

VOLUME TWO

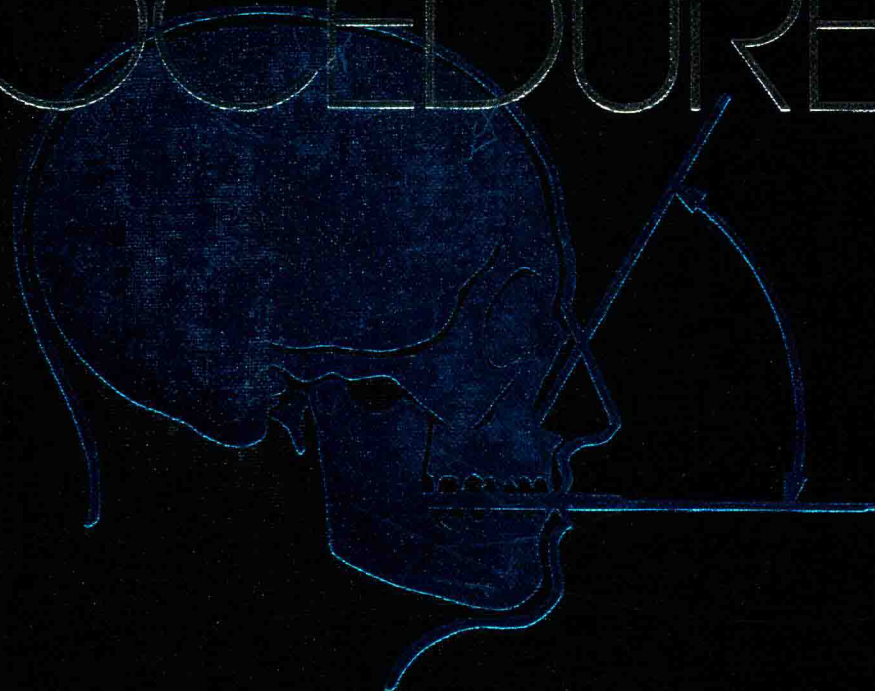
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MERRILL'S ATLAS OF

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RADIOGRAPHIC  
POSITIONS

and  
RADIOLOGIC  
PROCEDURES



Philip W. Ballinger

SEVENTH EDITION

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**MERRILL'S ATLAS OF**  
**RADIOGRAPHIC**  
**POSITIONS**  
**and**  
**RADIOLOGIC**  
**PROCEDURES**

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**Seventh Edition**

with **2987** illustrations, including **9** in full color

 **Mosby**  
**Year Book**

St. Louis Baltimore Boston Chicago London Philadelphia Sydney Toronto



Dedicated to Publishing Excellence

Editor: David Culverwell  
Developmental Editor: Elaine Steinborn  
Assistant Editor: Ellen Baker Geisel  
Production Editing Manager: Mark Spann  
Production Editor: Mary Stueck  
Design: Gail Morey Hudson  
Illustrations prepared by Graphic Works, Inc.

#### **SEVENTH EDITION**

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Previous editions copyrighted 1949, 1959, 1967, 1975, 1982, 1986

Printed in the United States of America

Mosby—Year Book, Inc.  
11830 Westline Industrial Drive, St. Louis, Missouri 63146

#### **Library of Congress Cataloging in Publication Data**

Ballinger, Philip W.

Merrill's atlas of radiographic positions and radiologic procedures.—7th ed./Philip W. Ballinger.

p. cm.

Includes bibliographical references.

Includes index.

ISBN 0-8016-0194-0

ISBN 0-8016-0170-3 (set)

1. Radiography, Medical—Positioning—Atlases. I. Title.
- II. Title: Atlas of radiographic positions and radiologic procedures.

[DNLM: 1. Technology, Radiologic—atlases. WN 17 B192m]

RC78.4.B35 1990

616.07'572—dc20

C/MV/MV 9 8 7 6 5

# PREFACE

Hardly is the ink dry on one edition when new knowledge, different procedures, and technological advancements dictate that the revision process begin. Such was the case with this edition of *Merrill's Atlas of Radiographic Positions and Radiologic Procedures*.

One of the more noticeable changes can be attributed to the Twelfth International Congress of Anatomists, which met in London in 1985. Substantial alterations of nomenclature were adopted; these results were published in the 1989 sixth edition of *Nomina Anatomica*, the third edition of *Nomina Histologica*, and the third edition of *Nomina Embryologica*. Because the terminology authorized by the International Congress is the standard terminology for anatomy, this seventh edition of *Merrill's Atlas* reflects these nomenclature changes.

To make the transition to the new anatomic terminology easier, the decision was made to list the new term first and the older term parenthetically. An example of the change is that of the carpal navicular; the accepted name is the scaphoid, so it is printed in the text as *scaphoid (navicular)*. Some reviewers of the early manuscript did not like all of the terminology changes, but we as health care professionals must adopt the terminology used in anatomy textbooks and taught to radiography students, medical students, and residents in radiology. I personally prefer *odontoid process* to the term *dens*, and *extremity to limb*, but in the new edition these examples are printed as *dens (odontoid process)*, and *limb (extremity)*. To assist the reader of *Merrill's Atlas* in identifying which anatomic terms have changed since the sixth edition, a summary listing the new and old terms is printed on the inside cover.

Other changes were designed to make using the text easier. The phase of patient respiration has been consistently placed in this edition. *Respiration* instructions have been included just before the central ray for those procedures involving the head and torso. For all chapters involving radiography of the head, *italics* were added to the primary posi-

tioning landmarks to help the user to quickly identify the positioning lines and points needed to accurately position the patient. The terms *position* and *projection* have been changed to reflect the terminology adopted by The American Registry of Radiologic Technologists. Descriptions of all positioning terms are included in Chapter 3 on p. 43 to 50, including summary Table 3-2 on p. 45. The entrance and exit points for the central ray were expanded and clarified to more precisely identify the centering points when positioning the patient. Similarly, some centering points were slightly changed to reflect the anatomical centering points of the body part, which are required when using positive beam limitation equipment. Other changes include placing the running heads on the edges of the pages. This makes locating a chapter or a specific position much easier.

The organization of the book remains essentially unchanged; Volumes 1 and 2 contain the radiologic procedural examinations, and Volume 3 contains descriptions of the radiology specialties. This organization was planned so, as an option, a student radiographer might purchase Volume 1 for the first term in the educational program, Volume 2 for the second educational term, and Volume 3 during the second year of professional radiography education.

Two entirely new chapters were added to Volume 3: Digital Subtraction Angiography and Computed Radiography. In addition, all chapters received substantive revisions with the addition of new illustrations and text.

Before, during, and after revising the textbook, many reviewers made significant contributions by offering suggestions for clarifying the information for the reader. Grateful appreciation is extended to three radiologists, Javier Beltran, M.D., Jerome J. Cunningham, M.D., and James Jerele, D.O., who reviewed selected chapters and offered suggestions for improvement. Several technologists devoted extensive time and effort in reviewing new chapters and new

material and, in general, offering suggestions for improvement. Thanks and my true appreciation are extended to Michael W. Drafke, M.S., R.T. (R), from the College of DuPage in Glen Ellyn, Illinois; Eugene D. Frank, B.S., R.T. (R), FASRT, from the Mayo Clinic and Foundation in Rochester, Minnesota; Michael L. Fugate, M.Ed., R.T. (R) from Southwest Virginia Community College in Richlands, Virginia; Bruce W. Long, M.S., R.T.(R) from the Indiana University School of Medicine in Indianapolis, Indiana; Kenneth Roszel, B.S., R.T., from Geisinger Medical Center in Danville, Pennsylvania; Jeffrey L. Rowe, M.S., R.T.(R), from Muskingum Area Technical College in Zanesville, Ohio; Dennis Spragg, M.S.Ed., R.T.(R), from Lima Technical College in Lima, Ohio; and Anton R. Zembrod, M.Ed., R.T.(R) of Wichita Falls, Texas. I also want to thank Professor Spragg for his evaluation of the material from *Merrill's Atlas* that was published in the first edition of the *Pocket Guide to Radiography* published by Mosby-Year Book, Inc. in 1989. Mark Smith, R.T. and Debra Saunders, R.T., colleagues and graduate students at The Ohio State University, assisted me by critiquing manuscript, reviewing new material, assisting in obtaining new radiographs, proofreading manuscript, and responding to multiple requests for assistance. Your work was appreciated, and I gained a great deal of respect for each of you. I'm sure your futures will be bright.

Literally thousands of journal articles must be searched for and reviewed in revising each edition. Terry Kempton, R.T. devoted extensive time and effort to search for, locate, and review thousands of journal articles. As a result, over 1300 articles written by over 2800 authors were reviewed and added to this edition in the bibliographic sections of all three volumes. The task was extremely demanding and would not have been possible without Ms. Kempton's help.

Two anatomists at The Ohio State University assisted greatly in revising this edition. Margaret Hines, Ph.D. re-

viewed the anatomy sections following the publication of the 1989 edition of *Nomina Anatomica*. Dr. Hines' comments were extremely valuable and timely in making the changes in terminology possible. Her continual support and assistance are truly appreciated. Professor John Chidley also reviewed the anatomy sections and offered suggestions for changes.

Eva James, R.T., reviewed the comments of the anatomists and those received from users, synthesized them, compared them with *Nomina Anatomica*, and organized the anatomy sections of the chapters for consistency and clarity. In addition, Ms. James reviewed the final manuscript and prepared a summary of the anatomic terms that have changed from the previous edition.

Sincere thanks are extended to Julie Gilhousen, R.T.(R)(N) from Picker International, Inc. for her cooperation in arranging for the use of the radiographic equipment needed to produce new photographic illustrations. Picker International, Inc. has demonstrated strong support for this *Atlas* through all seven editions and that support is truly appreciated.

Although every effort has been made to ensure accuracy and consistency of information, an occasional mistake escapes. When such occurs, you can assist me by marking the error on a photocopy of the page and mailing it directly to me. Suggestions for improvement are also welcome, for it is only with the assistance of concerned professionals that the text is strengthened.

This *Atlas* requires extensive visual support and without the professional staff of the medical illustrators, medical photographers, and the concerned staff of the Biomedical Communications Division in the School of Allied Medical Pro-

fessions and The Ohio State University, the illustrations printed in this textbook would not be of such high quality. Particular thanks are extended to chief photographer Robert Jones for his patience and cooperation in shooting, printing, and reprinting the illustrations to show just what is desired. Thanks also to Mr. Harry Condry and Mr. Matthew Eppley for their responding to my many, sometimes impossible, requests.

Sincere thanks are extended to scores of individuals (R.T.s, students, and physicians) who assisted by locating radiographs for this edition. As is the custom, whenever a radiograph is printed in the *Atlas*, the name of the individual supplying the original radiograph is printed adjacent to the image. Unfortunately there were a few radiographs I was not able to print because they were duplicates. Thanks again to all who assisted by supplying illustrations of excellent quality for this edition.

Sincere thanks are extended to Eileen Buckholz who has served as secretary to the Radiologic Technology Division at The Ohio State University (and manager of my schedule) for several years. Her ability to assist the faculty and students, get me to classes with students, attend university meetings, respond to phone calls, and many other tasks while keeping track of me is truly appreciated. Thanks again, Eileen, for all your help.

To David Culverwell, Peggy Fagen, Christi Mangold, Cecilia Reilly, Elaine Steinborn, Mary Stueck, and the entire professional staff of Mosby-Year Book, Inc., I enjoyed working with you in our mutual quest to produce a quality textbook. Although some of the deadlines were a little tight, we generally made them.

Without the total support of my family this project would not have been possi-

ble. To my father-in-law, L. Neil Hathaway, thanks for your understanding and encouragement. I also thank my parents, D.W. and Mildred Ballinger, for their love and encouragement demonstrated throughout my career and their continuing support and assistance. They are always there when they are needed and I apologize for taking that for granted. To my wife, Nancy, loving appreciation is extended for her understanding and assistance. In addition to being an understanding wife (well, most of the time), my multiple requests for her help have generally been answered. Many times the family schedule has been revised or something rescheduled because I was out of town or "just had to work." Thanks for your love and support over the years. My son, Eric, and daughter, Monica, are relatively understanding of the never-ending revision process. I apologize for the many times I should have been doing things to assist and support them, but was instead working on the book or attending a professional meeting. Over the years Eric and Monica have learned to stop asking, "Is the book done yet?" because they know that as soon as it is complete, it and other projects will compete for my attention. Eric and Monica, I love you and appreciate your patience. I only wish that sometimes when you see my travel schedule posted on the refrigerator door, instead of asking, "Now where are you going?" you'd ask, "When will you be back?"

**Philip W. Ballinger**  
Columbus, Ohio

# CONTENTS

## VOLUME ONE

### **1 Preliminary Steps in Radiography, 1**

Radiography, 2  
Clinical history needed by technologist, 5  
Initial examination, 5  
Diagnosis and the technologist, 5  
Ethics in radiologic technology, 5  
Care of radiographic examining room, 7  
Aseptic technique, 7  
Disinfectants and antiseptics, 7  
Isolation unit, 7  
Operating room, 8  
Minor surgical procedures in radiology department, 8  
Procedure book, 8  
Bowel preparation, 8  
Motion and its control, 9  
Structural relationship in positioning, 10  
Patient instructions, 10  
Patient's attire, ornaments, and surgical dressings, 11  
Lifting and handling patients, 11  
Preexposure instructions, 12  
Foundation exposure technique, 12  
Adaptation of exposure technique to patient, 12  
Identification of radiographs, 13  
Film placement, 13  
English-metric conversion, 14  
Direction of central ray, 15  
Source-to-image receptor distance (SID), 15  
Collimation of x-ray beam, 15  
Gonad shielding, 16

### **2 Radiation Protection, 17** **STEWART C. BUSHONG**

Introduction, 18  
Radiation units, 20  
Radiation sources and levels, 21  
Radiation protection guides, 23  
Medical radiation dose and exposure, 25  
Protection of patient, 28  
Protection of technologist, 30

### **3 General Anatomy and Radiographic Positioning Terminology, 35**

General anatomy, 36  
Body habitus, 39  
Radiographic positioning terminology, 43

### **4 Upper Limb (Extremity), 51**

**Anatomy, 52**  
Hand, 52  
Forearm, 53  
Arm, 54  
Upper limb articulations, 55  
**Radiography, 57**  
Digits (second through fifth), 58  
First digit (thumb), 64  
Hand, 66  
First carpometacarpal joint, 74  
Wrist, 75  
Carpal canal, 85  
Carpal bridge, 86  
Forearm, 88  
Elbow, 91  
Olecranon process and distal humerus, 102  
Humerus, 104  
Proximal humerus, 108

### **5 Shoulder Girdle, 111**

**Anatomy, 112**  
Clavicle, 112  
Scapula, 112  
Humerus, 114  
Shoulder girdle articulations, 115  
**Radiography, 116**  
Shoulder, 116  
Shoulder joint, 120  
Acromioclavicular articulations, 138  
Clavicle, 142  
Scapula, 148  
Scapular spine, 156

### **6 Lower Limb (Extremity), 161**

**Anatomy, 162**  
Foot, 162  
Leg, 164  
Thigh, 165  
Patella, 166  
Lower limb articulations, 166  
**Radiography, 168**  
Toes, 168  
Sesamoids (metatarsophalangeal), 174  
Foot, 176  
Congenital clubfoot, 190  
Tarsus: calcaneus (os calcis), 193  
Talocalcaneal (subtalar) joint, 197  
Ankle, 204  
Leg, 210  
Knee, 214  
Weight-bearing knee, 218  
Knee, 222  
Intercondylar fossa, 224  
Patella, 229

Patella and patellofemoral joint, 232  
Femur, 236

### **7 Pelvis and Upper Femora, 241**

**Anatomy, 242**  
Hip, 242  
Femur, 243  
Articulations of the pelvic girdle, 244  
**Radiography, 246**  
Pelvis and upper femora, 246  
Pelvis and hip joints, 250  
Femoral necks, 252  
Hip, 256  
Acetabulum, 270  
Anterior pelvic bones, 272  
Ilium, 277

### **8 Vertebral Column, 279**

**Anatomy, 280**  
Vertebral curvature, 281  
Cervical vertebrae, 282  
Thoracic vertebrae, 286  
Lumbar vertebrae, 286  
Sacrum and coccyx, 288  
Vertebral articulations, 289  
**Radiography, 290**  
Atlantooccipital (occipitocervical) articulations, 290  
Atlas and axis (open mouth), 292  
Dens (odontoid process), 294  
Atlas and dens (odontoid process), 295  
Dens (odontoid process), 296  
Atlas and axis, 298  
Cervical vertebrae, 300  
Cervical intervertebral foramina, 306  
Cervical vertebrae, 310  
Cervical and upper thoracic vertebrae, 312  
Cervical vertebrae: trauma, 316  
Cervicothoracic region, 318  
Thoracic vertebrae, 322  
Lumbar-lumbosacral vertebrae, 330  
Lumbosacral junction and sacroiliac joints, 334  
Lumbar-lumbosacral vertebrae, 336  
L5-S1 lumbosacral junction, 338  
Last lumbar intervertebral foramina, 339  
Lumbar-lumbosacral zygapophyseal joints, 342  
Sacroiliac joints, 344  
Sacrum and coccyx, 350  
Sacral vertebral canal—sacroiliac joints, 354  
Lumbar intervertebral disks, 356  
Scoliosis series, 358  
Spinal fusion series, 360

## 9 Bony Thorax, 363

**Anatomy,** 364  
 Sternum, 364  
 Ribs, 365  
 Bony thorax articulations, 366  
**Radiography,** 368  
 Sternum, 368  
 Sternoclavicular articulations, 376  
 Ribs, 382  
 Upper anterior ribs, 384  
 Posterior ribs, 386  
 Axillary portion of ribs, 388  
 Costal joints, 392

## 10 Thoracic Viscera, 395

**Anatomy,** 396  
 Body habitus, 396  
 Respiratory system, 396  
 Mediastinal structures, 400  
**Radiography,** 402  
**Positioning,** 405  
 Trachea, 405

Trachea and superior mediastinum, 406  
 Trachea and pulmonary apex, 408  
 Chest-lungs and heart, 410  
 Lungs, 422  
 Pulmonary apices, 424  
 Lungs and pleurae, 430  
 Bronchography, 433

## 11 Long Bone Measurement, 435

Radiation protection, 436  
 Position of patient, 436  
 Position of part, 436  
 Localization of joints, 436  
**Orthoroentgenography,** 437  
**Leg measurement with CT scanner,** 440

## 12 Contrast arthrography, 443

Contrast arthrography of knee, 446  
 Double-contrast arthrography of knee, 448  
 Wrist arthrography, 450

Hip arthrography, 450  
 Shoulder arthrography, 452  
 Temporomandibular joint (TMJ) arthrography, 454  
 Other joints, 455

## 13 Foreign Body Localization and Trauma Radiography Guidelines, 457

**Foreign body localization,** 458  
 Preliminary considerations, 461  
 Penetrating foreign bodies, 462  
 Aspirated and swallowed objects, 468  
 Aspirated foreign bodies, 473  
 Swallowed foreign bodies, 473  
**Trauma radiography guidelines,** 474  
 Reversing/modifying a position, 474  
 Trauma radiographs, 477

## Glossary, 481

## Bibliography, 505

# VOLUME TWO

## 14 Mouth and Salivary Glands, 1

**Anatomy,** 2  
 Mouth, 2  
 Salivary glands, 3  
 Sialography, 4  
**Radiography,** 6  
 Parotid gland, 6  
 Parotid and submaxillary glands, 8  
 Submaxillary and sublingual glands, 10

Minimal hiatal hernia, 102  
 Small intestine, 105  
 Large intestine, 110

## 18 Urinary System, 137

**Anatomy,** 138  
**Radiography,** 141  
 Excretory urography, 151

## 15 Anterior Part of Neck, 11

**Anatomy,** 12  
**Radiography,** 15  
 Soft palate, pharynx, and larynx, 15  
 Thyroid gland, 23  
 Pharynx and larynx, 24  
 Soft palate, pharynx, and larynx, 26

## 19 Male Reproductive System, 171

**Anatomy,** 172  
**Radiography,** 174  
 Seminal ducts, 174  
 Prostate gland, 176

## 20 Female Reproductive System, 179

**Anatomy,** 180  
 Fetal development, 182  
**Radiography,** 183  
 Nongravid patient, 183  
 Uterus and uterine tubes, 184  
 Vagina, 186  
 Gravid patient, 188  
 Fetography, 188  
 Radiographic pelvimetry and cephalometry, 190  
 Localization of intrauterine devices, 200

General body position, 220  
 Cranium, 222  
 Cranial base, 238  
 Cranium, sella turcica, and ear, 244  
 Sella, 248  
 Sella turcica (dorsum sellae and posterior clinoid processes), 250  
 Sella turcica, 252  
 Orbit, 256  
 Optic canal (foramen), 258  
 Optic canal (foramen), superior orbital fissure, and anterior clinoid process, 264  
 Sphenoidal strut, 266  
 Superior orbital fissures, 268  
 Inferior orbital fissures, 270  
 Eye, 272  
 Nasolacrimal drainage system, 288

## 16 Digestive System, 29

**Anatomy,** 30  
 Liver and biliary system, 30  
 Pancreas and spleen, 32  
**Radiography,** 33  
 Abdomen, 33  
 Liver and spleen, 44  
 Liver, 45  
 Spleen, 46  
 Biliary tract, 47  
 Gallbladder, 60

## 22 Facial Bones, 291

**Radiography,** 292  
 Facial bones, 292  
 Facial profile, 294  
 Facial bones, 296  
 Nasal bones, 306  
 Zygomatic arches, 310  
 Maxillae, 322  
 Mandible, 328  
 Mandibular symphysis, 330  
 Mandibular rami, 336  
 Mandible, 338  
 Temporomandibular articulations, 348  
 Panoramic tomography of mandible, 360

## 17 Digestive System, 77

**Anatomy,** 78  
 Stomach, 79  
 Small intestine, 80  
 Large intestine, 81  
**Radiography,** 86  
 Esophagus, 86  
 Stomach: gastrointestinal series, 90  
 Stomach and duodenum, 94

## 21 Skull, 201

**Anatomy,** 202  
 Cranial bones, 204  
 Vestibulocochlear organ (organ of hearing), 212  
 Facial bones, 214  
 Articulations of the skull, 216  
**Radiography,** 217  
 Skull topography, 217  
 Skull morphology, 218

## 23 Paranasal Sinuses, 363

**Anatomy,** 364  
**Radiography,** 366  
**Positioning,** 368  
 Paranasal sinuses, 370

Frontal and anterior ethmoidal sinuses, 372  
 Maxillary sinuses, 374  
 Ethmoidal and sphenoidal sinuses, 376  
 Ethmoidal, sphenoidal, and maxillary sinuses, 378  
 Sphenoidal sinuses, 382

Ethmoidal, frontal, and sphenoidal sinuses, 385  
 Relationship of teeth to antral floor, 386

## 24 Temporal Bone, 387

Radiography, 388  
 Mastoid process, 388

Mastoid and petrous portions, 400  
 Petrous portions, 406  
 Temporal styloid processes, 432  
 Jugular foramina, 440  
 Hypoglossal canal, 446

## Bibliography, 449

# VOLUME THREE

## 25 Pediatric Radiography, 1

JOHN P. DORST  
 ANN HRICA SEGLINSKI  
 JANINE BLOME  
 THOMAS J. BECK  
 JOAN A. WODARSKI

Approach to the child, 2  
 Sedation, 5  
 Patient care, 5  
 Protection of the child, 8  
 The principal problem: patient motion, 11  
 Common pediatric examinations, 13  
 Special pediatric examinations, 20

## 26 Tomography, 23

JEFFREY A. BOOKS

Blurring motions, 28  
 Factors affecting tomographic image, 31  
 Equipment, 31  
 Clinical applications, 32  
 Basic principles of positioning, 42  
 Immobilization techniques, 43  
 Scout tomograms, 44  
 General rules for tomography, 46  
 Summary, 50

## 27 Mammography, 53

JOHN O. OLSEN

Introduction and historical development, 54  
 Risk versus benefit, 56  
 Anatomy and physiology of the breast, 58  
 Breast imaging, 62  
 Method of examination, 68  
 Localization of nonpalpable lesions for biopsy, 78  
 Breast specimen radiography, 83  
 Examination of milk ducts, 83  
 Summary, 84

## 28 Thermography and Diaphanography, 85

JOSEPH FODOR III  
 JACK C. MALOTT

### Thermography, 86

Physics, 87  
 Equipment and methodology, 88  
 Selected clinical applications, 90  
 Summary, 92

### Diaphanography: transillumination of the breast, 93

Historical development, 93  
 Diaphanography equipment, 94

Optical principles, 95  
 Clinical applications, 95

## 29 Central Nervous System, 95

NINA KOWALCZYK

### Anatomy, 96

### Radiography, 99

Plain radiographic examination, 99  
 Myelography, 100  
   Computed tomographic myelography, 108  
 Diskography, 109  
 Chemonucleolysis, 113  
 Magnetic resonance imaging, 113  
 Cerebral pneumography/ventriculography, 114  
 Stereotactic surgery, 116

## 30 Circulatory System, 119

MICHAEL G. BRUCKNER

### Anatomy, 120

Blood-vascular system, 121

Lymphatic system, 124

### Diagnostic visceral and peripheral angiography, 126

Visceral angiography, 133  
 Pulmonary arteriography, 135  
 Central venography, 139  
 Selective visceral venography, 141  
 Peripheral angiography, 142  
 Angiography in the future, 145  
 Cerebral angiography, 146  
 Aortic arch angiogram, 152  
 Positioning, 152

### Interventional radiology, 161

Percutaneous transluminal angioplasty, 162

Transcatheter embolization, 166

Percutaneous nephrostomy tube placement and related procedures, 168

Inferior vena caval filter placement, 170

Other procedures, 172

Interventional radiology: present and future, 172

### Lymphography, 173

Lymphatic injection of feet, 175

Lymphatic injection of hand, 178

### Photographic subtraction technique, 180

First-order subtraction, 181

Second-order subtraction, 183

## 31 Cardiac Catheterization, 187

RONALD D. WEINSTEIN

Historical development, 188

Indications, contraindications, and risks, 188

Specialized equipment, 190

Catheterization methods and techniques, 192

Catheterization studies and procedures, 195

Postcatheterization care, 200

Cardiac catheterization on the horizon, 200

## 32 Sectional Anatomy for Radiographers, 203

TERRI BRUCKNER

Cranial region, 204

Thoracic region, 212

Abdominopelvic region, 216

## 33 Computer Fundamentals and Applications in Radiology, 225

JANE A. VAN VALKENBURG

Definition, 226

History, 227

Types of computers, 229

Functional components of a computer, 230

Computer operations, 233

Applications in radiology, 235

Digital imaging processing, 240

Summary, 246

## 34 Computed Tomography, 247

KENNETH C. JOHNSON  
 ALAN H. ROWBERG

Comparison with conventional radiography, 250

Historical development, 254

Equipment and methodology, 256

Reconstructed image parameters, 260

Examination protocols, 261

## 35 Computed Radiography, 265

MARCUS W. HEDGECOCK, JR.  
 RICHARD C. PASKIET, JR.

Analog and digital information, 266

Computed and analog radiography, 267

Historical development, 267

Operational components, 268

Characteristics of a computed radiographic image, 271  
 Clinical applications, 272  
 Other techniques to improve diagnostic efficacy, 275  
 Clinical acceptance of computed radiography, 275  
 Quality assurance concerns, 276  
 Pitfalls, 276  
 Benefits of computed radiography, 276  
 Department efficiency, 277  
 Summary, 277

**36 Digital Subtraction Angiography, 279**  
**WALTER W. PEPPLER**

Historical development, 280  
 Equipment and apparatus, 282  
 Performing DSA procedures, 283  
 Image post-processing, 284  
 Clinical uses, 286  
 Conclusion, 288

**37 Magnetic Resonance Imaging, 291**  
**JAMES H. ELLIS**

Comparison of MR to conventional radiology, 292  
 Historical development, 292  
 Physical principles, 293

Equipment, 295  
 Biomedical effects of MR, 296  
 Examination protocols, 297  
 Clinical applications, 301  
 Spectroscopy, 304  
 Summary, 305

**38 Diagnostic Ultrasound, 307**  
**SANDRA L. HAGEN-ANSERT**

Historical development, 309  
 Physical principles of the modality, 312  
 Clinical applications, 326  
 Summary, 357

**39 Nuclear Medicine, 361**  
**PAUL J. EARLY**

Physics of nuclear medicine, 362  
 Instrumentation, 365  
 Radiation protection: factors unique to nuclear medicine, 369  
 Clinical nuclear medicine, 370

**40 Positron Emission Tomography, 385**  
**RICHARD D. HICHWA**

Historical development, 386  
 Underlying principles and necessary facilities, 388  
 Clinical studies, 397

Future studies, 397  
 Summary, 398

**41 Radiation Oncology, 401**  
**CHARLES H. MARSCHKE**

Historical development, 402  
 Theory, 403  
 Clinical applications, 408  
 The future, 412  
 Summary, 413

**42 Introduction to Radiographic Quality Assurance, 417**  
**WILLIAM F. FINNEY III**

Quality assurance versus quality control, 419  
 History, 419  
 Benefits, 420  
 National Center for Devices and Radiological Health quality assurance program recommendation, 420  
 Quality assurance program design, 422

**Bibliography, 433**

---

## Chapter 14

# MOUTH AND SALIVARY GLANDS

### **Anatomy**

Mouth

Salivary glands

Sialography

### **Radiography**

Parotid gland

Parotid and submaxillary glands

Submaxillary and sublingual glands

## Mouth

The *mouth* (Fig. 14-1) is the first division of the digestive system. It encloses the dental arches and receives the saliva secreted by the salivary glands. The cavity of the mouth is divided into (1) the *oral vestibule*, the space between the teeth and the cheeks, and (2) the *oral cavity*, or *mouth proper*, the space within the dental arches. The roof of the oral cavity is formed by the hard and soft palates. The floor is formed principally by the tongue, and it communicates with the pharynx posteriorly by an aperture termed the *faucial isthmus*.

The vault of the *hard palate* is formed by the horizontal plates of the maxillae and palatine bones. The anterior and lateral boundaries are formed by the inner wall of the maxillary alveolar processes, which extend superiorly and medially to blend with the horizontal processes. The height of the hard palate varies considerably, and it determines the angulation of the inner surface of the alveolar process. The angle is less when the palate is high and greater when it is low.

The *soft palate* (*velum*) begins behind the last molar and is suspended from the posterior border of the hard palate. Highly sensitive to touch, the soft palate is a movable musculomembranous structure, and it functions chiefly as a partial septum between the mouth and the pharynx. At the center of the inferior border, the soft palate is prolonged into a small, pendulous process called the *uvula*. On each side of the uvula two arched folds extend laterally and inferiorly. The anterior pair of arches, which form the *faucial isthmus*, project forward to the sides of the base of the tongue. The posterior pair of arches project posteriorly to blend with the posterolateral walls of the pharynx. The triangular space between the anterior and the posterior arches is occupied by the palatine tonsil.

The *tongue* (Figs. 14-1 and 14-2) is situated in the floor of the oral cavity, with its base directed posteriorly and its apex directed anteriorly. The tongue is freely movable, composed of numerous muscles, and covered with mucous membrane that varies in character in the different regions of the organ. The extrinsic muscles of the tongue form the greater part of the oral floor. The mucous membrane covering the undersurface of the tongue is reflected laterally over the remainder of the floor to the gums. This part of the floor lies under the free anterior and lateral portions of the tongue and is called the *sublingual space*. Posterior movement of the free anterior part of the tongue is restricted by a median vertical band, or fold, of mucous membrane called the *frenulum of the tongue* (*frenulum linguae*), which extends between the undersurface of the tongue and the sublingual space. On each side of the frenulum, extending around the outer limits of the sublingual space and over the underlying salivary glands, the mucous membrane is elevated into a crest-like ridge called the *sublingual fold* (*plica sublingualis*). In the relaxed state the two folds (*plicae*) are quite prominent and are in contact with the gums.

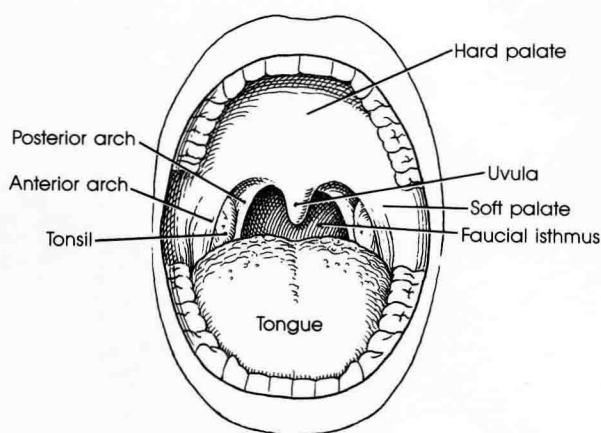


Fig. 14-1. Anterior aspect of oral cavity.

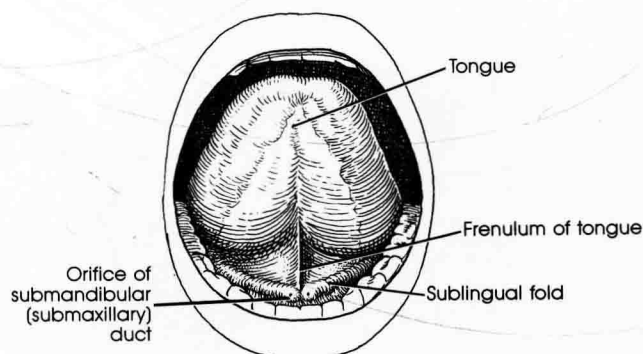


Fig. 14-2. Anterior view of undersurface of tongue and floor of mouth.

## Salivary Glands

The three pairs of salivary glands are the *parotid*, the *submandibular (submaxillary)*, and the *sublingual* (Fig. 14-3). The glands are composed of numerous lobes, each of which is made up of small lobules, the whole being held together by connective tissue and a fine network of blood vessels and ducts. The ductules of the lobules coalesce into larger branches, which in turn unite and form the large efferent duct, which conveys the saliva from the gland to the mouth.

The *parotid gland* is the largest of the salivary glands and consists of a flattened superficial portion and a wedge-shaped deep portion (Fig. 14-4). The superficial part lies immediately inferior and anterior to the external ear, overlapping the mandibular ramus and the mastoid process, and extends from the level of the external acoustic (auditory) meatus inferiorly almost to the angle of the mandible. The deep, or retromandibular, portion extends medially toward the pharynx. The parotid duct (*Stensen's duct*) runs anteriorly and medially to open into the oral vestibule opposite the second upper molar.

The *submandibular (submaxillary) gland* is irregularly shaped, is fairly large, and extends posteriorly from a point below the first molar almost to the angle of the mandible (Fig. 14-5). Although the upper part of the gland rests against the inner surface of the mandibular body, its greater portion projects below the mandible. The submandibular duct (submaxillary or *Wharton's duct*) extends anteriorly and superiorly to open into the mouth on a small papilla at the side of the frenulum of the tongue, the sublingual caruncle.

The *sublingual gland*, composed of a group of smaller glands, is narrow and elongated in form (Fig. 14-5). This gland is located in the floor of the mouth beneath the sublingual fold (plica sublingualis). It is in contact with the mandible laterally, and it extends posteriorly from the side of the frenulum linguae to the submandibular (submaxillary) gland. There are numerous small sublingual ducts (*ducts of Rivinus*), some of which open into the floor of the mouth along the crest of the sublingual fold and others of which open into the submandibular (submaxillary) duct. The main sublingual duct (*Bartholin's duct*) opens beside the orifice of the submandibular duct (submaxillary or Wharton's duct).

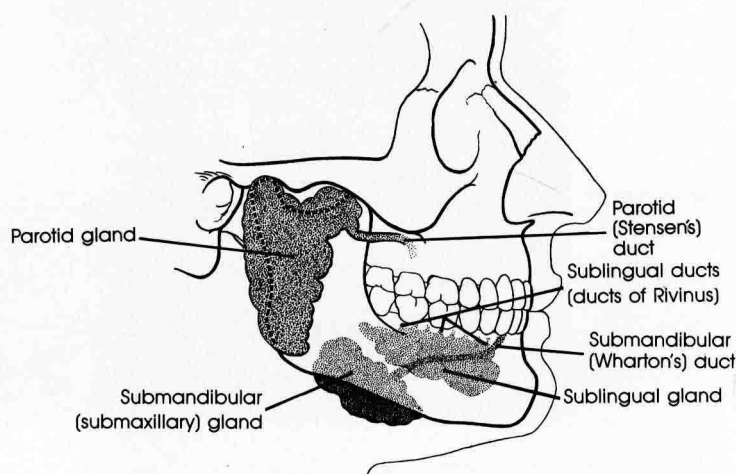


Fig. 14-3. Salivary glands from right lateral aspect.

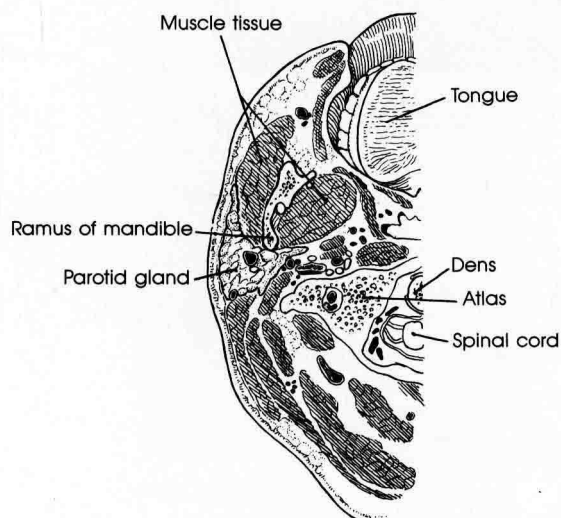


Fig. 14-4. Transverse section of face showing relation of parotid gland to mandibular ramus.

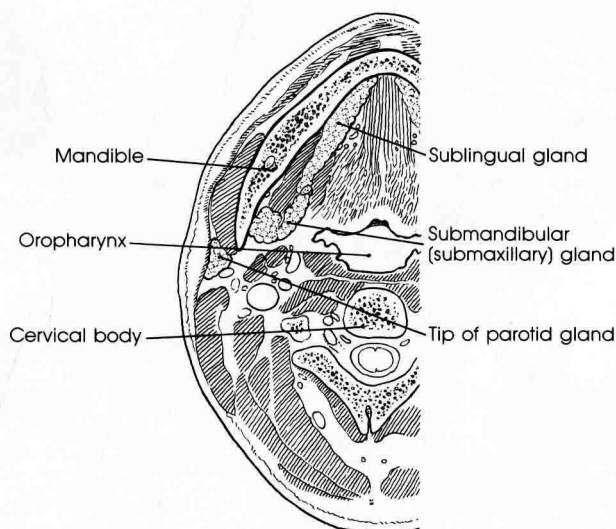


Fig. 14-5. Transverse section of face showing relation of submandibular (submaxillary) and sublingual glands to surrounding structures.

## Sialography

*Sialography* is the term applied to radiologic examinations of the salivary glands and ducts with the use of a contrast medium, usually one of the water-soluble iodinated media. The frequency of performing sialograms has decreased during the past few years because of improvements in computed tomography (CT) and magnetic resonance imaging (MRI) techniques. When the clinician is evaluating a patient with a suspected salivary stone or lesion, CT or MRI is often the modality of choice. However, when a definitive diagnosis is needed involving one of the salivary ducts, sialography remains a viable diagnostic tool.

In performing a sialogram, the radio-paque medium is injected into the main duct, from where it flows into the intraglandular ductules. This makes it possible to demonstrate the surrounding glandular parenchyma as well as the duct system (Fig. 14-6). The procedure is used to demonstrate such conditions as

inflammatory lesions and tumors, to determine the extent of salivary fistulae, and to localize diverticulae, strictures, and calculi. Because the glands are paired, and the several pairs are in such close proximity, only one gland at a time can be examined by the sialographic method (Fig. 14-7).

Submandibular  
(submaxillary) or  
Wharton's duct

Submandibular  
(submaxillary) gland

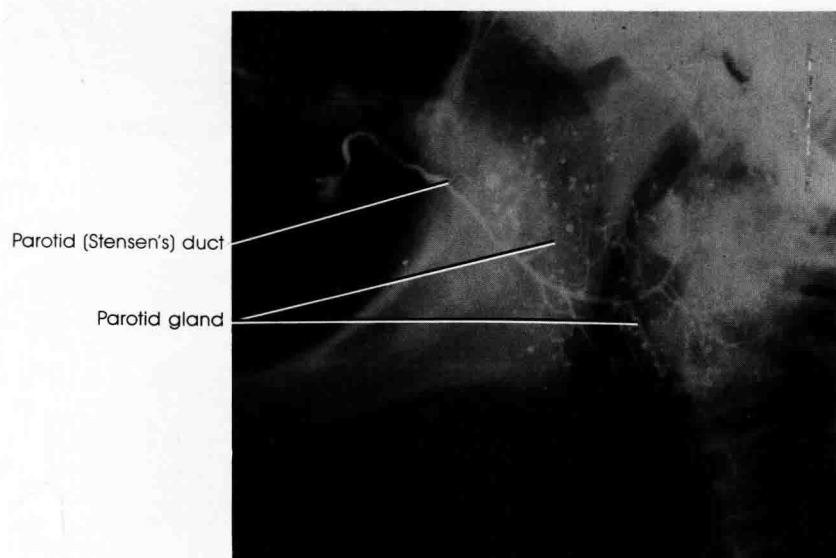


**Fig. 14-6.** Sialogram showing opacified submaxillary gland.

Preliminary radiographs are obtained to detect any condition demonstrable without the use of a contrast medium and to establish the optimum exposure technique.

Two or three minutes before the sialographic procedure, the patient is given a secretory stimulant to open the duct for ready identification of its orifice and for easier passage of a cannula or catheter. Having the patient suck a wedge of fresh lemon serves this purpose and is repeated on completion of the examination to stimulate rapid evacuation of the contrast medium. A radiograph may be taken some 10 minutes later to verify clearance of the medium.

Most examiners inject the contrast medium by manual pressure, that is, with a syringe attached to the cannula or catheter. Other examiners advocate that the medium be delivered by hydrostatic pressure only. The latter method requires the use of a water-soluble iodinated medium, with the contrast solution container (usually a syringe barrel with the plunger removed) attached to a drip stand and set at a distance of 28 inches (70 cm) above the level of the patient's mouth. Some examiners carry out the filling procedure under fluoroscopic guidance and obtain spot radiographs. The reader is referred to the articles listed in the bibliography for a detailed description of each of the numerous methods of performing sialography.



**Fig. 14-7.** Sialogram showing parotid gland.

## Parotid Gland

### TANGENTIAL POSITION

**Film:** 8 × 10 in (18 × 24 cm) lengthwise.

#### Position of patient

The patient may be placed in either a recumbent or a seated position. Since the parotid gland lies midway between the anterior and posterior surfaces of the skull, a tangential position of the gland region can be taken from either the posterior or the anterior direction.

#### Position of part

**AP body position.** With the patient supine, rotate the head toward the side being examined so that the parotid area is perpendicular to the plane of the film. Center the film to the parotid area. With the patient's head resting on the occiput, adjust it so that the mandibular ramus is parallel with the longitudinal axis of the film (Fig. 14-8).

**PA body position.** With the patient prone, rotate the head so that the parotid area being examined is perpendicular to the plane of the film. Center the film to the parotid region. With the patient's head resting on the chin, adjust its flexion so that the mandibular ramus is parallel with the longitudinal axis of the film (Fig. 14-9). When the parotid (Stensen's) duct does not have to be demonstrated, rest the head on the forehead and nose.

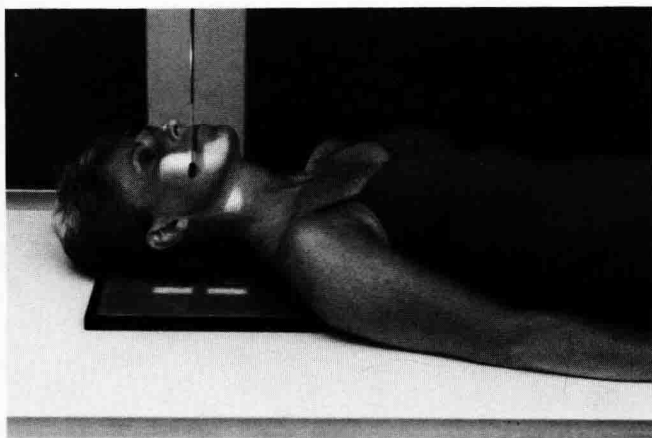


Fig. 14-8. Patient supine.



Fig. 14-9. Patient prone.

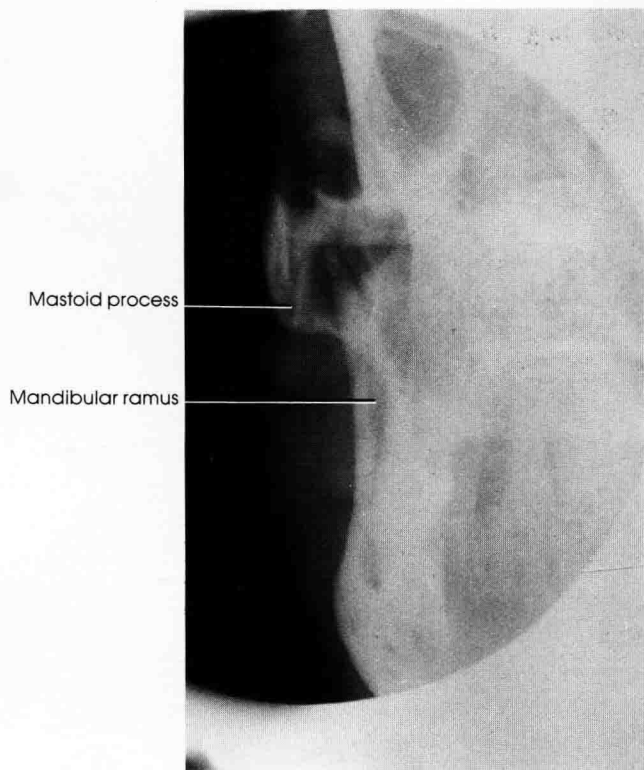
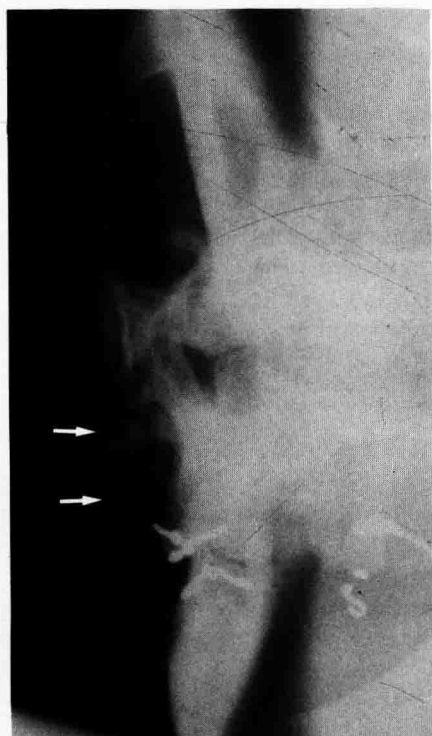


Fig. 14-10. Examination of right cheek area to rule out parotid gland tumor. Soft tissue fullness. No calcification.



Fig. 14-11. Same patient as in Fig. 14-10. Right cheek distended with air in mouth. No abnormal finding in region of parotid gland.

(Courtesy Dr. William H. Shehodi.)



**Fig. 14-12.** Right cheek distended with air. Considerable calcification seen in region of parotid gland (arrows).

(Courtesy Dr. William H. Shehodi.)

**Respiration.** To study the parotid gland, better detail can be obtained, particularly for the demonstration of calculi, by having the patient fill the mouth with air and then puff the cheeks out as much as possible. When this cannot be done, ask the patient to suspend respiration for the exposure.

#### Central ray

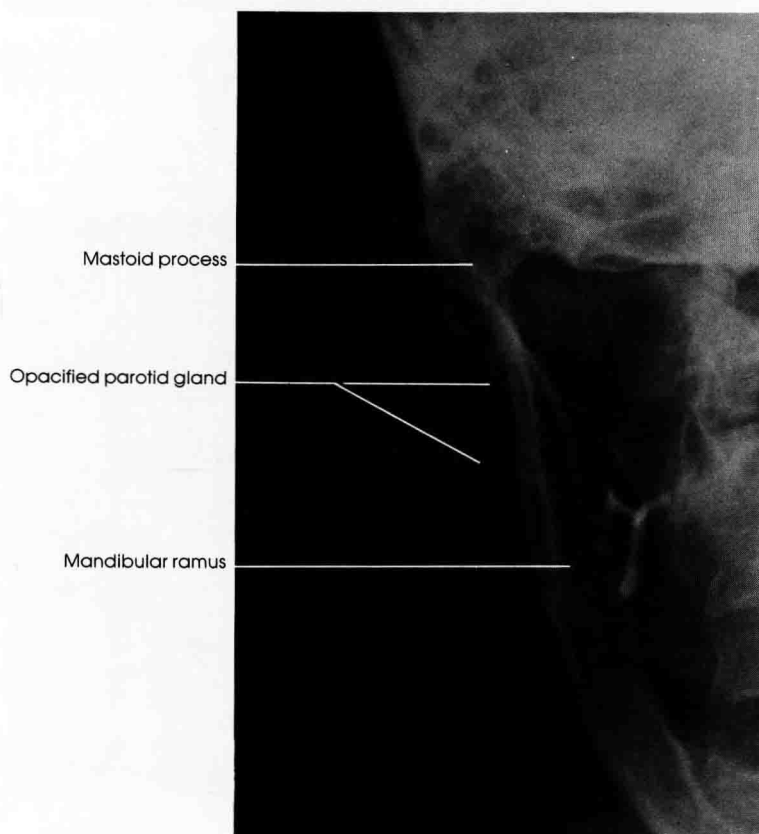
With the central ray perpendicular to the plane of the film, direct it along the lateral surface of the mandibular ramus.

#### Structures shown

A tangential position demonstrates the region of the parotid gland and duct. These structures are clearly outlined when an opaque medium is used (Figs. 14-10 to 14-14).

#### Evaluation criteria

- Soft tissue density should be visible.
- Most of the parotid gland should be demonstrated lateral to and clear of the mandibular ramus.
- Mastoid should only overlap the upper portion of the parotid gland.



**Fig. 14-13.** Tangential position showing opacified parotid gland.



**Fig. 14-14.** Tangential position showing opacified parotid gland.

(Courtesy Dr. Milford D. Schultz.)

## Parotid and Submaxillary Glands

### LATERAL POSITION

**Film:** 8 × 10 in (18 × 24 cm) lengthwise.

#### Position of patient

The patient may be examined in a semiprone or seated-upright position.

#### Position of part

**Parotid gland.** Extend the patient's neck so the space between the cervical area of the spine and the mandibular rami is cleared. Center the film to a point approximately 1 inch (2.5 cm) superior to the mandibular angle. Adjust the head so that the midsagittal plane is rotated forward approximately 15 degrees from a true lateral position.

**Submandibular gland.** Center the film to the inferior margin of the angle of the mandible. Adjust the patient's head in a true lateral position (Fig. 14-15).

Iglauer<sup>1</sup> suggested depressing the floor of the mouth to displace the submandibular gland below the mandible. When the patient's throat is not too sensitive, this is done by placing an index finger on the back of the patient's tongue on the affected side.

*Respiration* is suspended for the exposure.

<sup>1</sup>Iglauer S: A simple maneuver to increase the visibility of a salivary calculus in the roentgenogram, *Radiology* 21:297, 1933.

### Central ray

Direct the central ray perpendicularly to the center of the cassette at a point (1) 1 inch (2.5 cm) superior to the mandibular angle to demonstrate the parotid gland or (2) at the inferior margin of the mandibular angle to demonstrate the submandibular gland.



Fig. 14-15. Lateral submandibular gland.