Originals
Cavernous Sinus Venography by Transbasilic Catheter Technique

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Summary
The purpose of this paper is to present a new, possibly preferable method for cavernous sinus and orbital venography, by retrograde catheterization from the arm. With this procedure, good opacification of cavernous sinus may be offered also in patients who have heart diseases. This procedure can be tolerated with minimal discomfort. The patterns of the cavernous sinus are demonstrated in those with intracranial diseases. There have been no complications in our initial experience of 28 examinations.

Key words: Cavernous sinus venography, Orbital venography, Pituitary tumor, Orbital mass lesion

Introduction
The diagnostic value of cavernous sinus venography has been established in the evaluation of sellar and orbital tumors. The opacification of cavernous sinus and orbital vein may be accomplished by any of three separate approaches—transorbital, transjugular and transfemoral cavernous sinus venography.

Dejean and Boudet first described the procedure of orbital venography in 1951. Krayenbühl and Lombardi modified their technique.

Hanafsee et al. described the procedure of transjugular cavernous sinus venography using the Seldinger technique in 1965. They established the diagnostic value of cavernous sinus venography in the evaluation of the pituitary tumors. Takahashi reported cavernous sinus venography by transfemoral catheter technique in 1971. But there are some disadvantages in any approach that will be discussed below, so we performed cavernous sinus venography by a new catheter approach from the bilateral arms. Ray et al. reported the procedure of retrograde jugular venography in 1951. Gabrielsen and Bookstein modified their technique in 1968. They inserted a catheter into a basilic vein in the arm and under fluoroscopic control passed upward through the subclavian vein and into the internal jugular vein to the superior bulb for visualization of the jugular venous system in 1969. In 1969, Meyer introduced a catheter into the internal jugular bulb through a basilic vein for accurate measurement of total cerebral blood flow. We modified their technique for excellent opacification of cavernous sinus by advancing a catheter tip into the inferior petrosal sinus and called this method transbasilic cavernous sinus venography.

Materials
Since April 1974, 28 cavernous sinus venographies have been performed, 21 by transbasilic approach and seven by transfemoral approach. Twelve were performed in patients with pituitary adenomas and three were investigated for clarification of the exact location of aneurysms in the cavernous sinus. Seven were of a miscellaneous group, namely, basilar aneurysms, hemangioma of ophthalmic vein, optic glioma, craniopharyngioma, painful ophthalmoplegia, and sphenoid ridge meningioma. The remaining six patients showed normal patterns of cavernous sinuses. (Table 1)

Table 1. Cases.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Cases</th>
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</thead>
<tbody>
<tr>
<td>Pituitary tumor</td>
<td>12</td>
</tr>
<tr>
<td>Giant aneurysm of cavernous portion</td>
<td>3</td>
</tr>
<tr>
<td>(bilateral: 1, unilateral: 2)</td>
<td></td>
</tr>
<tr>
<td>Basilar aneurysm</td>
<td>2</td>
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<tr>
<td>Hemangioma of ophthalmic vein</td>
<td>1</td>
</tr>
<tr>
<td>Optic glioma</td>
<td>1</td>
</tr>
<tr>
<td>Craniopharyngioma</td>
<td>1</td>
</tr>
<tr>
<td>Sphenoid ridge meningioma</td>
<td>1</td>
</tr>
<tr>
<td>Painful ophthalmoplegia</td>
<td>1</td>
</tr>
<tr>
<td>Normal</td>
<td>6</td>
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<tr>
<td>Total</td>
<td>28</td>
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Method

The catheters used are B.-D. No. 7640 "Blue" catheters. The tip of the catheter is angled 120° approximately 1.5 cm from the tip. After cleaning the skin with antibacterial detergent, the skin overlying the basilic vein in the antecubital fossa is draped and a 1 to 2 mm stab-wound incision is made to allow easier passage of the catheter under local anesthesia using 1% Xylocain. Upon tightening the upper arm, the catheter is inserted into the basilic vein using the Seldinger technique. Then the catheter is advanced under direct visualization, using fluoroscopy with an image amplifier, via the basilic, subclavian, and innominate veins into the superior vena cava. Then the catheter is withdrawn a few centimeters and now rotated 180 degrees, preferably counterclockwise on the right side and clockwise on the left side. This allows the catheter to slip easily into the internal jugular vein rather than into the external jugular vein. Occasionally, the catheter may slip into the external jugular vein, then resistance will be felt about 5 cm above its orifice and injection of radiopaque material at that point reveals numerous tributaries in the neck. With further advancement, the tip of the catheter is placed in the jugular bulb and catheterization of the inferior petrosal sinus is performed with the catheter tip directed anteriorly and medially. When the catheter tip is placed in the ostium of the inferior petrosal sinus, the patient usually experiences slight pain in the ear. By injection of a small amount of contrast medium, it is seen to be a 0.5 to 1.5 mm channel coursing anteriorly in the groove between the petrous bone and petrous portion of the occipital bone. Once this venous channel is identified, the tip of the catheter is advanced into its orifice. At the same time, both sides are routinely catheterized in order to assure complete filling of the cavernous sinuses.

Simultaneous hand injection of 10 ml of 60% Conray are made into both catheters during serial filming with the patient in position for a basal projection. For the excellent opacification of the cavernous sinus, we compress both jugular veins of the patient. As a matter of routine, initial pictures for subtraction are taken followed by ten serial roentgenograms taken at the rate of two exposures per second. Series are made in both the antero-posterior and lateral projections in addition to the basal view. Following venography, subtraction is performed to obtain a photographic film of the cavernous sinus in the various projections without the confusing shadows of the overlying skull.

Results

Excellent opacification of the cavernous sinuses was obtained in 25 out of 28 patients. Out of our 28 cases which underwent this procedure, 10 cases showed bilateral free communication between the cavernous sinuses and the superior ophthalmic veins. (Table 2). The cavernous sinus venography offers the opportunity to obtain detailed information concerning the pituitary gland, and sometimes free communication with the ophthalmic veins allows investigation for orbital mass lesions.

In addition, the outer limit of the wall of an aneurysm of the intracavernous portion can be seen as a negative shadow in the opacified sinus. An occasional laminated clot in the wall of an

<table>
<thead>
<tr>
<th>Table 2. The opacification of superior ophthalmic veins.</th>
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<tr>
<td>Cases</td>
</tr>
<tr>
<td>Pituitary tumor</td>
</tr>
<tr>
<td>Giant aneurysm of cavernous portion</td>
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<tr>
<td>Optic glioma</td>
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<td>Basilar aneurysm</td>
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<tr>
<td>Hemangioma of ophthalmic vein</td>
</tr>
<tr>
<td>Painful ophthalmoplegia</td>
</tr>
<tr>
<td>Normal</td>
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aneurysm may obscure the true extent of the lesion judging from the findings obtained from carotid angiography.

**Normal pattern**

Normal pattern of the cavernous sinuses is shown in fig. 1 and fig. 2 obtained by our method. The anatomical description is referred to that of Bedford.

**Pituitary tumor**

Cavernous sinus venographies were performed in 12 patients with pituitary adenomas. Of these, one patient showed ballooning of circular channels connecting the cavernous sinuses and seven patients showed lobular defect of unilateral cavernous sinus.

Fig. 1. A: Schematic drawing of normal pattern in cavernous sinus venography. (basal projection)
B: Normal pattern of the cavernous sinus venogram.

Fig. 2. The venograms of normal pattern of cavernous sinuses obtained by our method.
A: antero-posterior projection
B: lateral projection

The remaining patients showed unilateral or no opacification of cavernous sinuses. Concerning the opacification of anterior intercommunicating sinus, ten patients showed no opacification.

In the normal patient, the combination of anterior and posterior intercommunicating sinuses, together with the cavernous sinuses, completely surrounds the pituitary gland, but we could not get the opacification of anterior intercommunicating sinus in one of six normal patients. (Table 3).

It is considered that intrasellar pituitary tumor will show the stretching of anterior intercommunicating sinus and the ballooning of circular channels connecting the cavernous sinuses, and as the tumor grows unilaterally,
Table 3. The opacification of cavernous sinuses in pituitary adenomas.

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<th>(-)</th>
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<tbody>
<tr>
<td>Pituitary adenoma</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Optic glioma</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Craniopharyngioma</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Giant aneurysm of cavernous portion</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Hemangioma of ophthalmic vein</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
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<td>0</td>
</tr>
<tr>
<td>Sphenoid ridge meningioma</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Painful ophthalmoplegia</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Normal</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

lobular defect of unilateral cavernous sinus will be obtained.

**Giant aneurysm of cavernous portion**

Cavernous sinus venographies were performed in three patients with intracavernous giant aneurysms. One patient showed a filling defect of unilateral cavernous sinus, and other one patient showed filling defects of bilateral cavernous sinuses. We failed to puncture the basilic vein in the last one patient.

**Hemangioma of superior ophthalmic vein**

Excellent opacification of the venous angioma was obtained by the cavernous sinus venography in a patient being investigated for intermittent unilateral exophthalmos. Orbital venography was also performed but was not so contributory.

We failed only one time to advance the catheter tip into the internal jugular vein. The internal jugular vein of that patient was shown to be narrowed and it might be probably due to thrombophlebitis.

**Cases**

**Case I**

37 year old male being investigated for acromegaly. Capillary network from the meningohypophyseal trunk feeding the tumor was seen in carotid angiogram. Pneumoencephalogram did not reveal any evidence of pituitary adenoma. Cavernous sinus venogram was most contributory to the diagnosis. (Fig. 3) Pituitary microadenoma was identified in operation.

![Fig. 3. Intrasellar pituitary adenoma.](image-url)

A: Ballooning of circular channels connecting the cavernous sinuses. Anterior intercommunicating sinus is markedly stretched.

B: The suprasellar cisterns appear well filled and capacious.
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Transbasilic Cavernous Sinus Venography

Case II

50 year old female being investigated for visual disturbance and nausea, headache, vomiting. Carotid angiogram demonstrated elevation of anterior cerebral arteries. Anterior part of the third ventricle was compressed and elevated to the supero-posterior direction in pneumoencephalogram. Cavernous sinus venogram showed the direction of the tumor growth. (Fig. 4) Lateral extension of the suprasellar pituitary adenoma was identified in operation.

Case III

44 year old male being investigated for visual disturbance and headache. Plain lateral roentgenogram of the skull demonstrated ballooning of the sella turcica. Carotid angiogram demonstrated elevation of anterior cerebral arteries. Anterior part of the third ventricle was compressed and elevated to the supero-posterior direction in pneumoencephalogram. Cavernous sinus venogram revealed lateral extension of the pituitary adenoma. (Fig. 5)

Case IV

59 year old female being investigated for left ptosis and double vision. Left carotid angiogram demonstrated giant aneurysm of cavernous portion. Next, cavernous sinus venography and left carotid angiography were simultaneously performed. The outer limit of the wall of an aneurysm was demonstrated as a negative shadow in the opacified sinus. (Fig. 6)

Case V

53 year old female being investigated for right intermittent unilateral exophthalmos. Carotid angiogram offered no information for diagnosis. Orbital venography was also performed but was not so contributory. Cavernous sinus venography demonstrated excellent opacification of the venous angioma. (Fig. 7) A right frontal craniotomy was performed and the venous angioma was totally removed.

Discussion

Opacification of the cavernous sinus and the orbital vein may be accomplished by any of the following three separate approaches.
1. transorbital cavernous sinus venography
2. transjugular cavernous sinus venography
3. transfemoral cavernous sinus venography

There are some disadvantages in each of approaches. In the transorbital approach, the frontal and the angular veins may be too small for successful puncture and there may not be a good reflux of contrast media into the cavernous sinus via the superior ophthalmic vein. In the trans-jugular approach, patients' discomfort is considerable and radiation exposure to the

![Fig. 4. Chromophobe adenoma with lateral extension. Lobular defect of right cavernous sinus shows lateral extension of the tumor.](image1)

![Fig. 5. Pituitary adenoma with lateral extension. Lobular defect of right cavernous sinus and marked stretching of anterior intercommunicating sinus show the direction of the tumor growth.](image2)
Fig. 6. Giant aneurysm of cavernous portion. Cavernous sinus venography and left carotid angiography were simultaneously performed.
A: basal view—white shadow (giant aneurysm)
black shadow (cavernous sinus)
B: latera! view—white shadow (cavernous sinus)
black shadow (giant aneurysm)
The outer limit of the wall of an aneurysm is demonstrated as a negative shadow in the opacified sinus.

examiner is not negligible\textsuperscript{14}. As for the transfemoral approach, atrial fibrillation may be elicited during passage of the catheter through the right atrium and it is impossible to insert two catheters in the bilateral inferior petrosal sinuses at the same time.

These disadvantages prompted us to take transbasilic cavernous sinus venography. Our transbasilic method has the following advantages.
1. Excellent opacification of the cavernous sinus can be offered because two catheters into bilateral inferior petrosal sinuses are introduced simultaneously.

2. There is minimal discomfort to the patient and he can walk home soon after the examination.
3. This method can be indicated also in patients with heart diseases because catheters never pass near the atrium.
4. The procedure can be performed without difficulty as long as the superficial veins are visible in the arm.

In our clinic, cavernous sinus venography has been indicated to patients with pituitary adenoma, intracavernous aneurysm, and others. In cases of pituitary tumors, the dimensions of a pituitary tumor can be approximated by roentgenographic studies of the sella turcica. Pneumoencephalograms will show suprasellar tumor extensions, and bilateral carotid angiography will, in some cases, demonstrate lateral and suprasellar growth patterns. There are, however, great variations in the normal size and configuration of the sella turcica, and so,
the diagnosis of pituitary tumors based on the size and configuration of the sella turcica in the absence of any structural change is unreliable. The variability of the vascular anatomy reduces the reliability of carotid angiography for diagnosis of pituitary tumors. Carotid angiographic changes are usually not reliable unless the lateral extension is of considerable size.

Pneumoencephalograms do not offer information concerning the intrasellar tumor. On the other hand, cavernous sinus venography can demonstrate the accurate delineation of the lateral extension of pituitary adenoma and the true extent of that portion of the intrasellar tumor that has not as yet extended into the cerebral subarachnoid spaces.

In case of intraorbital lesions, this cavernous sinus venography is often contributory. Out of our 28 cases which underwent this procedure, only 10 cases showed bilateral free communication between the cavernous sinuses and the superior ophthalmic veins. (Table 2) That is probably because most of our cases have mass lesions in the cavernous sinuses. When intraorbital tumor or angiomatous is located near rather proximal portion of the superior ophthalmic vein, transorbital venography can not sometimes demonstrate accurate location or size of lesions and cavernous sinus venography is often more useful in such cases as our intraorbital hemangioma.

With recent advances in microneurosurgery, transsphenoid approach to pituitary microadenoma or transclival approach to verteobasilar aneurysm is becoming popular. For transsphenoid approach, exact location of tumor in the sella turcica as mentioned above as well as relation between the sphenoid sinus and the cavernous sinus is necessary to be known, not to injure the cavernous sinus when opening the sella turcica. Recently, we performed transoral-transclival approach to two cases of intracranial aneurysms of verteobasilar junction and vertebral artery. Before these operations, this transbasilic cavernous sinus venography was performed in order to know location and extension of venous channels in the dura near the clivus that was opened in this approach and venous bleeding could be minimized.

References