Introduction

Radicular pain is one of the most common complaints handled by orthopedic surgeons. As the cause of sciatica, the mechanical compression of the nerve root and the chemical reactions induced by herniated disc containing nucleus pulposus have been reported, however, the pathological mechanism is still unknown. On the other hand, neuropathic pain followed by peripheral nerve injury is considered that there are two types of pain state: sympathetically independent pain (SIP) and sympathetically maintained pain (SMP) attenuated by sympathectomy or sympathetic nerve block. Recent immunohistological studies in a peripheral nerve injury model have shown that sympathetic nerve fibers sprout the neurons in dorsal root ganglion (DRG). This abnormal sympathetic-somatotomosensory interaction seems to lead SMP. Likely the sympathetic nervous system is suggested to be concerned in the radicular pain on the basis of the clinical effectiveness of the sympathetic block on radicular pain. Previously we reported using the root constriction rat model that tyrosine hydroxylase as a marker of sympathetic nerve immunoreactive fibers were more abundant in DRG, and abnormal sympathetic-somatotomosensory interaction was seen at myelin sheath. Therefore the sympathetic nervous system may be related to a trigger of radicular pain. The purpose of this study is to investigate using analysis of pain-related behavior if sympathectomy in the lumbar root constriction model is effective on radicular pain.

Materials & Methods

A total of 14 male Sprague-Dawley rats weighing 150-200g at the beginning of the experiments were used for the study.

1. Surgical procedure

All surgical procedures were performed on rats anesthetized intraperitoneally with sodium pentobarbital (50mg/kg) under sterile conditions with a microscope.

Lumbar root constriction: Through a midline dorsal incision at L4-S1, the paraspinal muscles were retracted to expose the left L5/L6 facet joint. A left L5 hemilaminectomy and L5/L6 partial facetectomy were performed. The left L5 spinal root and DRGs were carefully exposed. Then the left L5 spinal root was tightly ligated extradurally with 8-0 nylon suture just proximal to the DRG until muscle spasms in the left leg were observed. Sympathectomy: Immediately after root constriction, sympathectomy was performed using transperitoneal approach. The lumbar sympathetic chains were identified and the sympathetic chains along with ganglia of both sides were resected from the L2 to L5. The left L5 root constriction was performed on all rats. Seven rats received sympathectomy after root constriction operation (as symp group). Meanwhile other 7 rats were operated only root constriction (as non-symp group).

2. Behavioral study

Investigators who were blinded to the surgical protocol of each rat performed behavioral tests. For mechanical withdrawal response, the rats were placed in a plexiglas chamber above a wire mesh floor that allowed full access to the hindpaw. Before behavioral testing, behavioral accommodation was allowed for at least 20 minutes. Mechanical withdrawal response was measured as the frequency of hindpaw withdrawals elicited by a defined mechanical stimulus of 4.5g and 9.2g using calibrated nylon filaments (Semmes-Weinstein Monofilaments, North Coast Medical Inc., San Jose, CA, USA). The mechanical stimulus was applied to the middle area between the foot pads on the plantar surface of the left (constriction side) and right (contralateral side) hindpaw. Each hindpaw was probed consecutively with 10 tactile stimulations alternating between the left and right. The trial was repeated successively three times with at least a 10 minute interval, which resulted in each foot receiving 30 mechanical stimulations. The mechanical withdrawal frequency of each rat was expressed as the number obtained when the number of responses obtained from the contralateral side (non-constricted) was subtracted from the number of responses from the ipsilateral or constricted side. Behavioral tests were performed before two days and after the operation on the 3rd, 7th, 10th, and 14th days.

Results

When stimulated with 4.5g using Semmes-Weinstein Monofilaments, mechanical hypersensitivity was observed in non-symp group, while withdrawal response in symp group was not observed (Fig. 1). When stimulated with 9.2g, the increase of withdrawal frequency was observed at both groups, but hypersensitive withdrawal response in symp group seemed to be delay more than that in non-symp group (Fig. 2). In non-symp group, the increases in withdrawal frequency were saturated at 10 days after the operation.

Discussions

In the current study, mechanical hypersensitivity observed in lumbar root constriction model was improved by sympathectomy. This may be a plausible explanation for effectiveness of sympathectomy on clinical experience, which suggests that the sympathetic nervous system may be related to a trigger of radicular pain. In future, which influence of sympathectic blocker on DRG neurons in lumbar root constriction model will be needed to study using electrophysiological study.

References