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LOWER URINARY TRACT FUNCTION IN SPINAL CORD INJURY RATS: CONTUSION VERSUS TRANSECTION OF THE SPINAL CORD

Hypothesis / aims of study

Spinal cord injury (SCI) is clinically classified into complete injury that function below the level of the injury is lost and incomplete injury that some sensory and/or motor function is retained below the level of the injury. However, even in complete injury, some neural fibers could be retained. Since lower urinary tract (LUT) dysfunction that frequently accompanies SCI, results from damage to descending pathways and alterations in primary afferent pathways, LUT function has been physiologically and pharmacologically investigated in many studies, using complete transaction of the spinal cord as animal models of SCI. In the present study, to compare contusion injury of the spinal cord as a clinically relevant model with complete transection model, we investigated LUT function and neural fibers at the lumbosacral spinal cord.

Study design, materials and methods

Feale Sprague-Dawley rats were used and a laminectomy was performed at T8/9 following anesthesia for surgery of SCI. Contusion injury produced using the impact rod of the MASCIS device dropped from a height of 25mm (Contusion, n=9)[1)]. In a complete transection model (Transection, n=9), the spinal cord was completely cut with scissors as previously performed[2)]. Unoperated rats were used as normal controls (Normal, n=6). Rats with SCI were placed in a metabolic cage for 24 hrs to investigate micturition behaviour preoperatively and at weekly intervals from 2 weeks to 9 weeks after SCI. At 9 weeks after SCI, cystometry was performed under consciousness. After cystomery, rats were dissected under deep anesthesia to remove the spinal cord. Coronal sections were made at the L6-S1 level, and then immunocytochemical staining was performed to identify the neural fibers of serotonin and adrenergic dopamine-beta-hydroxylase (DβH) as descending modulatory pathways as well as calcitonin gene-related peptide (CGRP) as dorsal root afferents. Cystometry and immunocytochemical staining were also performed in Unoperated rats.

Results

In micturition behaviour, voided volume/micturition was gradually increased with time, which could indicate recovery of spinal shock phase. Although an increase of voided volume/micturition in Contusion looked earlier compared to Transection, there was no significant difference between Contusion and Transection (Fig. 1). Urodynamic parameters of cystometery in both Contusion and Transection, such as micturition pressure (MP), non-voiding contraction (NVC), bladder capacity (BC) and post-void residual urine volume (PVR), were significantly different from Normal (†: Normal vs. Contusion, ‡: Normal vs. Transection). However, there was no significant difference between Contusion and Transection (Table 1). At the lumbosacral spinal cord, although some serotonin- (Fig. 2) and DβH- (Fig. 3) positive fibers identified in Contusion, there was no fibers of these descending pathways in Transection. Meanwhile, CGRP-positive fibers, which may be implicated in NVC, were denser in both Contusion and Transection than in Normal (Fig. 4).

Interpretation of results

Since there was no significant difference in LUT function in micturition behaviour and cystmetry, contusion injury could induce LUT dysfunction as same as complete transaction of the spinal cord. However, supraspinal descending pathways such as serotonin and adrenergic fibers were significant different between Contusion and Transection. These differences of supuraspinal projection to the lumbosacral spinal cord could affect pharmacological effects in SCI models.

Concluding message

Although a significant difference in LUT function was not found regarding micturition behaviour and cystometry, supraspinal projections to the lumbosacral spinal cord were significantly different between Contusion and Transection. To apply data to clinical fields, pharmacological studies are necessary in contusion injury of the spinal cord as a clinically relevant model of SCI in addition to a transection model.

Fig. 1 Micturition Behavior

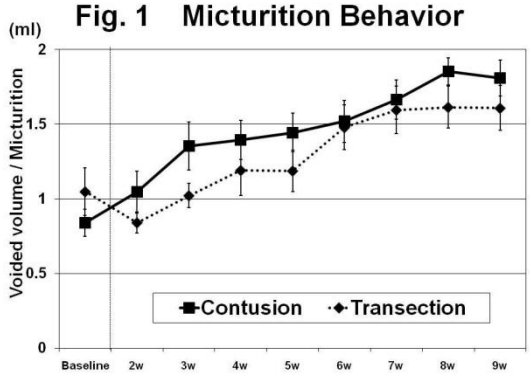


Table 1 Cystometry

Parameters	Normal	Contusion	Transection
MP (cm water)	19.5 +/- 0.8	36.1 +/- 2.9†	33.3 +/- 1.5‡
NVC (/micturiion)	0	7.0 +/- 1.1†	5.9 +/- 1.1‡
BC (ml)	0.44 +/- 0.05	1.54 +/- 0.07†	1.53 +/- 0.14‡
PVR (ml)	0.03 +/- 0.01	0.16 +/- 0.04†	0.20 +/- 0.06‡

Fig. 2 Serotonin-positive fibers

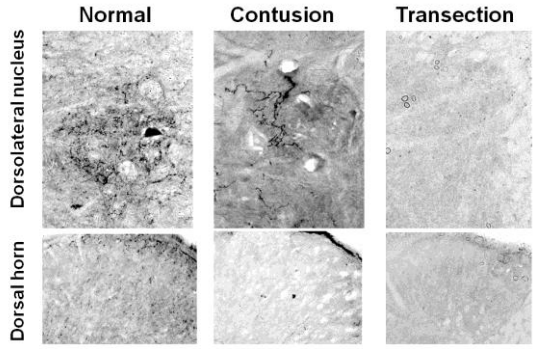


Fig. 3 DβH-positive fibers

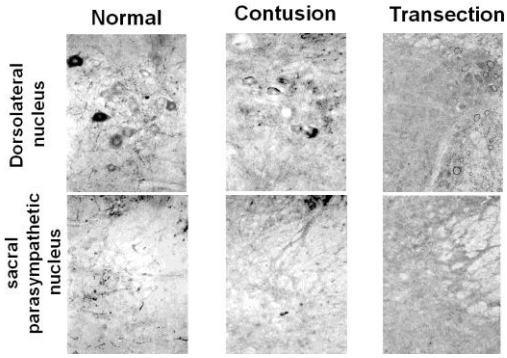
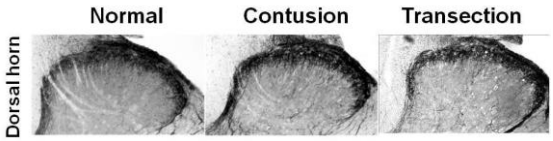


Fig. 4 CGRP-positive fibers



References
1. Mitsui, T., et al.: J Neurosci, 25:9624-9636, 2005
2. Nothias, J.-M., et al.: Neurorehabil Neural Repair, 19:296-, 2005

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What were the subjects in the study?	**ANIMAL**
Were guidelines for care and use of laboratory animals followed or ethical committee approval obtained?	**Yes**
Name of ethics committee	**Hokkaido University Institutional Animal Care and Use Committee**