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MACRORADIOGRAPHY IN 4 TIMES MAGNIFICATION APPLIED TO CEREBRAL ANGIOGRAPHY*

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SUMMARY

This is the first time that macroradiography in four times magnification has been applied in the field of cerebral angiography.

The macroradiography can demonstrate much more clearly the state of branching of the arteries arising from the carotid syphon. In the brain tumor the finer structures of the tumor mass such as tumor stain are well demonstrated. In the arterio-venous fistula the finer communication between both vessels can be easily observed in detail by this technique.

It was found that macroradiography is useful and advantageous clinically in the various points mentioned above when compared with normal cerebral angiography.

INTRODUCTION

In general discussion our attentions have been directed to the relatively rough structures of the vascular system in the usual cerebral arteriography. But we should pay more attention to the changes in the finer structures of the vascular channels in order to find early minor changes in intracranial lesions, and we considered our 4 times direct magnification radiographic technique to be useful in discussing the finer changes in the intracranial vascular channels. The reason lies in macroradiography having the advantage of revealing findings which are not possible by routine radiography and in greater detail.

METHODS

No meal is given before the examination. The patient is placed on the radiographic table in the supine position. Under local anesthesia using 0.5%–1% Xylocaine, 8 ml. of the contrast medium (76% Urografin) is injected with a needle percutaneously punctured in the common carotid artery. The roentgenograms are taken immediately after the injection, with the patient's head kept still and fixed.

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The roentgenographic factors are 125 kVp. 2 mA, 0.5-0.9 sec. for A-P view, and 0.3-0 6 sec. for Lat. view. The focal spot-film distance is 106 cm, the focal spot-skin distance 24 cm, the skin-film distance 82 cm.

The film used was of Kodak Royal Blue brand.

The rotational anode tube with very fine focal spot capable of resolving a test chart made of metal wire of 25 μ in diameter was used. The size of the focal spot is difficult to express as it is too small to be measured practically by the usual pin-hole camera method. It was, however, estimated to be less than 50 μ[1) 2)].

At the same time as for the macroradiography the routine cerebral arteriograms are taken under the following conditions; focal spot size of 1×1 mm, 80 kVp, 100 mA, 0.1 sec., focus-film distance 100 cm.

A discussion is made of how the finer vascular structures are shown on the macroradiograms when compared with the routine cerebral arteriograms.

RESULTS

The cases examined were a normal person, patients suffering from the arterio-venous fistula and a patient bearing a brain tumor.

Case 1. Normal, male, age 30.

In our lateral macroarteriogram, the carotid syphon is well visualized and the appearance of bifurcation into the anterior and middle cerebral arteries and the running fashion are much more clearly visualized than in the routine arteriogram (Fig. 1). The vascular walls are smooth and even.

In the A. P. macroadiogram, A. striatica rostralis is well visualized as arising from the anterior cerebral artery, and A. striatica caudalis also so from the middle cerebral artery (Fig. 2). On the other hand, in the routine radiogram these fine vascular channels are not clearly shown.

Case 2. Glioblastoma multiforme, male, age 34.

In childhood, the patient injured the head by falling from a height of 3 meters.

The patient has had attacks of cramp every 6 months on the left cheek, for the past 3 years. During the attack, the left hand shows slight numbness. The systolic blood pressure is 180 mmHg. The EEG shows spike and sharp wave in the right frontal area.

A right carotid arteriography was performed. In the lateral view, along the insular portion a band-like vascular proliferation is prominently seen, from which a vascular communication with the sagital sinus is seen (Fig. 3).

In the macroradiogram, the band-like vascular proliferation seen in the routine arteriogram is found to consist of finer vascularity arising from the insular portion and angular artery. This is clearly demonstrated only in this

macroradiogram. These findings can be taken for conclusive diagnosis of a vascular rich brain tumor (Fig. 3), and was verified by the existence of glioblastoma multiforme at operation.

Case 3. Arterio-Venous fistula, male, age 38.

The patient had an attack of loss of consciousness following dizziness and nausea about 5 years ago. Since then the patient complained of palsy of the right half of the body. Under the diagnosis of subarachinoideal bleeding, the patient was treated for 5 months and recovered. The cerebro-spinal fluid was found to be bloody. The patient had another attack of palsy of the right leg while watching the television after taking liquor. At this time the cerebro-spinal fluid was also found to be bloody.

Disturbance of speech continued for one month and the patient became forgetful. Right hemi-migraine and hydrosis of the right half of the body increased.

The routine carotid arteriogram shows an anomalous arteriovenous communication in the region of the insular portion of the middle cerebral artery which runs to the straight sinus in the lateral view. But the details of the vascular communication are not clear.

The macroradiogram clearly demonstrates an arterio-venous communication in detail, occurring in the periphery of the anterior choroidal artery branching from the carotid syphon just proximal to the anterior cerebral artery. At this portion many finer linear vascular formations and punctate shadows are seen, and after passing this vascular channel, two relatively thick vascular channels appear and lead to the straight sinus. These findings at the site of this a v malformation can only be demonstrated clearly on the macroradiogram (Fig. 4).

Case 4. A-V fistula, female, age 27.

The patient became aware of slight weakness in the right elbow since 3 years ago, and numbness of the right thumb, headache, and numbness of the right angle of the mouth since 5 months ago. Difficulty of speech was also noted. Generalized convulsions and unconsciousness occurred since then and these attacks became rather frequent.

Routine carotid arteriogram shows abnormal vascular formation in the periphery of the posterior temporal artery which runs into the straight sinus.

In the macroradiogram, these are seen as finer vascular communications at the site of the A. V. fistula shown up in more detail than in the ordinary arteriogram (Fig. 5).

DISCUSSION

The high magnification radiography has been applied to the arteriography of various parts of the body, clinically and also experimentally[4]. But these

were performed by a focal spot of 0.3 mm in size, so that the maximum magnification has been limited to only two times.

It has been stated by Büchner[7] and Takahashi[5) 8)] that two times macroradiography with an X-ray tube having a 0.3 mm focal spot would be difficult in adding further information due to the resolving power, to that obtained by normal radiography. Based on this an X-ray tube, though of fixed anode, with less than a 0.3 mm focal spot was experimentally prepared by Takahashi in 1954[8)]. Later, a rotating anode tube with an ultrafine focal spot was produced and the possibility of higher magnification, such as direct 11 times magnification, was reported for the first time by Aderhold und Seifert in 1954[3)], and 15 times magnification by Takahashi in 1957[6) 9)].

The high magnification radiography using an ultrafine focal spot, such as 50 μ, has never been applied in the field of cerebral arteriography.

As stated above, our fine focal spot tube[6)] is capable of resolving the test pieces of 25 μ in diameter. The vessels taken by this fine focal spot tube can be expected to be imaged on the radiogram to up to the size of 25 μ in diameter, if the X-ray absorption is the same as between the test pieces and vessels. But the absorption rate is different for the vessel and metal, the absorption of the latter being larger than the former. When a vessel of 25 μ diameter is filled with contrast medium, theoretically, its image should be clearly shown up, but as the contrast between the vessel and its surrounding tissues is poor a taper effect[1)] results.

The positioning of the skull is also rather difficult because the X-ray tube and the film are fixed in definite positions. The exposure time of 0.3–0.9 sec. is rather longer for the arteriography, because the limitation of the total milliampares tolerated by targets of the fine focal spot is small. This requires keeping the head fixed in position. Despite these difficulties in procedure, the finer structures in vascularity of the brain can be demonstrated by this technique.

For instance the branching of the arteries arising from the carotid syphon is clearly demonstrated. The small arteries such as the rostral striate artery, caudal striate artery including pallido-thalamic artery, pallido striate artery and anterior choroidal artery, ophthalmic artery, iris artery are also well visualized. These arteries are faintly visualized even on the routine arteriogram, but are easily visualized on the macroradiogram, because the magnification improves the visual acuity by the gap effect[1)]. The vascular structures of the brain tumor and the site of fistulous communication of vessels are especially well demonstrated due also to the gap effect. Therefore, the detection of abnormal vascularity becomes quite easy.

CONCLUSIONS

Macroradiography can demonstrate easily and much more clearly the state of branching of the arteries arising from the carotid syphon such as rostral striate artery, caudal striate artery, including the pallido-thalamic artery, pallido-striate artery and finer vascularity such as tumor stain, arterio-venous fistulous communication, and the changes of the vascular wall are also demonstrated in detail by this technique.

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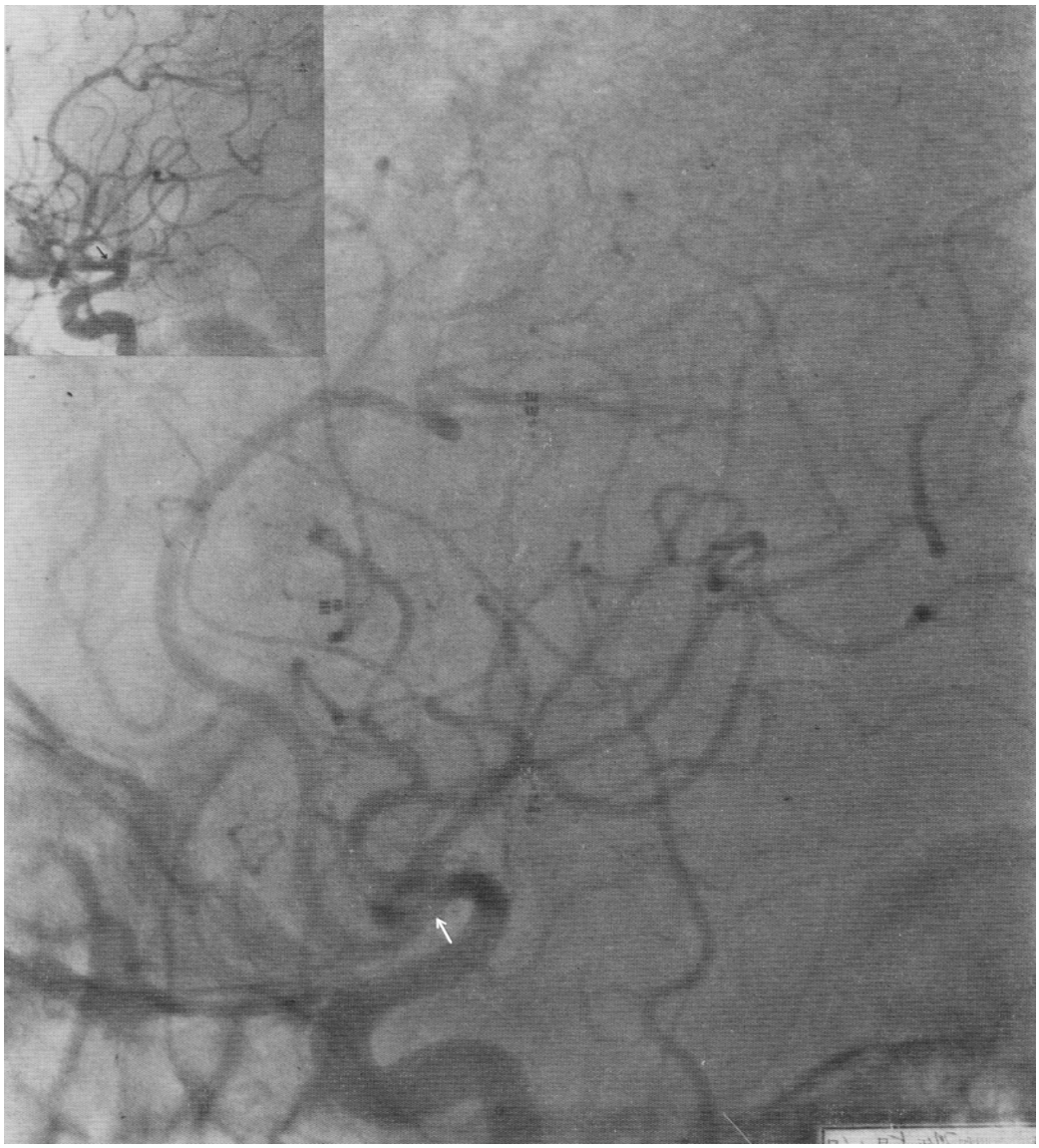

FIG. 1. NORMAL. In the enlargement arteriogram, the carotid syphon is well visualized and the appearance of bifurcation into the anterior and middle cerebral arteries is much more clearly visualized than that of the routine arteriogram. (↑) (Scale: 3/5)

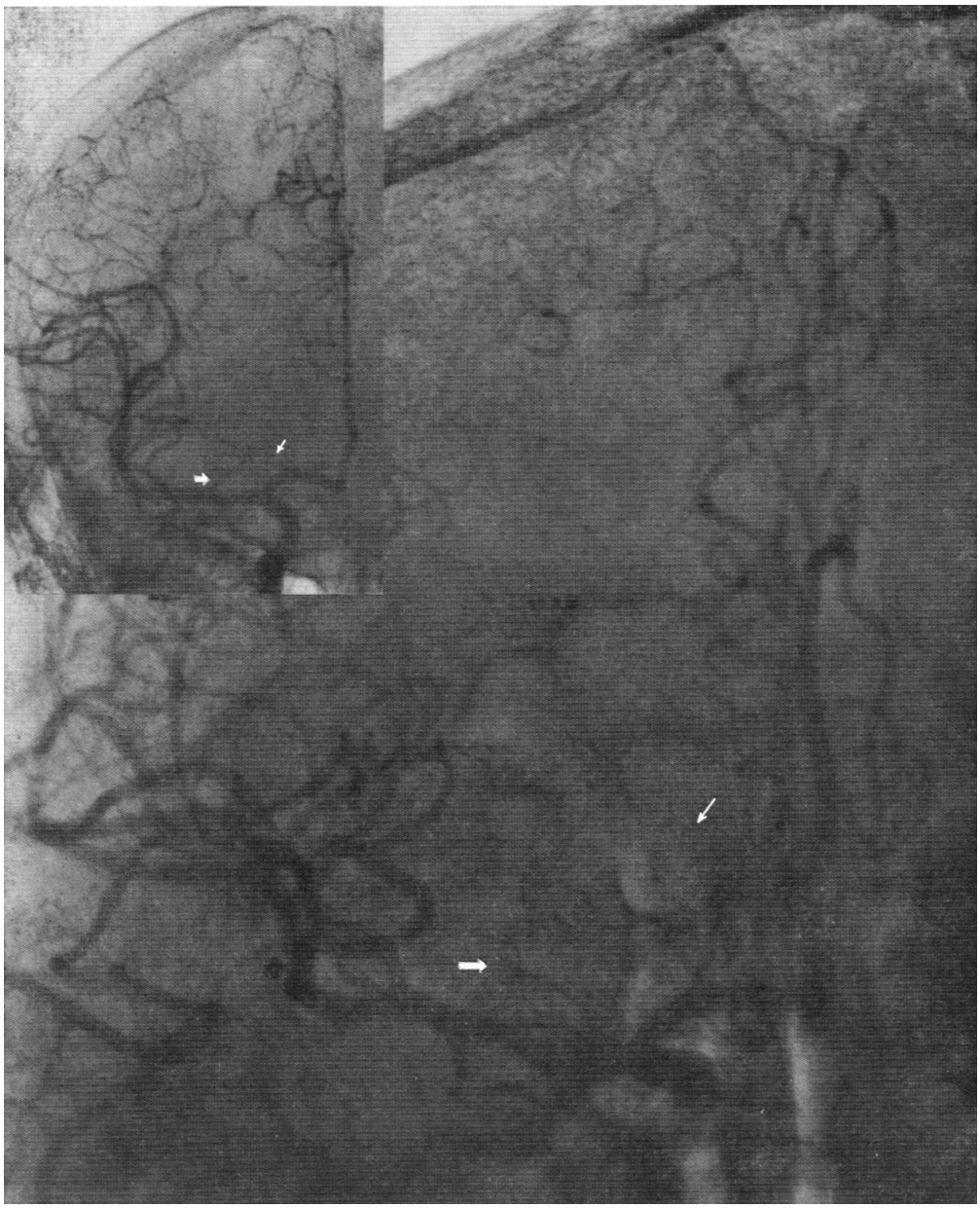

FIG. 2. NORMAL. In the enlargement arteriogram, A. striatica rostralis (↑) is well visualized arising from the anterior cerebral artery, and A. striatica caudalis (⇑) is also well visualized coming from the middle cerebral artery. (Scale: 3/5).

FIG. 3. GLIOBLASTOMA OF THE PARIETAL LOBE. There are many feathery finer arterial proliferation arising from the parietal artery, particularly its finer structures are well recognized, while the routine arteriogram shows only a relatively broad band-like shadow along the parietal artery. (↑↑↑) (Scale: 3/5)

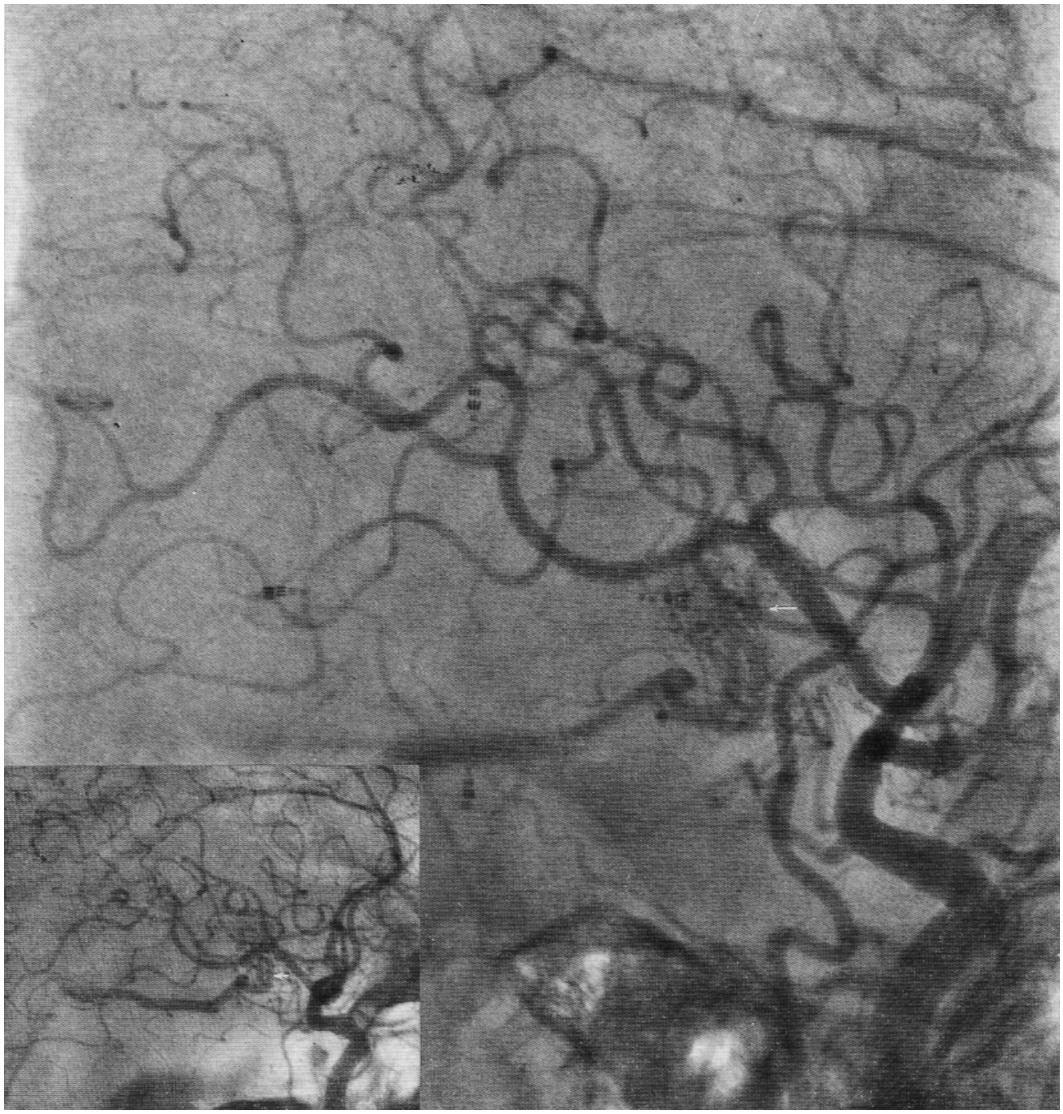

FIG. 4. ARTERIO-VENOUS FISTULA. There is a vascular anomalous communication in the suprasellar region. The enlargement arteiogram reveals that the communication arising from the anterior choloidal artery and the structure of arterio-venous fistula are much more detailed. The punctiform shadows are grouped together at the site of anastomosis in the enlargement arteriogram. (↑) (Scale: 3/5)

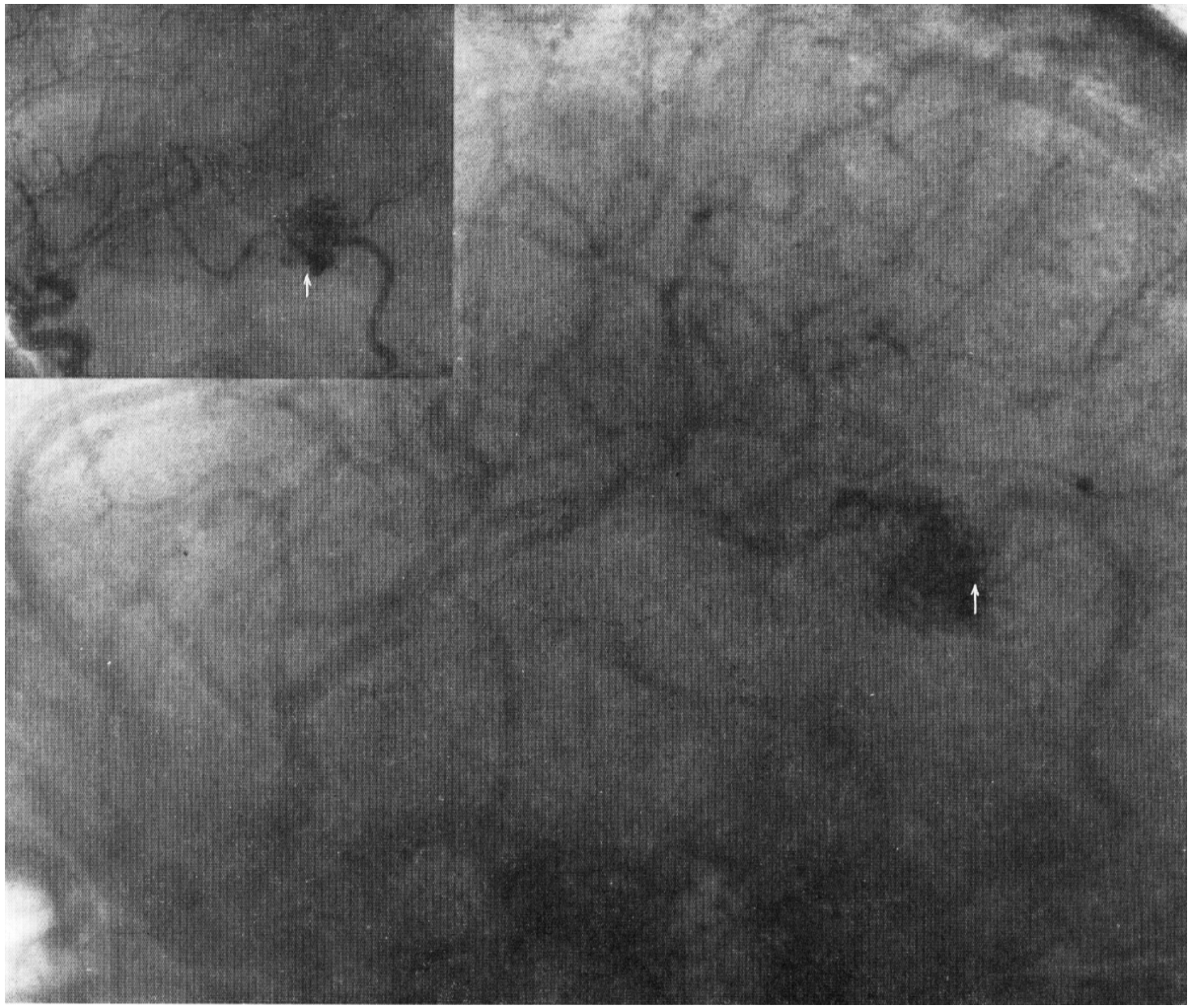

FIG. 5. ARTERIO-VENOUS FISTULA. In the enlargement arteriogram, there are finer vascular communications at the site of arterio-venous fistula which are more slightly detailed than that of the routine arteriogram. (↑) (Scale: 3/5)