ATLAS OF THE HUMAN BRAIN AND THE ORBIT FOR COMPUTED TOMOGRAPHY

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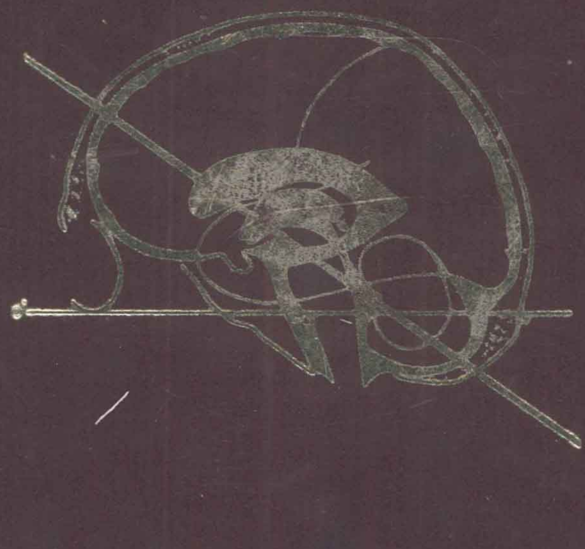

2nd EDITION

SECOND EDITION

ATLAS OF THE HUMAN BRAIN AND THE ORBIT FOR COMPUTED TOMOGRAPHY

By

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TO
Nancy, Stella and Suzy,
Our Wives

PREFACE TO 2nd EDITION

A demand for more extensive labeling of the CT scans and the rapid improvement in anatomic detail achieved by recent technical developments has led the authors to publish a second edition of this atlas.

At present, General Electric scanning equipment consistently produces scans with the most anatomic detail. As with other scanning equipment some levels are shown in greater detail than others because of many factors. Even with this drawback, the scans we have picked are remarkably detailed. We replaced all the original scans except pages 52, 54 and 58 where similar planes couldn't be matched.

The detail in the new scans have allowed much greater labeling than in the previous ones. In addition, at the request of our neurosurgical associates, we have indicated the *external auditory meatus* on the three planes.

We wish to thank Dr. Saul Taylor, Department of Radiology, St. Paul Ramsey Hospital, St. Paul, Minnesota for providing the 1978 GE scans taken on his model 8800 scanner. We also want to thank Tom Spagnolia and Jeanne Smith who did the tedious work of labeling the new pictures and Jeanne Smith and Carolyn Eldridge who revised the index.

JH
WRS
CMS

June 1979

INTRODUCTION

PURPOSES

The recent development of computed tomography* has afforded an opportunity to visualize the cross-sectional anatomy and pathology of the brain, ventricular system, and subarachnoid cisterns. The technique provides a non-invasive means for investigating human intracranial anatomy and pathology and produces computed pictures that depict cross-sections of the brain and orbit.

The cranial computed tomography equipment most widely used is designed in such a way that sections of the brain at angles from 0° to 35° to Reid's baseline can be obtained, but not the more standard coronal or sagittal planes. Cranial scanning with recent body scanning equipment does allow a wider selection of section angles, and coronal sections with such equipment are possible. The most commonly used planes of section, however, are angles between 25° and 35° to Reid's baseline, passing through the anterior, middle, and posterior cranial fossae. These angled planes of section are significantly different from the traditional ones, and no anatomic references are presently available to aid in the interpretation of the computed prints. The purpose of this atlas is to provide a practical and accurate anatomic reference book of whole brain sections that are matched with corresponding computed tomographic cuts in the same plane.

PLANES OF SECTION

Universal aggreement on a standard plane of section has not been reached, but the ones currently most widely used are angled 25° to 35° craniocaudally to Reid's baseline (anatomic or anthropologic baseline). These planes allow routine visualization of supratentorial and posterior fossa structures. Although the orbits can be seen at these angles, the 0° plane is preferable. Techniques have already been developed for computer reconstruction of coronal or sagittal planes from the data obtained during horizontal scanning. There are therefore innumerable planes of section that could be produced. Coronal and sagittal brain anatomy references are already available and such planes of section will not be included in this work. This atlas will be limited to the 0°, 25°, and 35° planes which are now in common use.

METHODS

Preparation of Sections

Whole head sections were obtained from non-fixed cadavers frozen solid at 0°. The cadavers had been donated to the Stanford University Anatomy Department. Reid's baseline (infraorbital margin to the top of the external auditory canal) was marked on the skin and the hair was clipped short. In addition, lines at 25° and 35° angles to the anatomic baseline were marked on the head and sections of the frozen head, approximately 8mm thick, parallel to the three planes, were made with a commercial bandsaw. Accurate right left symmetry in section thickness was maintained with careful freehand guidance. Initial sectioning of frozen, formalin-fixed heads yielded poor results because of brain shrinkage. A considerable number of the specimens were technically unusuable because of distortion that occurred with defrosting. These sections chosen, therefore, had minimal but varying amounts of brain swelling and shrinkage. The lower eight sections at 25° were from a different specimen than the upper four sections. The 0° and 35° sections were from single specimens.

The sections were partially defrosted immediately prior to photography. Five to ten minutes was sufficient for softening the surface, but further thawing made handling the sections difficult. Minor swelling and surface cracking was unavoidable. The lower eight sections at 25° were fully defrosted and formalin-fixed for several hours prior to photography, which resulted in some artifactual shrinkage. All sections

* The term "computerized axial tomography" was changed to "computed tomography" at the First International Symposium of Computerized Axial Tomography in Montreal, 1974.

were eventually formalin-fixed for ease in handling during subsequent anatomic study.

The authors appreciate that the quality of fine anatomic detail suffers considerably by freezing and bandsaw sectioning when compared with the more traditional methods of brain sectioning following perfusion fixation. The amount of anatomic detail preserved in our specimens is surprising, however. Demonstration of the relationships between brain, ventricular system, basal cisterns, skull base, and orbits, however, was believed to more than compensate for the loss of fine detail.

SELECTION OF COMPUTED TOMOGRAPHY PRINTS

Good quality EMI computed tomography prints from studies at the 0°, 25°, and 35° planes were saved over one and a half years at the Stanford University and West Florida Hospitals. The prints were from studies that had been interpreted as normal, and artifacts are present on some of the prints. The 0° computed tomograms were obtained using columnation for 8mm section thickness. The 25° and 35° computed tomograms were of 13mm section thickness. It is important to bear in mind that the computed tomogram prints represent an integrated tissue thickness of 8mm or 13mm, while the anatomic specimens show a planar surface. Because of this three dimensional averaging, features occasionally appear on the computed prints that are not on the matching anatomic specimens.

The basal angles in the normal population vary widely. Therefore, there is an expected normal variation of computed prints and of anatomic specimens at a given angle. The computed tomograms and anatomic sections used in this atlas are felt to be anatomically typical for their stated angle.

ORIENTATION DIAGRAMS

The orientation diagrams are the result of repeated efforts to determine what should be shown in the drawings. A schematic simplification resulted in a lateral view of the cerebrum superimposed on midline, brain stem, ventricular, cerebellar and base of skull structures as well as the lateral ventricles. Because of normal anatomic variation from specimen to specimen, the orientation diagrams for the 0°, 25°, and 35° sections of the atlas vary slightly.

TERMINOLOGY AND LABELLING

Because of the wide use of English terms, it was decided for the sake of simplicity to use only one terminology. Most of the terms used are found in the *Nomina Anatomica*, Wiesboden, 1965. When necessary terms were not found in the *Nomina Anatomica*, other sources were consulted and these have been listed in the references.

The labelling of the basal cisterns presented problems because of the lack of standard, accepted, rigid definitions of the cisternal boundaries. Even relatively small cisternal spaces may require a number of different labels to reflect the merging components. For instance, the upper quadrigeminal, the retrothalamic and superior cerebellar cisterns, and the cisterna velum interpositum merge in a small space. In most instances, radiologic cisternal terminology was found preferable to corresponding anatomic terms (e.g., retrothalamic cistern instead of choroidal fissure).

No attempt was made to label every visible feature on the anatomic specimens since this would have required far more space for labels than is available. For the same reason, we attempted to avoid overly repetitious labelling (e.g., the falx cerebri and interhemispheric fissure). Portions of the lateral ventricles are frequently repeated. To avoid redundancy, we have used frontal horn, trigone, and occipital horn instead of *frontal horn of lateral ventricle*, etc. We have, however, retained *bodies of lateral ventricles* because other structures such as the corpus callosum and the caudate nucleus have a *body* portion. When muscles are indicated, i.e., lateral rectus, superior oblique, etc., we have omitted the word *muscle*.

In labelling the computed tomography prints we emphasized well-demonstrated ventricular, cisternal, and basal bone features in addition to the lobes of the brain. Artifacts were not labelled.

* * * * *

Magnification:

The anatomic specimens have been enlarged 1.2 times.

PHOTOGRAPHY

Pictures were taken with a Burke and James 4" x 5" view camera fitted with a Schneider-Xenar 135mm lens. Kodak Ektapan sheet film was exposed for 1.5 seconds at f16 with a Wratten #58 green filter to increase contrast.

The head slices were photographed on a clear glass plate four inches above an opaque glass ten inches above nine 60 watt bulbs arranged four inches apart in a 3 by 3 matrix. Front lighting was furnished by two Colortran flood lamps located 42 inches from the specimens.

The film was developed for 5.5 minutes in Kodak DK-50 developer at 70°, and negatives were printed on polycontrast paper.

ACKNOWLEDGMENTS

We are indebted to many people who have helped produce this atlas. We wish to thank Dr. Juan Taveras, Dr. Paul New, Dr. William Landau, and Dr. Frank Zboralske who acknowledged the worth of this project and supplied financial support. Mr. John Dolph of Stanford University School of Medicine, Department of Anatomy, helped obtain and section the specimens. We are in debt to Mr. Thomas Spagnolia for his fine orientation drawings and for many hours work on the plates. Mrs. Jeanne Smith also helped label the plates. The initial photography was done by Mr. Max Millsap at Stanford University and the final prints for publication by Mr. Cramer Lewis and his staff in the Department of Medical Illustrations at Barnes Hospital in St. Louis. Mrs. Kathryn Duchek was an invaluable editorial assistant, and spent many hours with Mrs. Patricia Evans organizing the index. Dr. William Hanaway, of the University of Pennsylvania, gave the introduction a final polish for which we are grateful. Mr. Jim Kiske of James Mulligan Printers was an invaluable aid in refining the plates in the final stages of preparation. Finally, we want to thank Warren Green for his enthusiastic support and willingness to accept our project.

W.R.S.
J.H.

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Atlas of the Human Brain and the Orbit for Computed Tomography

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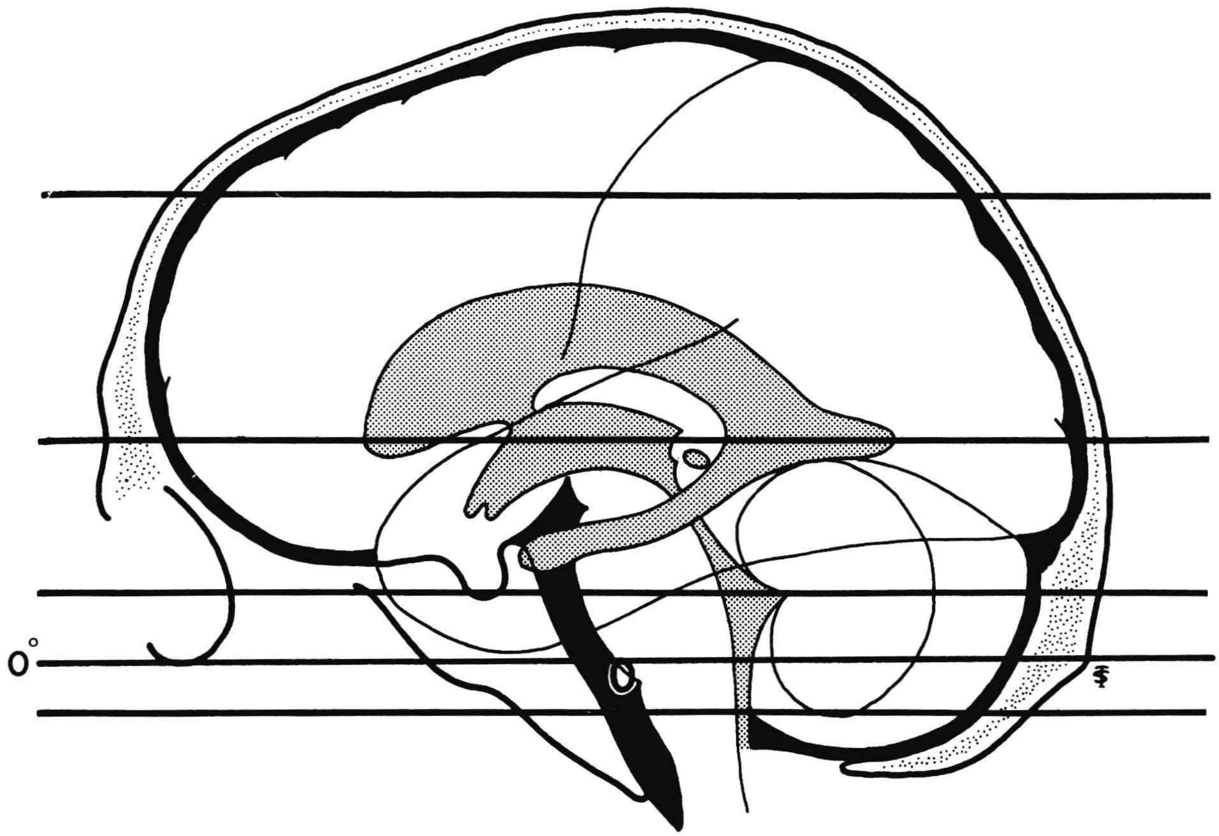
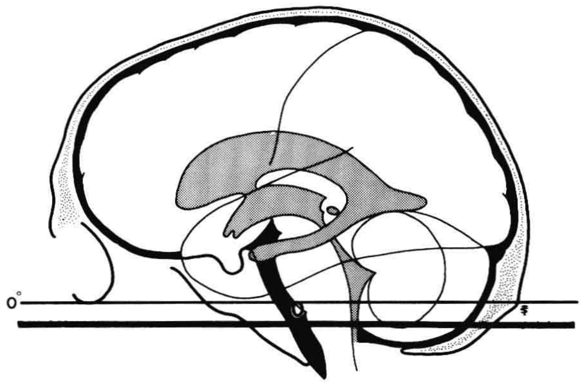
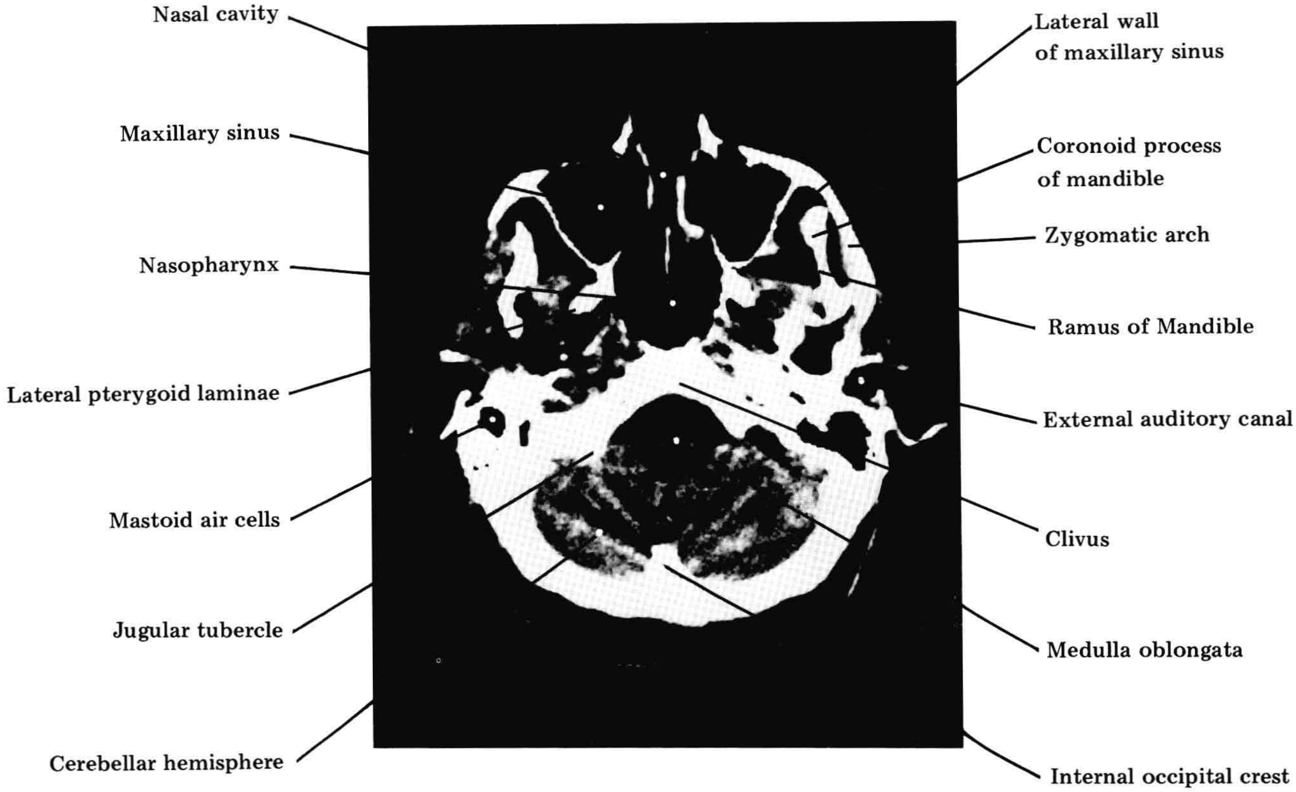
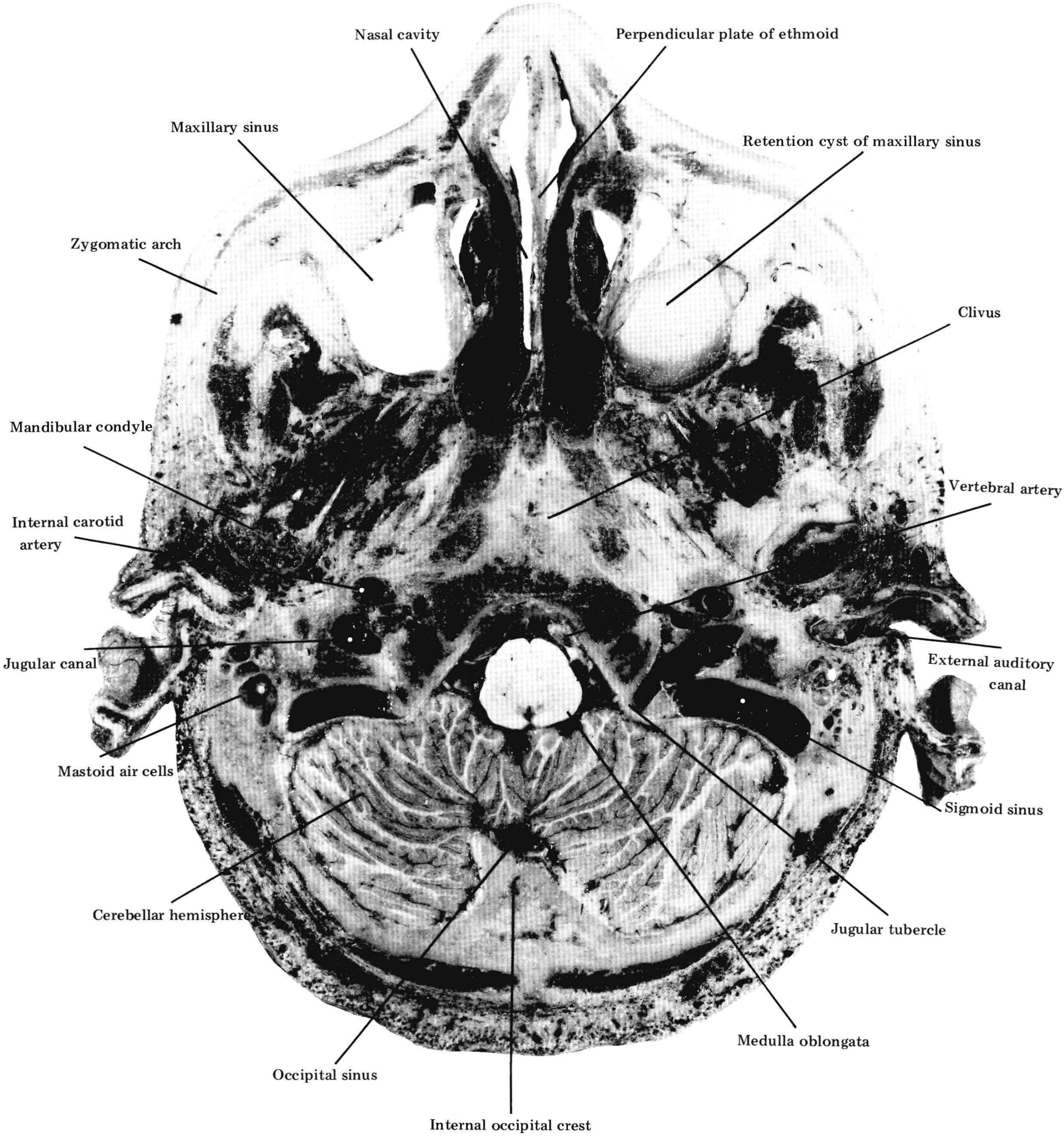
THE HORIZONTAL PLANE



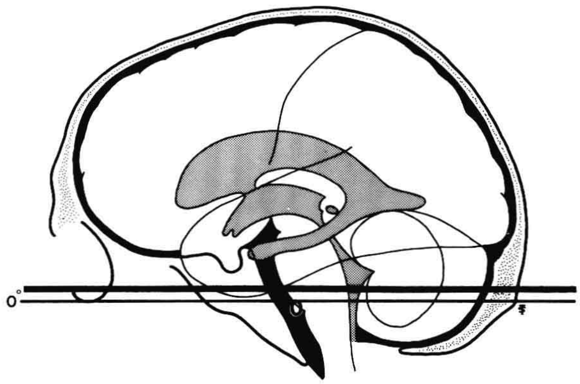
HORIZONTAL SECTION THROUGH THE MAXILLARY SINUS AND THE MEDULLA OBLONGATA x 1.2

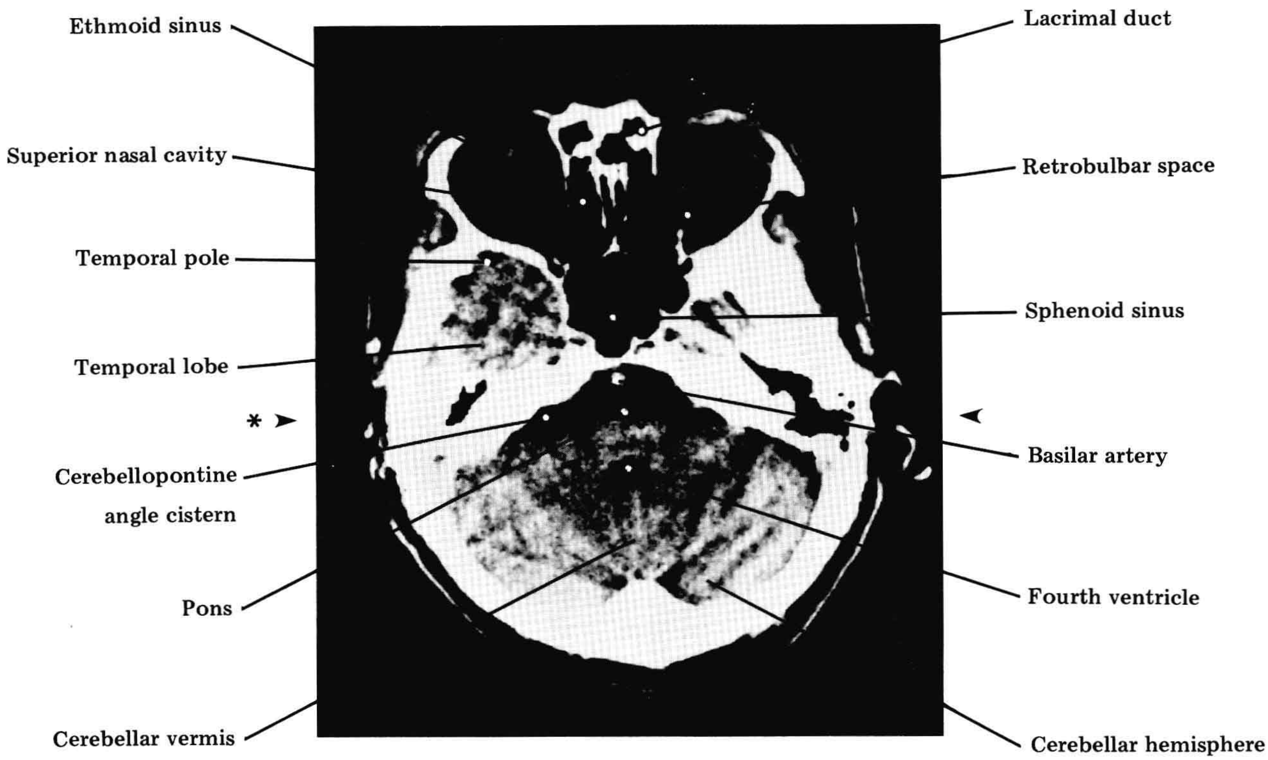




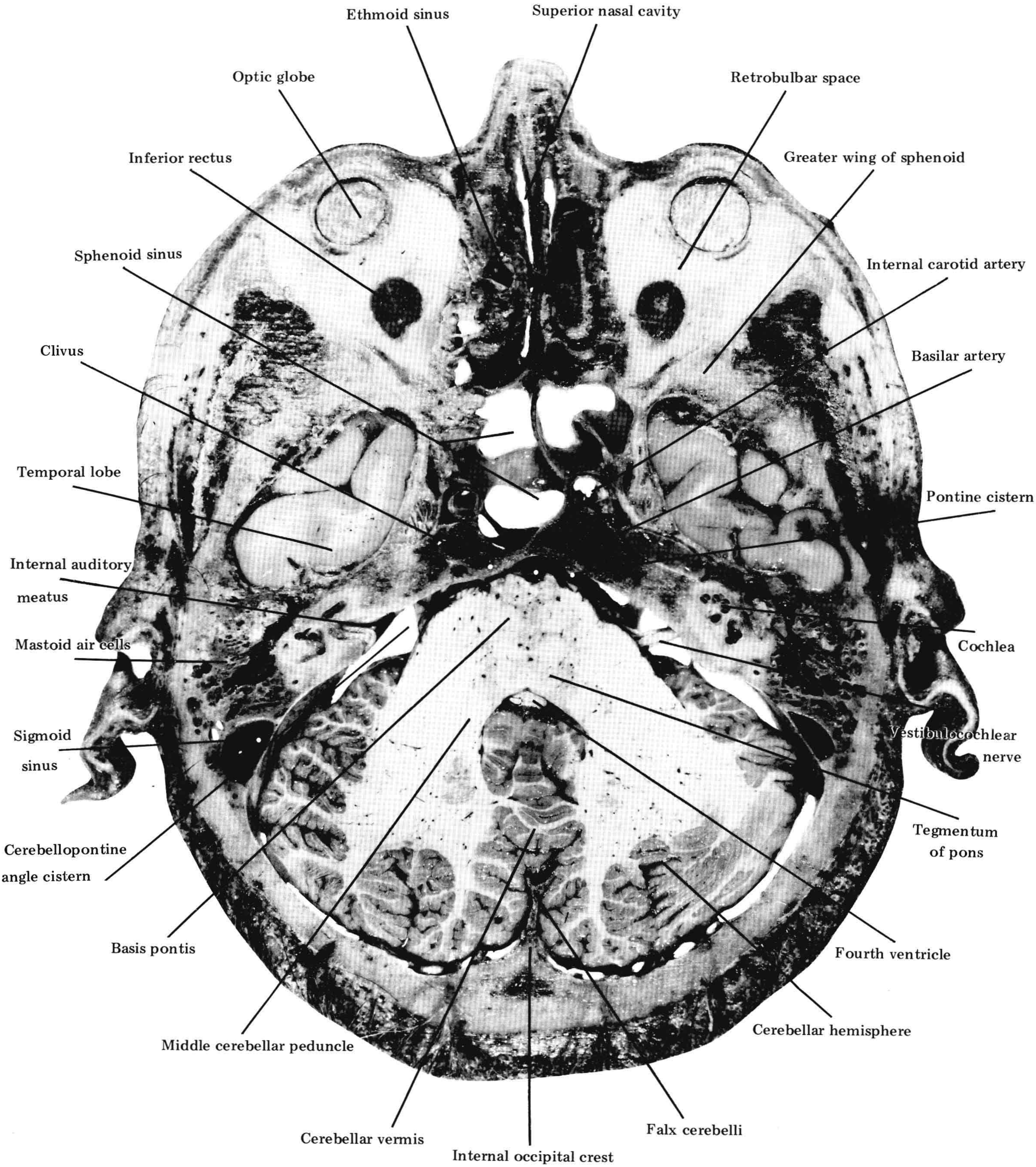

Nasal cavity
Perpendicular plate of ethmoid
Maxillary sinus
Retention cyst of maxillary sinus
Zygomatic arch
Clivus
Mandibular condyle
Vertebral artery
Internal carotid artery
Jugular canal
External auditory canal
Mastoid air cells
Sigmoid sinus
Cerebellar hemisphere
Jugular tubercle
Medulla oblongata
Occipital sinus
Internal occipital crest

HORIZONTAL SECTION THROUGH THE INFERIOR ASPECT OF THE ORBITS AND THE CAUDAL THIRD OF THE PONS x 1.2





* External auditory meatus


Ethmoid sinus
Superior nasal cavity
Optic globe
Retrobulbar space
Inferior rectus
Greater wing of sphenoid
Sphenoid sinus
Internal carotid artery
Clivus
Basilar artery
Temporal lobe
Pontine cistern
Internal auditory meatus
Mastoid air cells
Cochlea
Sigmoid sinus
Vestibulocochlear nerve
Tegmentum of pons
Cerebellopontine angle cistern
Basis pontis
Fourth ventricle
Cerebellar hemisphere
Middle cerebellar peduncle
Falx cerebelli
Cerebellar vermis
Internal occipital crest