Veins draining the pineal body
An anatomical and neuroradiological study of "pineal veins"

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The authors present a detailed anatomical and neuroradiological study of the veins draining the pineal body proper, which they designate "pineal veins." They describe three variations of the pineal veins. Since each has a characteristic angiographic relationship to the pineal body, the results of the study may permit early diagnosis of a pinealoma and distinguish the nature of the tumors of the posterior third ventricle.

Key Words: pineal veins, topographical anatomy, variation, vertebral angiography, pinealoma, third ventricle tumors

Detailed information on the veins draining the pineal body proper is lacking in the anatomical and neuroradiological literature. Angiographic study of the tumors in the posterior third ventricle has been made mainly on the basis of the displacement of the posterior choroidal arteries, the internal cerebral and basal veins, and the great cerebral vein of Galen. Large space-occupying lesions in this region can be localized from changes in the position of these vessels. But study of these larger vessels does not permit early diagnosis of the small tumors of the pineal region or a differential diagnosis regarding the nature of the tumors of the pineal region.

The purpose of this study is to present the anatomical variations of the veins draining the pineal body and the related angiographic anatomy and pathological findings in tumors of the pineal region. The diagnostic value of these veins in the early and specific recognition of pineal tumors is also discussed.

Materials and Methods
The venous system of the pineal body and the adjacent region was studied in six human brains in which polyester plastic was injected into the veins of the brain stem and posterior fossa. The injection was performed in brains obtained from cadavers from 10 to 40 hours after death.

The carotid arteries, vertebral arteries, and internal jugular veins were exposed and bilaterally cannulated. The arterial system was flushed with about 3 liters of normal physiological saline. Approximately 1½ liters of polyester plastic were injected into the bilateral internal jugular veins simulta-
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The entire body was kept in formalin for about 24 hours while the plastic hardened. After the plastic had hardened the skulls were opened and the brains removed, with care taken to preserve the dural coverings. The whole brain, with the dura opened and removed in several places, was fixed in 10% formalin for 2 to 3 months. After sufficient fixation, the cerebral hemispheres and deep cerebral ganglia were dissected and removed, with care taken to preserve all the veins draining into the great cerebral vein of Galen. The regions of the thalamus, posterior third ventricle, and pineal body were dissected so as to leave the veins draining these structures intact. After removing the arteries and arachnoid membrane, the veins that drain the pineal body and its vicinity were exposed and studied by dissection under a binocular surgical microscope. The angiographic anatomy and variations of the veins draining the pineal body were studied by selective vertebral angiography via femoral catheterization. Pathological changes in these veins in cases of tumors of the pineal region were also studied and described.

Results

Anatomical Findings

The thalamostriate and internal cerebral veins and the great cerebral vein of Galen were carefully dissected and exposed bilaterally (Fig. 1). When both internal cerebral veins were reflected backward and the suprapineal recess was opened, the pineal body and its draining veins on the superior surface of the pineal body made their appearance just under the terminal portion of the internal cerebral veins. The veins draining the upper surface of the pineal body could be well identified (Fig. 2). These veins, which we have named the "pineal veins," started from the trigonum habenulae or from the junction between the trigonum habenulae and the pineal body. There were generally three or four smaller veins on the upper surface of the pineal body, the largest close to both lateral margins of the pineal body. These superior pineal veins passed backward over the upper surface of the pineal body to form a single trunk or a few common channels in the quadrigeminal cistern.

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The inferior group of pineal veins consisted of several vessels draining and traversing the inferior surface of the pineal body. The veins originated at the junction of the superior colliculi with the base of the pineal body; the most lateral veins were usually the largest. They also united and formed a main channel which then coursed in the quadrigeminal cistern posteriorly and superiorly to connect with the superior group of veins that drain the upper surface of the pineal body and form a single trunk or a few channels that empty into the great cerebral vein of Galen (Fig. 3).

In some specimens (Fig. 4) there were short great cerebral veins of Galen interpreted as normal variations. In these the pineal veins consisted of right and left main channels which originated from the superior and inferior surfaces of the pineal body in its proximal portion and ran along both lateral margins of the pineal body backward. These main channels emptied independently into the terminal portion of the internal cerebral veins on each side (Fig. 5).

There was a combined type representing the third variant. In this type the superior pineal veins emptied into the connecting point of the basal and internal cerebral veins, that is, the great cerebral vein of Galen and the inferior pineal veins joined the terminal portion of the internal cerebral vein (Fig. 6, Type 3). The three types of normal variations of the topographical anatomy of the pineal veins studied in the six brains are summarized in Fig. 6.

Radiological Findings

It is important to study these pineal veins by satisfactory visualization of the small vessels in serial selective vertebral angiography via femoral catheterization. The pineal veins are usually easily seen in the lateral projection but are difficult or impossible to identify in the anteroposterior projection because of the overlapping larger veins and sinuses in the midline.

The pineal veins were visualized between the internal cerebral veins and basal veins (Fig. 7). The superior and inferior pineal veins ran posteriorly and superiorly in the quadrigeminal cistern, and emptied into the great cerebral vein of Galen. These superior and inferior pineal veins formed a V-shaped or “claw-of-a-crab” configuration. The form and size of the pineal body proper can be evaluated from this configuration of the pineal veins and the distance between the superior and inferior pineal veins in the venous phase of selective vertebral angiography.

The following findings could be obtained in the cases of pineal tumors. In astrocytomas or other gliomas (except for so-called pinealomas) arising in the posterior part of the third ventricle, the pineal veins had a
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FIG. 5. Dissection showing the main channels of the pineal veins emptying into the terminal portion of the internal cerebral veins. i.c. = internal cerebral veins (displaced laterally), c.p. = corpus pineale, m. = mesencephalon, III. = third ventricle, r.p. = right pineal veins, l.p. = left pineal veins, g. = great cerebral vein of Galen.

FIG. 6. Schematic drawings showing variations of the pineal veins. Left: Type 1. Veins draining the superior and inferior surfaces of the pineal body converge to form one or two main trunks, run posteriorly and superiorly in the quadrigeminal cistern, and empty into the great cerebral vein (upper: superior surface of the pineal body; middle: inferior surface of the pineal body). Center: Type 2. Veins originating from the proximal portion of the pineal body drain the inferior and superior surface of the pineal body, form one main trunk in the lateral aspect of the pineal body, and empty into the terminal portion of the ipsilateral internal cerebral vein. This type was seen in specimens in which the great cerebral vein of Galen was very short. Right: Type 3. This is a combination of Types 1 and 2. The superior pineal veins draining the superior aspect of the pineal body run superiorly and posteriorly to join the great cerebral vein of Galen, while the inferior pineal veins draining the inferior aspect run backward and upward to empty into the terminal portion of the internal cerebral vein separately. This variation was found in one brain. g = great cerebral vein of Galen; ic = internal cerebral vein; b = basal vein; p = pineal vein; cp = corpus pineale.
normal configuration and position except for downward displacement of the internal cerebral veins due to the concomitant internal hydrocephalus, as shown in Fig. 8. This tumor was found to be an astrocytoma of the posterior third ventricle at autopsy. The pineal body, suprapineal recess, and pineal veins could be well identified as normal structures. The tumor lay just below and in front of the pineal body and occluded the Sylvian aqueduct completely (Figs. 8 right and 9).

Figure 10 shows the radiological findings in a patient with a pinealoma (not histologically verified). The patient had a positive Parinaud's sign, hypernatremia, unsatisfac-

Fig. 7. Venous phase of the selective vertebral angiography showing the pineal veins between the internal cerebral and basal veins. i.c. = internal cerebral veins, p. = pineal veins, b. = basal veins, g. = great cerebral vein, s.p. = superior pineal vein, i.p. = inferior pineal vein, c. = pineal calcification.

Fig. 8. Left: Angiogram showing an astrocytoma of the pineal region. The configuration and position of the pineal veins (arrow) are normal. Right: Ventriculogram showing small shadow defect with forward convexity in the pineal region (arrows) and occlusion of the Sylvian aqueduct by the astrocytoma.
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tory pupillary reaction to light, and the tumor was highly sensitive to irradiation. In the lateral view of the vertebral angiography, the superior pineal vein was displaced upward following the upward convexity of the tumor while the inferior pineal vein was displaced downward with the downward convexity. The normal configuration of the pineal veins was lost, and the distance between the superior and inferior pineal vein was widened, thus forming the opened “claw-of-a-crab” configuration shown in Fig. 10 left. A pneumoventriculogram is also shown for comparison (Fig. 10 right).

In conclusion, if the pineal veins have a normal configuration and position in the venous phase of the vertebral angiography, the tumor of the posterior third ventricle is likely to be another type, such as a glioma, rather than a pinealoma. When, on the contrary, the pineal veins are deformed and especially assume the configuration of the opened “claw of a crab,” a pinealoma is more likely. Thus, the pineal veins may permit the early diagnosis of a pinealoma and distinguish the nature of the tumors of the posterior third ventricle.

Discussion

The pineal body receives its arterial blood supply from the medial posterior choroidal arteries, which originate from the interpeduncular or crural portion of the posterior cerebral artery, and run around closely adherent to the mesencephalon, appearing in the quadrigeminal cistern lateral to the pineal body. They pass through the tela choroidea and form the choroidal plexus of the third ventricle rostrally and of the lateral ventricle laterally. Numerous radiating arteries, arterial rami to the pineal body, originate from the medial posterior choroidal arteries running lateral and back to the pineal body, run forward and penetrate into the pineal body.1,4,5

Fig. 9. Autopsy specimen showing the normal pineal body, suprapineal recess, and pineal veins (double arrow indicates tumor).

Fig. 10. Left: Vertebral angiogram of a “pinealoma” showing upward and backward displaced superior pineal veins (double arrows) and downward and backward displacement of inferior pineal veins (triple arrows). Right: Pneumoventriculogram shown for comparison.
Wackenheim and Braun⁵ pointed out that the close relationship of the medial choroidal arteries and the pineal body is constant; the distance between its external margin and the pineal gland varies between 4 and 5 mm. Because of this close anatomical relationship, angiographic studies of the medial posterior choroidal arteries relative to the diagnosis of the tumors in the pineal region were made. A diagram for measuring the distance from the bifurcation between the basilar artery and the posterior cerebral artery to the lateral posterior choroidal artery was created, and the pathological changes in the pineal tumors were described by Löfgren.⁶ Upward and backward displacement of the terminal portion of the internal cerebral vein and downward and backward displacement of the basal vein were reported in pineal tumors. Löfgren pointed out that venous displacement appears earlier than the displacement of the arteries so that a straightening of the internal cerebral veins may sometimes be demonstrated without any arterial displacement.

In his study of 21 cases of pineal tumors, Löfgren⁶ found that small tumors measuring 2 cm or less in diameter did not displace the posterior choroidal arteries or the internal cerebral veins. Wackenheim and Braun⁵ also observed from their experience with 10 pineal tumors that tumors less than 1 cm in diameter were impossible to diagnose by angiography alone.

It is also generally accepted that even by Myodil ventriculography there was no constant correlation between the type of filling defect and the nature of the tumors.⁸

Pneumoencephalography or ventriculography using positive contrast media have generally been considered more adequate means of diagnosing the pineal tumors than angiography. However, vertebral angiography has become increasingly precise, accurate, and detailed, and has gained more and more diagnostic value since the catheter method has provided good visualization of the small arteries and veins of the brain stem and the posterior fossa structures. Precise, detailed, anatomical studies also enable us to study and interpret the vertebral angiograms more accurately. We predict that in the near future vertebral angiography will take the place of pneumoencephalography or ventriculography in the diagnosis of brain stem and posterior fossa tumors, as in the supratentorial cerebral tumors. Emphasis must therefore be placed on the study of the topographical anatomy and the normal variations of small vessels. It is hoped that our study of the topographic anatomy of the pineal veins and their angiographic investigation may permit the early diagnosis of small pineal tumors, and of the nature of the tumors in the posterior third ventricle.

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References


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