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Meningiomas with a Non-meningotheliomatous Component

A New Type of Tumour?

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Summary. Seven cases of meningiomas with "pseudopsammoma bodies" have previously been described in the literature. Two additional cases are presented. Electron microscopy of the cells surrounding the "pseudopsammoma bodies" reveals an ultrastructure different from that of the meningotheliomatous cells. It is concluded that meningotheliomatous meningiomas with "pseudopsammoma bodies" are mixed tumours, including a non-meningotheliomatous component, the origin and significance of which is uncertain.

Key words: Meningioma – "Pseudopsammoma bodies" – Ultrastructure – Intracytoplasmic lumina – Hyaline inclusions

Introduction

The meningioma is a tumour distinguished by a varied histological appearance, originating, however, from a single cell type (Humeau et al. 1979).

Psammoma bodies in varying numbers are a characteristic feature of the tumour. Hyaline inclusions, so-called "pseudopsammoma bodies" (Bérard et al. 1978; Kepes 1961), have been described in seven meningiomas of meningotheliomatous type. The "pseudopsammoma bodies" have been regarded as a secretory product of the meningothelial cells themselves (Bérard et al. 1978; Kepes 1961, 1975).

Two cases of meningotheliomatous meningioma with "pseudopsammoma bodies" are reported. We advance the view that these tumours are mixed tumours, and that the cells surrounding the "pseudopsammoma bodies" represent a non-meningotheliomatous component.

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Case Reports

Among 30 consecutive meningiomas studied ultrastructurally two tumours contained "pseudopsammoma bodies".

Case 1

A 70-year-old woman presented a 2-year history of dizziness and fainting fits. Arteritis temporalis was diagnosed and she was treated with steroids (SR: 123→67), without effect upon these symptoms. During the final hospitalization, a transitory right hemiparesis was found, followed by a left hemiparesis and a right facial paresis. The patient died of pneumonia, verified by autopsy. Furthermore, an encapsulated, greyish white tumour was found in the right cerebellopontine angle. The tumour measured 5.5 × 4 × 3.5 cm and was adherent to the dura. The cut surface was greyish white and lobulated. No other tumours were found.

Case 2

A 66-year-old woman had symptoms for about 6 years, consisting of total loss of vision of her left eye and, 4 years later, suddenly diminished vision of the right eye. Dizziness and headache were found during the same period. CT scanning showed a left suprasellar and parasellar tumor, about 4 cm in diameter. The tumour could not be totally removed. Postoperative CT scanning showed a small remnant of the parasellar tumour, together with a meningioma in the right middle fossa. No other tumours were found. Eight months after the operation, the patient was aphasic, and the vision was unchanged. There was a right hemiparesis and a moderate central facial paresis, together with a left oculomotorius paresis.

Methods

Tissue for light microscopy was fixed in 10% formaldehyde for 24 h, embedded in paraffin and cut in 4 µm sections. These were stained with hematoxylin-eosin (HE), van Gieson-Hansen, PAS stain reaction with and without prior application of diastase, Gordon-Sweet's reticulin stain, and alkaline congo-red for amyloid. Small pieces of tissue were fixed for electron microscopy in 2.5% glutaraldehyde, pH 7.3, then postfixed in 1% osmiumtetroxide and dehydrated, and embedded in Epon.

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Results

Light Microscopy

In both cases light microscopy showed characteristic meningotheliomatous meningiomas. The cells were polygonal or in places elongated, forming whorls and clusters with occasional psammoma bodies. Furthermore, homogenous, eosinophilic, rounded inclusions, 5–20 μm in diameter, were seen, both intracellularly and in small lumina, formed by several cells (Fig. 1). The inclusions were single or in groups (Fig. 2). In the van Gieson stain these inclusions were yellow to bright orange, they were strongly PAS-positive, and diastase-resistant. The inclusions did not contain reticulin or amyloid. They were isotropic in polarized light (Table 1).

Electron Microscopy

The tumours were composed of two cell types, the majority being typical meningioma cells with indented, cleft nuclei and ample cytoplasm. Numerous cytoplasmic interdigitations between the cells were seen, and desmosomes, a few gap junctions, and several hemi-desmosome-like specializations were observed (Fig. 3).

The cells surrounding the hyaline inclusions had relatively small, dense often indented nuclei. The cytoplasm was ample. The cells showed numerous desmosomes, but no hemi-desmosome-like structures or gap-junctions. The cytoplasm appeared more dense in the electron microscope than the cytoplasm of the meningotheliomatous cells, revealing an increased "intrinsic" osmiophilia. The cells had considerable amounts of cytoplasmic tonofilaments. In places basement membrane material was seen on the outside of the cell membrane (Figs. 5 and 6). No intercellular contacts with the surrounding meningioma cells were observed (Fig. 4).

The "pseudopsammoma bodies" consisted of lumina, formed both intracellularly and extracellularly among several cells (Figs. 4, 5, 7). The lumina were lined by the cellular membrane, the inner surface of which was covered by microvilli in varying numbers. The contents of the lumina were partly homogeneous and partly of homogeneous material, laminar structures, microvesicles, and spherical "dense bodies" (Fig. 7). The cells around the "pseudopsammoma bodies" and the meningotheliomatous cells were totally separated. No intermediary cells, showing a combination of the characteristics of the two cell types, were observed. These characteristics are summarized in Table 2.

Discussion

The hyaline inclusions described here are distinct from psammoma bodies, both by light microscopy (Table 1) and ultrastructurally. In the electron microscope the cells surrounding the "pseudopsammoma bodies" differ essentially from the meningotheliomatous cells (Table 2), showing features not previously described in meningotheliomatous cells.

Meningiomas have an extremely varied appearance in the light microscope. An ultrastructural study of 23 meningiomas (Humeau et al. 1979) makes an attempt to classify the meningiomas into seven groups, on the basis of light microscopy, and low power electron microscopy. On the basis of high power electron microscopy, however, the concept of one cell type as the origin of all meningiomas is confirmed. This work has not reported cells with features like those described by us in the cells surrounding the "pseudopsammoma bodies".

Intercellular contacts like desmosomes, gap junctions and tight junctions in meningiomas are described (Humeau et al. 1979). Another type of intercellular contact has been described recently: the hemidesmosome-like specialization (Copeland et al. 1978). This structure has been depicted by Peters et al. (1976) between the arachnoidal cells, with no comment, however, on its significance.

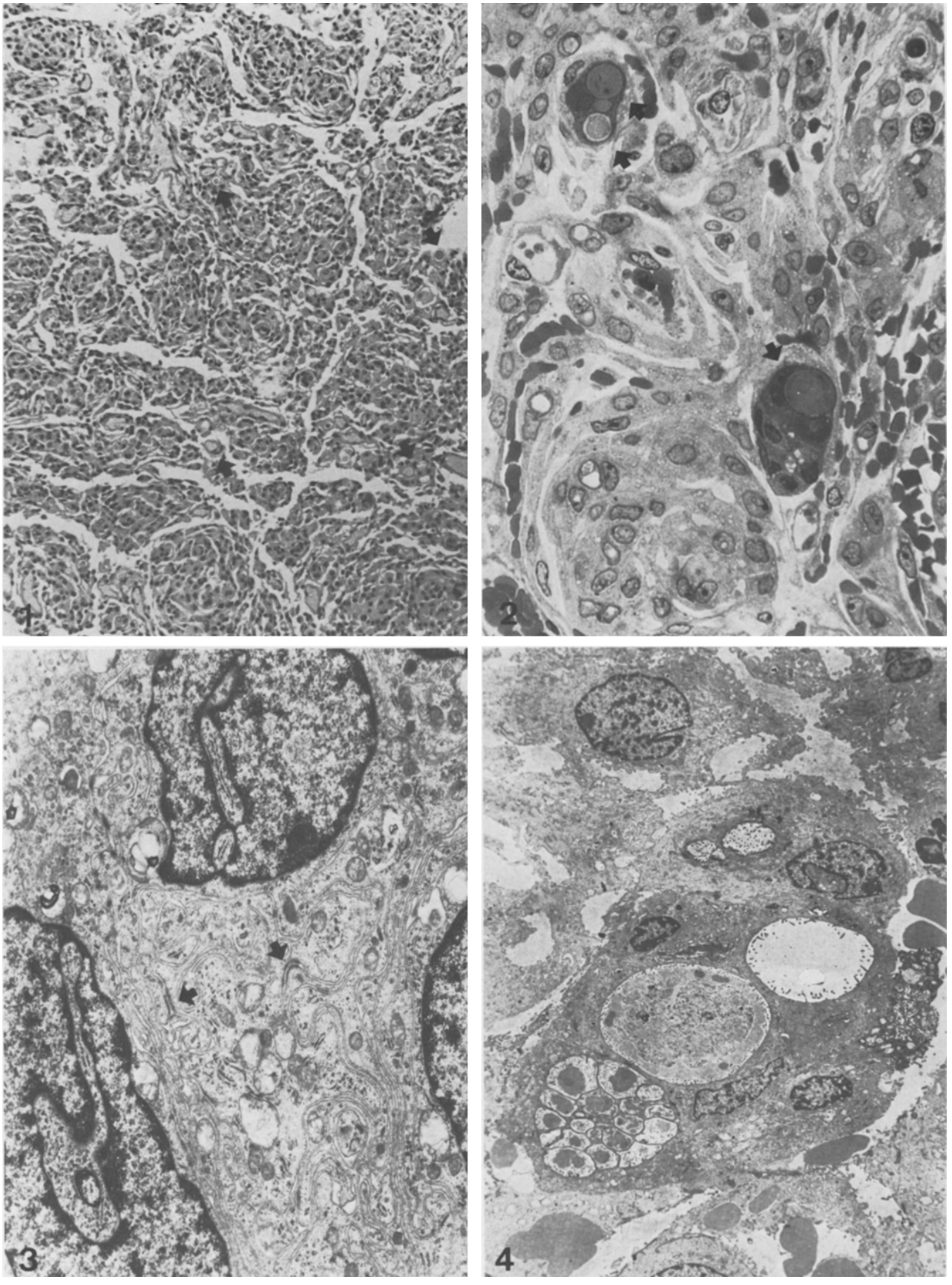
The examination of five human meningiomas of different histological types (four benign and one malignant, including a pulmonary metastasis from the latter) (Copeland et al. 1978), showed in all cases hemidesmosome-like structures between the tumour cells, as well as the other types of intercellular contacts. This work (Copeland et al. 1978) confirms the arachnoidal cell as the origin of the meningioma and establishes the

Fig. 1. Low power view of the tumour (case 1) showing the pattern of a meningotheliomatous meningioma. "Pseudopsammoma bodies" (*arrows*) are difficult to observe at this magnification. HE, ×103

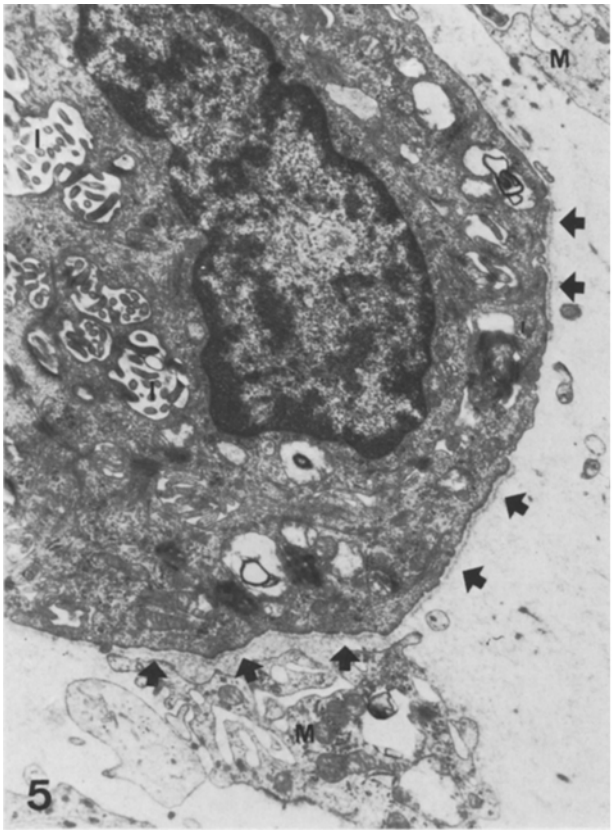
Fig. 2. Meningotheliomatous meningioma with "pseudopsammoma bodies" (*arrows*). Note the darker staining of the cytoplasm of the cells surrounding the "pseudopsammoma bodies". 1 μm epon section, toluidine, ×515

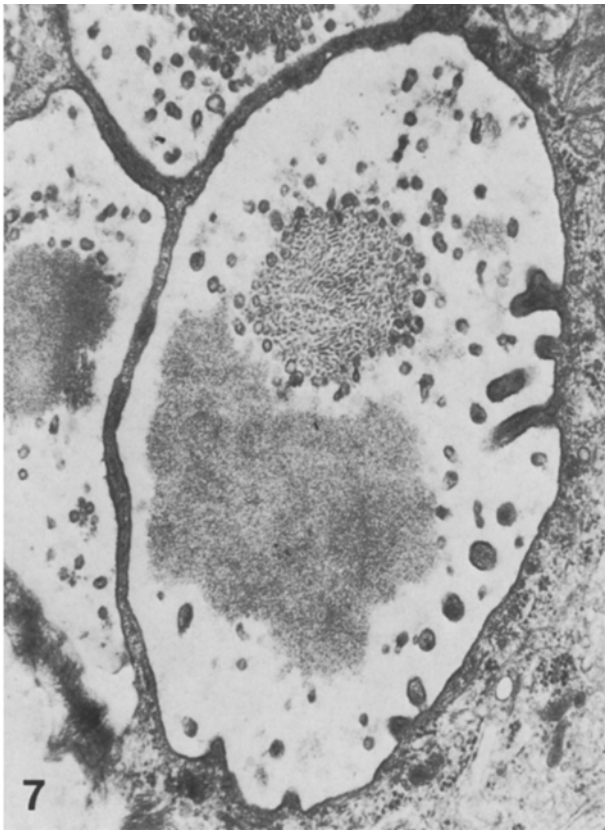
Fig. 3. Meningotheliomatous tumour cells. The cellular membranes show multiple interdigitations. Two hemidesmosome-like intercellular specializations are shown (*arrows*). No cytoplasmic tonofilaments are seen and basement membrane is not present. EM, ×11,330

Fig. 4. A group of cells forming "pseudopsammoma bodies". Even at this low power microvilli lining the inner surface of the intercellular and extracellular lumina are seen. EM, ×2,880



Figs. 1–4





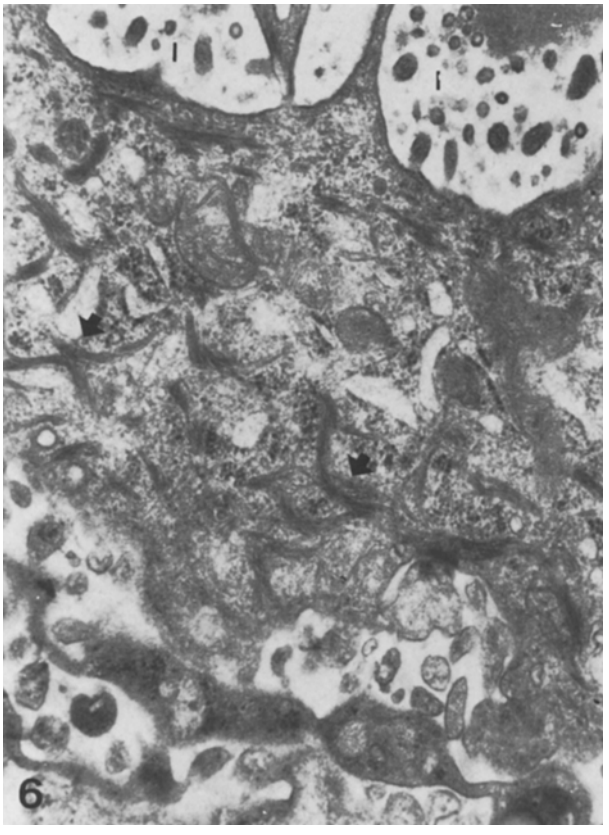


Fig. 5. Cell forming "pseudopsammoma bodies". Multiple intracellular lumina (*l*) with microvilli, and many desmosomes are seen. Basement membrane material is present (*arrows*). Note the increased "intrinsic" cytoplasmic osmiophilia as compared to the meningotheliomatous cells (*M*). EM, ×11,000

Fig. 6. High magnification of a cell forming "pseudopsammoma bodies". Cytoplasmic tonofilaments (*arrows*) and intracytoplasmic lumina (*l*). EM, ×28,000

Fig. 7. "Pseudopsammoma body". Granular material, laminar structures, microvesicles and "dense bodies". EM, ×27,700

Table 1. "Pseudopsammoma bodies" compared with psammoma bodies (light microscopy)

	Psammoma bodies	"Pseudopsammoma bodies"
Hematoxylin-eosin (HE)	Eosinophilic	Eosinophilic
van Gieson	Bright red	Yellow-bright orange
PAS reaction	Positive	Positive
PAS + diastase	Diastase-resistant	Diastase-resistant
Gordon-Sweet (reticulin)	Positive	Negative
Alkaline congo-red (amyloid)	Negative	Negative
Polarizing microscopy	Anisotropic	Isotropic

Table 2. Ultrastructural characteristics of the meningotheliomatous cells compared with the cells around the "pseudopsammoma bodies"

	Meningotheliomatous cells	Cells around "pseudopsammoma bodies"
Desmosomes	+	+
Gap junctions	+	−
Tight junctions	+	−
Hemidesmosome-like structures	+	−
Cytoplasmic tonofilaments	−	+
Microvilli	−	+
Basement membrane material	−	+/−
Increased cytoplasmic osmiophilia	−	+

hemidesmosome-like structure as an unequivocal indicator of the meningioma. On this basis, the cells surrounding the "pseudopsammoma bodies" can hardly be acknowledged as derived from arachnoidal cells. Several authors (Battifora 1975; Harris et al. 1978; Kondo et al. 1970; Murad and Scarpelli 1967; Nevalainen and Järvi 1976) have described the formation of intracellular "neolumina" in malignant tumours, such as mammary, gastric and hepatic cancer, and mesothelioma. These lumina were lined by microvilli, and bundles of microfilaments occurred in the surrounding cytoplasm. In benign tissue, intracytoplasmic, hyaline corpuscles or inclusions have been demonstrated, e.g. alcoholic hyaline in the liver (Rumpelt 1977) and hyaline globules in the adrenal medulla (Dekker and Oehrle 1971). A single case with hyaline globules in a chromophobe adenoma of the pituitary gland has been described (Dekker and Oehrle 1971). These changes are well elucidated by electron microscopy and do not correspond to the cells with hyaline inclusions described in the present report.

Seven meningotheliomatous meningiomas with hyaline inclusions, identical to the "pseudopsammoma bodies" described here, have been published (Bérard et al. 1978; Kepes 1961, 1975). In a series of 430 meningiomas Kepes found five cases (Kepes 1961) and later described another case (Kepes 1975). Bérard et al. (1978) reported one case with "pseudopsammoma bodies".

These authors assume that the "pseudopsammoma bodies" develop by metaplasia of the meningotheliomatous cells, which themselves produce the homogeneous, proteinous material. According to these authors, the "pseudopsammoma bodies" are the result of an overproduction of this material, in the process of creating true psammoma bodies, in which the underlying fibrillary structure is lacking.

In our opinion, this theory of metaplasia of the meningotheliomatous cells is not very likely. Firstly, transitional cell forms between the meningotheliomatous cells and the cells surrounding the "pseudopsammoma bodies" have not been demonstrated. Secondly, the organelles of the two cell types differ essentially from each other. On this basis we consider meningiomas with hyaline inclusions to be mixed tumours, composed of two different cell types, and thus different from the meningiomas usually described (Humeau et al. 1979). Ultrastructurally, the cells around the "pseudopsammoma bodies" have epithelial features but their origin is quite uncertain. Cells of this type have not been described in the normal leptomeninges (Peters et al. 1976).

Considering the increasing use of electron microscopy as a routine procedure in the classification of tumours, it is of importance to identify these cells to avoid errors in diagnosis as, for instance, confusion with metastatic adenocarcinoma.

Whether these mixed tumours are biologically different from the "usual" meningiomas cannot be concluded on the basis of the few cases published.

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