Research Note

Superficial tectal neurons projecting to the dorsolateral pontine nucleus in the rabbit

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Summary. After WGA–HRP injections in the pontine grey involving the dorsolateral pontine nucleus, a great number of labeled cells were found in the superficial layers of the ipsilateral superior colliculus. The majority of these cells were located in the stratum griseum superficiale (SGS). Few labeled cells were found in the stratum opticum, and the stratum zonale (SZ) showed no labeled cells. Labeled cells in the SGS formed a rather homogeneous population as most of them had fusiform somata with an upper dendritic process which runs vertically to reach the SZ. These cells were mainly located in the middle third of the SGS, forming a sublamina in this layer. These results demonstrate the participation of the superficial tectal layers in the ipsilateral descending pathway of the superior colliculus, allowing visual information to reach precerebellar stations at the dorsolateral pontine nucleus.

Key words: Tectopontine projection – Superior colliculus – Dorsolateral pontine nucleus – Visuomotor pathways

Descending pathways of the superior colliculus (SC) mediate orienting and defensive responses to novel sensory stimuli. These pathways arise mainly from the deep tectal layers, but it is also known that superficial layers of the SC participate in the ipsilateral descending pathway through the tectoparabigeminal and tectopontine projections (Holcombe and Hall 1981a, b; see Huerta and Harting 1984 for a review).

The major target of the tectopontine projection (TP) is the dorsolateral pontine nucleus (DLPN) of the pontine grey, in all mammals studied (Martin 1969; Kawamura and Brodal 1973; Harting 1977; Burne et al. 1981; Holcombe and Hall 1981b; Holstege and Collewijn 1982). This nucleus sends information to the cerebellar vermis, and functional studies in the monkey have demonstrated its participation in the smooth pursuit eye movement system (Suzuki et al. 1990). Cells of origin of the TP have been located in both superficial and deep layers of the SC (Hashikawa and Kawamura 1977; Mower et al. 1979; Holcombe and Hall 1981b; Wells et al. 1989). The present paper shows for the first time the principal morphological features of the superficial tectal cells which give rise to the TP and it also shows that the majority of these cells form a sublamina in the stratum griseum superficiale (SGS) of the SC of the rabbit.

A total of fourteen adult albino rabbits were studied after one to two injections of WGA–HRP (0.03–0.1 μl injection of a 3% solution in distilled water) into the pontine nuclei or the pontine tegmentum. Animals underwent surgery under Ketamine (40 mg/kg) and Urethane 20% (0.75 g/kg) anesthesia. Each WGA–HRP injection was made stereotaxically with a 1 μl Hamilton syringe that was angled 48° in the sagittal plane towards the pons via the cerebellum. After survival times of 48 h, animals were deeply reanesthetized and transcardially perfused with a 0.9% warm saline followed by 1% paraformaldehyde with 3% glutaraldehyde in 0.1 M phosphate buffer. Transverse sections from the brainstem were cut in a cryostat and processed for TMB histochemistry (Gibson et al., 1984). Slices were then dried in air, alternate sections being stained with neutral red and coverslipped with DPX mountant.

In the four animals in which the dorsolateral pontine nucleus (DLPN) was filled (Fig. 1A, B), labeled cells were found in both superficial and deep layers of the ipsilateral superior colliculus. Animals with injections placed in pontine nuclei other than the DLPN (Fig. 1C) or in the pontine tegmentum (Fig. 1D), showed no labeled cells in the superficial layers of the SC.

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Fig. 1A–D. Diagram of transverse sections through the basilar pons from four different cases showing the locations of the injection sites (shaded areas). In case A, the WGA–HRP injection covers the rostral part of the dorsolateral pontine nucleus, while in case B the injection covers the caudal part of the same nucleus. In case C, the injection involves the rostral part of the paramedian and ventral pontine nuclei. In case D, the injection site is placed in the nucleus reticularis pontis oralis. brp, brachium pontis; cp, cerebral peduncle; nl, medial lemniscus; mlf, medial longitudinal fasciculus; nrtp, nucleus reticularis tegmenti pontis; pg, pontine grey. The scale bar is 1 mm

The majority of pontine projection cells in the superficial layers were housed in the SGS where they were located in the lower two thirds throughout its medio-lateral and rostro-caudal extents (Fig. 2). Specifically, the majority of the labeled cells were found in the middle third of the SGS and the density of labeled cells declines in the lower third of this layer. These cells had for the most part small fusiform or ovoid somata with a long upper dendritic trunk running vertically throughout the SGS and a short lower dendrite vertically oriented, resembling the narrow field vertical neurons described in Golgi studies in the upper SGS (Graham and Casagrande 1980) (Fig. 3A, B, C). Labeled cells located in the boundary between the SGS and stratum opticum had ovoid or triangular somata with one or two dendritic trunks oriented obliquely to the collicular surface (Fig. 2). The more medial and lateral regions of the SGS showed more variety of labeled cells, some of them being horizontal fusiform and multipolar neurons (Fig. 3D).

In contrast, retrograde labeling was never found in the stratum zonale and it was very sparcely distributed in the stratum opticum.

This work shows that in the superficial tectal layers of the rabbit, pontine projection cells constitute a significant population of vertically oriented neurons in the SGS. These neurons are distributed continuously in the horizontal plane but they mainly occupy the middle third of the layer in the dorso-ventral dimension. This type of distribution has been characteristically found in the SGS, where cells projecting to the dorsal lateral geniculate nucleus form an efferent sublamina in the dorsal half of this stratum while cells projecting to the pulvinar form a sublamina in the ventral half of the SGS (Huerta and Harting 1984). Thus cells projecting to the DLPN could constitute another efferent sublamina in the SGS which overlaps in part lateral geniculate and pulvinar projec-

Fig. 2. Dark-field photomicrograph that shows the distribution and morphology of cells of origin of tectopontine pathway in superficial tectal layers. The injection site covered the rostral third of the dorsolateral pontine nucleus (Fig. 1A). The arrows point to the soma and upper dendritic trunk of a labeled cell in the boundary between the stratum griseum superficiale and stratum opticum. SZ, stratum zonale; SGS, stratum griseum superficiale; SO, stratum opticum; SGI, stratum griseum intermediale. The scale bar is 200 μm