The Circular Sinus: An Anatomic Study with Neurosurgical and Neurointerventional Applications

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Key words
- Anatomy
- Cavernous sinus
- Neurosurgical procedures

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BACKGROUND: **Skull base surgery requires knowledge of the intracranial venous sinuses, which overall have been well studied. However, the intercavernous sinuses and their contribution to the so-called circular sinus have received scant attention.**

METHODS: **Dissection was performed on 35 latex-injected cadaveric heads with attention to the morphology of the anterior and posterior intercavernous sinuses. A scale was created to describe the presence and morphology of the intercavernous sinuses, and morphometrics were performed.**

RESULTS: **Both anterior and posterior intercavernous sinuses were identified in 28 specimens (80%; type I). Of the 80% with both sinuses, a circular connection between these was found in 25% (type II). Only the anterior intercavernous sinus was observed in six specimens (17%; type III), and only the posterior sinus was seen in one specimen (2.9%; type IV). No specimen lacked both the anterior and the posterior intercavernous sinuses. The anterior intercavernous sinus was larger than the posterior intercavernous sinus in most specimens (n = 28). The anterior intercavernous sinus occupied the entire anterior wall of the sella turcica in five specimens. An inferior intercavernous sinus was present in only six specimens (17%) and was usually smaller than the anterior or posterior intercavernous sinuses.**

CONCLUSIONS: **A true "circular sinus" (type II) is present in only a few cases; both intercavernous sinuses disconnected are found in most specimens. No intercavernous sinus was found within the free edge of the diaphragma sella, which is typically depicted. These data are useful for invasive and minimally invasive procedures of the parasellar region.**

INTRODUCTION

The cavernous sinus is located at the center of the skull base on either side of the sella turcica. It has a close spatial relationship to the internal carotid artery and several cranial nerves at the medial aspect of the middle cranial fossa (2, 11). The cavernous sinus was first described in 1645, and at that time venous communications between the left and right sides of the cavernous sinus, referred to as the "circular" sinuses of Ridley, were noted (**Figure 1**) (11). The intercavernous sinuses extend across the midline and occupy a space between the meningeal dural layer covering the pituitary gland and the endosteal layer covering the osseous sellar floor (1, 4, 6). The anterior intercavernous sinus is said to be present in most cases and may cover the entire anterior wall of the sella turcica (1, 3, 18). Some authors have described it as larger in size (4, 7) and longer (12) than the posterior intercavernous sinus, which is located at the superior border of the dorsum sellae. One study found this structure in sagittal sections of all studied anatomic specimens (1). Others have suggested that the posterior intercavernous sinus is more variable and less frequently present and, under nonpathologic conditions, difficult to distinguish from the basilar venous plexus (18, 19, 21). An inferior intercavernous sinus may be present (7, 20); however, one venographic study did not identify this structure (22).

The intercavernous sinuses are important clinically and surgically. Kaplan et al. (7) emphasized the possible complications of encountering a sizable intercavernous sinus with a transsellar approach to the pituitary gland. Additionally, these interconnecting sinuses may be involved with carotid cavernous fistulas (14), may convey sepsis to the contralateral intracranial venous system (8), and can be sampled for diagnosis of pituitary adenomas (20, 21). With scant and conflicting reports regarding their anatomy, the present morphologic study sought to elucidate these structures better.

METHODS

For this study, we dissected 35 latex-injected cadaveric heads. There were 20 male specimens and 15 female specimens with an age range at death of 40–101 years (mean, 70 years). With the cadavers in the prone position, the scalps were removed, and a bone saw was used to remove the underlying calvaria. The dura mater was opened and the brain was removed in each specimen. Special attention was given to the morphology of the anterior and posterior intercavernous sinuses, and a scale was designed to describe their

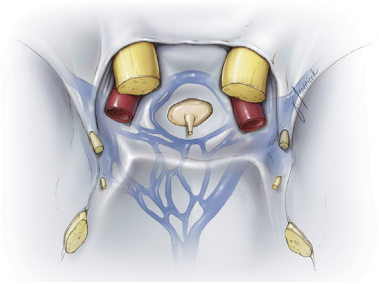

Figure 1. Schematic drawing of the venous sinuses of the central skull base and their relationships to surrounding neurovascular structures. Note the circular sinus around the periphery of the pituitary gland and the vertically oriented and more posteriorly positioned basilar plexus traveling over the dorsum sella to the dorsal surface of the clivus. In sequential order, the optic, oculomotor, trochlear, and trigeminal nerves are seen. (From The Neurosurgical Atlas, copyright Aaron A. Cohen-Gadol, M.D., M.Sc. Reprinted with permission from Aaron A. Cohen-Gadol.)

presence and structure. All measurements were made with calipers (Mitutoyo, Kanagawa, Japan) and under a surgical microscope (Carl Zeiss, Oberkochen, Germany). Statistical analysis was performed using Statistica for Windows (StatSoft, Tulsa, Oklahoma, USA). Statistical significance was set at $P < .05$.

RESULTS

A coexistent anterior and posterior intercavernous sinus was identified in 28 specimens (80%; type I). Of the 80% of specimens with both sinuses, a circular connection between these was found in 25% (type II) (Figure 2). Only the anterior intercavernous sinus was observed in six specimens (17%; type III), and only the posterior intercavernous sinus was seen in one specimen (2.9%; type IV) (Figure 3). No specimen demonstrated an absence of both the anterior and the posterior intercavernous sinuses. The anterior intercavernous sinus was larger than the posterior intercavernous sinus in most specimens (n = 28). The anterior intercavernous sinus occupied the entire anterior wall of the sella turcica in five specimens. Although not the focus of the present study, an inferior intercavernous sinus was present in only six specimens (17%) and was usually much smaller than the anterior or posterior intercavernous sinuses. All intercavernous sinuses hugged the periphery of the sella turcica and did not course in the free edge of the diaphragma sella. The mean diameter of the anterior intercavernous sinus was 4.9 mm (range, 2–6 mm), and the mean diameter of the posterior intercavernous sinus was 3 mm (range, 1.5–4.8 mm). Generally, if a large basilar venous plexus was observed, the intercavernous sinuses were smaller in caliber. No statistical differences were found between sexes or among different ages.

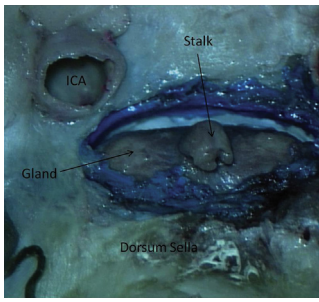

Figure 2. Cadaveric specimen exhibiting the circular sinus seen forming a ring around the pituitary gland (gland). Note the relationships to the internal carotid artery (ICA) and dorsum sella.

DISCUSSION

Permeability of the intercavernous sinuses has implications in the manifestation of clinical signs in disorders such as thrombophlebitic septic cavernous sinus thrombosis and carotid cavernous fistula.

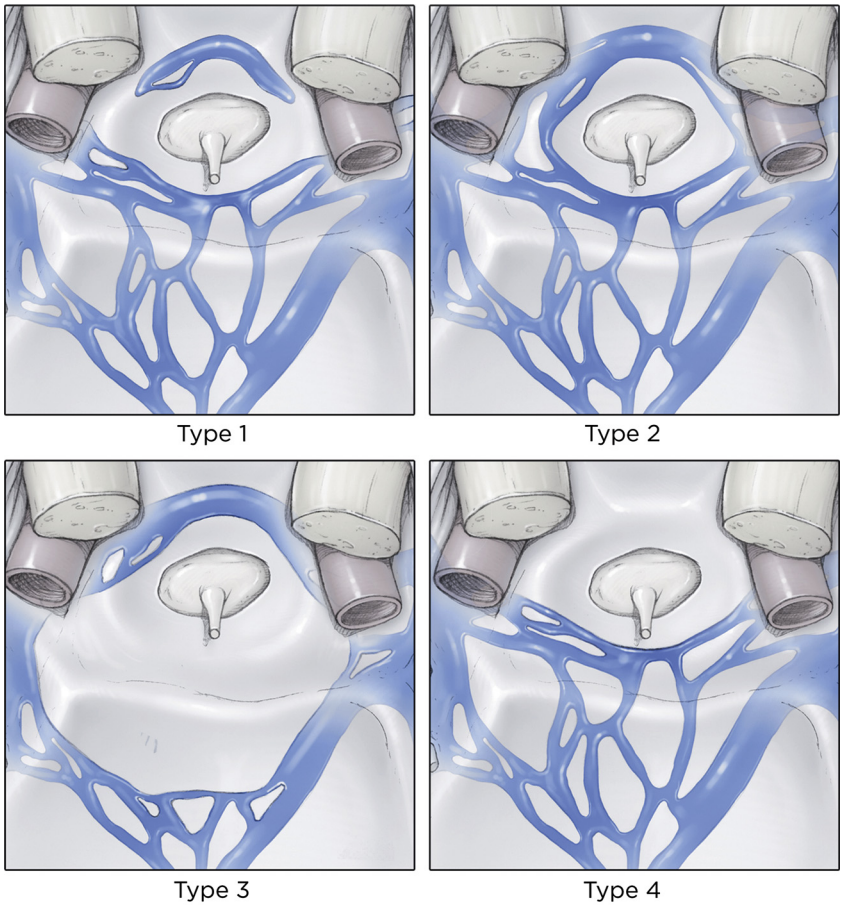

Figure 3. Drawing demonstrating the four types of intercavernous sinus connections found in the present study. A coexistent anterior and posterior intercavernous sinus was identified in 28 specimens (80%; type 1). Of the 80% of specimens with both sinuses, a circular connection between these was found in 25% (type 2). Only the anterior intercavernous sinus was observed in six specimens (17%; type 3), and only the posterior intercavernous sinus was seen in one specimen (2.9%; type IV). (From The Neurosurgical Atlas, copyright Aaron A. Cohen-Gadol, M.D., M.Sc. Reprinted with permission from Aaron A. Cohen-Gadol.)