SURGERY OF THE EAR

THIRD EDITION

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MICHAEL E. GLASSCOCK, III, M.D.

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1980

W. B. SAUNDERS COMPANY
Philadelphia London Toronto

W. B. Saunders Company: West Washington Square
Philadelphia, PA 19105

1 St. Anne's Road
Eastbourne, East Sussex BN21 3UN, England

1 Goldthorne Avenue
Toronto, Ontario M8Z 5T9, Canada

Library of Congress Cataloging in Publication Data

Shambaugh, George Elmer, 1903–

Surgery of the ear.

1. Ear—Surgery. I. Glasscock, Michael E., 1933– joint author. II. Title. [DNLM: 1. Ear—Surgery. WV200 S528s]

RF126.S5 1980 617.8′059 79–92613

ISBN 0–7216–8142–5

Surgery of the Ear ISBN 0-7216-8142-5

Last digit is the print number: 9 8 7 6 5 4 3 2 1

We are all like dwarfs seated on giants' shoulders. If we can see far, it is not because we are tall, but it is because we are seated on giants' shoulders.

BERNARD DE CHARTRES
12th Century

To the Memory of

GUNNAR HOLMGREN

Father of Microsurgery of the Ear

this book is dedicated

Gunnar Holmgren
BORN 1875
DIED 1954

Pioneer in fenestration surgery, the first to use the binocular operating microscope, founder of the *Acta oto-laryngologica.*

Author of the First and Second Editions of *Surgery of the Ear* and Senior Co-author of the Third Edition. Emeritus Professor of Otolaryngology, Northwestern University. Recipient of Honorary Doctorate, University of Freiburg, 1967, and University of Bordeaux, 1980. Founder of the Shambaugh Ear Institute.

George E. Shambaugh, Jr.

Founder of *The American Journal of Otology* and student of William F. House. Special interest in teaching anatomy of the temporal bone and in neurotology.

Michael E. Glasscock, III

Preface

Thirteen years have elapsed since preparation of the Second Edition of *Surgery of the Ear*. Most of the principles and techniques described in the Second Edition remain valid today and have been retained with few changes. Added to this Third Edition are intact canal wall techniques and osteoplastic epitympanotomy for chronic ear surgery, with improved tympanoplasty methods that are yielding better hearing results. New are middle fossa surgery pioneered by William House and skull base operations pioneered by Ugo Fisch that contribute to the new subspecialty of Neurotology.

Co-author of this Third Edition is Michael Glasscock who has rewritten parts of some chapters, most of a few chapters.

The authors wish to thank all those who have assisted in the monumental task of revising an entire text. Particular gratitude is due to Galdino Valvassori who within two decades has become recognized as the world's foremost authority in radiologic diagnosis of ear disease. Mrs. Lorayn Disosway has worked faithfully and well to complete the innumerable details in preparing and correcting the manuscript.

The senior author acknowledges once again the support and encouragement of his wife, Gene, and son, David, without whom the task would still remain unfinished.

Last, but by no means least, the authors wish to thank Richard J. Wiet for his well-done *Surgical Anatomy of the Temporal Bone Through Dissection* that is a companion to *Surgery of the Ear*, Third Edition, and that replaces the dissection instructions in the Second Edition.

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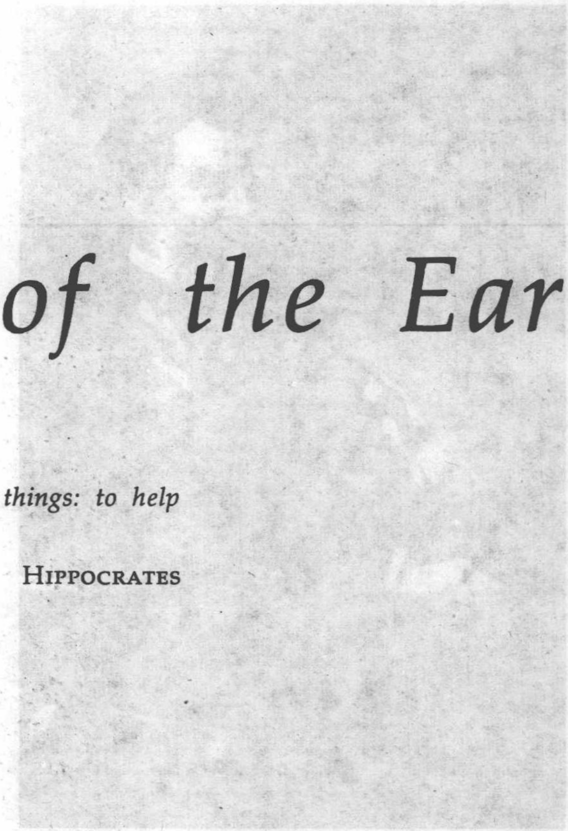
Surgery of the Ear



As to Diseases, make a habit of two things: to help or at least to do no harm.

HIPPOCRATES

Friedrich Bezold

BORN 1842
DIED 1908

Clarified the differentiation by tuning fork tests of conductive and sensorineural hearing losses and the clinical diagnosis of otosclerosis (otospongiosis). His clear and concise Textbook of Otology served as a model for this Surgery of the Ear.

Part One

"You will easily recognize that there is hardly another part of the body which calls for higher qualifications on the part of the operator as to anatomical knowledge than the temporal bone. . . ."

BEZOLD

Introduction to Surgery of the Ear

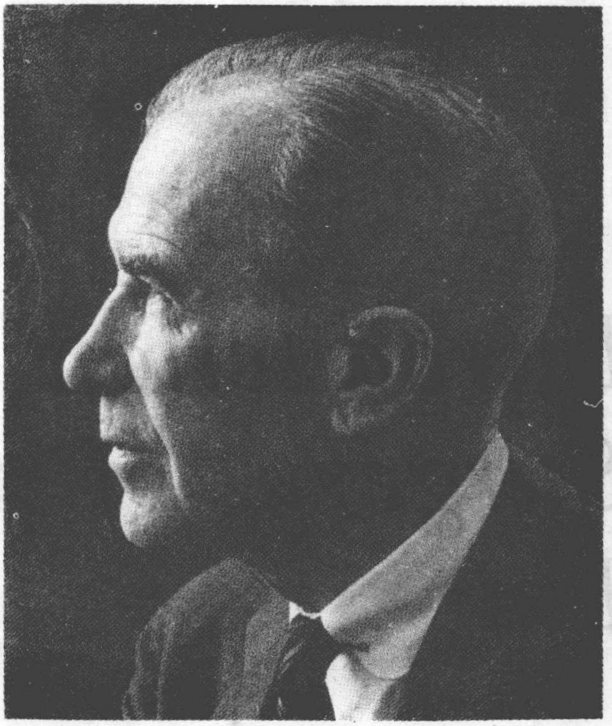
Theodore H. Bast

BORN 1890
DIED 1959

First described the utriculo-endolymphatic valve, and with Barry Anson restudied the developmental anatomy of the ear and temporal bone.

Barry J. Anson

BORN 1894
DIED 1974



Student and investigator par excellence of the gross and developmental anatomy of the temporal bone.

Chapter 1

Developmental Anatomy of the Ear

This chapter is based on the original researches of
PROFESSOR BARRY ANSON
and PROFESSOR T. H. BAST.[1]

An intimate knowledge of the **embryology** of the ear is necessary for the surgeon of the temporal bone, to help him to anticipate the anatomic variations that render operations within this crowded area difficult and hazardous, and to aid him in recognizing and surgically correcting congenital malformations of the sound-conducting system.

The developmental history of the ear is remarkable and without parallel in other organs of the human body in these respects:

The inner ear is the only organ that reaches full adult size and complete differentiation by midterm, even before the tiny fetus has become a viable premature infant.

The labyrinthine capsule and ossicles are the only parts of the osseous skeleton that retain primitive endochondral bone throughout the life span of the individual, and it is here that the unique disease of otospongiosis (otosclerosis) occurs. Everywhere else endochondral bone initially formed in cartilage is later removed and replaced by haversian periosteal bone.

The two functional parts of the hearing mechanism come from different and widely separated anlages. The sound-perceiving sensorineural apparatus of the inner ear comes from the ectodermal otocyst; the sound-conducting mechanism is derived from the branchial or gill structure of the embryo. In no other organ of the human body have our lowly phylogenetic ancestors left their trace more clearly.

ORIGIN AND DEVELOPMENT OF THE ENDOLYMPHATIC (OTIC) LABYRINTH

The earliest beginning of the ear is seen in the 3 week old human embryo as a platelike thickening of ectoderm on either side of the head near the hindbrain. This **otic placode** invaginates in a few days to form the **otic pit** (Fig. 1–1), and in a few more days, by the fourth week of embryonic life, the mouth of the pit has narrowed and fused to form the **otocyst.** The ectodermal-lined, fluid-filled otocyst constitutes the primitive otic or endolymphatic labyrinth, and it proceeds to differentiate by a series of folds and elongations as follows:

At 4½ weeks the oval-shaped otocyst has elongated and begun to divide into an endolymphatic duct and sac portion and a utricular-saccular portion. In a few more days archlike outpocketings of the utricular portion of the otic vesicle appear, which by 7 weeks have formed the three **semicircular canals.** Meanwhile, at 6 weeks (Fig. 1–2) the last part of the otic labyrinth to appear begins as a short evagination of the saccule, the **cochlea.** By 8 weeks it has elongated and begun to coil, and by 11 weeks it has formed nearly all of its two and a half turns.

As these appendages of the otic vesicle appear and develop, a constriction occurs between the utricle and saccule to form the longer **utricular duct** and the shorter **saccular duct,** which join to form the common **endolymphatic duct.** The otic or endolymphatic labyrinth, at first quite small, steadily enlarges despite its encasement in cartilage until midterm, at which time the endolymphatic labyrinth has reached the complicated adult form from which it derives its name (Fig. 1–3). The cartilaginous otic capsule then ossifies, preventing any further growth.

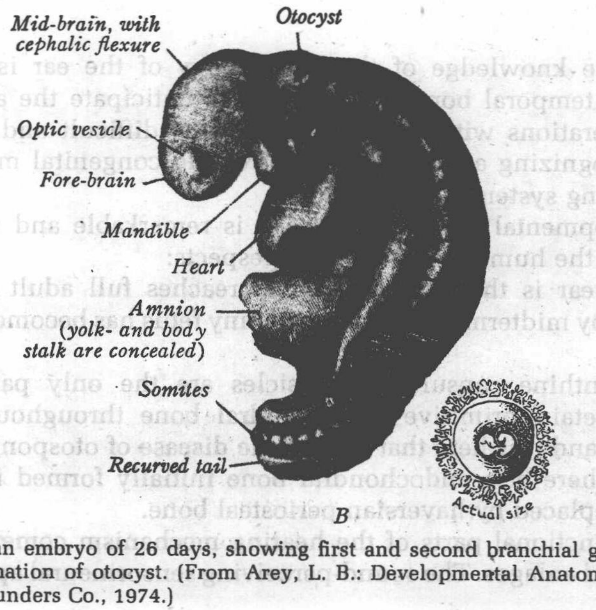


Figure 1–1 Human embryo of 26 days, showing first and second branchial grooves and the otic pit preliminary to formation of otocyst. (From Arey, L. B.: Developmental Anatomy, 7th ed., revised. Philadelphia, W. B. Saunders Co., 1974.)

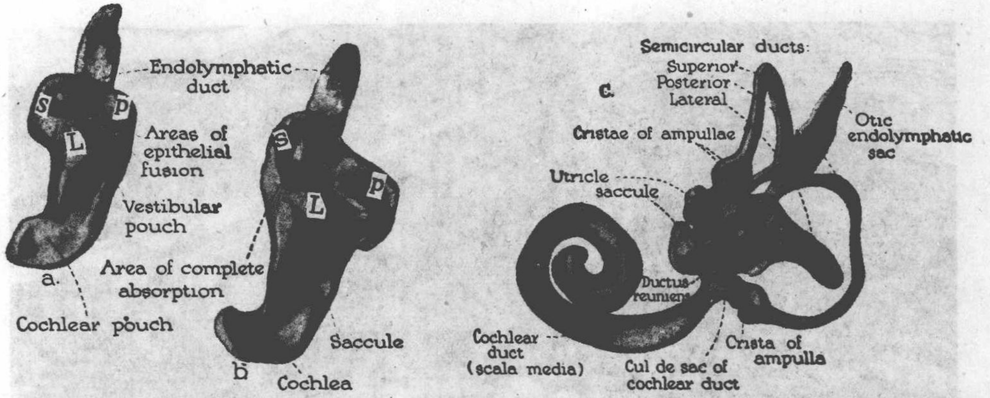


Figure 1–2 Development in a 3 week period of the membranous labyrinth, shown by reconstructions. *a*, Five weeks (8 mm.), ×27. *b*, Six weeks (13 mm.), ×27. *c*, Eight weeks (30 mm.), ×14. (From Anson, B. J.: Morris' Human Anatomy, 12th ed. New York, McGraw-Hill Book Co., 1966.)

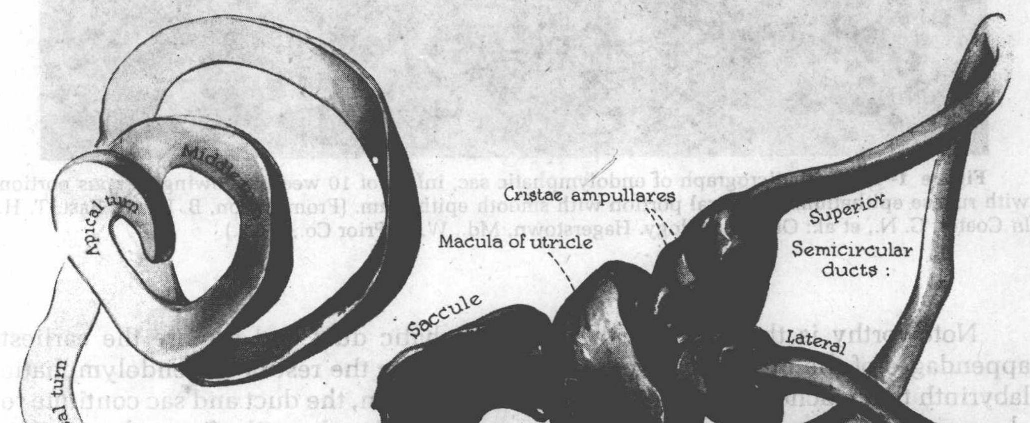


Figure 1–3 Drawing of a reconstruction of the lumen of the membranqus labyrinth. Anterolateral view. Mature form. Only the proximal part of the endolymphatic sac is included. Inset: Demonstrating the ducts that bring the utricle into communication with the saccule and the cochlear duct. (From Anson, B. J., Harper, D. G., and Winch, T. R.: The vestibular system. Anatomic considerations. Arch. Otol., *85*:497–514, 1967.)

Figure 1–4 Photomicrograph of endolymphatic sac, infant of 10 weeks, showing osseous portion with rugose epithelium and dural portion with smooth epithelium. (From Anson, B. J., and Bast, T. H. *In* Coates, G. N., et al.: Otolaryngology. Hagerstown, Md., W. F. Prior Co., 1955.)

Noteworthy is the fact that the endolymphatic duct and sac are the earliest appendages of the otic vesicle to appear; and unlike the rest of the endolymphatic labyrinth that reaches adult shape and size by midterm, the duct and sac continue to change and enlarge throughout infancy and childhood until after puberty. The adult endolymphatic sac lies half within bone, where its epithelium is in many folds with a vascular subepithelial connective tissue, and half between two layers of the

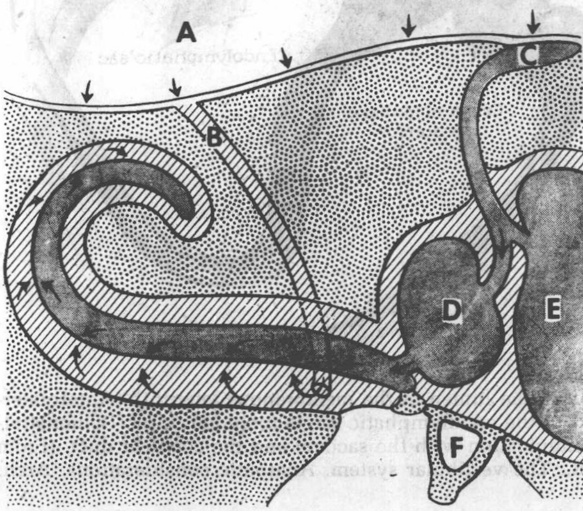


Figure 1–5 Increased cerebrospinal fluid pressure (*A*) causes cerebrospinal fluid to enter the perilymphatic system through the cochlear aqueduct (*B*). Pressure on the walls of the endolymphatic sac (*C*) forces endolymph into the labyrinth to equalize pressure on the walls of the endolymphatic labyrinth, including the cochlear partition. *D*, Saccule. *E*, Utricle. *F*, Stapes. (From Allen, G. W.: Endolymphatic sac and cochlear aqueduct. Arch. Otol., 79:322, 1964.)