INTRODUCTION
The spinal cord is subjected to tensile stress and is stretched along the craniocaudal axis physiologically. The physiological strain changes according to the motion of the spinal column and the growth and degeneration of the vertebrae and discs. The physiological tensile stress may also affect biomechanical response of the spinal cord. The purpose of this study is to examine the effect of the tensile stress on morphological plasticity of the spinal cord under compression and decompression condition in rabbits.

MATERIALS AND METHODS
Materials
Four Japanese white rabbits weighing 2.600 g on average (range; 2.400 - 2.800 g) were sacrificed by intravenous injection of a high dose of pentobarbiturate. The C1 - T2 spinal column containing the spinal cord was excised from each rabbit.

Experiment
All tests were accomplished within 30 minutes after the excision. The specimen was put on the test table with the lamina up, and the C3 - C7 laminae and lateral masses were removed. After incision of the dura mater, the dentate ligaments and anterior and posterior rootlets were carefully dissected. The spinal cord was confirmed not to adhere to surrounding structure. A rod with the tip of 5mm-diameter was put on the center of the spinal cord. The rod was connected with a pan of the scale balance (Fig. 1). Varying the weight on the scalepan, the indentation of the rod was measured as a vertical displacement of the pan using a laser displacement meter at C4, 5 and 6 levels. The origin of the measurement was taken as the point before applying the load. The load on the spinal cord was changed 0g → 1g → 3g → 5g → 10g → 20g → 10g → 5g → 3g → 1g → 0 g at 60-second intervals. The displacement was measured just before the change of the load. Then, the spinal cord was cut transversely and separated at C2 /3 and C7/T1, and tensile stress was removed. The measurement with the same protocol was performed again at points 10mm caudal on the spinal cord so that the residual indentation of the spinal cord caused by the previous measurement did not affect the present one.

The shape recovery rate was defined as the proportion of elastic recovery under unloaded condition to the maximum deformation as follows:

Shape recovery rate (%) = (maximum indentation – residual indentation) / maximum indentation x 100

The shape recovery rate of 100% means complete recovery to the original condition.

RESULTS
Measurements of the spinal cord length
The craniocaudal length of the spinal cord was 55.5 ± 3.9mm (mean ± sd) before the separation, and 50.1 ± 3.8mm after the separation. It reduced to 90% (p <0.01).

DISCUSSION
In the present study, the tensile stress of the spinal cord did not affect the spinal cord deformation in response to the compression, but affect the shape recoverability following the decompression. Harada et al [1] compared the shape of the spinal cord before and after decompression surgery in patients with cervical myelopathy on MRI. The shape recovery was worse in aging patients compared to younger patients. The decrease in the tensile stress of the spinal cord due to aging was supposed to contribute to the poor resilience of the shape after decompression surgery.

We studied mechanical properties of the spinal cord concerning on the plasticity of the spinal cord. Factors such as elastic modulus of the spinal cord [2], pia mater [3], spinal cord pressure, the dentate ligaments, and roots involve in the spinal cord deformation under compression. In addition the tensile stress along the craniocaudal axis affects the shape recoverability of the spinal cord.

CONCLUSION
In Situ tensile stress along craniocaudal axis improved the shape recoverability of the spinal cord.

REFERENCES