Morphological changes of the cervical spinal canal and cord due to aging on MR imaging

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Objective

The relationship between neurologic symptoms and treatment outcome in cervical spondylosis and ossification of the posterior longitudinal ligament has been extensively studied using magnetic resonance imaging (MRI)-based morphometry of the cervical cord, but there is a paucity of data on evaluation of spinal cord morphology using MRI. The aim of the present study was to measure age-related changes in the proportion of space occupied by the cervical cord in individuals between 20 and 70 years of age without appreciable space-occupying lesions in the cervical portion of the spinal canal.

Subjects and Methods

Age	Cases	Average of age
Group A 20-39 years old	55 cases (male:27, female:28)	28.2 years old
Group B 40-59 years old	32 cases (male: 14, female: 18)	49.5 years old
Group C 60-79 years old	36 cases (male: 18, female: 18)	66.3 years old

We studied 55 individuals aged 20-30 years old (group A), 32 individuals aged 40-50 years old (group B), and 36 individuals aged 60-70 years old (group C) who did not have appreciable space-occupying lesions in the spinal canal on MRI.

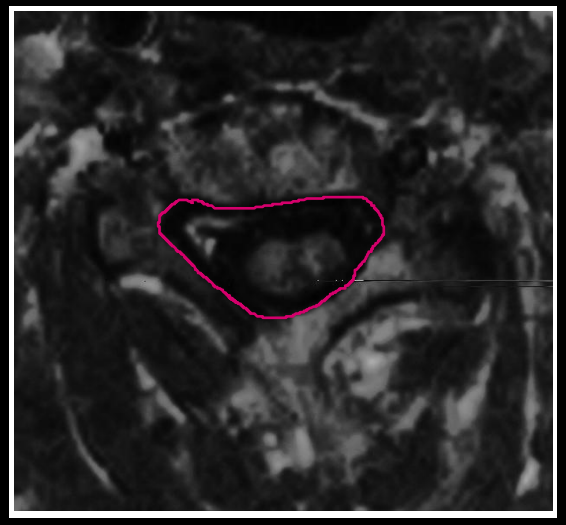
MR Imaging Study

* Equipment : MRP-7000 (0.3T : Hitachi)
* Pulse Sequence : Spin echo, T1-weight (500/35)
* Slice Section : Axial
* Slice Thickness : 7 mm

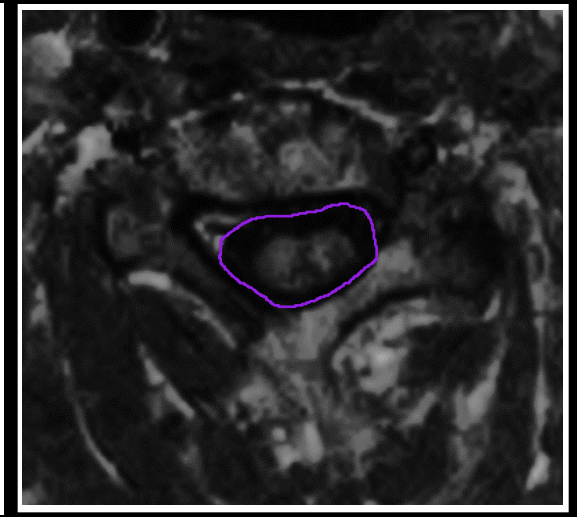
Measurement of the Transverse Areas

of the Spinal Canal, Dural Sac, and Spinal Cord

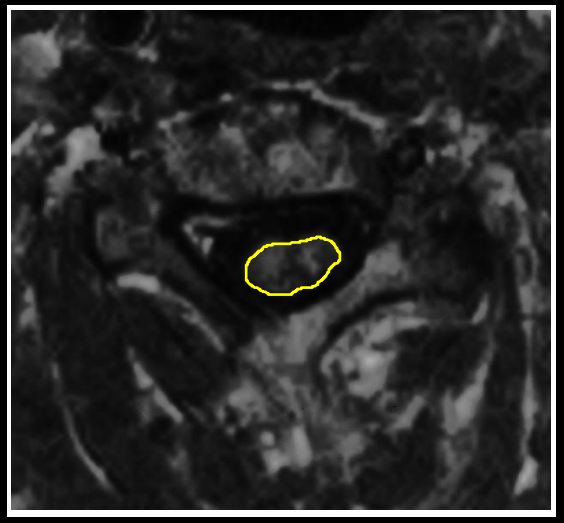
Spinal Canal



Dural Sac



Spinal Cord

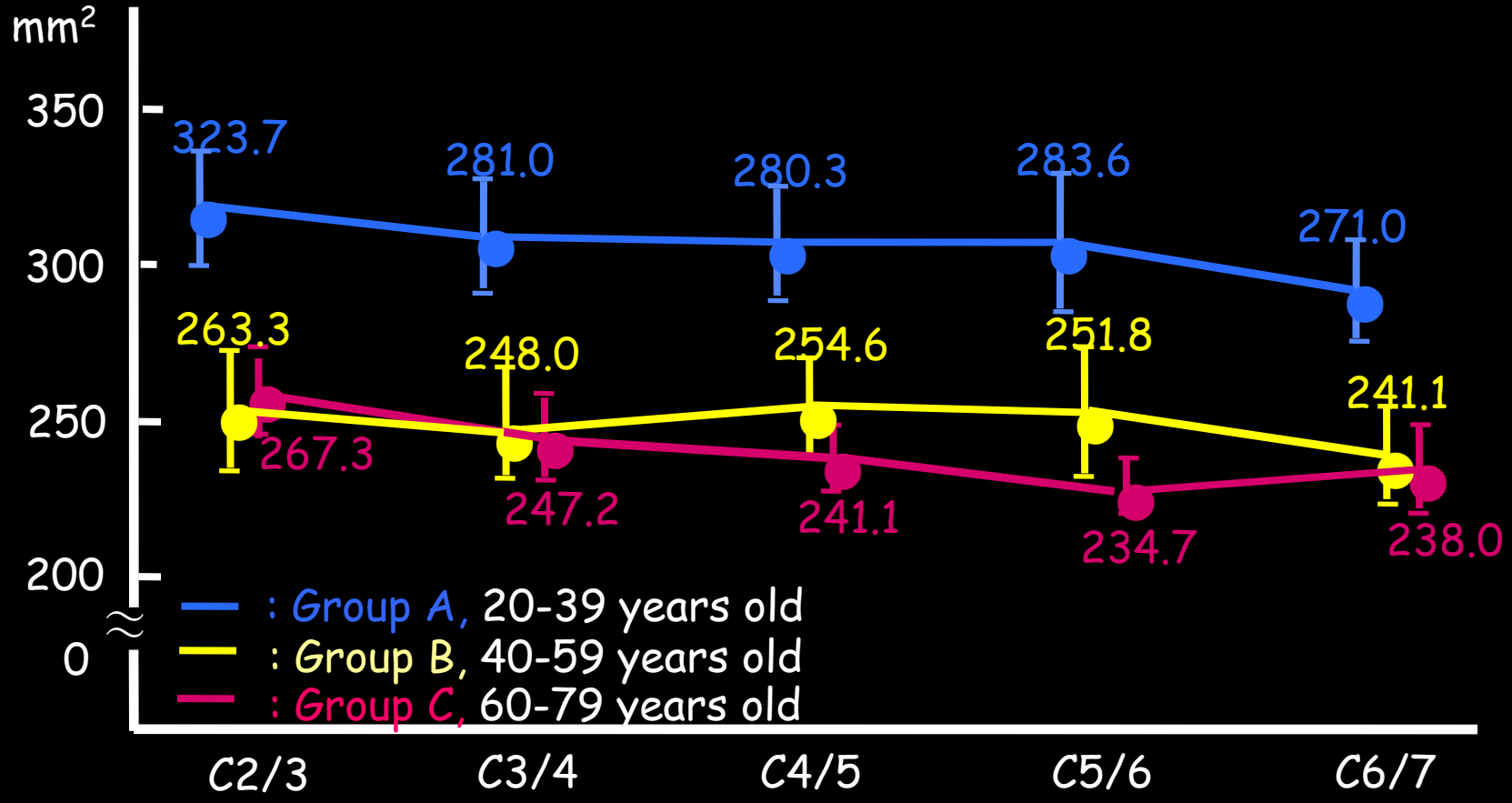


Levels: C2-3 to C6-7.
(at the middle of the intervertebral disc)

The transverse areas were measured at each level using an image analyzer attached to the MRI scanner.

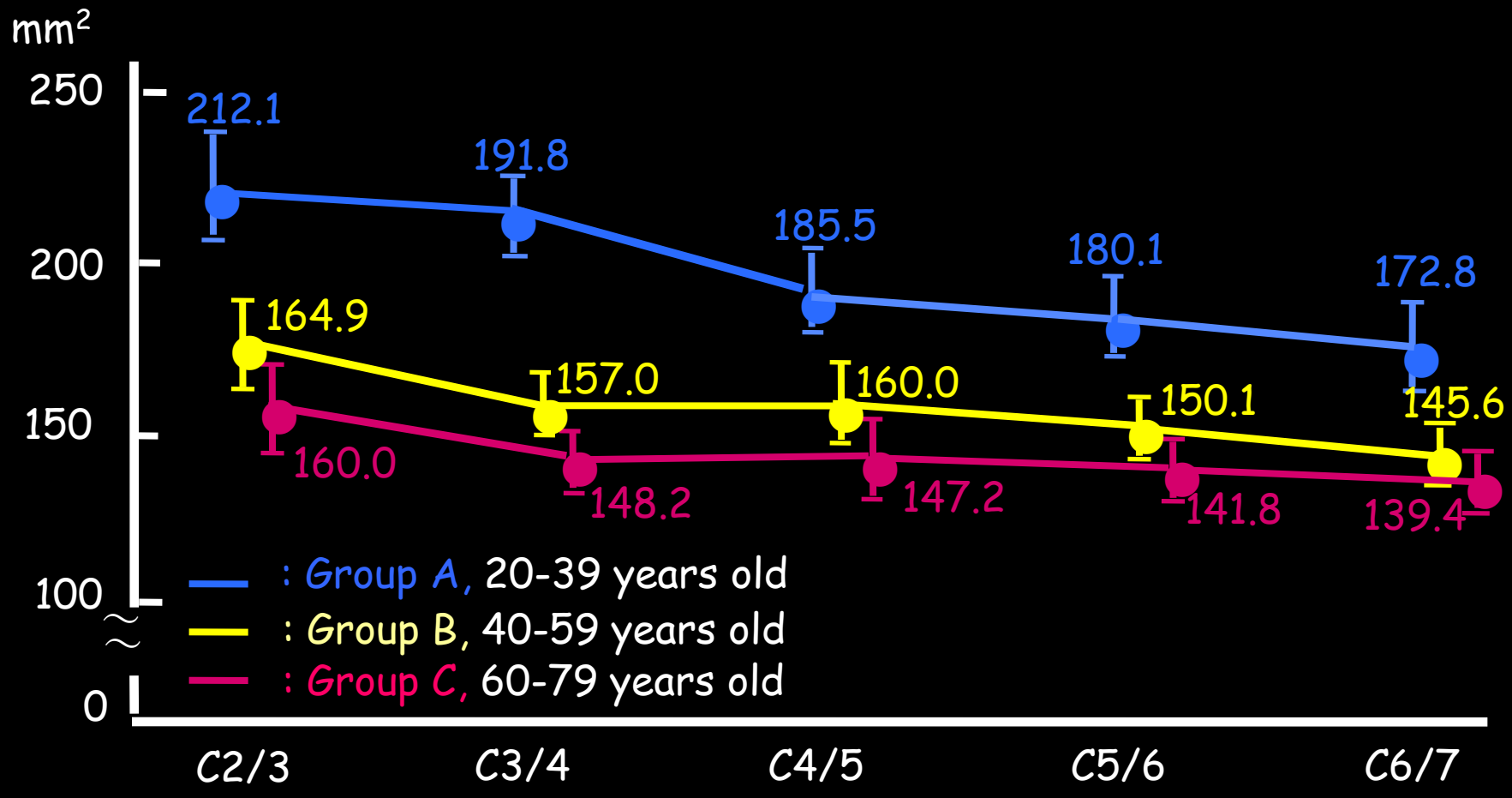
Results

➢ Transverse Areas of the Spinal Canal



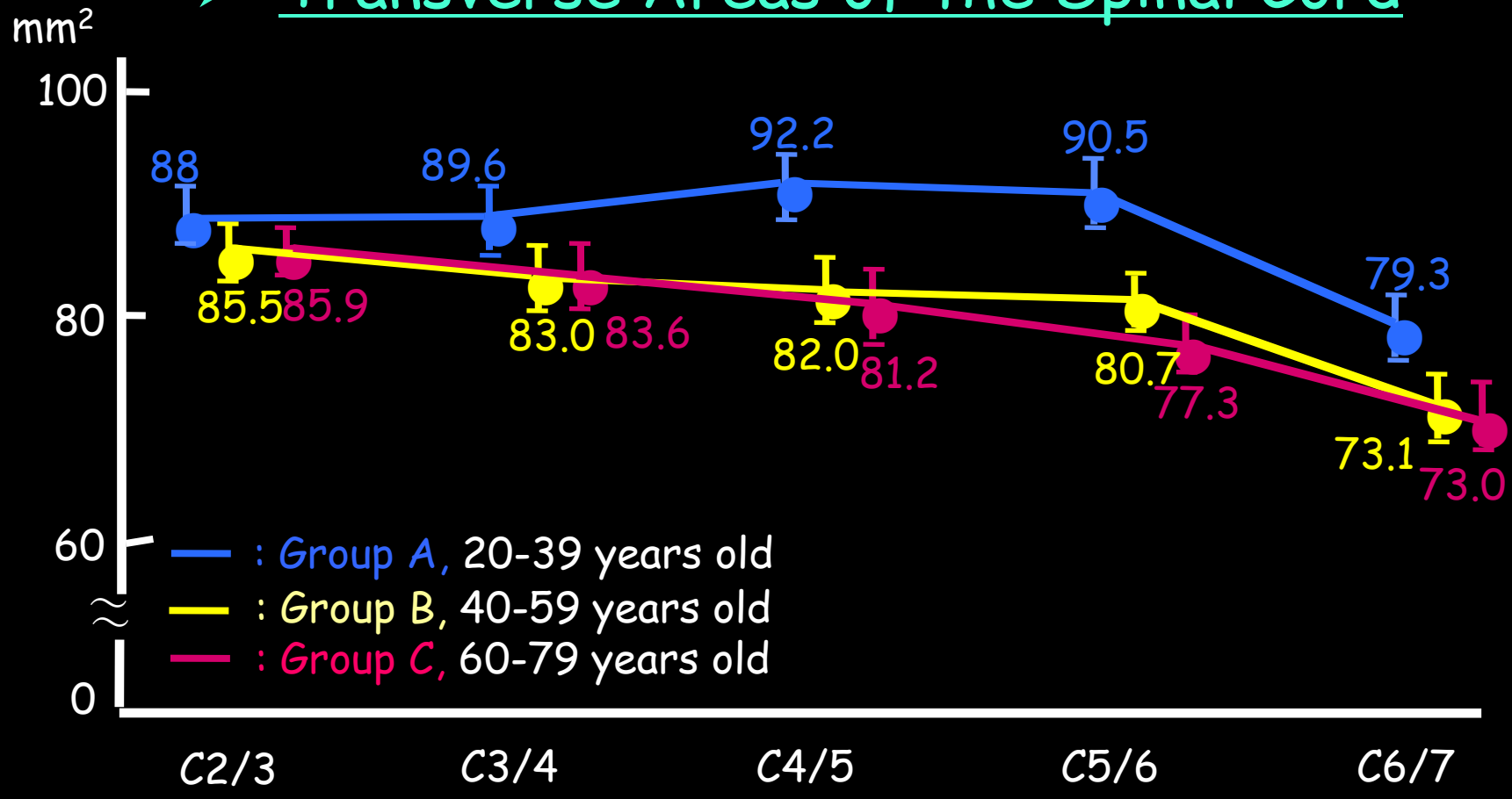
The area of the spinal canal at each intervertebral disk level was far smaller in groups B and C than in group A.

➢ Transverse Areas of the Dural Sac



The area of the dural sac decreased at a relatively uniform rate from C2-3 to C6-7 in each age group.

➢ Transverse Areas of the Spinal Cord



In group A, the area of the spinal cord was greatest at C4-5, the level of the cervical intumescence, and decreased from C5-6 to C6-7. In groups B and C, the area of the spinal cord decreased from C2-3 to C6-7 at a relatively uniform rate.

Discussion

➢ Pathogenesis of Compression Myelopathy

① direct mechanical compression

disc herniation

bony spur

OPLL etc..

② secondary vascular insufficiency

Mechanisms leading to morphologic changes of the spinal cord in compression myelopathy include direct mechanical compression caused by disc herniation, bony spurs, or OPLL, and secondary ischemic changes in the spinal cord. These changes appear to be closely associated with the proportion of the spinal canal occupied by the spinal cord, and are heavily influenced by developmental factors as well as by disease severity.

Transverse Areas of the Spinal Canal at C4/5

	Group A 20-39 years old (N=55)	Group B 40-59 years old (N=32)	Group C 60-79 years old (N=36)
Maximum area (mm^2)	391.6	299.0	322.2
Minimum area (mm^2)	178.7	205.5	169.5
Max./ Mini.	2.2	1.5	1.9

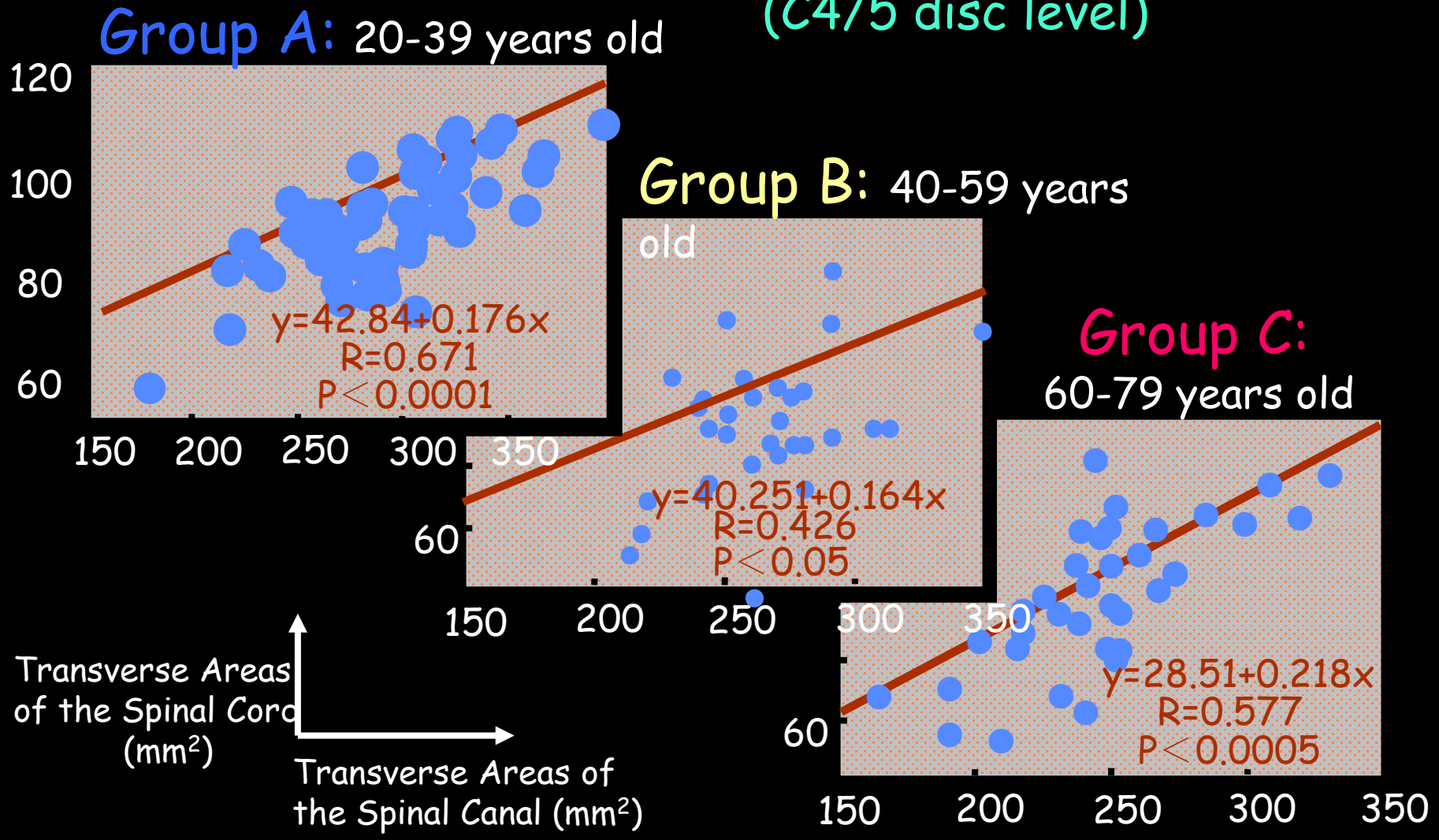
Our findings show that there is considerable inter-individual variation in the transverse areas of the spinal canal and cord in humans. The maximum area of the spinal canal at C4-5, a level of high clinical significance, was approximately twice the minimum area in groups A and C, and approximately 1.5 times the minimum area in group B.

Transverse Areas of the Spinal Cord at C4/5

	Group A 20-39 years old (N=55)	Group B 40-59 years old (N=32)	Group C 60-79 years old (N=36)
Maximum area (mm^2)	112.0	99.9	106.4
Minimum area (mm^2)	60.2	50.5	54.2
Max./ Mini.	1.86	1.98	1.96

The maximum area of the spinal cord was approximately twice the minimum area in all age groups.

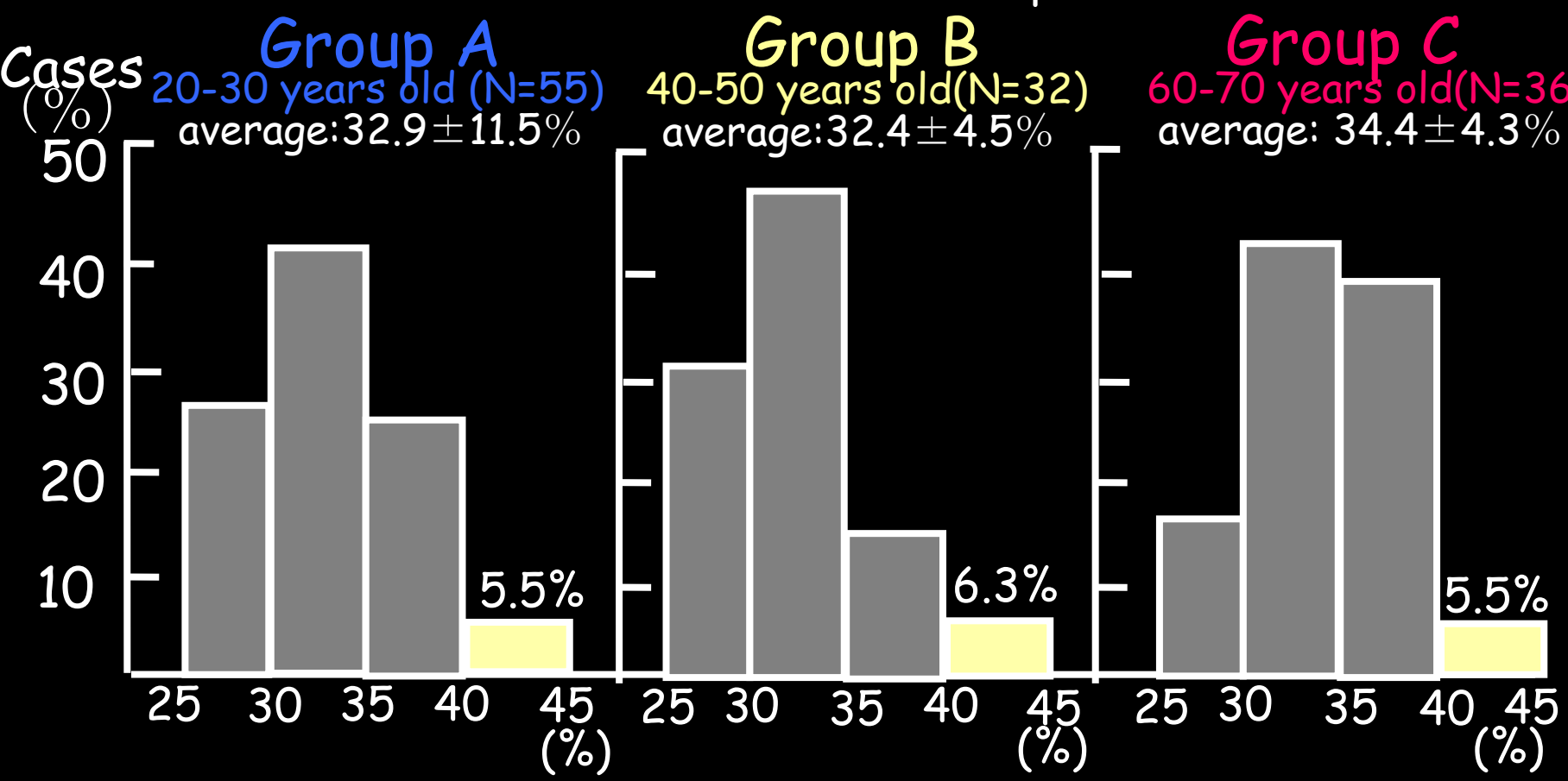
A correlation between the areas of the spinal canal and cord (C4/5 disc level)



The areas of the spinal canal and that of spinal cord were correlated in all groups. When the spinal canal was larger, the spinal cord was also larger, and vice versa.

The Proportion of Space Occupied by the Spinal Cord (C4/5 level)

$$\left[= \frac{\text{the transverse area of the spinal cord}}{\text{the transverse area of the spinal canal}} \times 100 \right]$$



However, the spinal cord occupied 40% or more of the spinal canal in 5-6% of individuals in each age group. It is possible that such individuals may be at greater risk of developing cord symptoms due to spinal canal stenosis.

Conclusions

Our results suggest that individuals in whom the spinal cord occupies a large proportion of the spinal canal when young are more likely to develop compressive myelopathy due to disk herniation and degenerative changes in the soft tissue around the spinal cord as they grow older.