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# Brain Scanning; Normal Anatomy With Technetium-99m Pertechnetate

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Brain scanning is an area of nuclear medicine which recently has developed into widespread usage. Before pathological processes can be accurately evaluated on such scans, an understanding of the normal anatomy involved is necessary.

The purpose of this paper is to outline briefly the normal anatomical pattern on the anterior, lateral, and posterior views, and to describe a recently employed top view.

In current applications of radioisotopes to brain scanning, isotopes or compounds are used which will not diffuse across the blood-brain barrier of the normal brain but instead will remain within the blood vascular system. These substances outline the normal brain as areas of lack of activity. Pathological processes such as tumor, infection, or infarction may cause a breakdown of the normal blood-brain barrier, and abnormal areas of increased activity are visible on the scan.

Recently, we have performed brain scans using pertechnetate ($^{99m}$Tc), a pure gamma emitter (140 KeV) with a half-life of six hours. Comparison top views using chlormerodrin ($^{197}$Hg) also will be described.

Technetium is an element of the manganese series, closely related to the halogens. In its pertechnetate form, it behaves similarly to the iodide ion and is concentrated in the salivary glands, gastric mucosa, and thyroid (1).

Because of the small amount of $^{99m}$Tc required in clinical procedures (less than .002 $\mu$g), chemical toxicity has not been considered a problem. When using 10 mC of $^{99m}$Tc, radiation toxicity has been calculated to give 100 mr total body dose (2, 3). Target organ doses for intravenous administration are in the order of thyroid—1 rad, gastric mucosa—.8 rad, liver—.7 rad, and large bowel—1 rad.

## METHOD

Technetium is obtained from a column of alumina on which molybdenum ($^{99}Mo$) in the form of molybdate is absorbed. By eluting this column with physiological saline, pertechnetate ion is readily separated from the molybdate. This eluate is caught in a pyrogen-free vial, and autoclaved before intravenous administration.

Using a three-inch diameter by two-inch thick thallium activated NaI crystal, scanning is begun approximately fifteen minutes after administration of technetium-99m. The machine[1] is set at the $^{99m}Tc$ peak of 140 KeV. Scanning is done in both directions at 90 cm/min with a spacing of one-eighth inch. Background suppression of ten per cent was employed. A 19 hole collimator is used. The time required for each view is approximately fifteen minutes.

Because of the relatively high count achieved with the use of $^{99m}Tc$, a more uniform appearance was noted than in previous scans in which other radioisotopes were used. Anatomical landmarks are more easily appreciated with the use of $^{99m}Tc$, although they are also seen by using other methods. Correct identification of these normal structures assists in the identification of abnormal concentrations of radioisotope.

On the *anterior view* (Fig. 1) both cerebral hemispheres are clearly encircled by vascular areas of increased activity. Superiorly we see the superior sagittal sinus as a dark area of activity, laterally diploe and superficial vessels and inferiorly the vessels in the region of the petrous ridge. The cavernous sinus and midline cerebral vessels cause increased activity along the lateral inferior margin of the scan.

The *posterior view* (Fig. 2) consistently shows us the superior sagittal sinus as an area of increased activity. The midline vascular structures are consistently seen leading to the confluence of the sinuses, but there is a wide variation in the amount of activity noted in the lateral sinuses. This is most likely due to the developmental differences in the lateral sinuses. Frequently one lateral sinus is large with the contralateral sinus showing little or no activity. Again the parotid glands are seen if the scan is carried far enough inferiorly.

The *lateral view* (Fig. 3) gives an excellent opportunity to concentrate the majority of information obtained from each cerebral hemisphere. Posteriorly the confluence of the sinuses and lateral sinus are consistently seen when $^{99m}Tc$ is the scanning agent. Inferiorly the muscles of the neck and temporalis muscle appear as dark areas of increased activity. An unusual area of increased activity has been frequently seen in the posterior, temporoparietal region above the anterior position of the lateral sinus. The cause of this accumulation of activity is not definitely known, but this region lies in the area of the choroid plexus and deep veins. Care must be taken to differentiate this area of activity from a pathological mass lesion. At times a curvilinear area of increased density can be seen to extend upwards and posteriorly from the temporal region. We feel that this represents the vascularity of the Sylvian fissure.

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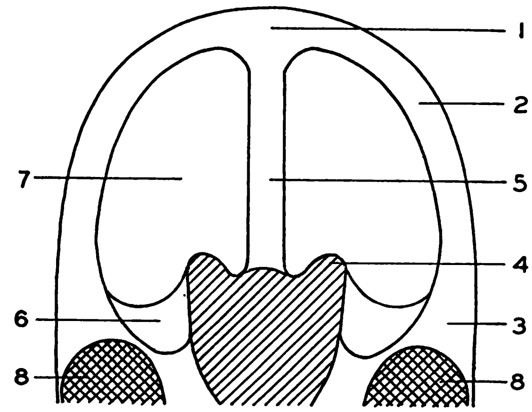
[1]Pho/Dot Scanner—Nuclear Chicago Corp. was used in these studies.



1. SUPERIOR SAGITTAL SINUS.
2. DIPLOË, MENINGES, AND SUPERFICIAL CEREBRAL ARTERIES.
3. TEMPORALIS MUSCLE.
4. CAVERNOUS SINUS.
5. MIDLINE VASCULARITY, INCLUDING ANTERIOR CEREBRAL ARTERIES.
6. SLIGHT INCREASED ACTIVITY DUE TO PETROUS RIDGES.
7. DECREASED ACTIVITY OF CEREBRAL HEMISPHERES.
8. PAROTID GLANDS.

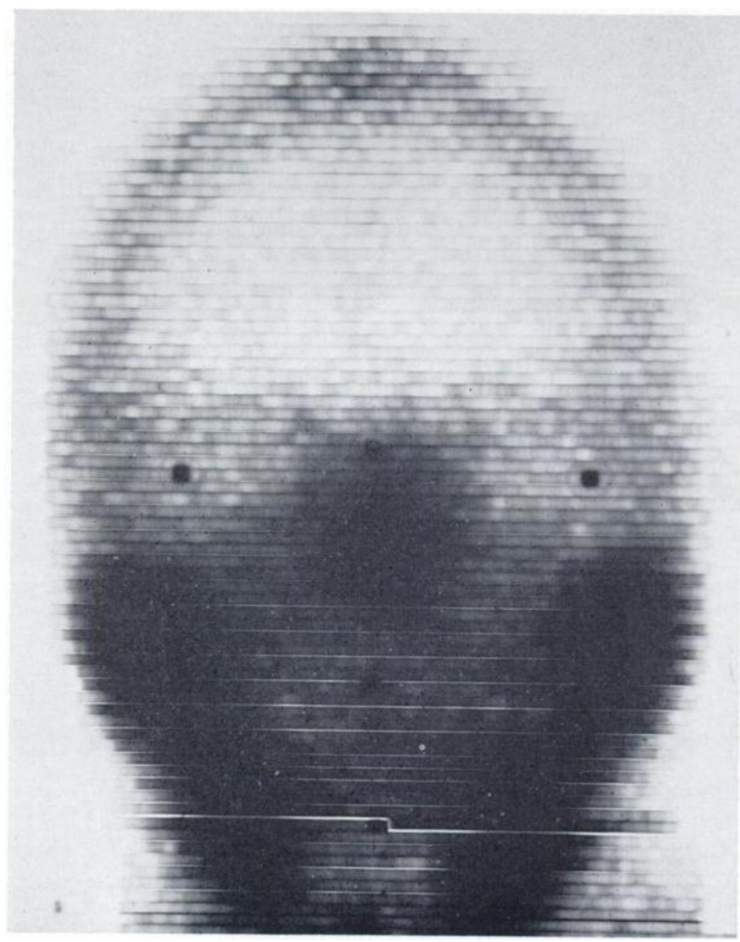
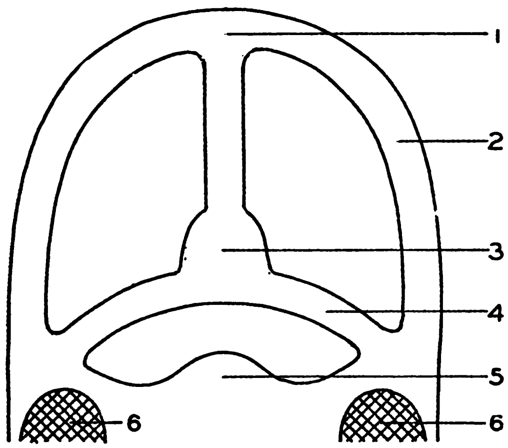


**Fig. 1.** Normal anatomy, front view, showing the typical pattern of the skull outline formed by diploe, meninges, and superficial vessels.




1. SUPERIOR SAGITTAL SINUS.
2. DIPLOË, SCALP, MENINGES, AND SUPERFICIAL ARTERIES.
3. CONFLUENCE OF SINUSES.
4. LATERAL SINUS.
5. BASILAR STRUCTURES, POSSIBLY CAVERNOUS SINUS AND PITUITARY REGION.
6. PAROTID GLANDS.

**Fig. 2.** Normal anatomy, posterior view, the sagittal and lateral sinuses are well seen as is the confluence of the sinuses. The occipital protuberance may present in the confluence of sinuses as an area of decreased activity.

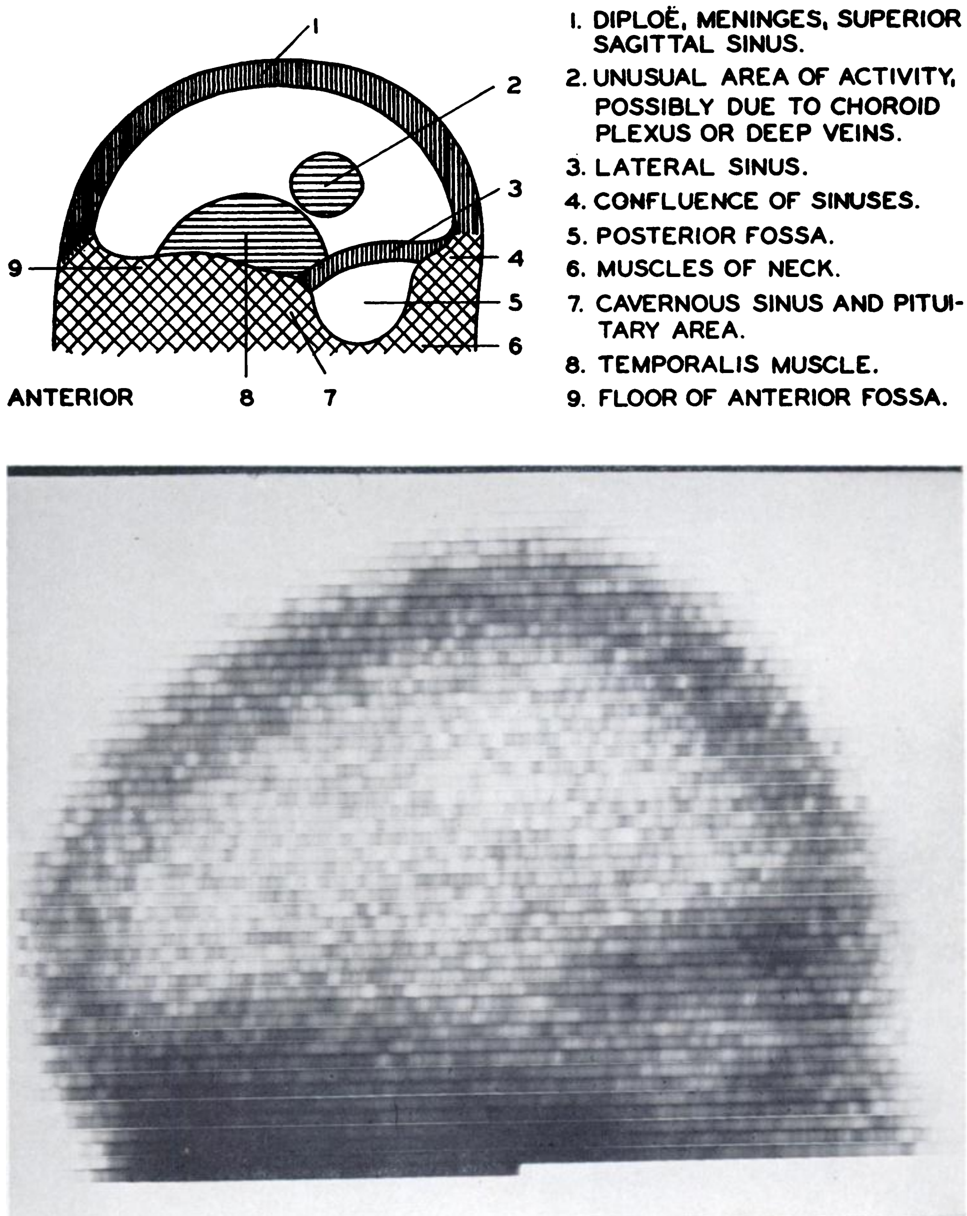
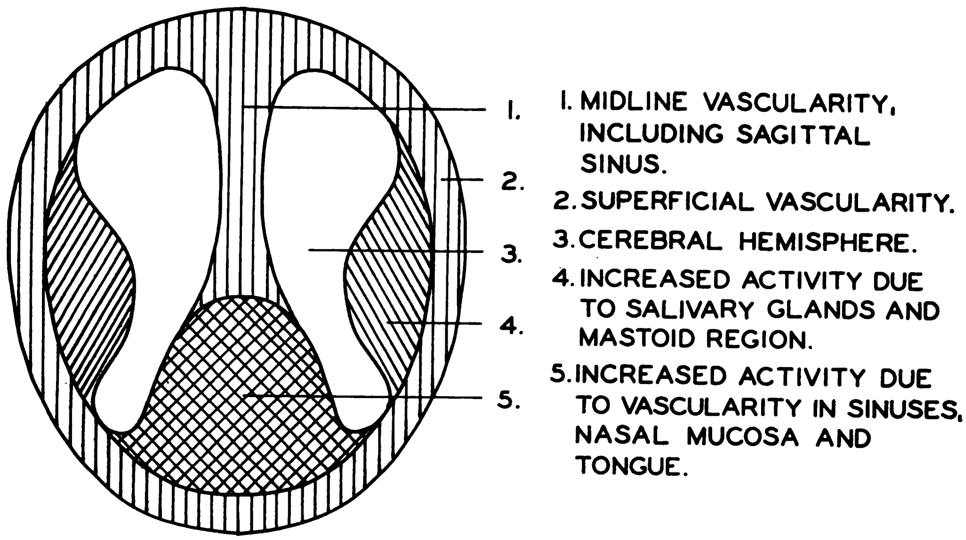



**Fig. 3. Normal anatomy, lateral view, the normal structures are shown in the diagram. Of interest is a frequently visualized area of increased activity in the posterior temporoparietal region. Although not proven we have speculated that this may be due to activity in the choroid plexus or deep veins. If the scan is continued inferiorly, activity is noted in the parotid gland.**



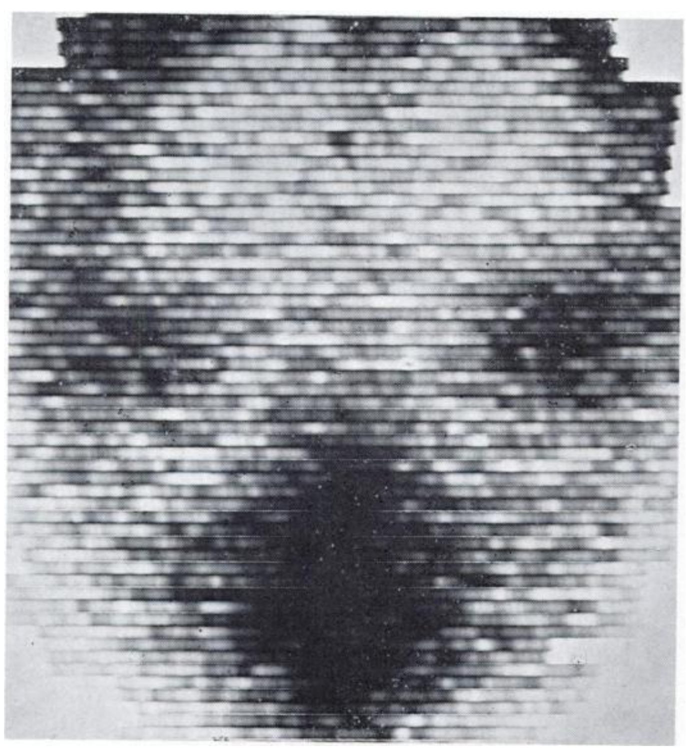
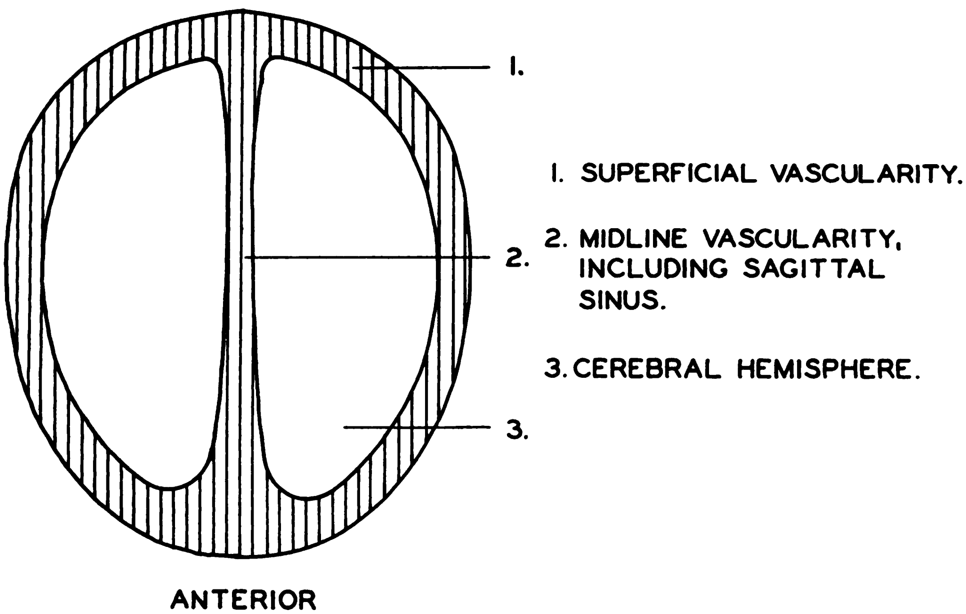



Fig. 4. Normal anatomy, top view, the midline vascular structures are clearly seen as areas of increased activity. Lateral areas of increased activity are thought to be due primarily to the parotid salivary gland with some superimposed density from the mastoid regions. The large area of activity anteriorly is believed due to vascularity in the tongue, nasal mucosa, sinuses, and submaxillary and sublingual salivary glands. Comparison top views using $^{197}Hg$ and $^{99m}Tc$ are shown to demonstrate the additional anatomical details visualized on the $^{99m}Tc$ scans.



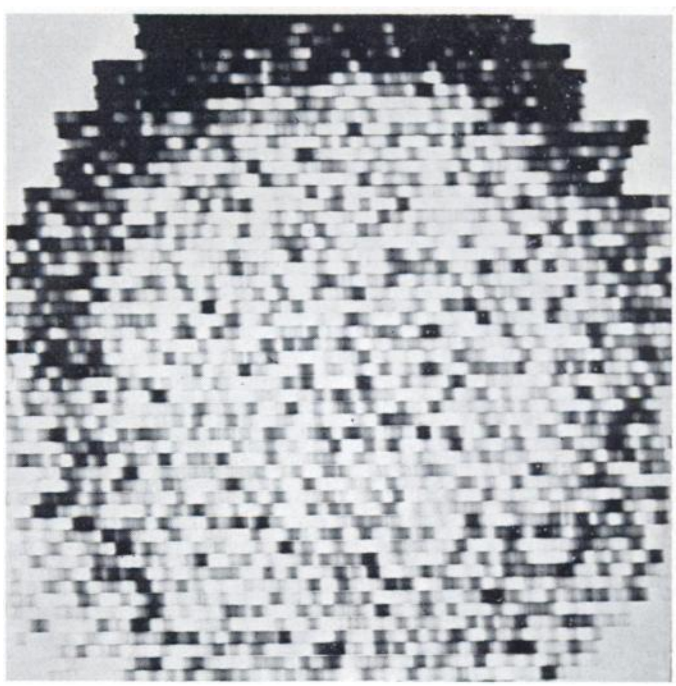



Fig. 5. Top view done with $^{197}Hg$ chlormerodrin. Note absence of activity in several areas compared to $TcO_4$ scan. If disease is suspected in these areas, $^{197}Hg$ would be preferable for the top view.

The *top view* (Fig. 4) has been utilized in our department for two years to clarify lesions lying along the superior portion of the cerebral hemispheres. This was described recently by Overton and Associates (4). Again the sagittal sinus is consistently seen as midline activity. Laterally in the approximate midportion of the scan the parotid glands stand out as greatly increased areas of activity. Anteriorly we see a large oval shaped area of activity that is contributed to by the tongue and vascularity in the sinuses, nasal mucosa and the saliva.

We found saliva, when removed from the mouth and placed under the scintillation crystal, to have a high concentration of activity. By blocking the tongue with a lead shield we were able to reduce the count-rate over this anterior region by twenty per cent.

The top view done with $^{197}$Hg chlormerodrin (Fig. 5) has an altogether different appearance as shown. Some regions which are seen as dense in the pertechnetate scan (including nasal mucosa and mouth regions, as well as parotid glands) are not demonstrated on the $^{197}$Hg chlormerodrin study. Chlormerodrin may therefore be of greater value than pertechnetate, when a study is concerned about the area that may be obscured by concentrations of pertechnetate in the above mentioned regions.

## SUMMARY

The use of $^{99m}$Tc in brain scanning has made it possible to visualize better anatomical details not seen quite as well using other scanning methods. The top or vertex view is discussed in addition to the conventional anterior, lateral, and posterior views.

## ACKNOWLEDGEMENT

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