Choroidal arteries in the diagnosis of thalamic tumors

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Arteriograms of 12 patients with space-occupying lesions involving the thalamus were compared with 100 vertebral and carotid arteriograms reported as normal. It was found that masses that involve the thalamus primarily or secondarily affect the choroidal arteries in a characteristic manner. The most commonly involved vessel is the lateral posterior choroidal artery. The medial posterior choroidal artery may also be affected because of its contribution to the dorsal medial nucleus of the thalamus and its occasional course around the pulvinar. Because the anterior choroidal artery is reciprocal in size to the lateral posterior choroidal artery, the lesion will often be demonstrated on carotid angiography.

Key Words: thalamus, brain tumor, choroidal artery, angiography

The radiological signs of thalamic tumors as demonstrated by air studies are well documented in the literature. Although numerous angiographic signs have been described, relatively little attention has been given to the choroidal arteries. Localizing signs develop relatively late in the course of thalamic lesions, and a characteristic clinical picture is often lacking. Carotid angiography is usually the first diagnostic procedure when a supratentorial space-occupying lesion is suspected, but with this study, thalamic tumors may be overlooked. Recently, with more widespread use of catheter techniques, vertebral angiography usually follows and is commonly performed before the pneumoencephalographic study. Because of the intimate relationship between the thalamus and the choroidal arteries, discovery of early abnormalities in these vessels might be expected with thalamic tumors.

In this report, we correlate the gross and angiographic anatomy of the choroidal arteries and describe the roentgen changes in these vessels in patients with tumors of the thalamus.

Material and Method

The arteriograms of 12 patients with space-occupying lesions that involved the thalamus were reviewed. Exclusion of lesions that arose elsewhere and invaded the thalamus secondarily was not attempted. The arteriograms of these patients were compared with 100 vertebral and carotid arteriograms reported as normal. The pneumoencephalographic and surgical reports of the 12 patients were reviewed. They included six patients with gliomas, one with mixed ependymoma with oligodendroglioma, one in whom "gliosis" was described, and four with no histological proof. Of these four patients, two had thalamic masses by air
studies. Another had multiple cerebral metastasis from a primary tumor in the chest, and in the remaining patient an air study was not available.

Results

The angiographic results in the 12 patients are summarized in Table 1. Abnormalities were noted in the choroidal vessels in all 12 patients. These abnormalities consisted of posterosuperior displacement of the lateral choroidal arteries in the lateral projection, and lateral displacement and stretching of these vessels in the anteroposterior

<table>
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<tr>
<th>Case No.</th>
<th>Diagnosis</th>
<th>Anterior Choroidal Artery</th>
<th>Lateral Posterior Choroidal Artery</th>
<th>Medial Posterior Choroidal Artery</th>
<th>Diagnosis proved by histologic examination or pneumoencephalography</th>
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<td>surgery</td>
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<td>+</td>
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views. The medial choroidal arteries, when involved, were displaced upward and backward with or without hypertrophy. The anterior choroidal artery was stretched in an arc wider than usual in its distal segment within the atrium of the lateral ventricle. Occasionally it was also hypertrophied. All three choroidal vessels (anterior choroidal, lateral posterior choroidal, and medial posterior choroidal) were involved in five patients. Abnormalities that involved only the lateral posterior choroidal artery were seen in three instances. In two additional patients, abnormalities of the anterior choroidal and lateral posterior choroidal arteries were seen. Involvement of the lateral posterior choroidal and medial posterior choroidal arteries was demonstrated in one patient. In another, the anterior choroidal artery alone was involved, but no vertebral arteriogram was available on this patient. Abnormalities of the medial posterior choroidal artery alone or in combination with the anterior choroidal artery were not seen.

When the anterior choroidal and lateral posterior choroidal arteries were involved they were more often displaced than hypertrophied. An equal number of medial choroidal arteries showed hypertrophy and displacement. A tumor blush made up of pathological vessels was demonstrated in two patients (17%). In six of the 12 patients (50%), the thalamoperforating vessels were stretched.

**Discussion**

**Normal Anatomy of Choroidal Vessels**

**Anterior Choroidal Artery.** In most instances the anterior choroidal artery originates from the internal carotid artery just above the posterior communicating artery. A significant number of anterior choroidal arteries may originate from the middle cerebral artery, posterior communicating artery, and from the junction of the anterior and middle cerebral arteries.

The first part of the anterior choroidal artery lies in close proximity to the medial and posterior surfaces of the uncus (Fig. 1). It describes a curve with a medial convexity passing through the space between the uncus and the cerebral peduncle, the crural cistern. This portion of the artery has been called the cisternal portion. The second portion of the artery or plexal portion turns laterally and kinks slightly as it penetrates the temporal horn. After it enters the choroid plexus of the temporal horn the artery may divide and form a network of small tortuous vessels, which appear to terminate in the choroid plexus of the temporal horn. In other instances the artery curves posteriorly with a lateral convex course. It continues up through the trigone into the body of the lateral ventricle, curves around the pulvinar of the thalamus, and anastomoses with the lateral posterior choroidal arteries (Fig. 1).

The size of the anterior choroidal artery is usually inversely proportional to the size of the lateral posterior choroidal artery.

Arteriographically, in the anteroposterior projection the anterior choroidal artery is seen to arise from the medial side of the internal carotid artery (Fig. 2 left). It courses with a medial convex curve around the uncus. It then turns laterally, kinking as it enters the temporal horn, to curve into a lateral convexity and course posteriorly. The appearance of the artery varies, according to the beam direction and is least foreshortened in the half-axial projection.

In the lateral projection the cisternal portion of the anterior choroidal artery is seen to run obliquely backward and somewhat upward. Usually its course is directed slightly superiorly in a convex curve (Fig. 2 right). The plane of the anterior choroidal artery in this projection parallels that of the larger vessels in the Sylvian fissure. In most instances, the anterior choroidal artery can be followed only into its plexal portion where it ramifies into several small branches and is no longer visible roentgenographically. In other cases, however, particularly when the posterior choroidal vessels are small, the anterior choroidal artery may curve in a posteriorly directed convexity around the pulvinar of the thalamus to enter the atrium and body of the lateral ventricles (Fig. 2 right).

**Medial Posterior Choroidal Artery.** The medial choroidal artery is usually a single vessel but may consist of multiple arteries. The origin of the medial choroidal artery varies, but it usually arises from the proximal segments of the posterior cerebral artery (Figs. 3 and 4). The artery then parallels
FIG. 1. Normal brain section shows that the anterior choroidal artery enters the temporal horn and then courses all the way to the atrium of the lateral ventricle and around the pulvinar of the thalamus.

FIG. 2. In both the anteroposterior (left) and lateral (right) angiograms, the anterior choroidal artery is identified as it extends all the way to the atrium of the lateral ventricle and around the pulvinar of the thalamus (arrows).
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**Fig. 3.** Basal view of the brain showing normal posterior choroidal arteries.

**Fig. 4.** Roentgenogram of injected specimen, demonstrating a normal medial choroidal artery on the right (*solid arrows*). The lateral choroidal arteries (*open arrows*) are seen in their normal position bilaterally.
the trunk of the posterior cerebral artery and is interposed between that artery and the adjacent midbrain, to which it contributes small branches. It courses posteriorly and medially to the quadrigeminal cistern where it lies lateral to the pineal gland (Fig. 5). The course then is forward in the roof of the third ventricle adjacent to the internal cerebral vein. Multiple small branches of the medial choroidal artery that extend forward almost to the level of the foramen of Monro supply the choroid plexus of the third ventricle. The dorsal medial nucleus of the thalamus also receives minor contributions from this artery. When the main trunk of the medial choroidal artery arises from more distal branches of the posterior cerebral artery it passes medially behind the pulvinar to supply the tela choroidea of the third ventricle. Small accessory branches may arise from the distal posterior cerebral artery or the lateral choroidal artery to augment the blood supply of the tela choroidea.

In the frontal and lateral projections the adjacent posterior cerebral arteries usually hide the proximal portion of the medial choroidal artery. In contrast, the distal portion may be visible (Fig. 6). This distal segment can be seen in the lateral projection to extend upward in a posteriorly directed convex curve from the posterior cerebral artery (Fig. 7). Here it appears roughly in the form of a “3.” Occasionally, because of their variable origin, differentiation of the medial and lateral choroidal arteries on lateral vertebral arteriograms is difficult.

**Lateral Posterior Choroidal Artery.** In most instances the lateral choroidal artery originates from the ambient segment of the...
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posterior cerebral artery (Figs. 3 and 4). When more than one lateral choroidal artery is present, the posterior is usually the larger (Fig. 8). Commonly, the origin of this vessel varies. The lateral choroidal artery arises from the proximal trunk of the parieto-occipital artery when the latter originates from the ambient segment of the posterior cerebral artery (Fig. 8). The lateral choroidal artery initially courses laterally to enter the choroidal fissure. An anterior branch extends forward to supply the anterior portion of the choroid plexus of the temporal horn. The size of this vessel is usually inversely proportional to the size of the anterior choroidal artery. The posterior branch courses posteriorly around the pulvinar, supplying the choroid plexus of the trigone and lateral ventricle (Fig. 5). In addition, the lateral choroidal arteries supply the crus, commissure, body, and part of the anterior columns of the fornix, and send prominent branches into the thalamus. These thalamic perforators supply most of the dorsomedial thalamic nucleus and pulvinar and part of the lateral

Fig. 7. Normal posterior choroidal arteries on lateral vertebral arteriogram. Medial choroidal artery (open arrows); lateral choroidal artery (solid arrows).

Fig. 8. View of the thalamus from behind, showing lateral choroidal arteries curving around the posterior aspect of the pulvinar.
geniculate body. Branches that arise from the distal portion of the lateral choroidal artery extend medially and anastomose with the medial choroidal artery. The anterior and smaller branch of the lateral choroidal artery is seldom identifiable by vertebral arteriography. Usually the more posterior branch of the lateral choroidal artery can be seen in the lateral view as the artery extends upward from the posterior cerebral artery in a posteriorly directed convex curve. In this projection, the vessel courses above and behind the medial choroidal artery in a smoother and wider arc (Fig. 7). This arc indicates the position of the posterior limits of the pulvinar and the anterior limits of the trigone. The terminal branches of the lateral choroidal artery course anteriorly in the floor of the lateral ventricle toward the foramen of Monro. Because of their variability in origin, separation of the medial and lateral choroidal arteries may be difficult in the lateral projection. In the frontal projection, a normal lateral choroidal artery is seldom identified because of superimposition of the posterior temporal branches of the posterior cerebral artery and branches of the superior cerebellar artery.

Effect of Thalamic Tumors

The changes seen in the choroidal vessels with tumors of the thalamus have seldom been emphasized. In 1956, Sjögren reported a case of thalamic tumor in which the anterior choroidal artery appeared enlarged and markedly stretched in both the anteroposterior and lateral views. Galloway and Greitz were the first to describe displacement of the lateral posterior choroidal artery associated with a primary tumor of the thalamus. They described in detail the origin and course of the medial and lateral posterior choroidal arteries. Tovi, et al., reported three thalamic tumors in which carotid angiography revealed the anterior choroidal artery displaced posteriorly and laterally in a wide circle around an expanding lesion in the thalamus. Vertebral angiography was performed in two of these patients, and, in both, the lateral posterior choroidal artery was displaced posteriorly around the enlarged thalamus. Potts and Taveras reported downward displacement of the anterior choroidal artery in six of 19 patients with thalamic masses. They also noted that the anterior choroidal artery in these patients often extended posteriorly to outline the posterior aspect of the enlarged thalamus. Occasionally the artery was displaced laterally as well, or was larger and longer than seen normally. They mentioned also that the lateral posterior choroidal artery, when visible on a carotid angiogram, described a wide arc around the enlarged thalamus. Vertebral angiography was not performed. In reporting on the angiographic changes in the choroidal arteries with intraventricular meningiomas, Falk described a glioma which was fed by an enlarged anterior choroidal artery. The location of the glioma was not stated. Lawrie reported carotid angiograms in six patients with thalamic tumors. In five of these the anterior choroidal artery was enlarged and elongated, and, in two of these five, it extended around the posterior and superior aspects of the tumor. The author hypothesized that this enlargement and elongation might be the result of filling of the lateral posterior choroidal artery through anastomoses within the choroid plexus. In the carotid angiogram of the one patient who did not demonstrate an enlarged anterior choroidal artery, the posterior cerebral artery was seen to fill and "the choroidal circulation appeared increased."

The artery most often affected by space-occupying lesions in the thalamus is the lateral posterior choroidal artery. Of our 11 patients with vertebral arteriograms, the lateral posterior choroidal artery was abnormal in every case. This artery is usually displaced laterally as seen in the anteroposterior projection (Fig. 9). In the lateral view the vessel is displaced posteriorly and superiorly in an arc wider than normal. With extension of the tumor across the midline to involve the opposite thalamus, both lateral posterior choroidal arteries may be displaced (Figs. 10 and 11).

As previously noted, the size of the anterior choroidal artery is often inversely proportional to the size of the lateral posterior choroidal artery. In some instances, therefore, a thalamic neoplasm may be demonstrated on the carotid arteriogram (Fig. 12). It should be remembered that the normal anterior choroidal artery may extend posteriorly around the pulvinar (Fig. 2). Therefore, the diagnosis of an expanding lesion within the thalamus should be based more
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Fig. 9. Case 7. Lateral (left) and anteroposterior (right) angiograms showing that both lateral posterior choroidal arteries on the left are stretched and displaced posterolaterally (solid arrows). In the lateral (left) projection, hypertrophy and upward displacement of a medial choroidal artery is also seen (open arrows). A left thalamic mass was demonstrated at pneumoencephalography, and surgical biopsy revealed a grade III cellular ependymoma with oligodendroglioma.

Fig. 10. Case 3. Lateral (left) and anteroposterior (right) angiograms. The lateral posterior choroidal arteries are stretched in a wider arc than normal and displaced posterolaterally on both sides (solid arrows). A medial choroidal artery is also seen displaced posterosuperiorly and somewhat elongated (open arrows). Note the marked stretching of the thalamoperforating arteries.

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The abnormalities in the medial choroidal arteries that are associated with thalamic tumors have been neither described nor explained. Changes in the medial choroidal arteries were seen in six of our 11 patients; these were well seen in the lateral projection, but poorly in the anteroposterior view. The abnormalities consisted of hypertrophy and displacement, with hypertrophy more common than when the anterior choroidal or lateral choroidal arteries were involved (Figs. 14, 15, and 16). The reason for these abnormalities may be explained by a review of the anatomical variations of the medial choroidal artery. When the medial choroidal artery arises from the parietooccipital branch of the posterior cerebral artery (more posteriorly than its usual origin), it courses around the pulvinar to reach the quadrigeminal cistern and the roof of the third ventricle. Also, the dorsal medial nucleus of the thalamus receives some branches from the medial choroidal artery. Additionally, there are anastomoses between the lateral and medial posterior choroidal arteries.

Other lesions that may cause thalamic enlargement and therefore simulate thalamic neoplasm are pinealomas and tumors arising in the posterior third ventricle. Either of these may invade the thalamus unilaterally or bilaterally.

References
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Fig. 11. Case 10. The lateral posterior choroidal arteries are markedly stretched and laterally displaced on both sides (arrows).
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Fig. 13. Intraventricular meningioma. The anterior choroidal artery is hypertrophied (open arrows) and supplies a rounded vascular lesion (solid arrows) which demonstrated a dense homogeneous blush on later serial films.

Fig. 14. Case 2. Vertebral angiography, lateral (left) and anteroposterior (right) projections, showing marked stretching and posterolateral displacement of the lateral choroidal arteries on the left (solid arrows). The medial choroidal arteries are hypertrophied and displaced posterosuperiorly (open arrows).
The lateral posterior choroidal artery is enlarged and displaced posteriorly and superiorly (solid arrows). The medial choroidal arteries are also enlarged and elevated (open arrows). A ventriculogram demonstrated a right thalamic mass, and surgical biopsy revealed a mixed glioma.

Fig. 15. Case 6. The lateral posterior choroidal artery is enlarged and displaced posteriorly and superiorly (solid arrows). The medial choroidal arteries are also enlarged and elevated (open arrows). A ventriculogram demonstrated a right thalamic mass, and surgical biopsy revealed a mixed glioma.

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