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# Sonography of the Posterior Fossa

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**An anatomic correlation of sonographic images and anatomy in cadavers was undertaken to establish a foundation for sonographically assisted recognition of structures and their relation to pathology. Such information would be useful for orientation purposes during surgery, for biopsies, and for follow-up studies. A specially designed technique of placing metal markers with sonographically guided needles was used. Anatomic cuts and dissections were subsequently performed. Sonographic clinical material obtained during surgery and in postoperative controls was analyzed based on this experimental work and previous investigations in this area. Detailed anatomy of the posterior fossa can be demonstrated with sonography.**

Technologic developments specially related to sector real time have made it possible for sonography to be used extensively in cranial applications in neonates and small children [1-4]. The diagnoses of hemorrhage and hydrocephalus can be made easily, and anatomic correlations have been published [5, 6]. But to our knowledge no detailed sonographic anatomy of the posterior fossa has been reported. Good representations of infratentorial structures in neonates and small children encouraged further anatomic correlation of the sonographic images and anatomy [7, 8]. Also, our previous positive experiences using sonography for orientation purposes during surgery and for follow-up studies stressed the need for a detailed sonographic anatomy. Its possible use in cytologic biopsies was also considered an objective of this study.

## Materials and Methods

The study used cadavers of adults. One craniotomy was performed in the midline of the vault and another in the occipital bone. The dura was maintained intact.

A sectorial real-time machine (Philips SDR-2000) with a 3 and 5 MHz 100° angle transducer was used. The transducers were placed in either of the craniotomies.

After identification of the main posterior fossa structures, small metal clips of various colors were directed sonographically using a long thin needle to the region of interest. The piece was pushed with a mandrin after the target point was achieved. The metal piece was marked with calipers and the picture recorded (fig. 1). Usually the observation was made with the transducer placed in the occipital craniotomy, with the needle introduced through the vault. The resistance offered by the tentorium was clearly felt when we looked for a posterior target.

Three main points were selected to place the clips. One was in the anterior inferior part of the pons, above the junction with the medulla. The second was in the vicinity of the floor of the fourth ventricle, close to the medial wall of the origin of the right lateral recess. The third was above the right dentate nucleus. These clips were used as points of reference to prove the correct recognition of various structures.

The cerebellum, brainstem, and brain were fixed in situ with formalin injected through one of the vertebral arteries. The specimen was then removed and kept in formalin for 48 hr. At that time radiographs were obtained to check the position of the clips. The specimens were then dissected and thin slices made to localize the clips.

Axial and half-axial planes were selected for sonography by inclining the direction of the beam. Sagittal and parasagittal views were also obtained. Subsequent multiple oblique views were made to show specific structures. Casts of the fourth ventricle and cisterns in situ were correlated with the sonographic results.

Sonographically assisted recognition of structures was made in two cases of acoustic neuromas. Immediate postoperative control was performed in two other cases of cerebellar tumors, comparing the results with those of computed tomography (CT). Follow-up studies were also made of these four cases.

## Results

It is essential to know the direction of the sonographic beam and the plane selected to understand the anatomic details presented.


Fig. 1.—Placement of metal clip. View is somewhat parasagittal. Visible are pons (P), medulla (M), and metal clip (C); also calipers.

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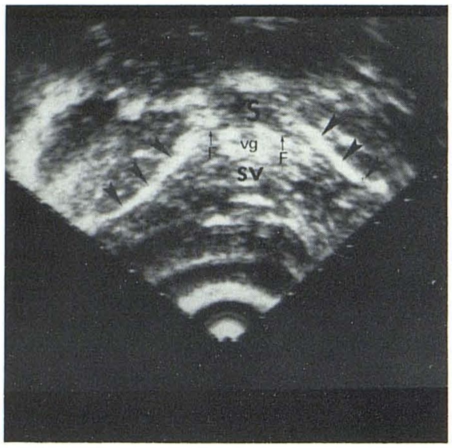


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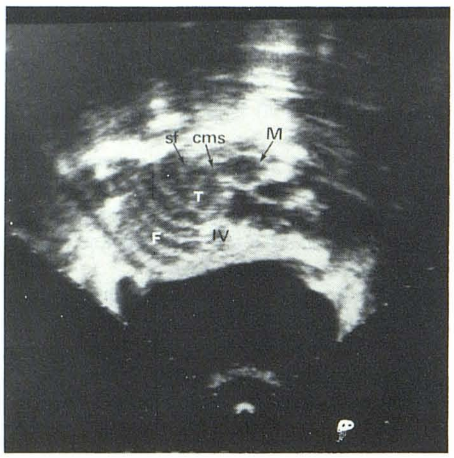


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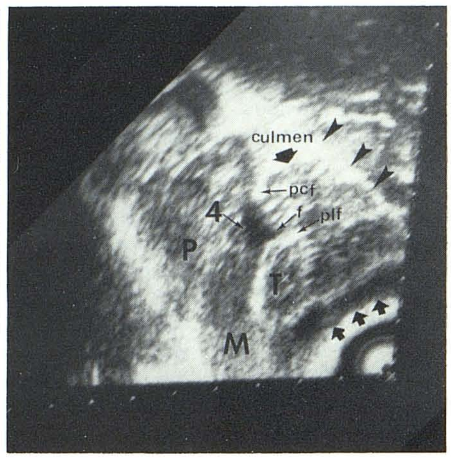


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Fig. 2.—Semiaxial view through occipital defect. Visible are splenium (S), fornix (F), vein of Galen (vg), superior vermis (SV), and tentorium (*arrowheads*).

Fig. 3.—Oblique view. Pons (P), medulla (M), metal clip (C), lateral recess of fourth ventricle (L), posterior superior recess (PS), nodulus (N), posterolateral fissure (PLS), fourth ventricle (4), culmen (*arrow*), and tentorium (*arrowheads*).

Fig. 4.—Low cut at level of medulla. Seen are medulla (M), cerebellomedullary space (cms), secondary fissure (sf), tonsil (T), folia cerebelli (F), and inferior vermis (iv).

Fig. 5.—Sagittal, somewhat parasagittal view. Pons (P), medulla (M), tonsil (T), fourth ventricle (4), posterolateral fissure (plf), fastigium (f), precentral fissure (pcf), culmen, tentorium (*arrow heads*).

With the transducer placed in the occipital craniotomy, set for a high semiaxial plane and with the beam directed toward the tentorial notch, the superior vermis, the vein of Galen, the fornix, and the splenium were demonstrated (fig. 2).

In a more axial plane the fourth ventricle will appear, seen from behind and below. The nodulus is seen, and the posterolateral and posterior parts of the lateral recesses can be recognized. The mesencephalum is better seen in a slightly oblique view.

In more oblique views the lateral recess of the fourth ventricle can be seen clearly (fig. 3).

In lower axial cuts at the level of the medulla, the medulla itself is very well recognized, as are the inferior folia cerebelli, the tonsil, the secondary fissure, and the tonsillomedullary space (fig. 4).

In the sagittal plane the fourth ventricle, vermis, pons, and medulla are well shown (fig. 5).

In a slightly parasagittal plane the tonsil, posterolateral recess of the fourth ventricle, posterolateral fissure, and retrotonsillar space are easily identified. In general, the subarachnoid space is echogenic mainly because of the vessels. Where the space is wide (e.g., the cisterna magna) it appears as an anechoic area, due to cerebrospinal fluid.

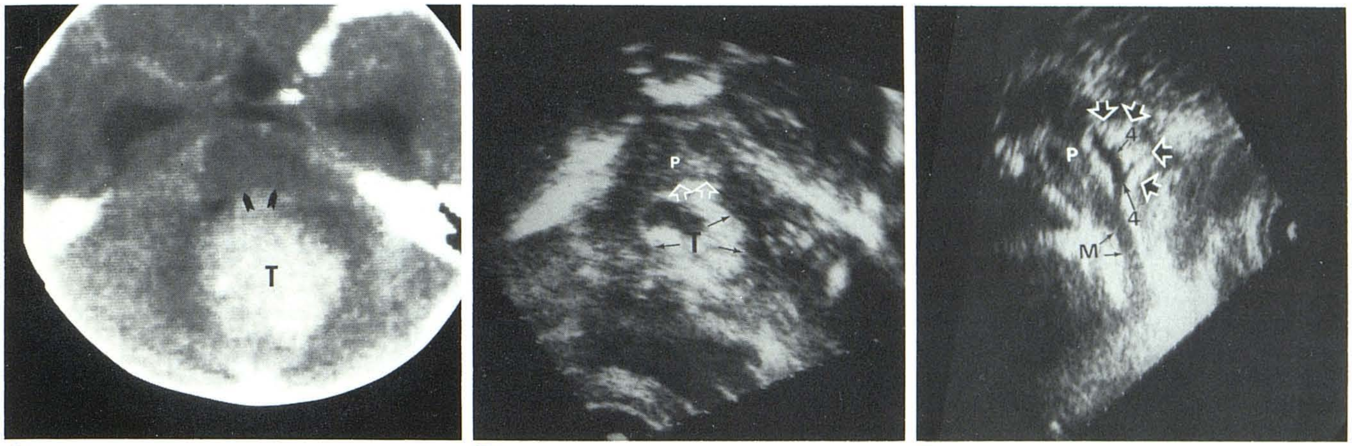
Some differences were noticed between the appearance of the subarachnoid space in cadavers and in patients. There were more anechoic areas in cadavers. This difference is explained by the pulsation of the arteries during life. The arteries are particularly well recognized during real-time observation because of this.

In the two cases of tumors of the cerebellum the correlation between the CT scans and the sonograms obtained through the craniotomy was very precise. One of these cases is illustrated in figure 6. In CT we can see the anterior part of the tumor is partially embedded in the pons (fig. 6A). This is clearly seen in sonography. The representation of the structures is more detailed in the sonogram (fig. 6B). In the sagittal view the site of the tumor as well as its extension is quite evident, the pons and upper part of the medulla are well shown. We can also recognize spaces filled with fluid representing probably a very deformed fourth ventricle (fig. 6C).

## Discussion

It is evident that accurate detailed anatomy provided by sonography can be extremely useful for diagnosis, orientation, and correlations in all tnose cases where there is an adequate window for the sonographic beam. The facility with which we placed markers at selected points gives rise to the possibility of obtaining useful cytologic specimens for diagnoses. That we can now use high-resolution real-time equipment with small probes of different frequencies is promising also. The recognition of relations of tumors or other types of lesions with vessels or other structures is now possible; this should help the surgeon. It is also evident that all other diagnostic methods must be performed before sonography, which should be considered complementary.

The short time required for this method, its lower cost, lack of




A B C

Fig. 6.—Cerebellar tumor. **A,** CT of posterior fossa. Anterior part of tumor (T) is embedded in pons (*arrowheads*). **B,** Sonogram through occipital craniotomy, axial plane. Tumor (T) extension clearly visualized (*black arrows*). Anterior part (*white arrows*) embedded in pons (P). **C,** Sagittal plane. Tumor (*arrows*) in pons (P). Part of deformed fourth ventricle (4) and medulla (M) also indicated.

ionizing radiation, and, now, its accuracy make it quite useful for follow-up studies through the postsurgical craniotomy window.

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