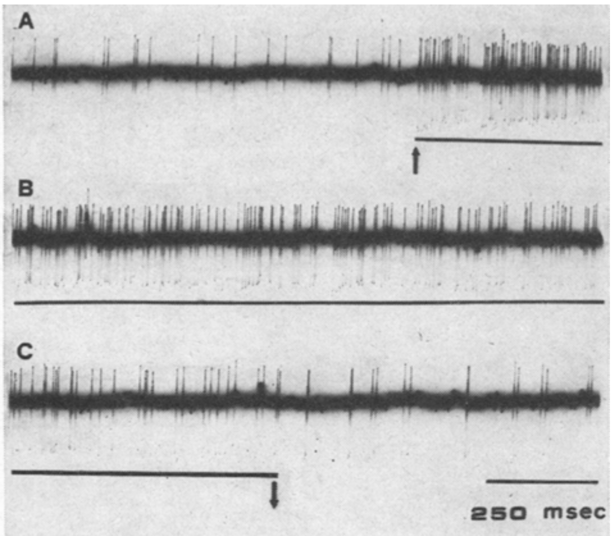
New Observations on the Representation of the Eye Muscle Proprioception Within the Descending Trigeminal Nucleus

Previous investigations carried out in our laboratories have shown that, in the lamb, pig and calf, the first order neurons of the eye muscle proprioception are contained in the semilunar ganglion[1-6], while the second order neurons are localized mainly in the oral pole of the ipsilateral descending trigeminal nucleus and at times in the main sensory nucleus of the 5th nerve[7,8].

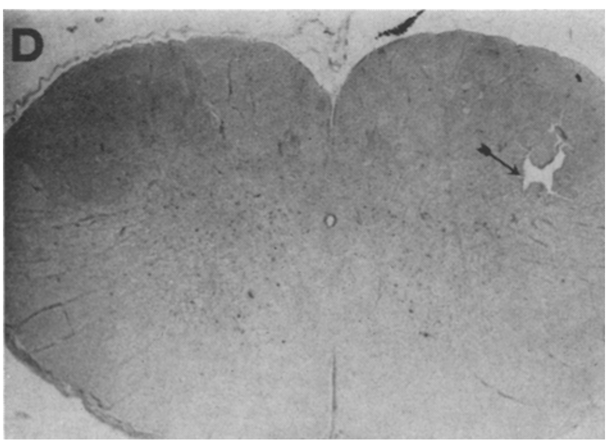
Typical responses to stretching individual extraocular muscles were recorded from the medial dorso-lateral portion of the semilunar ganglion and from the cranial part of the descending trigeminal nucleus; they were of the type induced by muscle spindle excitation. Single-shock electrical stimulation of the first order neurons in the semilunar ganglion elicited evoked potentials in the oral part of the descending trigeminal nucleus with a latency of 0.33–0.95 msec[7]. On the other hand, destruction of the semilunar ganglion cells involved in the eye muscle proprioception, induced degeneration of nervous fibers which could be followed along the ipsilateral trigeminal root, descending trigeminal tract till the oral pole of the descending trigeminal nucleus[8]. The cells of such a nucleus, which represent the second order neurons of the eye muscle proprioception, send their axons to the mesodiencephalic region through the ipsilateral medial lemniscus and the dorsal trigemino-thalamic tract; they end in the ventrobasal nuclei of the thalamus[9,10].

The present communication reports some new observations concerning the location of cells of the descending trigeminal nucleus involved in the eye muscle proprioception.

Lambs weighing 7–12 kg were anaesthetized with Nembutal (33 mg/kg) and tracheotomized. Then they were put in a stereotaxic apparatus and the 6 extraocular muscles of both sides were carefully isolated and protected with warm mineral oil. The 2 eye balls were removed according to the technique used in our previous investigations[1-10]. Subsequently a craniotomy was performed in order to expose the dorsal view of the cerebellum and the cranial portion of the cervical cord, which were protected with warm mineral oil. Responses to manual moderate stretch of single extrinsic eye muscles were sought in the descending trigeminal tract and nucleus by means of tungsten microelectrodes (tip diameter 4–5 μm, resistance 500 KΩ) introduced into the bulb and in the most rostral portion of the spinal cord by means of a microcontrol and connected through a conventional preamplifier with a beam of an oscilloscope; the other beam recorded the mechanogram of the stretch through a 4-stage amplifier. Figures A, B and C depict the response to a stretch of the ipsilateral lateral rectus muscle of a unit localized in the bulbar portion of the descending trigeminal nucleus approximately at the level of the hypoglossus nucleus. Similar responses were recorded in other 5 animals from the descending trigeminal nucleus and tract either at the level of the bulb or of the first cervical segment (Figure D). In fact all the sites of recording were marked by discrete electrolysis which permitted us to recognize the exact location of the tip of the recording microelectrode by means of histological control.



A) B) and C), lamb No. 229: 3 continuous records of unitary discharge (upper trace) taken from the bulbar portion of the descending trigeminal nucleus at the level of the hypoglossus nerve nucleus. A) after a short record of the resting discharge the arrow ↑ indicates the beginning of a moderate manual stretch (lower trace) of the ipsilateral lateral rectus muscle. B) represents the middle part of the stretch. The end of stretch is marked in C) by another arrow ↓.



D) Transverse section of the spinal cord of lamb No. 270 at the level of C1. The arrow indicates the electrolysis in the descending trigeminal nucleus at the border with the reticular formation. ×15.

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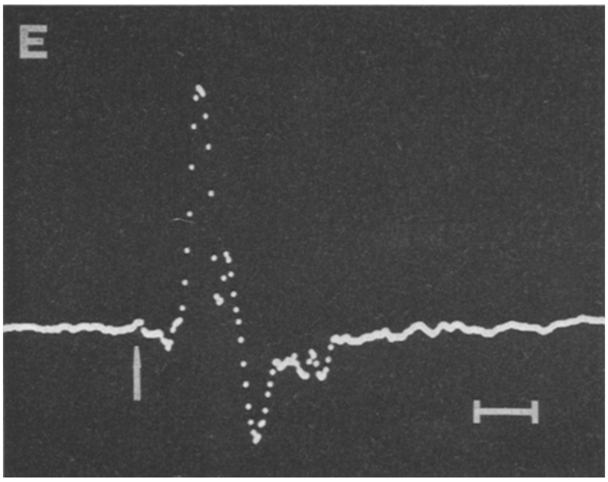
The bulbar and cervical sites influenced by stretch of extrinsic eye muscles could also be activated by single-shock electrical stimulation of the cells of the semilunar ganglion representing the first order neurons of the eye muscle proprioception with a latency of about 1.5 msec (Figure E).

In 2 lambs the experiment was carried out with the same procedure as that mentioned above, but under aseptical conditions. Only the left eye muscles were isolated and no tracheotomy was performed. After identification of a good response to stretch of single eye muscles within the bulbar portion of the descending trigeminal nucleus, a discrete electrolysis was made of the recorded site; then the cranial operation wounds and the 2 eyelids of the left side were sutured together and the animals were kept alive for 10 days. Subsequently the lambs were sacrificed in excellent general conditions under deep anaesthesia; the brain stem was perfused with saline solution and then with 10% formalin solution. The brain stem was removed and stained according to the Nauta-Gygax method for searching degeneration of nervous fibres. The histological examination showed degenerated nervous fibres along the remaining bulbar portion of the descending trigeminal nucleus down to the first cervical segment. The degeneration involved fibres of different diameter which were not collected in bundles but scattered within the nucleus.



E) The same animal as in D). Average of 64 potentials recorded from the descending trigeminal nucleus before the electrolysis, evoked by electrical stimulation (1/sec, 0.1 msec, 0.1 V) of the extraocular muscle representation in the ipsilateral semilunar ganglion. The arrow points to the stimulus artifact. Calibration time 2.5 msec.

In conclusion, the results of the present investigation show for the first time that cells responding to stretch of single extraocular muscles are present not only in the pontine oral pole of the descending trigeminal nucleus but also in its bulbar and cervical portions. Such cells could mediate both the excitatory and the inhibitory influences of the stretch of the eye muscles on the extensor muscles of the neck, as recently shown in the cat and in the lamb[11-14].

Summary. Units responding to stretch of single extraocular muscles were found in the bulbar and cervical portion of the descending trigeminal nucleus of the lamb. The electrolysis of these bulbar sites provoked degeneration of nervous fibres which could be followed till the first cervical segment of the spinal cord.

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Elevated Left Ventricular Stiffness by Noradrenaline in Myocardial Ischaemia

Despite their extensive cardiac effects, catecholamines apparently do not affect the resting ventricular distensibility[1]. At the same time there is a well-documented increase in the left ventricular wall stiffness during myocardial infarction and anginal attacks[2,3]. These phenomena are closely associated with or even precipitated by an enhanced release of the sympathetic transmitter in the cardiac tissue.

The question arises as to whether an indirect effect of the catecholamines plays a role in the development of the wall stiffness increase during myocardial ischaemia. The aim of the present study was to test the role of the combined effects of noradrenaline and tissue hypoxia in the genesis of the ventricular stiffening.

Methods. 24 experiments were carried out on open chest, pericardiectomized dogs (10–16 kg) of either sex, under chloralose anaesthesia. Pressures were measured by gauges Db 23, Statham, through rigid catheters introduced into the ascending aorta and left ventricular apex, respectively. The pressure curves were recorded simultaneously with cardiac output curves (thermodilution method) on an Elema Mingograph.

The diastolic pressure-volume curve of both the normal and infarcted ventricle is exponential at physiologic pressure[4,5]. Considering this fact, the stiffness of the left ventricle was characterized by the slope of the linear relationship between diastolic $\Delta P/\Delta V$ and $\bar{P}_D$ at various segments of the exponential P-V curves, where ΔP is the arithmetic difference between end-diastolic and end-systolic pressure, ΔV is the stroke volume, while $\bar{P}_D$ is the mean intraventricular diastolic pressure.

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