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The origin of cells of the cochlear ganglion in early human embryos

Małgorzata Bruska, Witold Woźniak

Department of Anatomy, University School of Medical Sciences, Poznań

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The study was conducted on 6 human embryos at stage 13. It was found that the facial-vestibulocochlear complex is closely related to the otic vesicle, and the particular components of that complex may be distinguished. They show different cellular arrangement and shape.
The neural crest cells migrating from the dorsal hindbrain are continuous with cells forming the cochlear ganglion. This gives evidence for neural crest contribution to the cochlear ganglion.

key words: human neuroembryology, cochlear ganglion, neural crest

INTRODUCTION

The origin of the sensory ganglia of cranial nerves is still controversial, particularly considering the cochlear ganglion which early in the development forms the common vestibulocochlear complex. Some ganglia are formed from the neural crest in the same way as the spinal ganglia, but others are derived partially or exclusively from the ectodermal placode.

The otic placode is the primordium of the membranous labyrinth of the inner ear, including the sensory receptors for hearing and balance, and of the vestibulocochlear ganglion.

Studies in amphibian and avian embryos showed that all neurons of the vestibular and cochlear ganglia originated from otic placode [6,13]. However, in mammals some neurons of the abovementioned ganglia may be derived from neural crest [4,7].

In our previous investigations [1,2] we described early topography and differentiation of the facial-vestibulocochlear complex in staged human embryos.

The aim of the present study is to trace the rhombencephalic neural crest and its relation to the developing cochlear ganglion. This gives evidence for the neural crest contribution to that ganglion.

MATERIAL AND METHODS

Study was based on the examination of 6 sectioned embryos in the collection of the Department of Anatomy in Poznań. Age of embryos was estimated according to developmental stages. All embryos were at stage 13 (32 postovulatory days). The planes of section and the staining methods varied. In three embryos graphic reconstructions were made.

The neural crest was traced from the rostral mesencephalic to the caudal hindbrain region. Also the position of the vestibulocochlear complex to the otic vesicle as well as the relationship of the vestibular and cochlear divisions of the complex were considered.

RESULTS

The otic vesicle at stage 13 is round, has a well-developed sheath, and is at the level of rhombomere 5. Its apex has an elongated shape forming the primordium of the endolymphatic duct (Fig. 1). It lies under the surface ectoderm with which it is in contact (Fig. 2). In its anterior side the otic vesicle is in close contact with the facial-vestibulocochlear complex in which particular ganglionic components may

Address for correspondence: Małgorzata Bruska, MD, PhD, Department of Anatomy, ul. Święcickiego 6, 60–781 Poznań, Poland, tel: +61 8699181 (ext: 564), fax: +61 8658985, e-mail:mbruska@usoms.poznan.pl

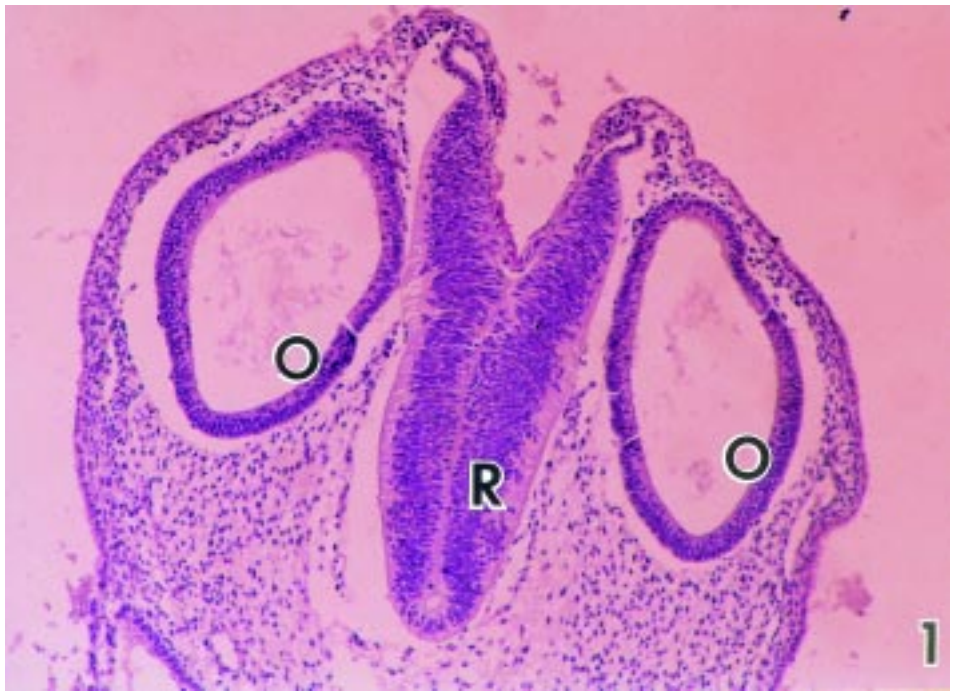

Figure 1. Transverse section through hindbrain in embryo at stage 13. H&E, x 100. O — otic vesicle, R — rhombencephalon.

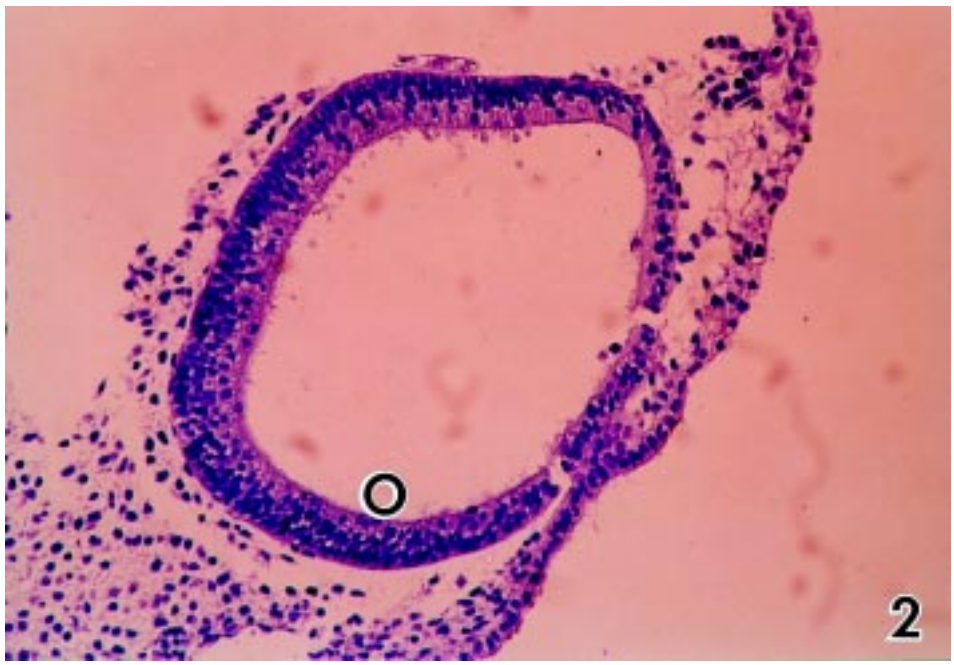

Figure 2. Otic vesicle in embryo at stage 13. H&E, x 200. O — otic vesicle.

be distinguished (Figs. 3, 4). The geniculate ganglion is positioned more rostrally and has an elongated shape. The cells of the ganglion are fusiform and are arranged along the longitudinal axis of the ganglion (Fig. 4). Cells forming the vestibular and cochlear ganglia are round or oval (Fig. 4). The vestibular component of the vestibulocochlear ganglion is more distinctive and its cells are darker and smaller (Fig. 4). No basement membrane is present between the otic vesicle and the vestibulocochlear ganglion, and cells are given off from the otic vesicle to the ganglion (Fig. 5). Neu-

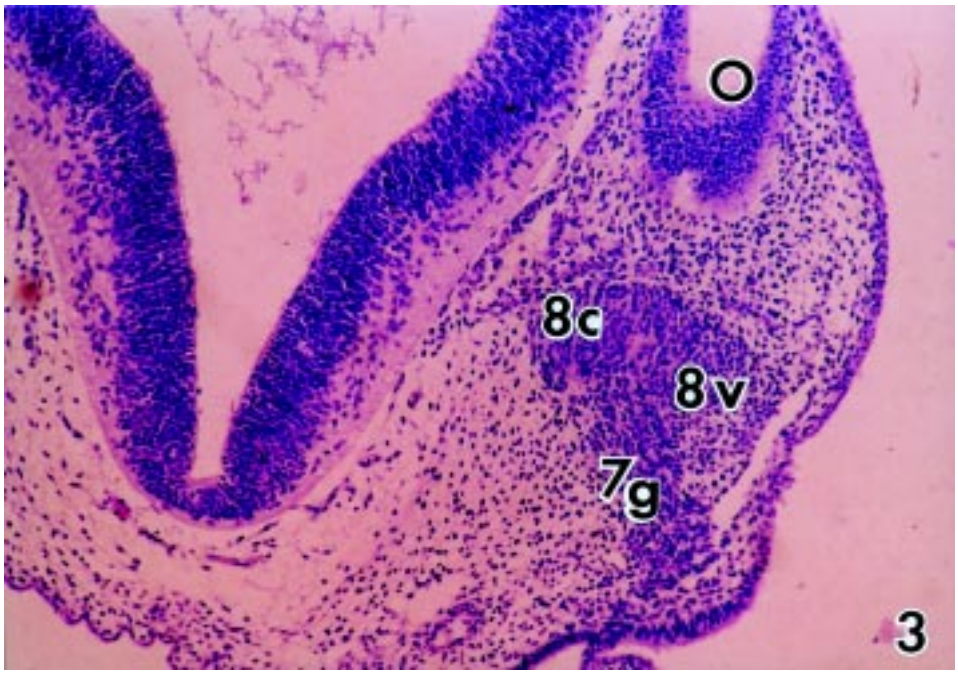

Figure 3. Transverse section through hindbrain in embryo at stage 13, showing facial-vestibulocochlear complex and otic vesicle. H&E, x 200. 7g — geniculate ganglion, 8c — cochlear ganglion, 8v — vestibular ganglion, O — otic vesicle.

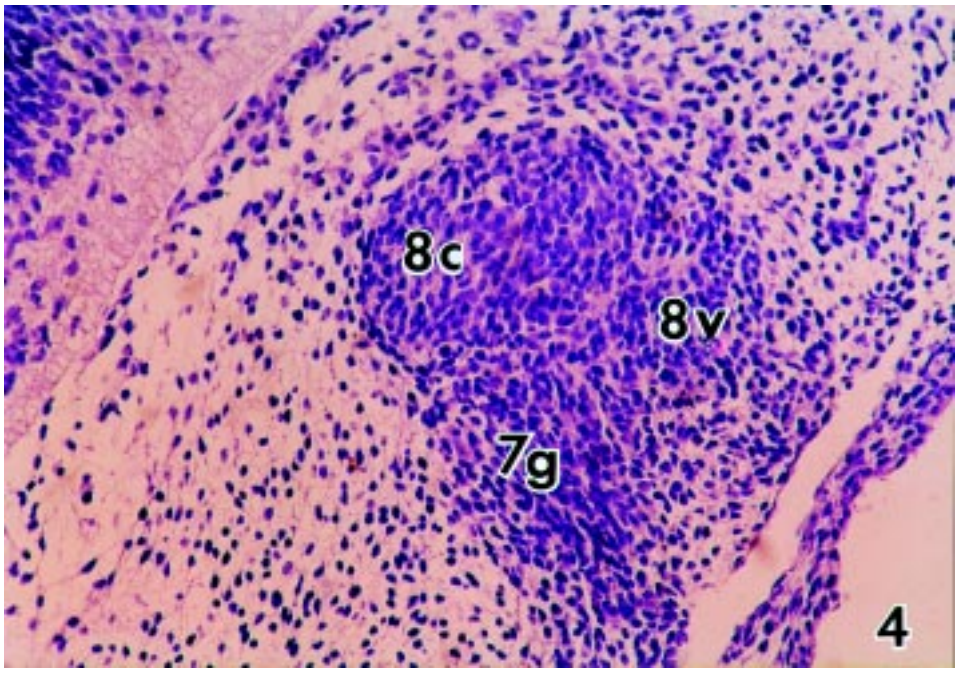

Figure 4. Facial vestibulocochlear complex and its components. H&E, x 400. 7g — geniculate ganglion, 8c — cochlear ganglion, 8v — vestibular ganglion.

ral crest cells migrate from the dorsal surface of the rhombencephalic neural tube and they are found between the tube and the ganglion (Figs. 6, 7). They form a continuous cellular strand with the cochlear division of the vestibulocochlear ganglion (Figs. 8, 9).

DISCUSSION

In embryos at stage 13 the particular components of the vestibulocochlear complex as well as vestibular nerve fibers can be distinguished [11].

The lack of basement membrane between the vestibulocochlear ganglion and the otic vesicle was

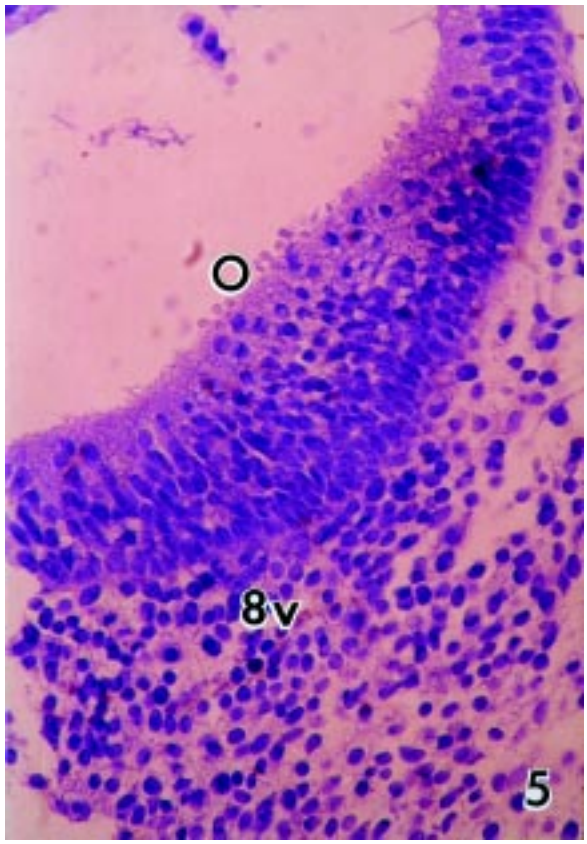

Figure 5. Migration of cells from otic vesicle to vestibulocochlear ganglion. H&E, x 400. O — otic vesicle, 8v — vestibular ganglion.

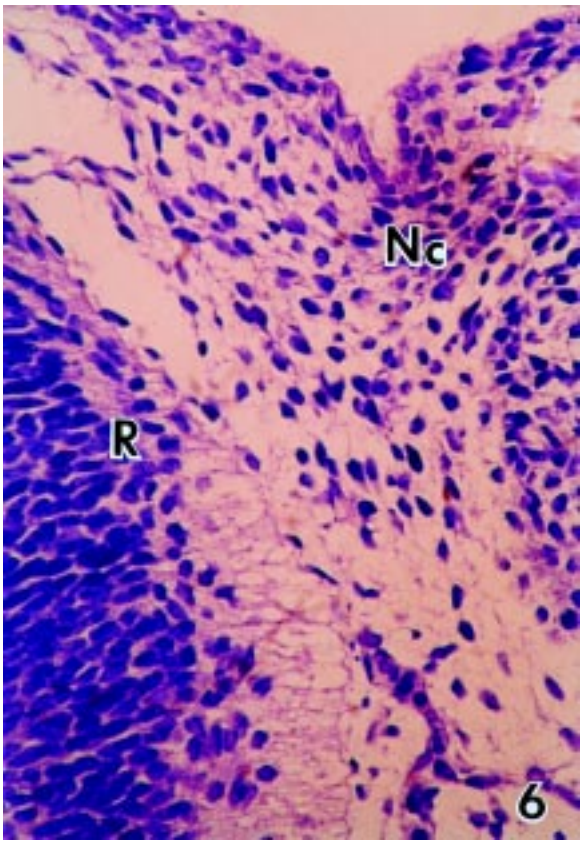

Figure 6. Rhombencephalic neural crest. H&E, x 400. Nc — neural crest, R — rhombencephalon.

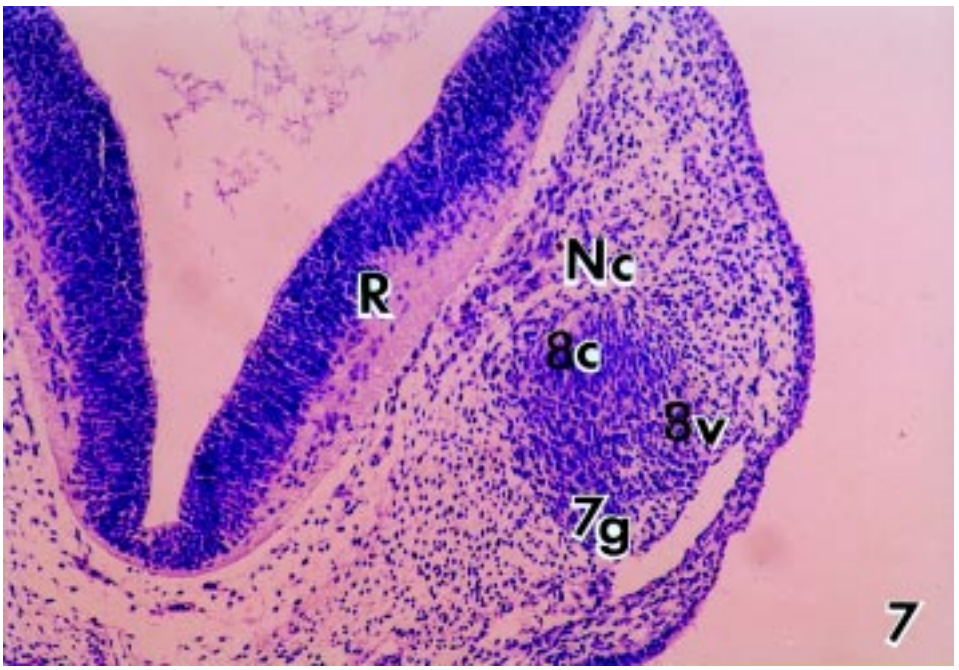

Figure 7. Rhombencephalon, neural crest and facial-vestibulocochlear complex. H&E, x 200. R — rhombencephalon, Nc — neural crest, 7g — geniculate ganglion, 8c — cochlear ganglion, 8v — vestibular ganglion.

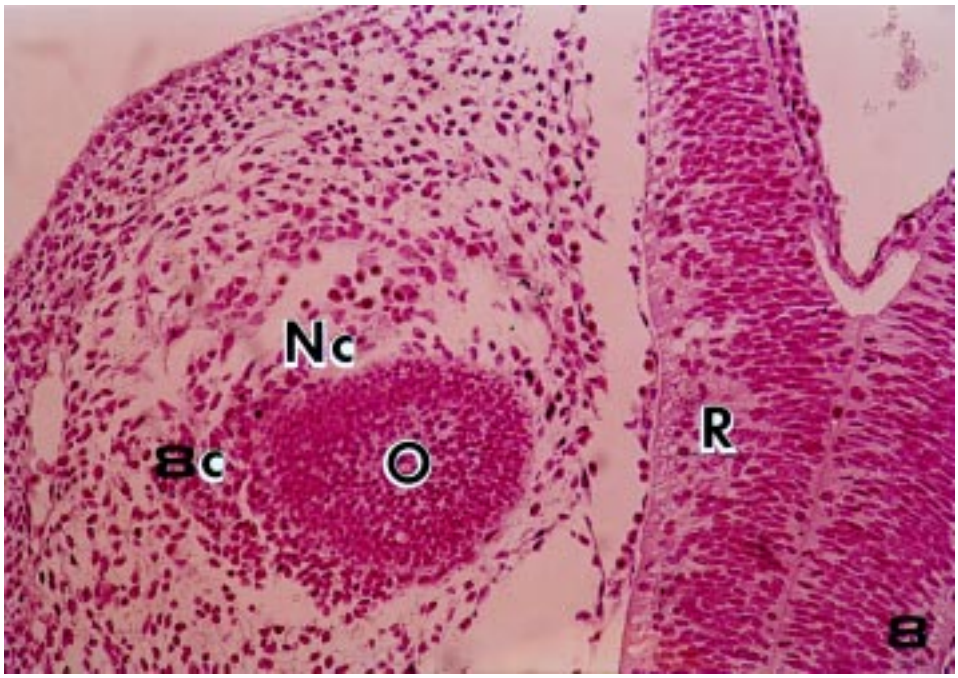

Figure 8. Contribution of neural crest cells to cochlear ganglion. H&E, x 400. R — rhombencephalon, Nc — neural crest, O — otic vesicle, 8c — cochlear ganglion.

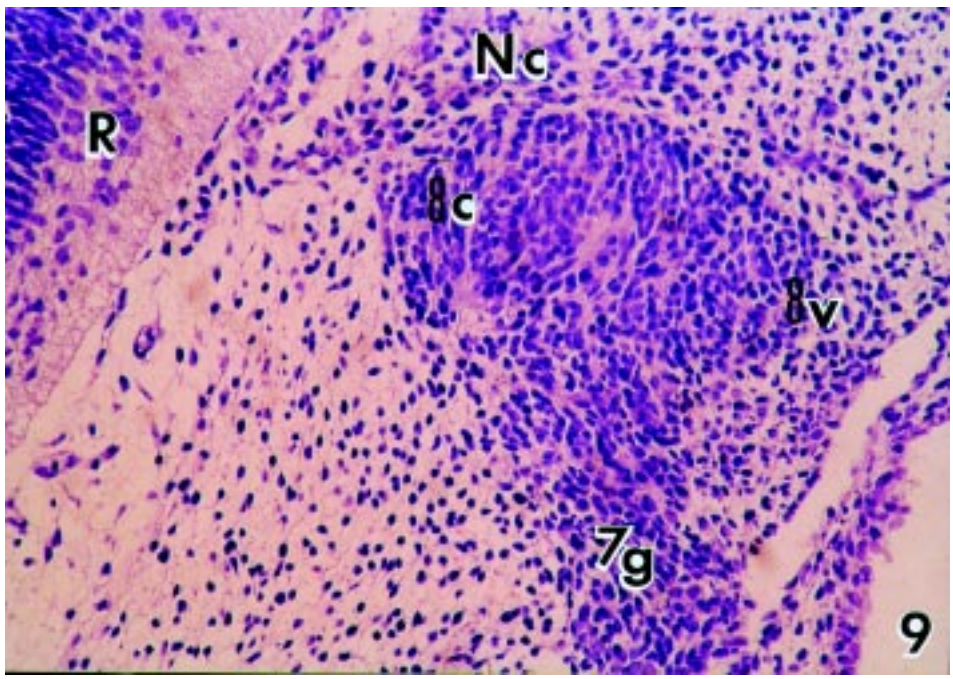

Figure 9. Neural crest cells are continuous with cochlear ganglion. H&E, x 400. R — rhombencephalon, Nc — neural crest, O — otic vesicle, 7g — geniculate ganglion, 8c — cochlear ganglion, 8v — vestibular ganglion.

also observed by Müller and O'Rahilly [10]. They mentioned that cells from the otic vesicle contribute mainly to the formation of the vestibular ganglion.

There is no agreement in the literature as to the neural crest contribution to vestibulocochlear ganglion [1,8,9]. Neural crest precursors are born in the ectodermal epithelium constituting the tip of the neural fold. During and after closure of the neural fold, neural crest cells emerge from the future roof plate region of the neural tube, undergoing epithelial-mesenchymal transformation [5]. The migration of the neural crest cells follows the segmental patterning of the hindbrain.

Results of the performed study give evidence that the human cochlear ganglion develops from the otic vesicle and neural crest.

It has to be stressed that the neural crest neurons during migration through mesenchyme may be mixed with placodal derived neurons and may change their phenotype showing the same histochemical reactions as placodal neurons [2,3].

Morphological data also suggest that placodes arise from a common anlage lying between the neural plate and epidermis, implying some similarities between placodal cells and the neural crest cells [2,3].

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