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Spiral prominence epithelium

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Abstract
Recent studies have shown neuroendocrine-type cells in human spiral prominence epithelium. A light microscopic and ultrastructural study was made on the guinea pig spiral prominence epithelium to try and identify neuroendocrine cells. The study showed that such cells were not present in the guinea pig spiral prominence epithelium. The spiral prominence epithelium was characterized by uniformity of cellular staining with Toluidine blue and the ultrastructural appearance. The morphology of the spiral prominence epithelium was similar to that previously described. The absence of neuroendocrine cells in spiral prominence epithelium in the guinea pig is discussed in relation to species differences.

Introduction

The spiral prominence runs throughout the length of the cochlear duct. The spiral prominence epithelium (SPE) is continuous with the external sulcus and stria vascularis epithelium; its function is unknown. Recent studies on human SPE have shown secretory granules within some of the epithelial cells, similar to those found in neuroendocrine cells (Arnold *et al.*, 1985). These cells were darkly stained with Toluidine blue in contrast to other SPE cells which stained lightly. Immunocytochemistry showed they had somatostatin-like reactivity (Arnold *et al.*, 1986). The possible function of these cells is as yet unknown.

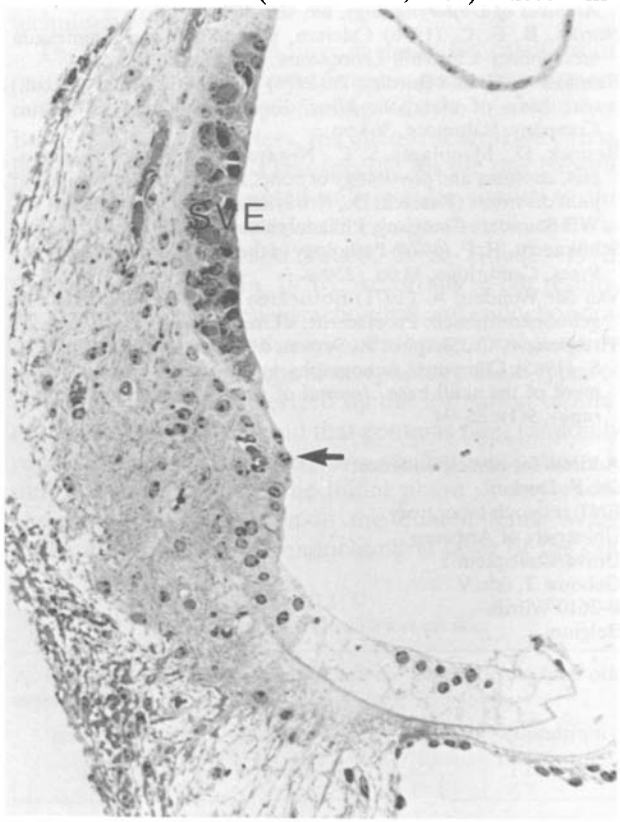


FIG. 1
Photomicrograph of the spiral ligament showing low cuboidal uniformly stained spiral prominence epithelium (➔) and the darkly stained stria vascularis epithelium (SVE). (2 μm, Toluidine blue, × 64)

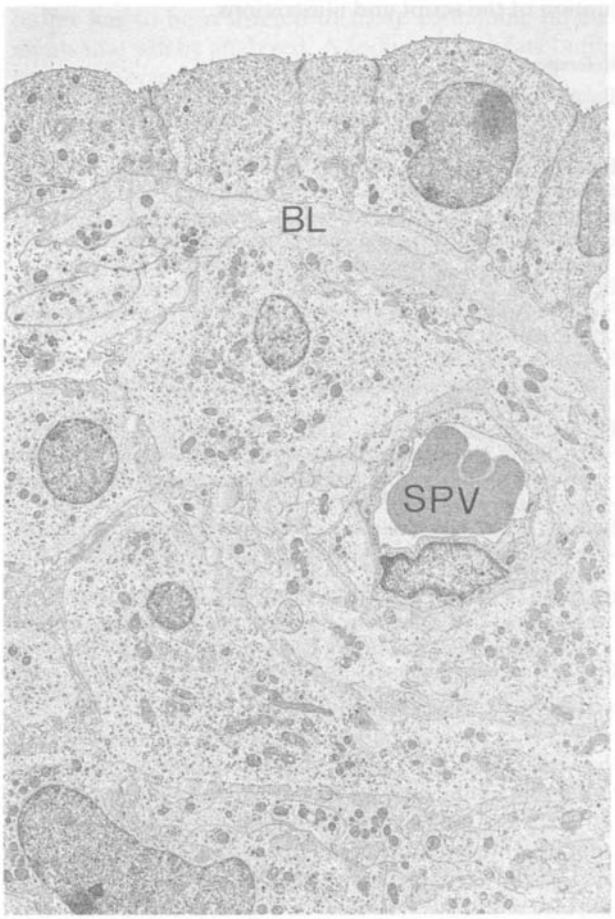


FIG. 2
TEM micrograph showing cuboidal SPE cells, the underlying basal lamina (BL) and their proximity to the spiral prominence vessel (SPV) and the surrounding spiral prominence fibroblasts. (× 2255)

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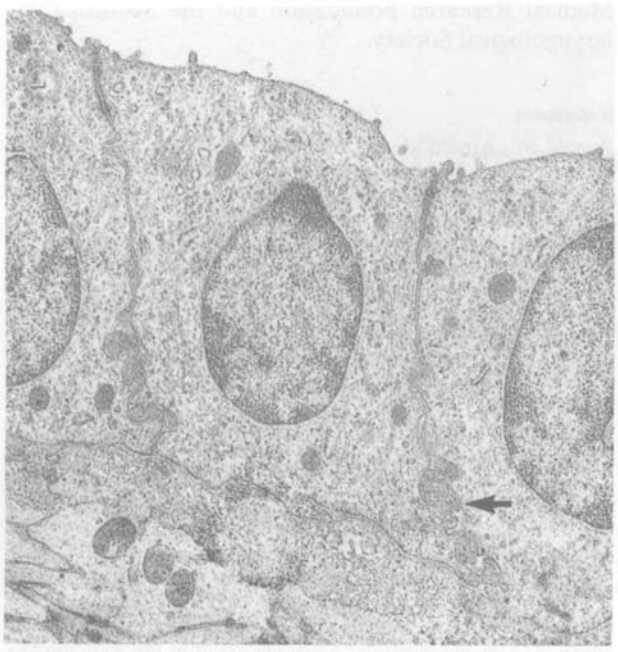


FIG. 3

TEM micrograph showing peripheral apical microvilli, tight junctions and basal lateral cell membrane unfoldings (➤) of the SPE cells. Scattered mitochondia and rough endoplasmic reticulum are seen along with a prominent golgi apparatus. (× 7354)

The aim of this study was to try and identify similar cell types in guinea pig SPE by light and electron microscopy in order to develop an animal model in which to investigate their function.

Materials and methods

Five adult male guinea pigs of the Dunken-Harley strain were used. All animals were free of ear infection and had a positive Preyer's reflex. The animals were decapitated after cervical dislocation, the bullae removed and the cochleae exposed within a few minutes of death. The apex and round window membrane were opened and the cochleae perfused with four per cent glutaraldehyde in 0.2 M cacodylate buffer, pH 7.2, equilibrated to room temperature and then immersed in fixative for 24 hours. The cochleae were micro-dissected under 0.2 M cacodylate buffer, the lateral wall of the basal turn (spiral ligament attached to otic capsule) was removed from one cochlea of each animal and from the other the spiral ligament was removed, without the otic capsule. All specimens were post-fixed in two per cent osmium tetroxide in 0.2 M cacodylate buffer.

The osmicated spiral ligament-otic capsule specimens were serially dehydrated in ethanol and critical point dried. The dried specimens were mounted and gold sputter coated. They were examined in a Jeol TSM 200 scanning electron microscope.

The osmicated spiral ligament specimens were serially dehydrated and blocked out in araldite. Semi-thin sections were cut and stained with one per cent toluidine blue. Thin sections were cut, stained with uranyl acetate and lead citrate and examined in the transmission electron microscope.

Results

Light microscopy

The basal turn spiral prominence and its covering epithelium in the guinea pig is shown (Fig. 1). The low cuboidal SPE cells had uniformly light staining with one per cent Toluidine blue and no darkly stained cells were identified.

Electron microscopy

TEM micrographs (Figs. 2 & 3) show cuboidal SPE cells and their associated, thick basal lamina. The SPE cells had large nuclei and within the cytoplasm scattered mitochondria, rough endoplasmic reticulum, Golgi apparatus and lysosomes. The cells were joined together towards their apices by tight junctions. The apical microvilli were distributed peripherally (Figs. 3 & 4). Toward the bases, SPE cells showed intercellular clefts and marked infolding of their cell membranes (Fig. 3).

Light microscopic and ultrastructural study showed uniformity of structure in the SPE cells. There was no evidence of SPE cells with secretory granules.

Discussion

The function of the spiral prominence and spiral prominence epithelium is unknown. Absorptive (Spoendlin, 1967; Hinojosa, 1972; Mees, 1981) and secretory (Borghesan, 1957; von Ilberg *et al.*, 1968; Nomura *et al.*, 1970; Mees, 1982a) functions have been variously attributed. Recent work on human material suggested that some of the spiral prominence epithelial cells had neuro-endocrine activity (Arnold *et al.*, 1985, 1986). In the present study, a search for neuroendocrine cells in the guinea pig spiral prominence epithelium was made. There was no morphological evidence for such cell types within the spiral prominence epithelium. The light microscopic and ultra-structural features of the spiral prominence epithelial cells was similar to those previously reported (Lawrence, 1956; von Ilberg *et al.*, 1968; Nomura *et al.*, 1970; Mees, 1982a,b).

Toluidine blue staining was uniform in the spiral

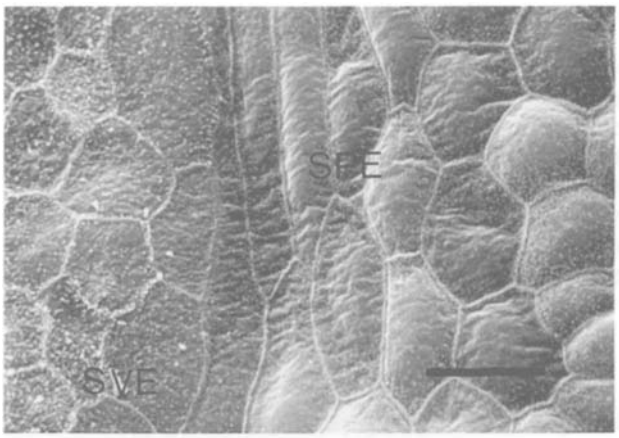


FIG. 4

TEM micrograph showing the surfaces of the stria vascularis (SVE) and spiral prominence (SPE) epithelium. At the SVE, SPE junction the SPE cells are elongated along the line of the spiral prominence for two to three cells width before becoming more regularly orthogonal in surface plan. Microvilli were most prominent around the cell surface margins. (Marker 10 μm, × 1500)

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prominence epithelium. Silver stains were not used, however, the cells reported by Arnold *et al.* (1986) which stained darkly with Toluidine blue and showed somatostatin-like immunoreactivity were negative when stained by the Grimelius method and the only light microscopy marker was differential staining with Toluidine blue. Fixation in the present study was with glutaraldehyde compared with the formaldehyde, mercuric-chloride, glacial acetic acid fixative used by Arnold *et al.* (1986). Degranulation of such cells in the SPE may have occurred; however, this is unlikely since excellent fixation was achieved and there was no ultra-structural evidence of degranulation within the SPE. The most likely reason for the absence of neuroendocrine-like cells in the guinea pig spiral prominence epithelium is one of species difference. These cells may be present but within a different anatomical location. Further study of the whole cochlea, using immunocytochemical methods with neuroendocrine cell markers is required to try and localize these cells. Likewise further study of other mammalian species is required. A suitable animal model should be sought to allow study of the function of these cells. Potentially they are of great importance because somatostatin may contribute to the control of calcium ion flux during hair cell stereocilia excitation—contraction coupling (Pickles, 1982). As described in man, the location of these spiral prominence neuroendocrine cells may permit them to function in an endocrine, exocrine and/or paracrine way thus facilitating a powerful regulatory mechanism within the cochlea (Guillemin and Gerich, 1976; Arnold *et al.*, 1986).

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