SECTIONAL ANATOMY AND TOMOGRAPHY OF THE HEAD

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An atlas of the normal sectional anatomy of the head, consisting of radiographs of 145 sections (each section 1 mm thick) of four human heads sectioned at every millimeter; one head sectioned coronally (frontally), one laterally, a third axially, and a fourth obliquely. Each section is discussed, and the structures contained therein are identified on 145 line drawings. Also presented are 169 hypocycloidal tomograms which were obtained at every millimeter when the heads were intact.

467 Illustrations

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FOREWORD

There is a need for a millimeter-by-millimeter sectional anatomy of the head. This book, with its radiographic and anatomical approach, fills that need.

In addition, the format is unique and presents the material in a practical way. On one page is the illustration: the radiograph of the anatomic section of the head and the corresponding tomogram. On the page opposite the illustration is the descriptive material: the line drawing of the section, with the structures contained in that section labeled, and the discussion of the structures and their relationships.

Every two facing pages—the illustration page and the descriptive page—is a complete unit. There is no thumbing through the book to find the illustration that fits the description.

This format is used throughout for all of the 145 anatomic sections. The illustration is on the left side, and the line drawing, the identification of structures, and the discussion are on the right side.

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INTRODUCTION

The aim of this book is to describe the gradually evolving appearance of the structures of the head, including the face, the orbit, the ear, the sinuses, and the base of the skull, from one millimeter to the next in the three cardinal directions and an oblique direction.

The book is an atlas of 145 radiographs of anatomic sections, obtained at every millimeter and having a thickness of only 1 mm, of four heads sectioned in the coronal, lateral, axial, and oblique directions.

A line drawing of each section is shown, and the anatomic structures revealed on each section are identified on the line drawing.

The descriptions of each section point out the anatomic function of the structures shown on the section and the sources of error in radiographic and tomographic interpretation. The verbal descriptions carry over from one section to the other to form a continuous anatomic narrative.

Hypocycloidal tomograms were taken at every millimeter when the heads were intact, and each tomogram is shown with the radiograph of the corresponding anatomic section.

When all of the sections are added together, one has a detailed three-dimensional concept of the anatomic formation of the structures of the head and their relation to one another.

I proceeded in the following manner: First, a head was placed in a plastic box and fixed in position by means of plastic dowels threaded through the sides of the box. These plastic dowels firmly impaled the head inside the box. I used four cadaver heads: one in the coronal (frontal) projection, one in the lateral projection, one in the axial projection, and one in the oblique projection.

In order to obtain sections in the coronal projection, two variables must be controlled: flexion-extension of the head and rotation of the head. The correct position for the head in the coronal projection was achieved by placing the head so that a line from the superior border of the external auditory canal to the anterior inferior orbital rim was perpendicular to the film. This controlled flexion-extension of the head. Then the rotation of the head was adjusted until a coronal tomogram of the head through the petrous pyramid showed the oval window on both sides. If the head were rotated from the true coronal position, both oval windows would not appear on the same coronal tomogram. Thus, showing the two oval windows on the same coronal tomogram ensured that there was no rotation of the head from the true coronal position.

The positioning for the lateral projection was obtained with a coronal tomogram through the ears, with the head supine, demonstrating the oval window bilaterally. This method ensured that there was no rotation of the head. An axial tomogram through the ear demonstrated the oval window on both sides. This ensured that there was no tilt of the head. If the head were tilted from the true lateral position, both oval windows would not show on the same axial tomogram.

In order to obtain sections in the axial projection two variables must be controlled: tilt of the head and extension-flexion. The head was positioned so that an axial tomogram through the oval window showed the oval window on both sides. This ensured that the head was not tilted. The second variable, flexion-extension, was controlled for the axial projection by placing the head in such a manner that a line from the tragus of the ear to the lateral canthus of the eye was parallel to the film. This line was used in preference to the Frankfort plane (the line from the superior border of the external auditory canal to the anterior inferior orbital rim parallel to the film). I did not use the Frankfort plane because, when tomograms are obtained in the living subject in the axial projection, most persons other than young children cannot extend their heads far enough to place the Frankfort plane parallel to the film. The tragocanthal line is usually the reference line used to obtain axial tomograms in clinical situations. Since the aim of this book is to present the sectional anatomy as it is encountered in the living patient, I decided to use the tragocanthal line as the reference line for the axial projection.

In order to obtain sections and tomograms in the oblique position, I decided to proceed in such a manner that they would be perpendicular to the long axis of the optic canal. The head was rotated 40° toward the opposite side of the optic canal being investigated, and the head was extended so that the tragocanthal line formed an angle of 30° with the film. A radiograph was then obtained to ensure that the image of the optic canal appeared in the infralateral quadrant of the orbit. When a radiograph shows the image of the optic canal in the infralateral quadrant of the orbit, then the long axis of the optic canal is perpendicular to the film.

Once the head was fixed in the plastic box by means of the plastic dowels in its proper orientation determined by tomograms and radiographic films for the respective positions, then the head was tomographed at every millimeter interval. The tomograms were obtained using the Polytome machine utilizing hypocycloidal motion. The hypocycloidal tomograms have a focal plane thickness of 1 mm. Since the tomograms were obtained at every millimeter interval, every portion of the head is demonstrated on these tomograms in the coronal, lateral, axial, and oblique projections.

After the tomograms were obtained—and without changing the position of the heads within the plastic boxes—each head within its plastic box was sectioned. The heads were cut on a specially constructed bandsaw producing sections 1 mm thick. Radiographs of each section were made, and these are seen in the book, together with the tomograms of the corresponding section made when the head was intact.

Since the hypocycloidal tomograms have a focal plane thickness of 1 mm and the anatomic sections are 1 mm thick, then the radiographs of the 1 mm thick sections correspond exactly to the tomograms.

This book is designed for radiologists, for surgeons and clinicians involved in the surgery of facial structures such as the ears, the orbits and sinuses, and the base of the skull, and for students of the anatomy of the head.

The book can be used in the following manner: For the radiologist, the anatomic sections can serve as the ultimate in resolution of structures. The radiologist can use these radiographs of the sections and the corresponding tomograms as a normal reference point. Any loss of resolution from these sections to his tomograms is that much loss from the ideal visualization that he could hope to obtain with tomograms. When one obtains tomograms of a structure, one is really obtaining the sectional anatomy of that structure, and this sectional anatomy presents itself in a way that is different from any other presentation in standard anatomical textbooks, which are mostly oriented toward the anatomy of given structures and not toward the sectional anatomy in which many structures are present. Sectional anatomic textbooks and atlases do exist, but the sections are taken at every centimeter, and this interval is too great if one is going to analyze the smaller structures and configurations in the head. For this reason, the sections in this book are taken at every millimeter.

By using this atlas, the radiologist can determine if the gaps in bone seen on tomograms represent abnormal dehiscence of bone or rather a normal gap produced by an anatomic structure. He will not be misled into errors of diagnosis by parasite shadows.

Any physician interested in the head, ear, eye, sinuses, and facial structures can use these sections to follow the complete sectional anatomy of the structures in which he is interested.

The student of anatomy can trace the gradually evolving appearance of the structures of the head, the face, the orbit, the ear, the sinuses, and the base of the skull from one millimeter to the next in the three cardinal directions and the oblique direction and can thus build up a three-dimensional concept of the anatomy of the head.

I wish to thank Dr. William B. Seaman, Professor and Chairman of the Department of Radiology, Columbia-Presbyterian Medical Center; Dr. Robin M. Rankow, Associate Professor of Clinical Otolaryngology, Columbia-Presbyterian Medical Center; Dr. Edward W. Dempsey, Professor and Chairman of the Department of Anatomy, College of Physicians and Surgeons, Columbia University; and Dr. Melvin L. Moss, Professor and Dean of the School of Dental and Oral Surgery, Columbia University, for their aid and advice in the preparation of this book. My thanks also to Georgina Wodraska for her fine drawings.

Guy D. Potter, M.D.

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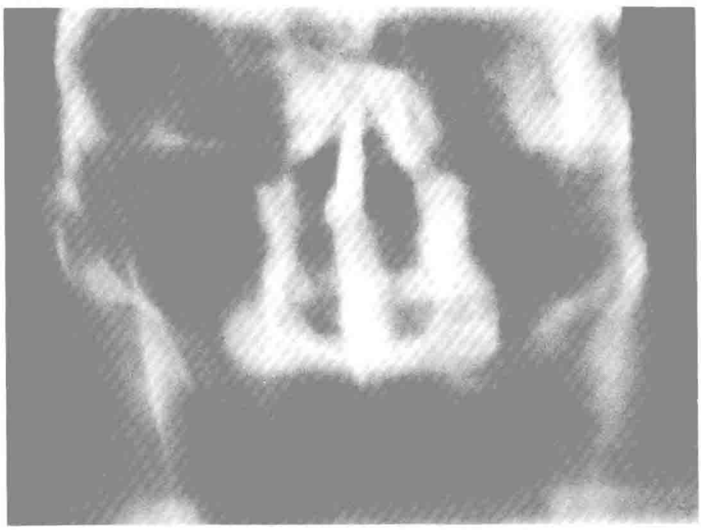
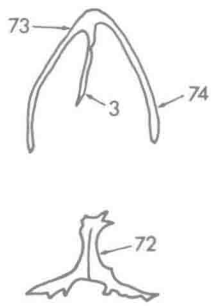
Coronal (Frontal) Head





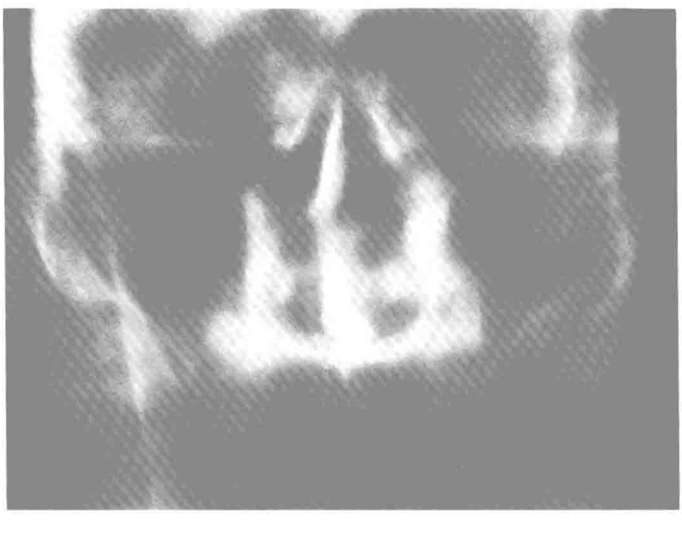
3. Perpendicular plate of the ethmoid
72. Premaxilla
73. Nasal bone
74. Frontal process of the maxilla

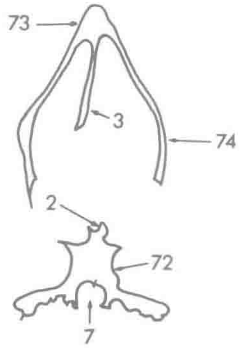
Anatomic Section

This is the most anterior coronal section. It shows the nasal bones above and, below them, the upper half of the nasal fossa formed by the frontal processes of the maxilla. It also shows the premaxilla. The upper portion of the bony nasal septum formed by the perpendicular plate of the ethmoid is seen. The lower half of the bony septum in this section is cartilaginous.

Tomogram

The anatomic section is very far anterior. Only a small portion of the nose and the most anterior part of the soft tissue of the face are actually in this section. On the other hand, the tomogram appears quite complex. The only structures in focus are the bony nasal septum formed by the perpendicular plate of the ethmoid, the nasal bones, the frontal processes of the maxilla forming the upper half of the nasal fossa, and the premaxilla. All the other shadows seen in this tomogram are parasite shadows derived from structures outside the plane of focus. The same number of out-of-focus parasite shadows are present on every tomographic section. However, it is only when few structures are actually in focus that these out-of-focus parasite shadows become so obvious. When many structures are in focus, the parasite shadows are less obvious.





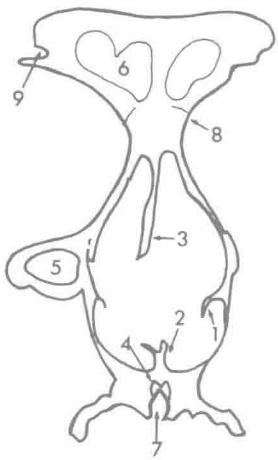
2. Incisive crest
3. Perpendicular plate of the ethmoid
7. Incisive foramen
72. Premaxilla
73. Nasal bone
74. Frontal process of the maxilla

Anatomic Section

Almost the entire nasal fossa is demonstrated. The upper half of the nasal fossa is formed by the nasal bones and the frontal processes of the maxilla; the lower half is formed by the body of the maxilla. The most anterior section of the inferior turbinate bones and the premaxilla are seen. In the midline on the inferior surface of the premaxilla is the incisive foramen. The incisive foramen is formed by the conjunction of the incisive canals. The incisive canals arise on each side of the nasal septum at the junction of the premaxilla and postmaxilla. The incisive canals and incisive foramen transmit the terminations of the sphenopalatine arteries which anastomose with the terminal branches of the greater palatine artery. They also transmit the terminal branches of the nasopalatine nerve. The sphenopalatine artery is the terminal branch of the internal maxillary artery. It passes into the nose through the sphenopalatine foramen, passing to the septum and running forward and downward on the vomer to the incisive foramen. The greater palatine artery, a branch of the descending palatine artery, originates on the inferior surface of the palate at the greater palatine foramen and runs forward to the incisive foramen. The nasopalatine nerve is derived from the sensory branches of the sphenopalatine nerve, a branch of the maxillary nerve. The fibers forming the nasopalatine nerve pass medial through the sphenopalatine foramen and follow the same course as the sphenopalatine artery. Above the nose is the most anterior section of the frontal bone.

Tomogram

The tomographic section appears much more complex than the anatomic section to which it corresponds. Again, this is because of parasite shadows. The nasal fossa and the upper half of the nasal septum, the bony portion, are clearly in focus. The incisive foramen is seen below in the premaxilla.



1. Inferior meatus
   Inferior turbinate (arrow)
2. Incisive crest
3. Perpendicular plate of the ethmoid
4. Incisive canal
5. Maxillary antrum
6. Frontal sinus
7. Incisive foramen
8. Frontomaxillary suture
9. Supraorbital canal

Anatomic Section

The incisive foramen is at the midline: to each side and above are the incisive canals. The inferior part of the nasal septum is formed by the incisive crest, the most anterior part of the nasal crest of the maxilla. The nasal crest forms the most inferior portion of the bony nasal septum. The anterior border of the vomer articulates with the incisive crest. In all sections posterior to this one, the inferior portion of the bony nasal septum is formed by the vomer. Superior to the incisive crest is the cartilaginous nasal septum, and superior to that, the perpendicular plate of the ethmoid. The roof of the nasal fossa is formed by the nasal bone. That portion of the nasal fossa inferior and lateral to the inferior turbinate is the inferior nasal meatus. In the frontal bone, the most anterior section of the frontal sinuses is seen. The articulation between the frontal bone and the frontal process of the maxilla forms the frontomaxillary suture. The supraorbital notch transmits the supraorbital artery and nerve. The supraorbital artery arises from the ophthalmic artery in the orbit. It supplies the periosteum in the roof of the orbit, the lateral palpebral and superior rectus muscles, the frontal diploë and the frontal sinuses, the pulley of the superior oblique muscle, and the upper eyelid. The supraorbital nerve is a branch of the frontal nerve, which is a branch of the ophthalmic nerve. It is a sensory nerve that innervates the upper eyelid, the scalp of the frontal region, and the parietal region almost as far as the lambdoid suture.

Tomogram

The frontal processes of the maxillae, the nasal bones, the nasal septum including the incisive crest and the perpendicular plate of the ethmoid, and the root of the attachment of the inferior turbinate are seen. Very faintly seen is the incisive canal.