The motor innervation of the soft palate*

An anatomical study in guinea pigs and monkeys

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Summary. In an effort to gain a more precise understanding of the motor innervation of the soft palate, a neuroanatomical tracer (horseradish peroxidase) was injected into the vela of nine guinea pigs and four monkeys. After 48 h the animals were sacrificed and frozen frontal sections were appropriately reacted with tetramethylbenzidine and counterstained with neutral red, and then evaluated by means of light microscopy. In all specimens retrogradely labeled neurons appeared in the brain stem. The distribution patterns of these labeled cells were to a large degree comparable in both the guinea pigs and the monkeys. The complex motor innervation of the soft palate was found to involve at least five different centers, with the strongest staining seen in the nucleus ambiguous and the motor nucleus of the trigeminal nerve. Additional cells of origin were discernible in the retrofacial nucleus. Facial neurons, however, were labeled only occasionally. Findings also showed that a previously undescribed component from the hypoglossal nerve appears to be essential for lateral soft palate movement in both animal models.

Key words: Soft palate - Motor innervation - Tracer technique - Brain-stem nuclei

Introduction

The velopharynx is equally important to phonation and swallowing. In these two processes, a finely differentiated muscular control of the soft palate is essential. This occurrence is clearly demonstrated in such pathological processes as cleft palate or paralysis of the soft palate. The musculature of the soft palate is composed of a mosaic of five different muscles: (1) the tensor veli palatini muscle; (2) the levator veli palatini muscle; (3) the palatopharyngeal muscle; (4) the palatoglossal muscle; (5) the acygos uvular muscle. Disagreement exists in the question of the motor innervation of these muscles, especially concerning observations based on the levator veli palatini muscle. An independent or co- innervation by the facial nerve has been suggested [8, 9], although the pathway involved has been somewhat controversial, i.e., via the greater superficial petrosal nerve [8], the posterior palatine nerve [8], or via an anastomosis between the facial nerve and the glossopharyngeal nerve [3].

While the description of the innervation of the soft palate has been based in particular on clinical observations, this innervation is easily demonstrated using modern neuroanatomical tracer technology. A tracer such as horseradish peroxidase (HRP) is injected into a muscle and is absorbed by the nerve endings. It is then transported by the axon in a retrograde direction to the motor parent cell, where it can be detected histochemically. The tracer is located inside those nerve cells which innervate the injected muscle (Fig. 1).

Materials and methods

In this study nine guinea pigs (weighing 380–450 g) and four monkeys (Callithrix jacchus, 350–450 g) were used. The guinea pigs were anesthetized with intraperitoneal ketamine (Ketavet) and dihydrothiazine (Rompun), while the monkeys were injected with pentobarbital (Nembutal) i.p. Injections of 10% HRP solution as 20–30 µl boluses were administered to the guinea pigs either in the general region of the soft palate (3 ani-
The monkeys were given bilateral injections of the tracer in the general region of the soft palate (30 µl, 10% HRP); in one case an injection of 10 µl (10% HRP) was placed paramedially.

After a survival of 1–2 days, the animals were anesthetized deeply and were then sacrificed with an intracardiac infusion of 1.5% glutaraldehyde and 1% paraformaldehyde. Frozen frontal sections (50 µm cuts) were treated with tetramethylbenzidine to demonstrate HRP [6] and were counterstained with neural red.

Results

In all cases retrogradely labeled neurons were present in the brain stem. The distribution patterns of these labeled cells were to a large degree identical in both the guinea pigs and monkeys. The marked cells appeared in different areas, with the number of cells present varying according to the location of the original injection in the palate. Both the medial and the paramedian palatal injections in the guinea pig showed a strong marking of cells in the nucleus ambiguus (Fig. 2A). The nucleus ambiguous is the motor nucleus of the glosopharyngeal nerve, the vagus...