extent of gliosis.

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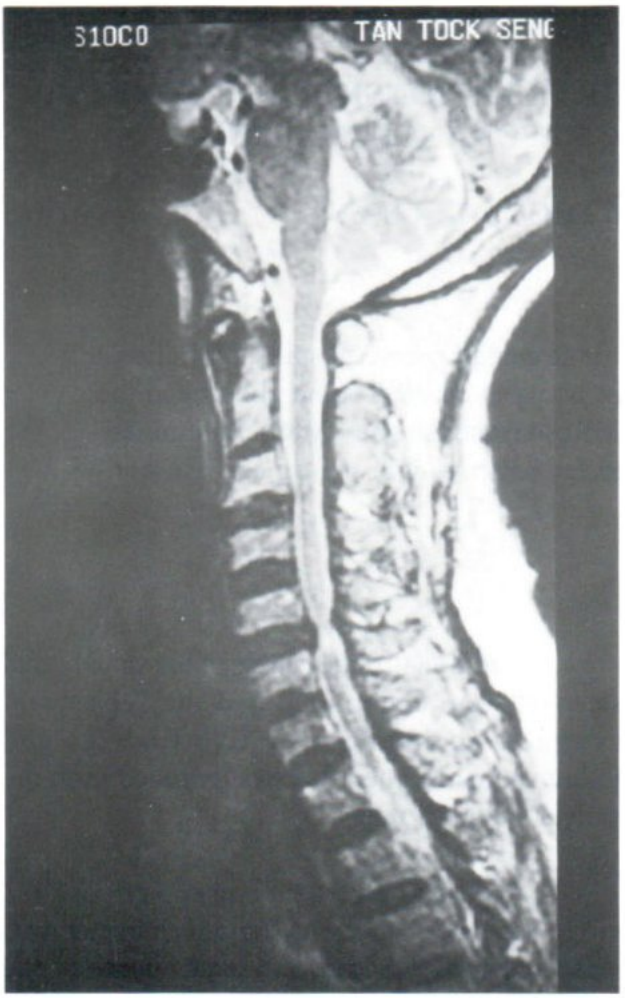

Fig 1a. T2-weighted MR image shows the measurements of the actual diameter, AD (white arrow) and the expected diameter, ED (black arrow) of the spinal canal in the sagittal plane.

RESULTS

There were 13 patients, 10 males and 3 females (12 Chinese and 1 Indian) with cervical cord gliosis. Their ages range from 33 to 82 years with a mean of 56 years. The patients at presentation gave a history of symptoms varying from 3 weeks to several years.

Cervical spine gliosis was seen from C2 to C6 vertebral levels. 10 patients had gliosis involving one intervertebral level and 3 patients had gliosis affecting 2 intervertebral levels. Therefore, a total of 16 intervertebral levels of gliosis were seen in these 13 patients. Analysis of these 16 intervertebral levels showed that the most frequent level of gliosis was at C3-4 (8 cases), followed by C4-5 (4 cases) as illustrated by Fig. 2 below.

The gliosis was most frequently caused by a combination of disc herniation and osteophytes in 9 patients. This is followed by disc herniation by itself in 2 patients and a combination of osteophytes, ligamentum flavum and facet joint hypertrophy in the remainder 2 patients. Cervical cord gliosis is associated with cervical atrophy in 38% of the patients.

Where gliosis was present, the associated sagittal spinal canal stenosis ratio varied widely from 0.25 to 0.88 and the axial spinal canal stenosis ratio varied from 0.43 to 0.9. Where the cord showed no gliosis the associated sagittal spinal canal stenosis ratio ranged from 0.5 to 1 and the axial spinal canal stenosis ratio ranged from 0.55 to 1. No specific relationship was demonstrated between the degree of cervical canal stenosis and the gliosis.

As expected, there is a general trend for the sagittal and axial ratios to be fairly similar in value at intervertebral levels with gliosis as illustrated in (Fig. 3.)

The location of the gliosis in relationship to the causative intervertebral levels was next evaluated. One of the thirteen patients was noted to have a long segment stenosis extending over two vertebral levels. As it was difficult to ascertain whether the site of gliosis occurred at or below the canal stenosis in this patient, he was excluded for this evaluation. Two of the remaining twelve patients were noted to have gliosis involving two intervertebral levels. Therefore, 14 intervertebral levels were evaluated for the site of gliosis in relation to the canal stenosis; this is illustrated in (Fig. 3.) 64% of the gliosis occurred below the site of the canal stenosis as compared to 36% at the level of the canal stenosis. (Fig. 4)

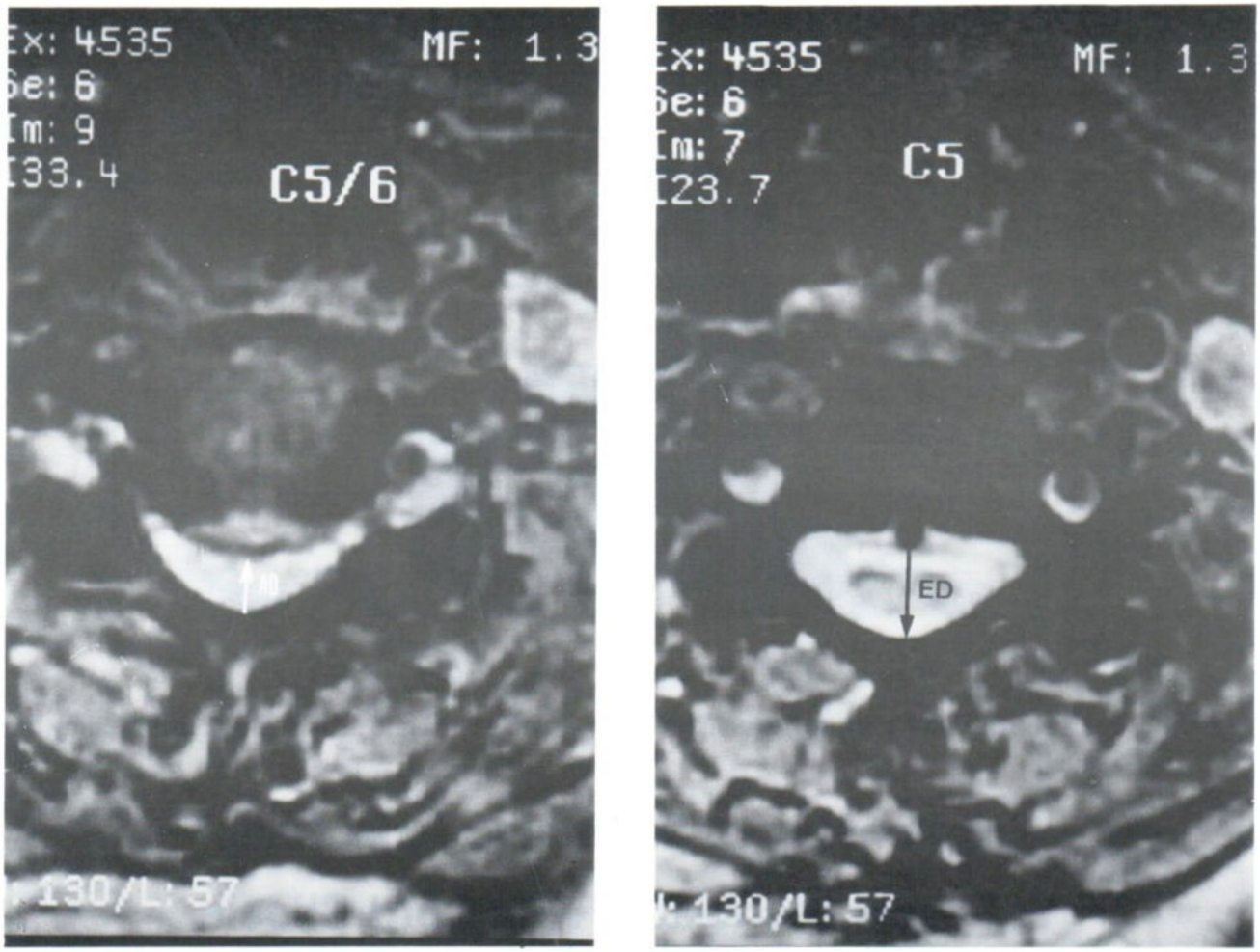

Fig 1b. T2-weighted images show the measurements of the actual diameter, AD (white arrow) and the expected diameter, ED (black arrow) of the spinal canal in the axial planes.

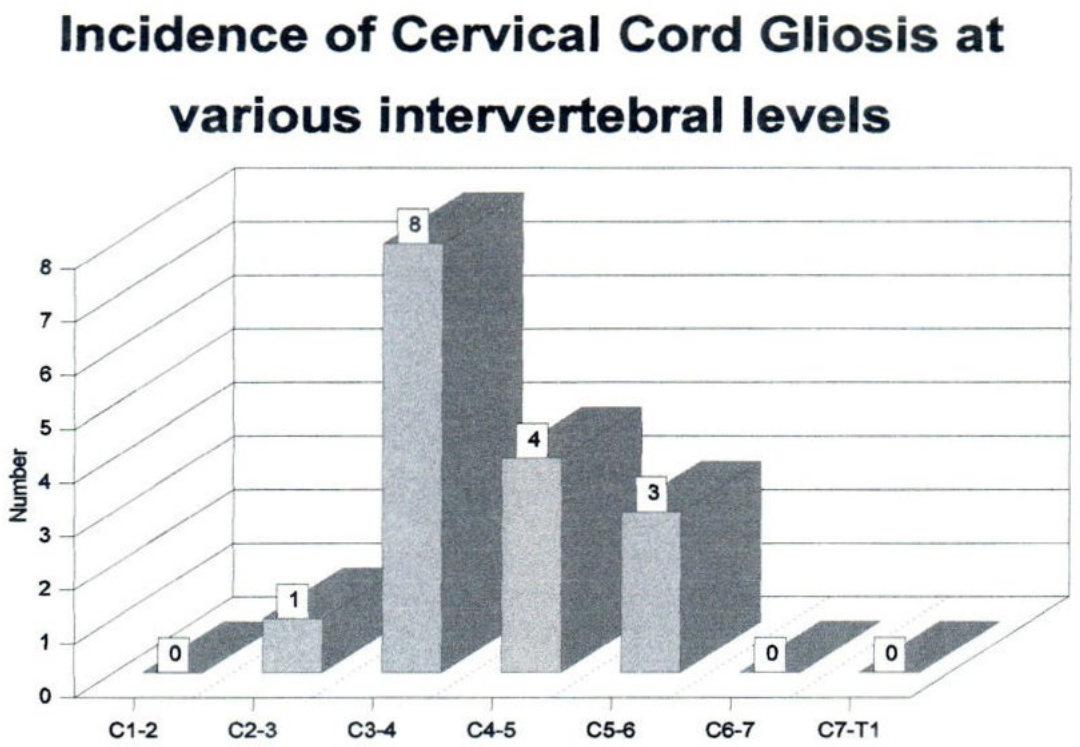

Fig 2. Bar chart shows that the most frequent level for cervical cord gliosis is at C3-4, followed by the C4-5 level.

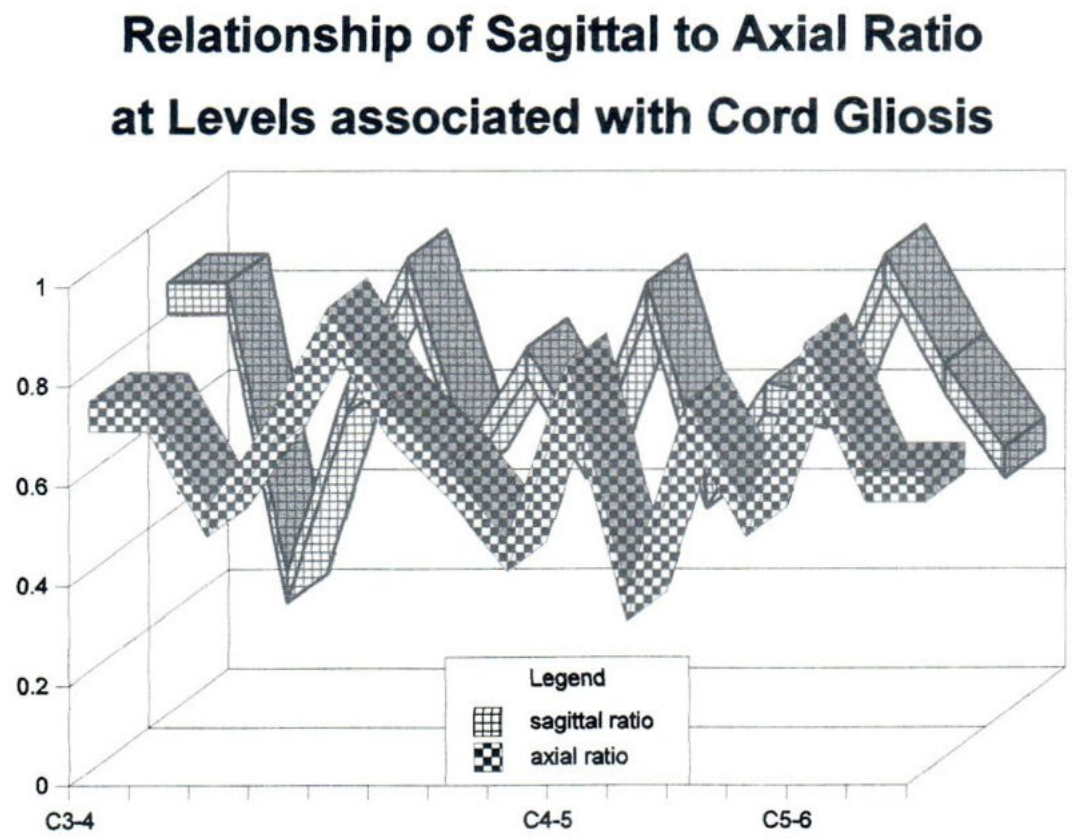

Fig. 3 Illustrates the relationship between the sagittal ratio and the axial ratio of diameters calculated at the various intervertebral levels associated with cervical cord gliosis.

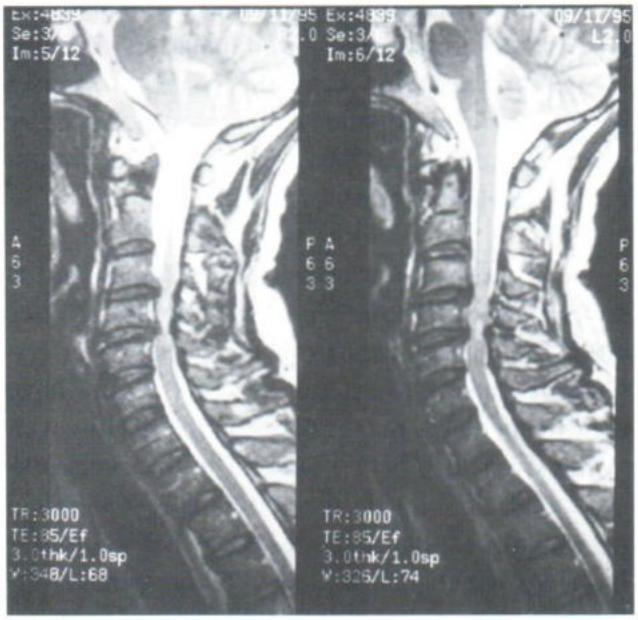

Fig. 4a. T2-weighted sagittal MR image shows gliosis at the level of stenosis.

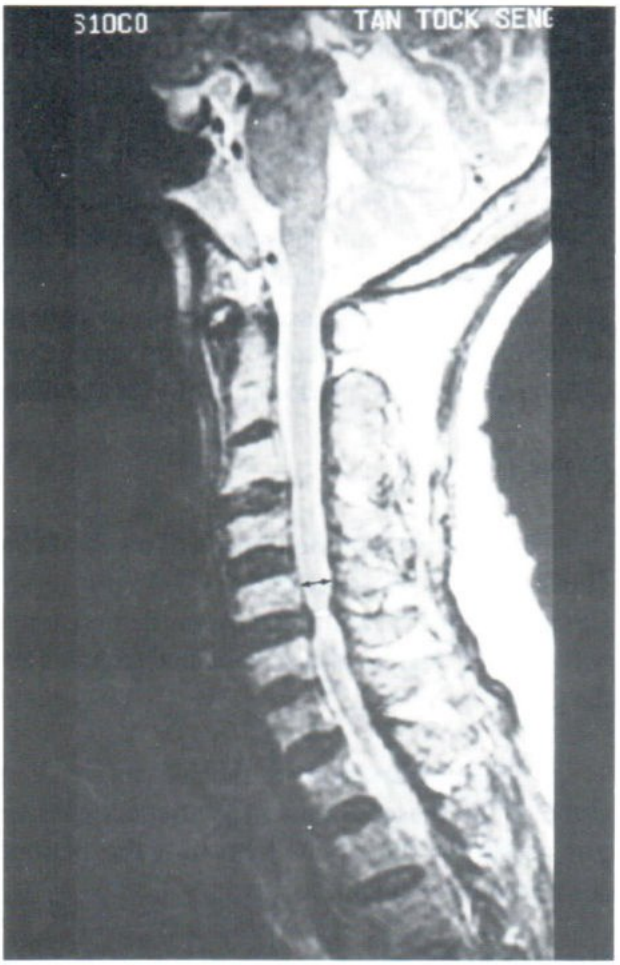

Fig. 4b. T2-weighted sagittal MR image shows gliosis at level caudad to stenosis.

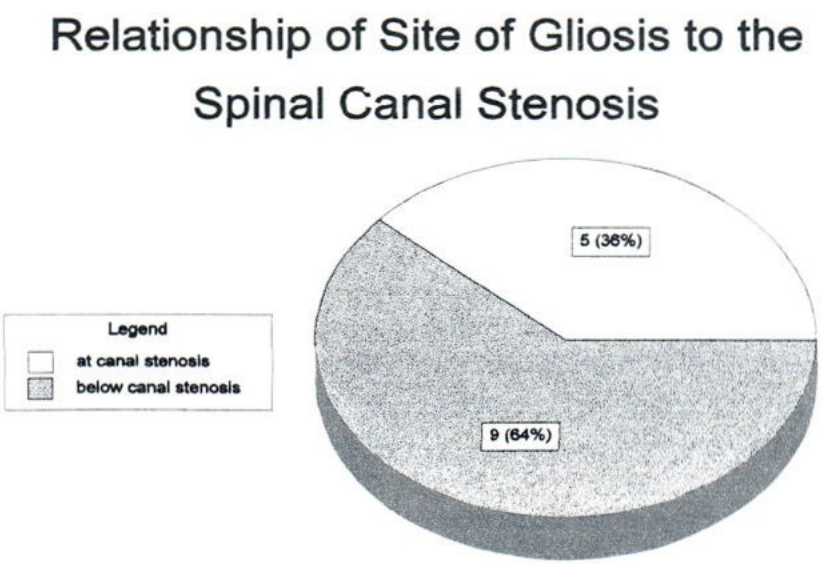

Fig. 5 Illustrates the relationship between the site of gliosis to the spinal canal stenosis in the 13 intervetebral levels evaluation in 11 patients.

On review of the clinical notes of these 13 patients, 11 patients went for cervical spine surgery. Post surgical follow up 6 months to a year showed improvement in 6 patients (55%), no change in 4 patients (36%) and deterioration of gait in 1 patient (9%). This was compared with 12 patients without gliosis who had cervical spine surgery who did not default follow up. Post surgical follow up in the second group of patients showed improvement in 9 (75%), no change in 2 (17%) patients and deterioration in 1 (8%) patient.

CONCLUSION

The most common levels of cervical cord gliosis in this study occurred at C3-4 followed by C5-6. No specific relationship was demonstrated between the degree of cervical canal stenosis and the gliosis.

Preliminary study of the post surgical outcome of the these 13 patients with cervical cord gliosis shows that more than half the patients showed improvement.

DISCUSSION

Innumerable aetiologies are responsible for narrowing the spinal canal. Besides acquired diseases, narrow spinal canal can also be associated with syndromes such as Achondroplasia, hypochondroplasia, pseudohypoparathyroidism and diastrophic dwarfism.[1]

However, the more common causes of spinal block include widespread malignancy, neural tumours and disorders of intervertebral joints. Intervertebral joint pathology is believed to be the third commonest cause of spinal block, responsible for up to 15% of such cases.[2]

Included in this subgroup are degenerate disease,[3] microtrauma or calcification of the posterior longitudinal ligament[4] and disc prolapse.

It has been previously recognised that spinal canal stenosis is most frequent at the C5-6 level. It is estimated that 90% of intervertebral disc herniation occur at the C5-6 and C6-7 levels and most of these herniations are degenerative in origin.[5] At the C5-6 level the spinal cord occupies a spinal canal space usually only 1.8 times as large as the spinal cord and a dural sac about 1.2 times as large as itself.[6]

The arterial supply to the cervical spinal cord is through the anterior spinal artery which is a branch originating from the vertebral arteries prior to their joining the basilar artery. This artery supplies the anterior two thirds to four-fifths aspect of the spinal cord.

The posterior aspect of the spinal cord is supplied by the paired posterior spinal arteries which also originates from the vertebral artery. Notably these two arterial systems do not have significant anastomoses between them. However, at the C3-4 to C7-T1 vertebral body levels (except at the C6-7 level), the vertebral, thyrocervical and costocervical arteries give off radicular branches which anastomose with the spinal arteries. The venous drainage is comparable to this arterial architecture.

The white matter of the central nervous system can be damaged by a variety of causes. Trauma, either chronic or acute, can result in Wallerian degeneration which refers to the antegrade degeneration of axons and their accompanying myelin sheath. It results from injury to the proximal portion of the axon or its cell body.[7]

In spinal cord injury one expects to visualize Wallerian degeneration in the corticospinal tracts below the lesion and in the dorsal columns above the lesion.[8] Several reports of MR Imaging of Wallerian degeneration have been published and even staging of it has been proposed.[9,10]

In the staging proposed for the brain by Kuhn et al,[7] Stage I represents physical degradation of the axon with little biochemical change in

the myelin. No abnormality on MR Imaging is seen in this stage which occurs in the first four weeks.

At four to fourteen weeks, the myelin protein breaks down and the tissues becomes more hydrophobic. This is Stage 2. The high lipid-protein ratio causes the hypointense signal on T2W MRI.

After fourteen weeks, which is termed Stage 3, the tissue becomes more hydrophilic with myelin lipid breakdown and hyperintense signal on T2W images.

The final Stage 4, sees volume loss from atrophy.

These changes in signal intensity would likely be similar to Wallerian degeneration in the spinal cord.[8]

In cord compression, the myelopathy resulting from it produces abnormally high signal intensity within the cord. This is believed to be due to myelomalacic changes.[5]

In the work published by J Becerra et al,[8] Wallerian degeneration in the spine was identified by MR at seven weeks and longer following injury. This corresponded to Stage 2 of Kuhn (4 - 14 weeks) in Wallerian degeneration in the brain.[9] Becerra et al believed their analysis explains abnormal MR signals at sites away from the centre of injury.

In our series 64% of the gliosis occurred below the site of canal stenosis and cord impingement. This possibly implies that in such situations there seems to be a predominance of associated descending degeneration.

This compared with only 36% of gliosis occuring only at the site of the stenosis.

In a study by Bucciero et al,[11] they reviewed 35 cervical spondylotic myelopathy patients showing high signal intensity within the cervical cord on T2 and proton density weighted MR images. They then measured on axial images, the ratio of the anteroposterior diameter to the transverse diameter (anteroposterior compression ratio or APCR at the most compressed segment of the cervical cord and compared this with the patient's neurological status. Their findings revealed patients having a better neurological status if their APCR was 40% or more, and following surgery, patients with preoperative APCR of 15% or more improved after the operation. Those patients who were unchanged postoperatively had pre-operative APCR of 10% or less.

Whilst our study did not primarily attempt to correlate surgical outcome with the degree of canal stenosis, we did discover that 55% of patients with gliotic change of the cevical cord showed improvement post-surgically compared with 75% of patients who did not exhibit gliotic change in the spinal cords on MRI.

We could find no specific correlation between the degree of cervical canal stenosis and the presence or extent of gliosis of the cervical spinal cord.

In concluding, our study showed that the most common level of cervical cord gliosis to be at C3-4 level followed by C5-6 intervertebral level. No specific relationship was found between the degree of cervical canal stenosis and gliosis. Preliminary review of the post-surgical outcome of these 13 patients with cervical cord gliosis shows that more than half the patients showed improvement. This correlates well with an ongoing trial involving the post-surgical outcome of 35 patients with high signal intensity on the T2W sequence prior to surgery.

Further work will be necessry to determine if MRI features of gliosis indeed has any prognostic relationship with post-surgical outcome.

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