On the origin and nature of the pituitary gland capsule

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Observations under the operating microscope confirming the presence of a pituitary capsule are reported. This capsule envelops the anterior lobe of the pituitary, the neurohypophysis, and the pituitary stalk. It merges along the stalk with the intracranial pia mater. The origin and nature of this capsule are discussed in light of the known facts of development of the pituitary gland and surrounding structures. It is concluded that the pituitary gland capsule is a derivative of the primitive pia mater.

KEY WORDS □pituitary capsule □pia mater

Embryological studies show that the pituitary gland is surrounded during its development by a mesodermal layer.\(^1\) Anatomists and radiologists have since shown that the arachnoid membrane can be found below the diaphragma sellae, its recesses enveloping in some cases the entire pituitary gland.\(^5,6,8\) While most neurological surgeons have confirmed the presence of arachnoid recesses below the diaphragma sellae, some have also recognized and described a separate pituitary capsule.\(^5,6,7,9-11,14\) Only a few neurological surgeons experienced in pituitary surgery have denied the existence of such a capsule,\(^4\) or have simply made no reference to it.\(^13\)

Observations under the operating microscope in a series of 150 patients undergoing transsphenoidal pituitary surgery have clearly shown that the anterior lobe of the hypophysis, the neurohypophysis, and the pituitary stalk are indeed invested by a single, common membranous layer (Fig. 1). The presence of this capsule, which is unrelated to and distinct from the arachnoid membrane, has necessitated a deliberate and sharp stalk section early in the process of hypophysectomy in order to prevent the postoperative occurrence of diabetes insipidus.\(^9\) The nature of this pituitary capsule, however, is still uncertain. A hypothesis that could explain both the origin and nature of the pituitary capsule is suggested. This hypothesis is based on the known facts of development of the pituitary gland and surrounding structures.

Hypothesis

By the fourth week of gestation, the primitive cerebral vesicle is separated from the stomodeum by a layer of mesoderm (Fig. 2 A). From the distal end of the stomodeal ectoderm Rathke's pouch forms through an evagination of the stomodeal epithelium into the overlying mesoderm and cerebral vesicle (Fig. 2 B and C). Subsequent separation of this pouch from the stomodeal epithelial lining leads to the formation of the Rathke's sac
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(Fig. 2 D). While the proximal part of the Rathke's sac proliferates rapidly to form the pars distalis of the anterior hypophysis, its distal segment fails to enlarge and persists as the pars intermedia and tuberalis, respectively (Fig. 2 E). Posterior to the Rathke's pouch, the cerebral vesicle begins to invaginate into the surrounding mesoderm (Fig. 2 B). The two leaves of this neuroectodermal recess later adhere together to form the stalk and the posterior or neurohypophysis (Fig. 2 C).

From the mesoderm immediately adjacent to the surrounding cerebral vesicle the pia mater will form (Fig. 2 C). Thus, even though the anterior hypophysis in its early developmental stages appears closely surrounded along its anterior and superior borders by the cerebral vesicle and along its posterior aspect by the neurohypophysis, in fact it continues to be separated from these structures by an uninterrupted layer of a primitive pia mater (Fig. 2 D). As the facial skeleton develops from the mesoderm which separates the stomodeum from the rostral part of the cerebral vesicle (Fig. 2 D), the latter is gradually elevated until it comes to rest on the high plateau of the anterior cranial fossa floor (Fig. 2 E). This upward migration of the rostral part of the cerebral vesicle results in a folding of the primitive pia mater along the anterior aspect of the pituitary gland and stalk (Fig. 2 E). The two layers of this duplicature later fuse to form the relatively strong anterior wall of the pituitary gland capsule (Fig. 2 F). The section of primitive pia mater between the pars intermedia of the anterior hypophysis and the neurohypophysis on the other hand, fails to develop further although it may persist as a rudimentary mesodermal layer (Fig. 2 F). This explains the cleavage plane sometimes found surgically between the anterior and posterior
Fig. 2. Diagrams showing possible evolution of the pituitary capsule. A: Cerebral vesicle (a), stomodeum (b), and mesoderm (c). (Modified after Netter.) B: Early stage of formation of Rathke's pouch and posterior pituitary. (Modified after Netter.) C: Formation of the primitive pia mater (arrow). D: Early stage of formation of the pituitary capsule from primitive pia mater (arrow) and early development of facial skeleton (arrowhead). E: Folding of the primitive pia mater (arrow) due to development of the facial skeleton (arrowhead). F: Completed formation of pituitary capsule from primitive pia mater. Arrow indicates anterior wall of pituitary capsule. Single arrowhead indicates the rudimentary mesodermal layer and double arrowheads, the posterior wall of the pituitary gland capsule.
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Fig. 3. Diagram shows the pituitary capsule merging imperceptibly with intracranial pia mater (arrow). Arrowhead indicates arachnoid membrane and double arrowhead indicates dura mater.

lobes of the hypophysis. The posterior wall of the pituitary capsule also develops from the primitive pia mater (Fig. 2 F).

With these embryological considerations in mind one can conclude that the pituitary capsule is in effect a derivative of the primitive pia mater. It is for this reason also that the pituitary capsule envelops not only the two lobes of the hypophysis but the pituitary stalk as well, along which it merges imperceptibly with the intracranial pia mater (Fig. 3). The arachnoid membrane, the dura mater, the sphenoid bone, and sinus also develop from the surrounding mesoderm (Fig. 3 and cover).

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References


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