

Increased spinal cord motion in degenerative cervical myelopathy (DCM): reproduction of a potential new pathophysiological mechanism revealed by phase-contrast MRI

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Introduction & Background

- cranio-caudal oscillations of the spinal cord depending on the heartbeat are well known (e.g., Figley C, Magn Reson Med.2007)
- significantly increased spinal cord motion has been demonstrated among 12 DCM-patients with stenosis at C5/C6 (Wolf et al., Spinal Cord 2018, axial measurements segments C2/C3 and C5/C6)

- ⇒ Can we reproduce focally increased spinal cord motion among DCM-patients?
- ⇒ How do the dynamics evolve across the entire cervical spinal cord?

Materials and Methods

- Prospective, controlled study
- 15 DCM-patients, stenosis at C5/C6 (age 55.2 ± 15.0 yrs), 15 controls (age 45.5 ± 10.1 yrs, $p=0.107$)
- ECG-triggered PC-MRI, sagittal orientation, spatial resolution $1 \times 1 \times 3 \text{ mm}^3$
- Analysis of cranio-caudal maximum velocity of the spinal cord per one heart-cycle by standardized ROIs (16 mm^2) per segment C2/C3 to C7/T1 (www.nora-imaging.org)
- Calculation and group comparison of the individual's velocity index (VI) per segment C3/C4 – C7/T1 ($\text{VI} = \text{velocity C}(x)^{(3-7)} \div \text{velocity C2/3} \rightarrow$ less influence of intraindividual differences, e.g., breathing, body size, etc.)

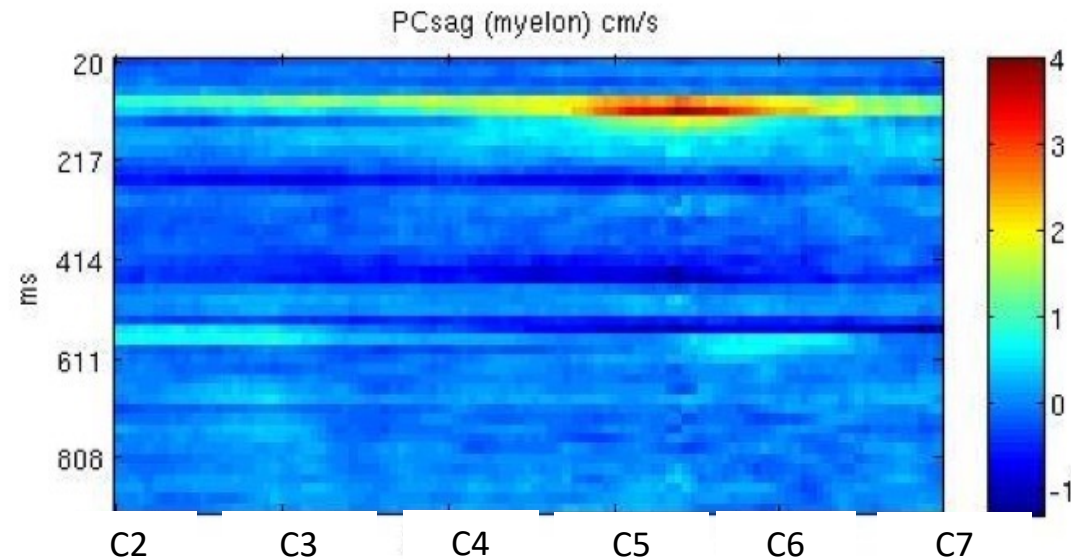


Figure 1: Example DCM-patient, stenosis at C5/C6: color-map of spinal cord (=myelon) velocities measured by phase-contrast (PC)-MRI in sagittal (sag) orientation; velocities per voxel given in cm/s (color coded, index on the right) per one heartbeat (given in ms on the vertical axis) indicating a local increase of spinal cord motion at level of stenosis C5/C6 (horizontal axis)

Results

VI	patients (n=15)	controls (n=15)	p- value
C3/C2	1.47 ±0.5**	1.27 ±0.5	0.276
C4/C5	1.95 ±0.5	1.48 ±0.5	0.017
C5/C6	2.78 ±1.1**	1.38 ±0.6	0.000
C6/C7	2.57 ±1.5	1.34 ±0.4	0.005
C7/T1	1.79 ±1.0**	1.13 ±0.4	0.021

Table 1: mean ± standard deviation of the velocity index per segment C3/C2 to C7/T1

** the increase from segment C3/C2 to C5/C6 and the decrease from level C5 to level C7 is significant, $p < 0.01$

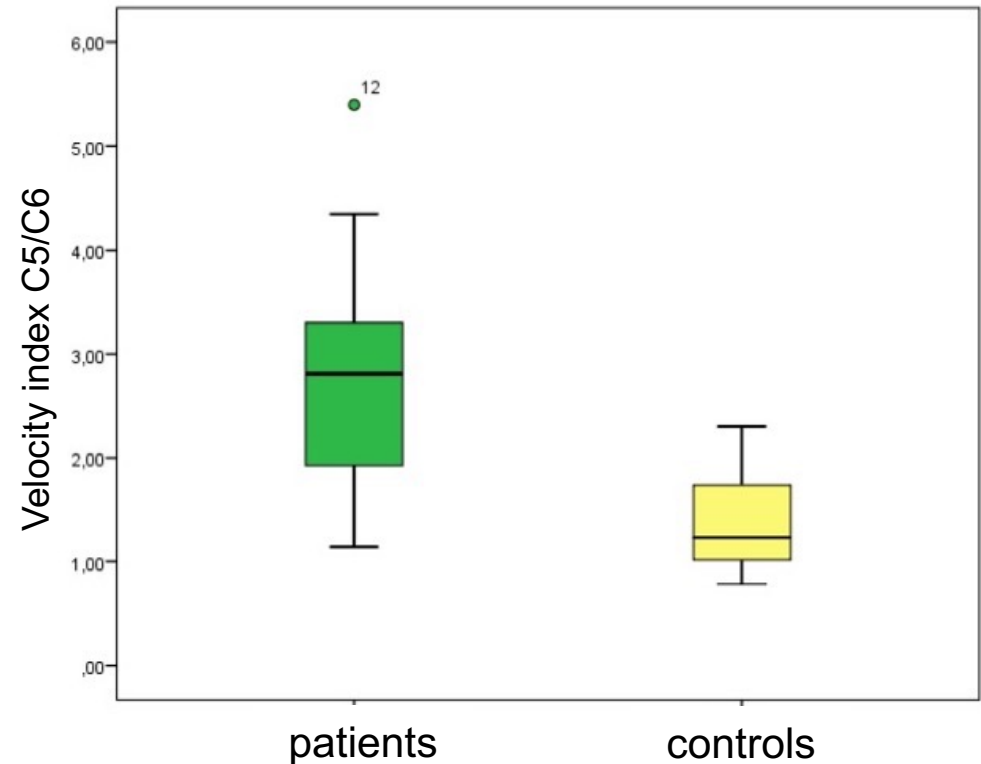


Figure 2: box-plot of the velocity index (VI) at segment C5/C6, significantly higher index among patients (green) compared to controls (yellow), $p = 0.000$

Conclusion/discussion

- An increased spinal cord motion was reproduced specifically at stenosis
- The cranio-caudal increase of the velocity indices towards stenosis followed by a decrease indicate relevant strain on spinal cord tissue
- Further clinical data is needed to evaluate the impact of the findings.

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