NOTE *Anatomy*

Spinal Projections of Cat Primary Afferent Fibers Innervating Caudal Facet Joints

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ABSTRACT. The spinal projections of afferent fibers innervating the facet joints between caudal vertebrae were examined by the use of anterograde transport of wheat germ agglutinin-horseradish peroxidase (WGA-HRP). Experiments were performed on 5 adult cats in which spinal dorsal roots below the 2nd sacral segment (S2) on the right side were cut. Injections of WGA-HRP into the caudal facet joints gave rise to extensive cranio-caudal distribution of WGA-HRP positive products along the spinal cord, indicating that many afferent fibers innervating unilateral facet joints terminate bilaterally in laminae I-II, V-VI and X of the thoracic, lumbar, sacral and caudal spinal cord. These afferent fibers may convey a series of sensory information from the caudal facet joints to the spinal cord.
KEY WORDS: caudal facet joint, feline, spinal projection.

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Tail movements are influenced by various muscle and cutaneous afferent nerve fibers from various parts of the body. Vice versa, these afferent fibers innervating the tail keep the body informed about the movements and posture of the tail to influence those of the other parts of the body. It has been well known that the afferent fibers innervating any kinds of joints may play an important role for adjusting movements and posture of those parts of the body [1]. However, studies of joint afferent nerve fibers have so far been concentrated mainly on joints of four limbs.

Recently, Gillette *et al.* [4] showed that there was the spinal projection of primary afferent fibers from the lumbar facet joints. Therefore, as a part of our studies on the neural control of tail movements in the cat, the present paper was aimed to confirm the existence of afferent fibers innervating the caudal facet joints. For this aim, we studied the spinal projections of afferent fibers from the tail, by the use of injection of wheat germ agglutinin-horseradish peroxidase (WGA-HRP) into the caudal facet joint capsule.

The experiments were carried out on 5 adult cats (3 females and 2 males, weighing 2.4 to 4.5 kg). Animals were anesthetized with an intraperitoneal injection of pentobarbital sodium (40 mg/kg). Laminectomy was performed between the 6th and the 7th lumbar segment (L6 and L7), and the spinal dorsal roots below the 2nd sacral segment (S2) on the right side were cut to eliminate the WGA-HRP labeled terminal of afferent fibers entering there in. Under sterile conditions, 5–10 μl of 2% WGA-HRP (Sigma, St. Louis, U.S.A) in saline was injected into the fibrous capsule of a single caudal facet joint between the 1st and the 2nd caudal vertebra (Ca1 and Ca2) under a dissecting microscope. Following slow injection (5 min) of WGA-HRP, the injection needle was left *in situ* for 5 min and then twisted off. The hole of injection was instantly sealed with a bonding agent.

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Following uneventful recovery, i.e., 48–52 hrs later, the animals were anesthetized again to be perfused transcardially with 2 *l* of warm heparinized saline followed by 3 *l* of fixative (2.5% glutaraldehyde and 1% paraformaldehyde in 0.1 M phosphate-buffered saline at pH 7.4). Tissue blocks of cervical, thoracic, lumbar, sacral and caudal spinal cords along with dorsal root ganglia (DRGs) were placed in cold fixative solution. All tissue blocks were sectioned at 50 μm on a cryostat. Peroxidase histochemistry using tetramethylbenzidine as a chromogen was applied according to the method of Mesulam [5] by the use of 0.03% hydrogen peroxide for 5 to 8 min as suggested by Gillette *et al.* [4]. All transverse sections were mounted on slides and examined microscopically under an alternate illumination, bright and dark. WGA-HRP labeling was photographed, and the locations of labeled terminals were transferred onto a sheet of paper using a personal computer.

Figure 1a shows an example of labeled terminals in the left dorsal horn in S2. The single facet joint (Ca1-2) injection produced a modest to a slight amount of HRP-reaction product (HRP-rp), bilaterally in the dorsal horn at the level of the injection (S3 and Ca1), and as a cranial as thoraco-lumbar segments (T10-L2) and as far caudal as Ca3-4 (Fig. 1b). HRP-rp was detected in the entire dorsal horn, but its distribution was typically denser laterally than medially and denser on the left side than on the right side. HRP-rp was localized predominantly in the medial side of lamina I and in the lateral side of laminae I and II of the dorsal horn [2]. There were also slight amounts of labeled products in the medial and lateral laminae V-VI. Consistently, thin trails of HRP-rp existed around the central canal (lamina X). The labeled ganglion cells were observed in S3 and Ca1 DRGs on the left side.

In the present experiments, a potential problem might be raised about a possible leakage of HRP into the surrounding muscles. However, this problem can be ruled out in the light of the facts as follows: Before perfusion of fixative solution, no leaking of HRP into the muscles was observed, and his-

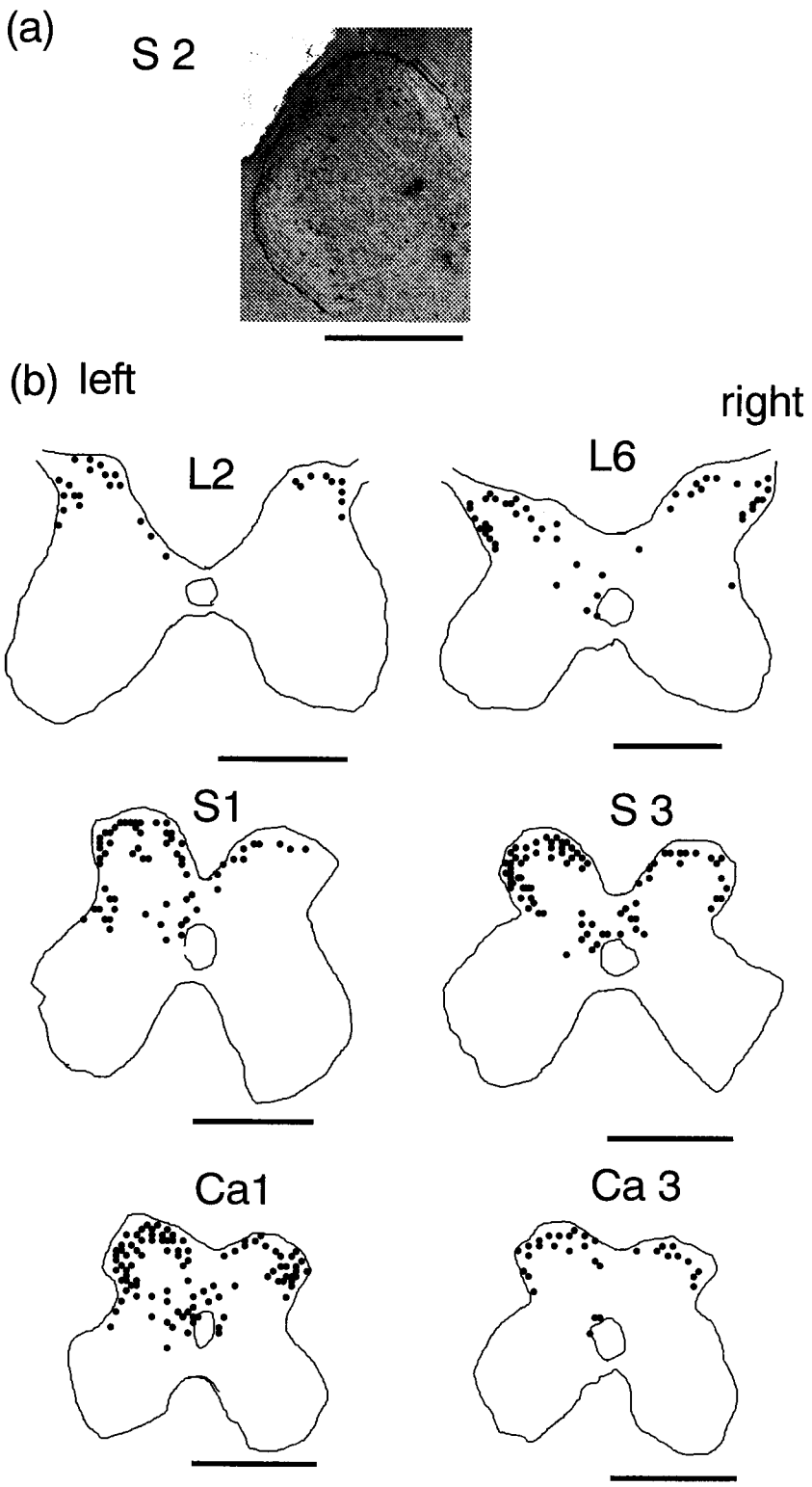

Fig. 1. (a) Photomicrograph of dorsal horn on the left side in the second sacral segment (S2). (b) Representative labeling of afferent terminals (filled circles) in the spinal cord at L2, L6, S1, S3, Ca1 and Ca3. Many labeled terminals were observed in the laminae I, II, V, VI and X. Scale bar: 1 mm.

tochemically, no labeling of motoneurons was confirmed in all the cats examined. These facts clearly indicate that the HRP-labeled terminals were originated from the afferent fibers innervating the caudal facet joints.

The foregoing results show that the afferent nerve fibers from the caudal facet joints between Ca1 and Ca2 on one side distribute their terminals between T10-L1 and Ca3-4 on the both sides, well consistent with some similar previous reports in that the terminals of afferent nerve fibers from knee joints were distributed in laminae I and V-VII [3], and in that those from lumbar facet joints were located in laminae I-II, V-VIII and X [4].

REFERENCES

1. Baldissera, F., Hultborn, H. and Illert, M. 1981. pp. 509-595. *In*: Handbook of Physiology: A Critical, Comprehensive Presentation of Physiological Knowledge and Concepts. sec. 1. The Nervous System. vol. 2 (Brooks, V. B. ed.), American Physiological Society, Bethesda.
2. Brown, A.G. 1981. pp. 1–12. *In*: Organization in the Spinal Cord, Springer-Verlag.
3. Craig, A.D., Heppelmann, B. and Schaible, H.-G. 1988. *J. Comp. Neurol.* 276: 279–288.
4. Gillette, R.G., Kramis, R.C. and Roberts, W.J. 1993. *Neurosci. Lett.* 157: 67–71.
5. Mesulam, M.-M. 1978. *J. Histochem. Cytochem.* 26: 106–117.