# The Influence of Transient Spinal Ischemia on Substance P Positive Nerve Structures

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**Abstract.** The aim of this study was to investigate, if transient spinal ischemia and a period of 4-day reperfusion will change the distribution pattern of substance P in the spinal cord of rabbits Strongly enhanced staining of substance P positive nerve structures appeared in the superficial dorsal horn (laminae I, II), the Lissauer's tract, the pericentral region (lamina X), and in the areas of autonomic nuclei (sympathetic – intermediolateral – IML nucleus and parasympathetic – sacral parasympathetic nucleus – SPN) in the control group Transient spinal ischemia was produced by occlusion of the abdominal aorta just below the left renal artery Neuropathology of the lesion 4 days after transient ischemia was characterized by selective necrosis of gray matter in the central part of dorsal horn and medial portions of anterior gray matter Areas with the most dense accumulation of substance P positive structures stayed almost intact Therefore, no significant change in the distribution pattern of substance P was found in the spinal cord of animals with ischemia-reperfusion-induced injury

**Key words:** Substance P — Spinal cord — Ischemia — Rabbit

The peptide substance P (SP) has long been considered as a major candidate for some of nonadrenergic and noncholinergic sensory responses (Pernow 1983) The demonstration of the presence of this peptide in the sensory neurons supported its role in the nociceptive transmission (Sluka *et al* 1992) It plays an important role in the spinal cord functions Dorsal horn substance P transmits nociceptive information from the primary afferent neurons (Jessell 1983) In the intermediolateral (sympathetic) nucleus, it plays a role in transmitting bulbospinal information to the sympathetic nervous system (Keeler *et al* 1985)

The highest density of SP structures in the spinal cord was found in the dorsal horns, particularly in laminae I and II (Besson and Chaouch 1987) A strong SP immunoreactivity was found in the tract of Lissauer and in the area around the central canal (lamina X) (Pernow 1983) Strong densities of binding have been also reported in the autonomic preganglionic regions of the thoracic, lumbar (intermediolateral cell column, IML) and sacral (sacral parasympathetic nucleus, SPN) spinal cord (Maurin *et al* 1984, Honda *et al* 1995)

Sixteen adult rabbits of both sexes weighing 2 5–3 5 kg were used The animals were divided into three groups (1) control group ($n = 4$), (2) 40 min abdominal aorta ligation followed by 4 days of reperfusion ($n = 6$), (3) sham-operated nonligated control ($n = 6$)

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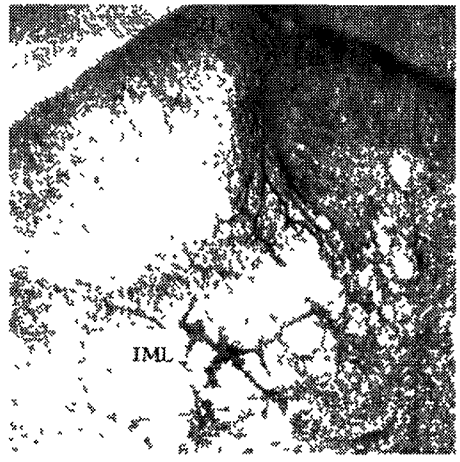


**Figure 1.** Transverse section through the lumbar cord SP positive staining in the areas of Rexed's laminae I , II (L I II ), zone of Lissauer (ZL), and intermediolateral nucleus (IML) (6 3 × 10)

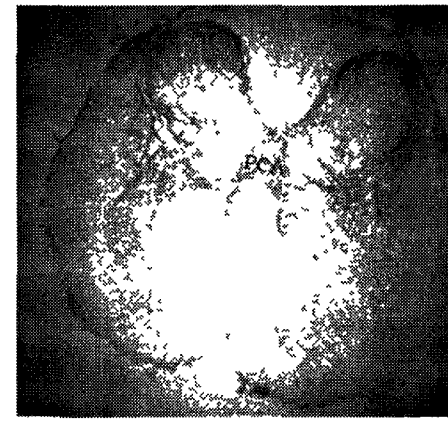


**Figure 2.** Transverse section through the lumbar cord Forty minute occlusion, four days survival Damage of gray matter whithin Rexed's laminae V–VII Intact pericentral area with dense accumulation of SP positive nerve structures (PCA) (5 × 6 3)

Rabbits were anesthetized with pentobarbital (30 mg/kg, i v ) The abdominal cavity was entered by subcostal incision The aorta was exposed at the origin of the left renal artery A ligature with a long file was then placed around the aorta, caudal to the left renal artery (Zivin *et al* 1982) The ligature was tightened for 40 min After this period, the ligature was removed and the abdominal incision was closed permanently with sutures Long-acting penicillin (3,000,000 units, sc) was applied after surgery in 4-day reperfusion group Sham-operated group was given a snare ligature in place, but not pulled tight

At the end of ischemia-reperfusion period, the animals showed the total neurologic impairment, including complete paralysis of hind limbs, unsensivity to deep pain in the lower extremities, and incontinence of urine and feces All sham-operated animals did not show any neurological impairment

At the end of survival period, all three groups of animals were again deeply anestethized with pentobarbital (50 mg/kg, i v ) and perfused transcardially with saline followed by Zamboni's fixative The spinal cords were removed and processed for SP activity using an indirect enzyme immunohistochemistry

The dense distribution of SP positive nerve structures has been observed in the superficial laminae (Rexed's laminae I and II ) of the dorsal horn, in the adjacent zone of Lissauer, and in the sympathetic preganglionic neurons which form the autonomic sympathetic intermediolateral nucleus in the intermediolateral column (Fig 1) Nerve fibers were also found in the pericentral area especially within the dorsal gray commissure (lamina X ) (Fig 2) In the sacral segments, we have found SP positivity in the same place of the intermediolateral column, where the sacral parasympathetic nucleus (SPN) is localized (Fig 3)

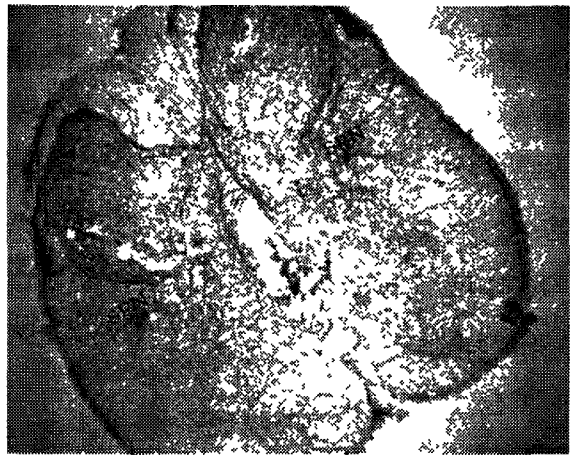

**Figure 3.** Transverse section through the sacral cord Forty minute occlusion, four days survival Areas with the most dense accumulation of SP stayed almost intact Intact sacral parasympathetic nucleus (SPN) (6 3 × 8)

In the 4-day reperfusion group, the neuropathology of the lesion was characterized by strong damage of central gray matter in the dorsal horn – Rexed's laminae V–VII, throughout the lumbar and sacral spinal cord The areas with the most dense accumulation of SP stayed almost intact (Figs 2, 3)

Thus, no significant changes in the contents and distribution of substance P were found in the rabbits spinal cord with experimental transient ischemia-reperfusion

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