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Title: CHANGES OF AMINO ACID LEVELS IN THE CENTRAL NERVOUS SYSTEM AND SERUM AFTER SPINAL CORD INJURY

Purpose

Flaccidity commonly occurs after spinal cord injury, but this phenomenon is transient and the gradual return of reflex activity can be anticipated. Several mechanisms of nervous plasticity after spinal cord injury have been suggested, but the actual process is unclear. In the central nervous system, glutamate is considered to be the major excitatory neurotransmitter, and glycine is a postsynaptic inhibitory neurotransmitter (1-3). Since amino acid neurotransmitters play a major role in the maintenance of muscle tone, abnormal neurotransmitter concentrations are associated with hypertonic or hypotonic states. In this study, we examined how amino acid neurotransmitter (glutamate and glycine) levels in the central nervous system were concerned to bladder activity after spinal cord injury and whether changes of these neurotransmitters in the central nervous system were reflected by the serum concentrations.

Materials and Methods

Spinal cord injury rats : Fifty-three female Sprague-Dawley rats weighting between 250-300 g were used in the study. The rats were divided into the following three groups: 1) intact control group (n = 7), 2) spinal cord injury group (n = 42), and 3) sham-operated group (n = 14). Rats were anesthetized with halothane, and the spinal cord was completely transected between the 9th and 10th thoracic vertebrae under direct vision. Rats from the sham- operated group only underwent laminectomy by the same procedure. In spinal cord injury rats, the central nervous system and blood sample were harvested at 1 and 3 days, and at 1, 2, 4, and 8 weeks (n = 7 each) after surgery. The glutamate and glycine levels in the cerebrum, cerebellum, brain stem, cervicothoracic cord, lumbosacral cord, and serum were measured by a capillary electrophoresis system.
Patients with spinal cord injury : We collected serum samples from patients with chronic spinal cord injury (n = 54) and healthy controls (n = 153). Their serum glutamate and glycine levels were also measured by a capillary electrophoresis system.
Results are reported as the mean±standard deviation. Student's *t*-test for paired data was used for statistical analysis, and $P < 0.05$ was considered to be statistically significant.

Results

Spinal cord injury rats : Three days after spinal cord injury, pinching of the tail induced body movement as a spinal reflex. Urinary retention was observed acutely, but bladder contractions occurred after 2 weeks. The glutamate and glycine levels in intact control rats and sham-operated rats at 1 day (n = 7) or 8 weeks (n = 7) after surgery were not significantly different in each central nervous system region and the serum. In spinal cord injury rats, however, the glycine level was significantly increased in the lumbosacral cord at 1 day after spinal

cord injury (1.53±0.30 mM) compared with that in the sham-operated rats (0.86±0.20 mM)(P = 0.002), although it stabilized at the baseline level after 1 week (0.91±0.20 mM). The glycine level subsequently showed a significant decrease below baseline at 2 weeks (0.49±0.08 mM)(P = 0.004). The serum glycine level was also significantly increased after 1 week (0.23±0.03 mM) compared with that in sham-operated rats (0.19±0.03 mM) (P = 0.044). It returned to baseline after 2 weeks (0.19±0.02 mM), and was significantly decreased at 4 weeks (0.14±0.02 mg/L)(P = 0.002) and 8 weeks (0.12±0.04 mg/L)(P = 0.006). After spinal cord injury, the glutamate levels in the central nervous system and serum were not different from those in the sham-operated group. Patients with spinal cord injury: The serum glutamate level was higher in the patients with spinal cord injury (13.76±10.58 mg/L) than in the controls (10.13±7.28 mg/L) (P = 0.023), while the glycine level was lower in the patients (12.83±6.21 mg/L) than controls (17.58±6.19 mg/L) (P < 0.001).

Conclusion

The glycine level in the lumbosacral cord may influence bladder activity after spinal cord injury, and this change may be reflected in the serum level after a few weeks later. Therefore, it may be possible to use the serum glycine level as an index of spinal inhibitory glycinergic neuronal activity.

References

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