THE COURSE OF THE PROPRIOCEPTIVE AFFERENTS FROM EXTRINSIC EYE MUSCLES

Alper Atasever M.D., H. Hamdi Çelik M.D., Barbaros Durgun M.D., Engin Yılmaz M.D.,

Department of Anatomy, Hacettepe University, Faculty of Medicine, Hacettepe 06100, Ankara, TÜRKİYE

Turkish Neurosurgery 2: 183 - 186, 1992

SUMMARY:

There are varying opinions among authors regarding the peripheral course of the afferent fibres from the extraocular muscles. Previous studies have shown that some fibres arising from the oculomotor nerve enter the ophthalmic branch of the trigeminal nerve. However their function is not identified. In this study we examined the course of the axons arising from the medial rectus muscle for their relation with the trigeminal and superior cervical ganglia using horseradish peroxidase (HRP) as a retrograde tracer. Labelled axons were found as a localized bundle in the ophthalmic branch of the trigeminal nerve. Sections of the trigeminal ganglion demonstrated a great number of labelled cell bodies but there were few in the ipsilateral superior cervical ganglion. These findins suggest that fibres from the oculomotor nerve entering the ophthalmic branch of the trigeminal nerve are afferent in nature and terminate on the cells in the trigeminal ganglion.

KEY WORDS:

Oculomotor nerve, Trigeminal ganglion, Horseradish peroxidase.

INTRODUCTION

Afferens fibres from the extraocular muscles have been widely studied on various species in the past. Beside some works supporting the theory that afferent nerve fibres from the extraocular muscles are conveyed by their motor nerves (5, 13, 14), others conclude that these fibres pass to the branches of the trigeminal nerve before they reach the brainstem (4, 12). The latter opinion gained support by the demonstration of some surviving fibres in the oculomotor branches after intracranial oculomotor neurectomy (6), and degeneration of some fibres in the distal portion of the oculomotor nerve after ophthalmic neurectomy (2).

Previous studies have shown that some fibres arising from the oculomotor nerve enter the ophthalmic branch of the trigeminal nerve (11, 15). Although it is generally accepted that the anastomosis between these two nerves takes place within the cavernous sinus, the exact localisation of their route is unclear. A recent study on monkeys suggests that most of the afferents from the inferior oblique muscle travel within the oculomotor nerve, and the fibres from this nerve entering the ophthalmic division of the trigeminal nerve are sympathetic in nature, supporting the idea that afferent nerve fibres from the extraocular muscles are conveyed by their motor nerves (11).

In this study, the fate of fibres from oculomotor nerve entering the ophthalmic division of the trigeminal nerve were investigated considering their relation with the trigeminal and superior cervical ganglia.

MATERIAL AND METHODS

18 adult rats of either sex (body weight 220-260 g) were anesthetized with intraperito-

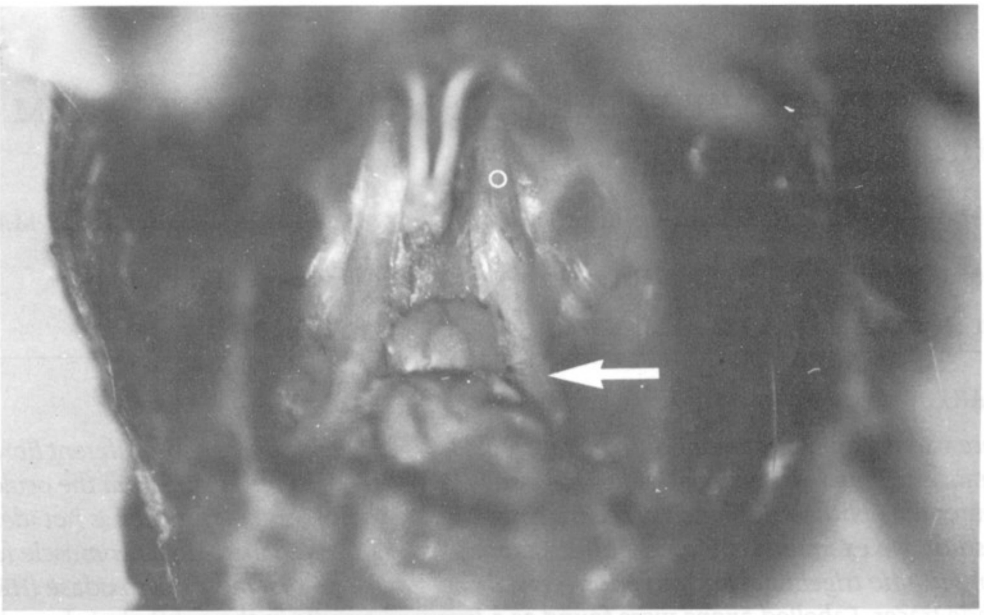

Figure 1 : Appearence of the skull base of the rat seen from above. Arrow shows trigeminal ganglion. (O: ophthalmic nerve).

neal injections of sodium pentobarbital (35 mg/kg). The right medial rectus muscle was exposed by retracting the eyelids, partially collapsing the eyeball, and making a conjunctival incision. 3-4 □l of 30% horseradish peroxidase (HRP Sigma type VI) was pressure injected into the muscle. After 24-36 hours survival time, the rast were perfused through the ascending aorta with 100 ml %0.9 saline, followed by %1.25 glutaraldehyde and %1 paraformaldehyde in 0.1 M phosphate buffer (pH 7.4) over 30 minutes and finaly 10% sucrose in 0.1 M phosphate buffer (pH 7.4) over 30 minutes. Following removal of the cranial bones, the brain was dissected exposing the base of the cranium. Under an operating microscope the ophthalmic branch of the trigeminal nerve and the trigeminal ganglion were identified (Fig. 1) and removed on the right side. Tissues were stored in the same sucrose-buffer solution at 4°C for 12 hours. Superior cervical ganglia from both sides were also removed and treated as described above. 40-60 □m thick frozen serial sections from the tissues were treated with tetramethyl benzidine for the demonstration of HRP (8). Sections were examined under a light microscope.

RESULTS

Coronal sections of the ophthalmic nerve demonstrated localized fibre bundles of labelled axons throughout its course (Fig. 2). Beside this, labeled cell bodies were found at intervals in the nerves. There were seldom more than 5 labelled cells in a single section through the distal portion of the nerve but the number of

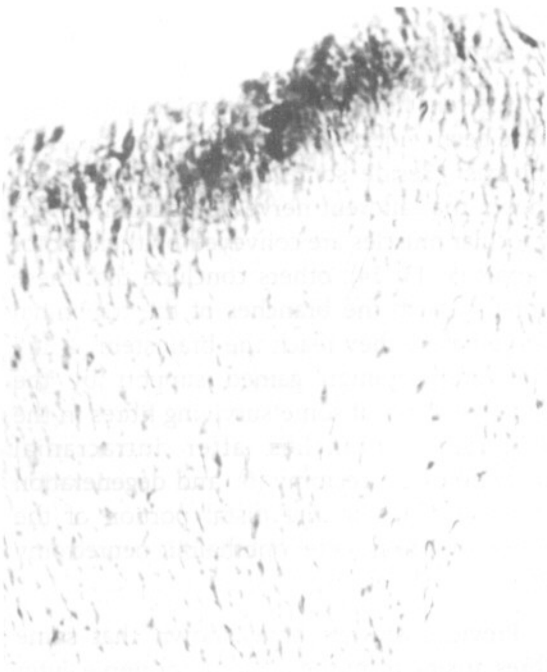

Figure 2 : Coronal section from the distal portion of the ophthalmic nerve. Labelled axons are seen as a localized bundle within the dorsal aspect of the nerve. 10x10.

labelled cell bodies apparently increased at the adjacent portion of the trigeminal ganglion (Fig. 3).

Figure 3 : Sagittal section of the ophthalmic nerve as it emerges from the trigeminal ganglion. Note the high number of labelled cell bodies within the nerve. 10x20

Sections of the trigeminal ganglion demonstrated HRP labelled perikaryons ranging between 28-51 in each section (Fig. 4).

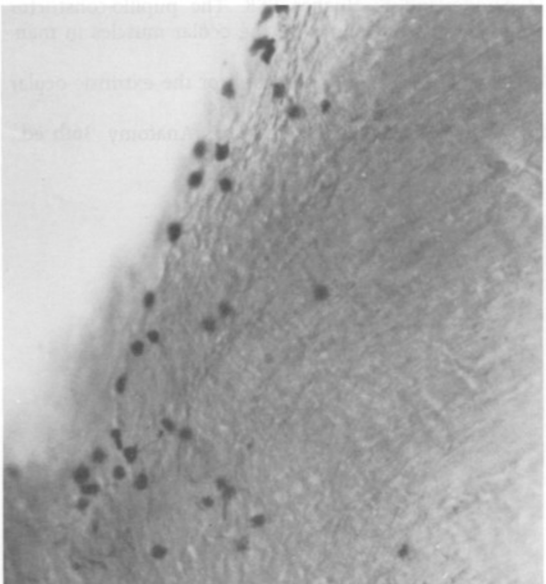

Figure 4 : Labelled cell bodies in the trigeminal ganglion. 10x20

Examination of the sections from the superior cervical ganglia revealed a few labelled cell bodies in the ipsilateral ganglion (Fig. 5) ranging between 3-9 in different experiments. These cells were located in the upper pole of the ganglion. Sections of the contralateral superior cervical ganglion demonstrated no labelled cell bodies in a few experiments when one or two were found.

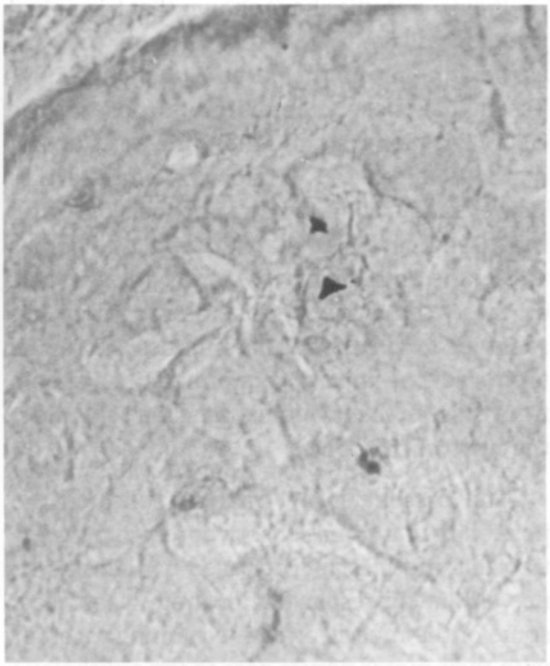

Figure 5 : Two labelled cell bodies located within the superior pole of the superior cervical ganglion. 10x40

DISCUSSION

Labelled axons in the ophthalmic branch of the trigeminal nerve clearly demonstrates that this nerve receives a number of fibres from oculomotor branches. This finding was observed in previous studies (4, 12). However claims of the authors about the nature of these fibres are controversial. Ruskell reported that these fibres are sympathetic in nature and serve no sensory function in the muscle (11). This opinion was challenged in another study (2).

Our observation concerning the few number of labeled cell bodies in the superior cervical ganglion suggests that there is a limited number of sympathetic axons reaching the extraocular muscles. Besides this, labeled cell bodies in the trigeminal ganglion put forth the idea that these fibres presumably serve a sensory function. If these fibres are regarded to be sensory, it is most likely that they convey proprioceptive impulses from extrinsic eye muscles. The sensory nature of these fibres is supported by the presence of sensory receptors in the extraocular muscles (7, 10). Moreover cell bodies of these afferents have been found in the mesencephalic nucleus of the trigeminal nerve (1).

Previous studies have shown that trigeminal ganglion cells may be displaced as far forward as the orbit within the nerve (3, 9). Ruskell proposed that these cells resemble those of the ciliary gnaglion cells and their processes do not reach as far as the extraocular muscles (11). However, our findings are inconsistent with those of Ruskell in that labelled cell bodies within the opthalmic nerve imply at least some of these cells give peripheral processes terminating in the extraocular muscles. Moreover their size and apperance are indistinguishable from those of the trigeminal ganglion cells under the light microscope.

The present study does not exclude the possibility that some sensory fibres from the extraocular muscles are conveyed by their motor nerves. But our results demonstrate that at least some of the muscle afferents running together with their motor nerves pass to the ophthalmic nerve to reach the trigeminal ganglion.

For Correspondence: Dr. Alper Atasever
Department of Anatomy,
Hacettepe University Faculty of Medicine
Hacettepe 06100, Ankara, Türkiye
Tel : (4) 310 71 69

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