

An attempt to early detection and early treatment of spinal cord ischemia using clinical MRI

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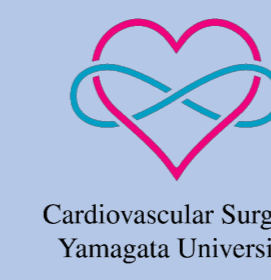


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Background

In aortic surgery, paraplegia due to spinal cord ischemia is an important complication that terribly reduces the patient's quality of life. However, there is currently no reliable treatment or early detection method that can be applied clinically beyond the realm of basic research.

Aim

To establish a reliable method for early detection and treatment of spinal cord ischemia, and as an initial step, we analyzed signal changes in the ischemic spinal cord of rabbits using clinical magnetic resonance imaging (MRI).

Materials and Methods

Animals: Japanese White rabbits ♂ (2.0-3.0 kg)

N=19	sham	n=6
	8hr group	n=5
	24hr group	n=4
	48hr group	n=4



Anesthesia: Mixed anesthetic / subcutaneous injection

Medetomidine hydrochloride	0.15 mg/kg BW
Midazolam	2 mg/kg BW
Butorphanol tartrate	2.5 mg/kg BW

Sevoflurane / inhalation anesthesia

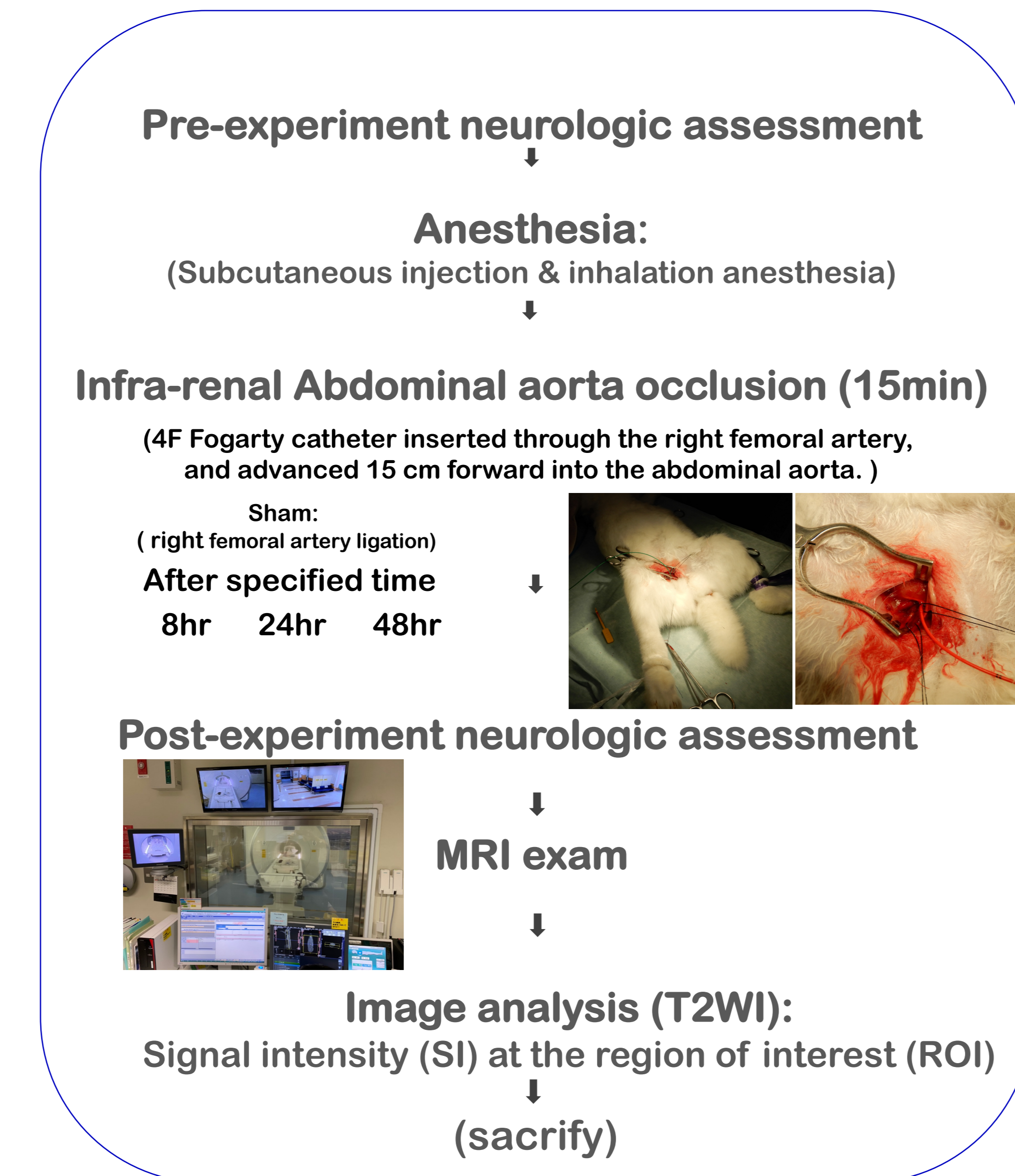
Neurological assessment:

Neurologic scores*

- 0 hind-limb paralysis
- 1 severe paraparesis
- 2 functional movement, no hops
- 3 ataxia, disconjugate jump
- 4 minimal ataxia
- 5 normal function

*5-point scale devised by Johnson and associates

Experimental Protocol

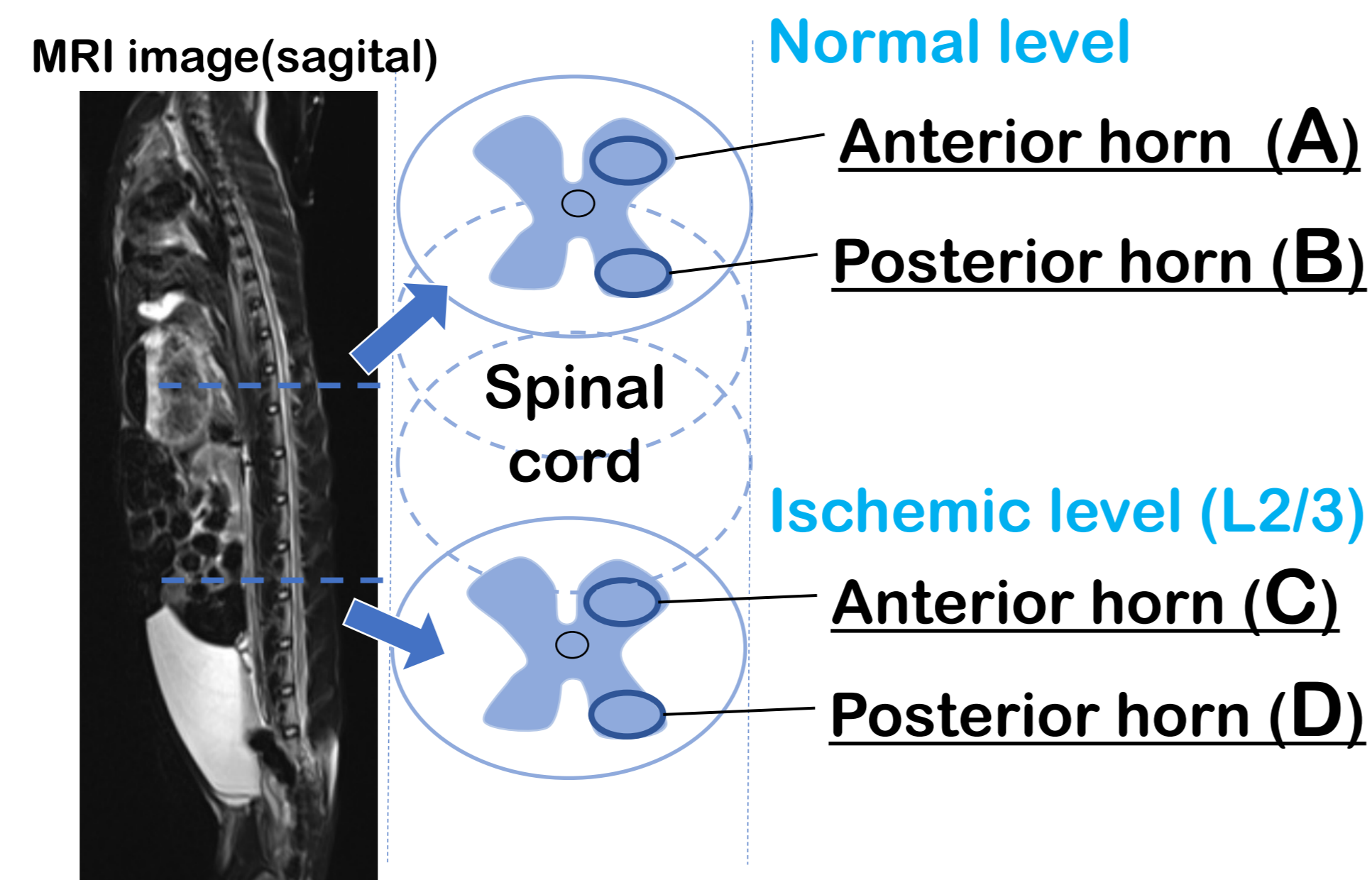


MRI Evaluation Method

① SI index at anterior horn ② SI index ischemic anterior horn

$$\frac{\text{SI (Ischemic anterior horn)}}{\text{SI (Normal anterior horn)}} = \frac{C}{A}$$

$$\frac{\text{SI (Ischemic anterior horn)}}{\text{SI (Ischemic posterior horn)}} = \frac{C/D}{A/B}$$

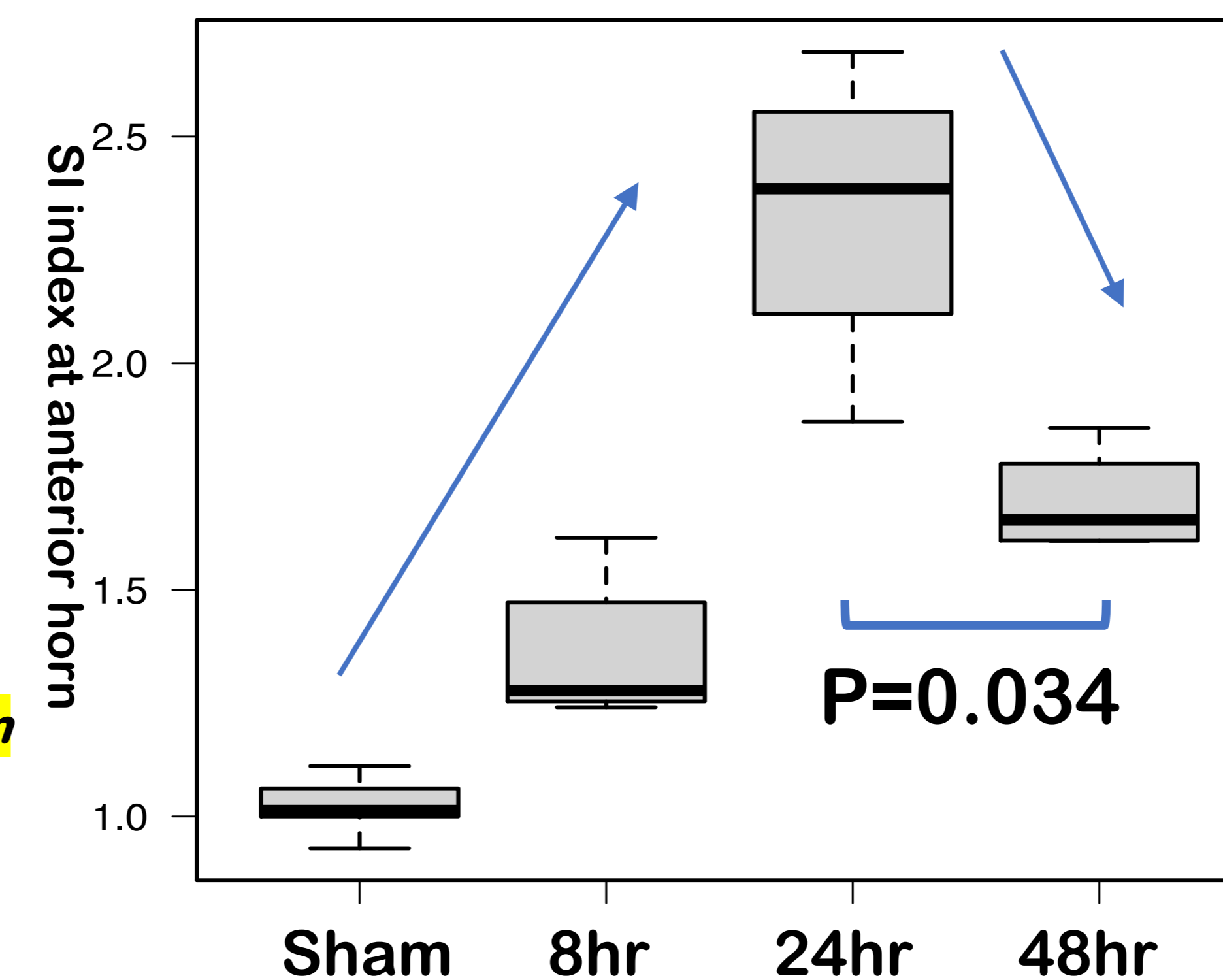


Results

1) Neurologic assessment

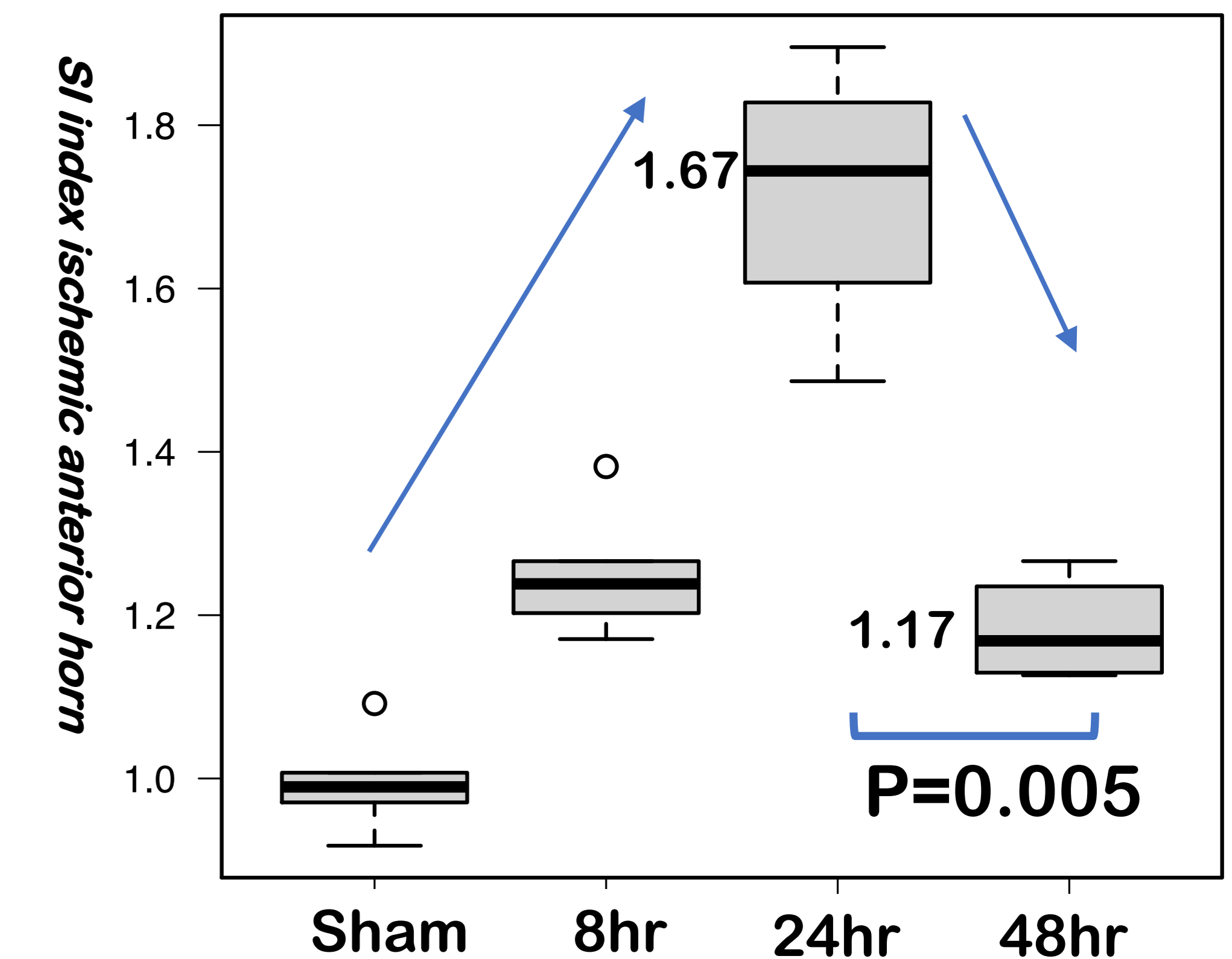
Rabbits	Pre-experiment	Post-experiment	Mean ± SD
Sham 1	5	5	5
Sham 2	5	5	
sham 3	5	5	
Sham 4	5	5	
Sham 5	5	5	
Sham 6	5	5	
8hr 1	5	0	1.2 ± 1.6
8hr 2	5	3	
8hr 3	5	0	
8hr 4	5	3	
8hr 5	5	0	
24hr 1	5	0	0
24hr 2	5	0	
24hr 3	5	0	
24hr 4	5	0	
48hr 1	5	3	1.3 ± 1.5
48hr 2	5	2	
48hr 3	5	0	
48hr 4	5	0	

2) MRI: ① SI index at anterior horn



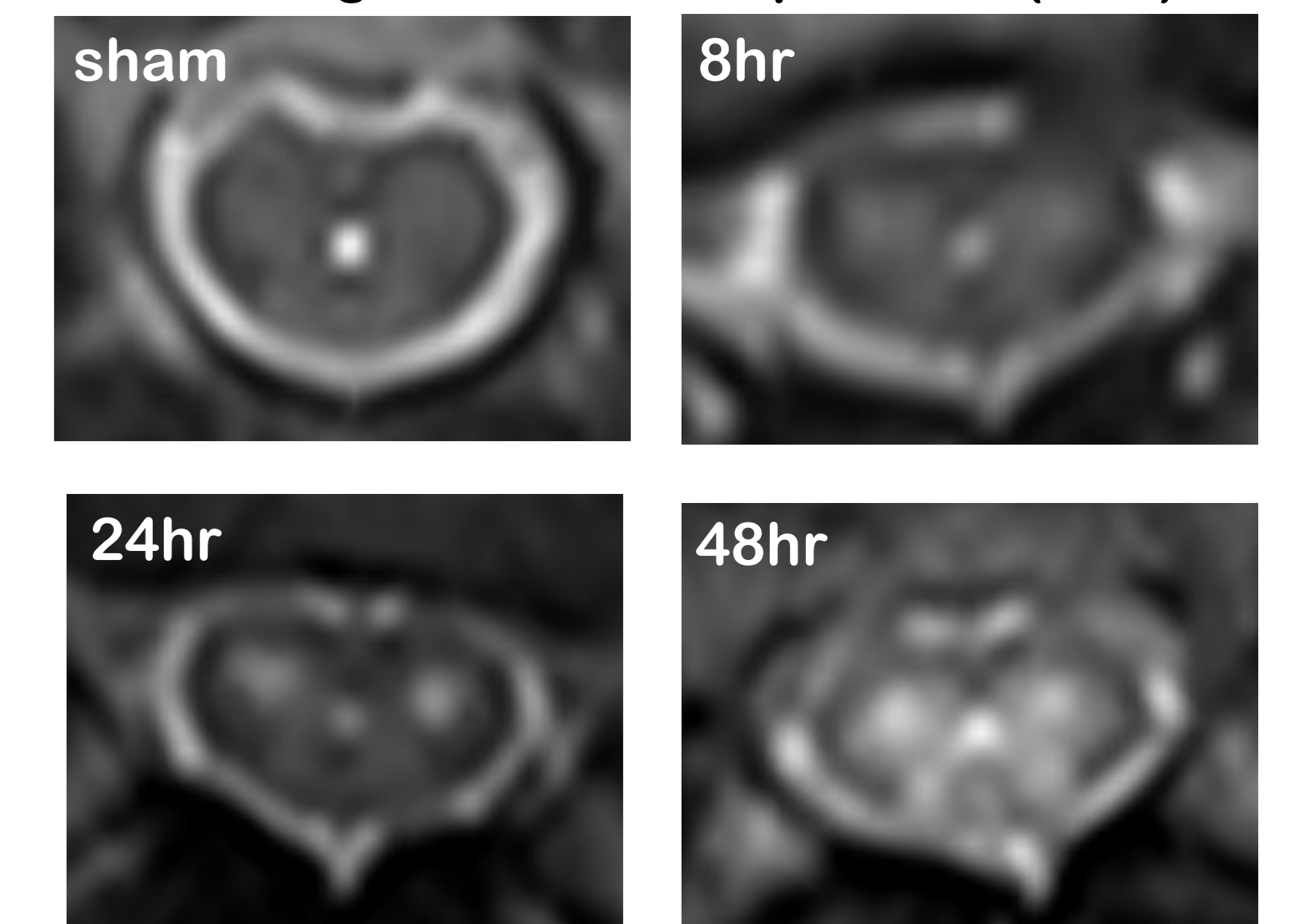
- Spinal cord anterior horn (motor neurons)
- The signal value of the anterior horn is maximal at 24 hours and then decays.

3) MRI: ② SI index ischemic anterior horn



- Peaks at 24 hours and decays.
- At 24 hours, the anterior horn was specifically high-signal, but at 48 hours, the posterior horn was also high-signal, and the overall signal was high.

MRI images of ischemic spinal cord(axial)



Comments & Conclusions

- 1) In our study, we found that in a rabbit spinal cord ischemia model, the anterior horn of the spinal cord, where motor neurons are concentrated, peaks at 24 hours on MRI scans, with a delayed high signal in the posterior horn.
- 2) This study is a valuable study that captured signal change data over time using a modality (MRI) used in a clinical setting.
- 3) This study is the first step in a series of studies, and its application is expected to contribute to the early treatment of spinal cord ischemia, a serious complication.