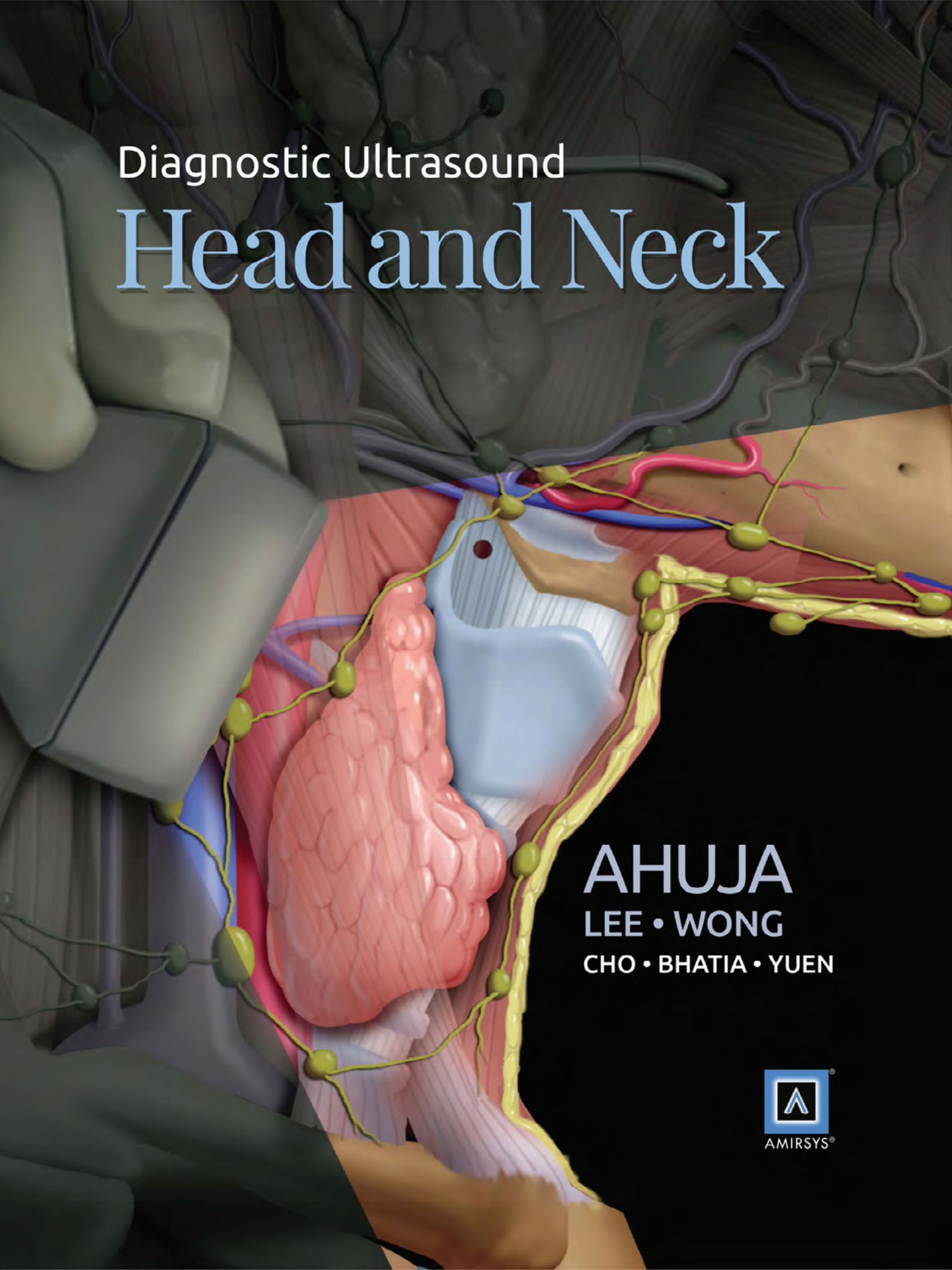
Diagnostic Ultrasound

Head and Neck



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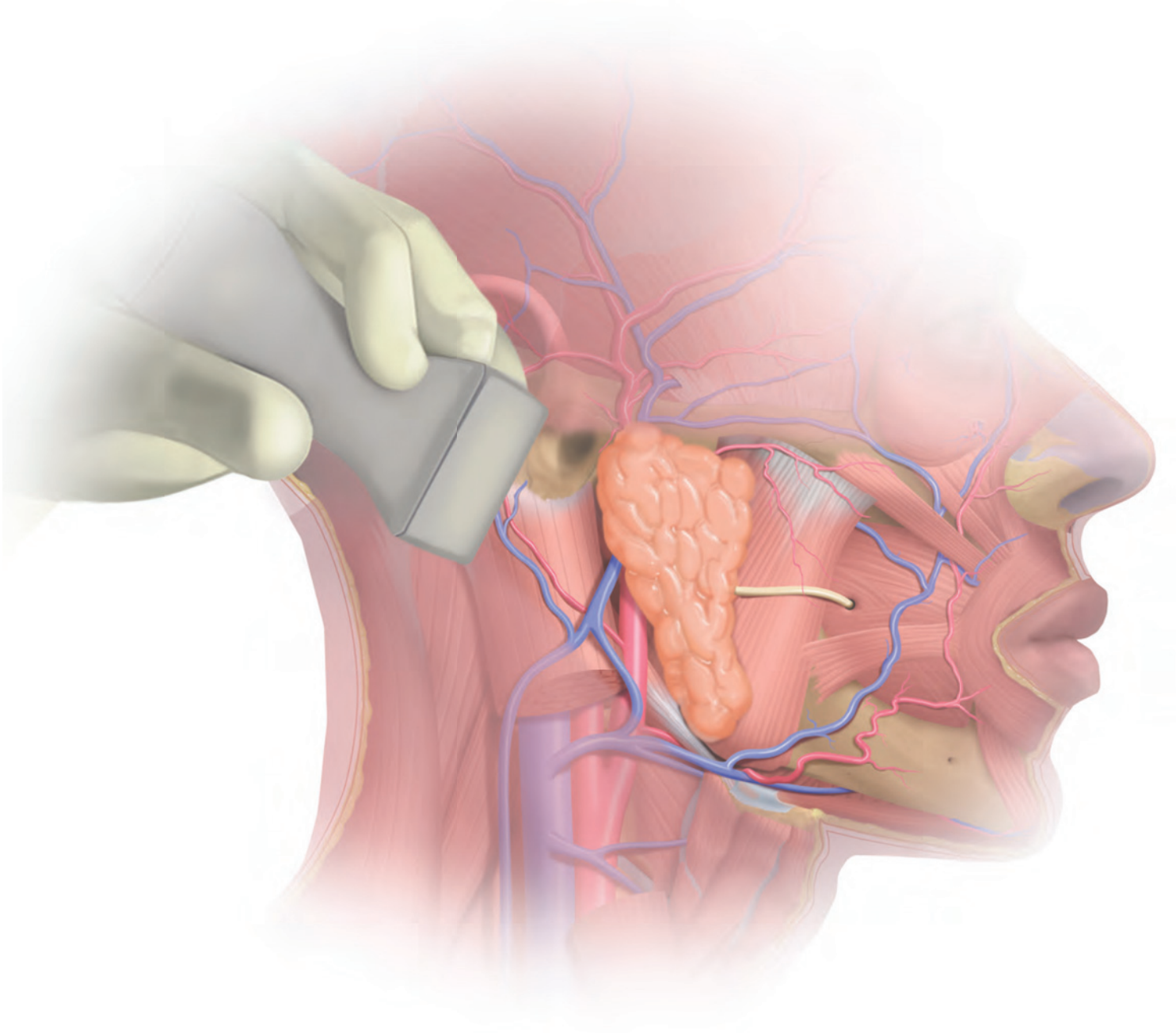

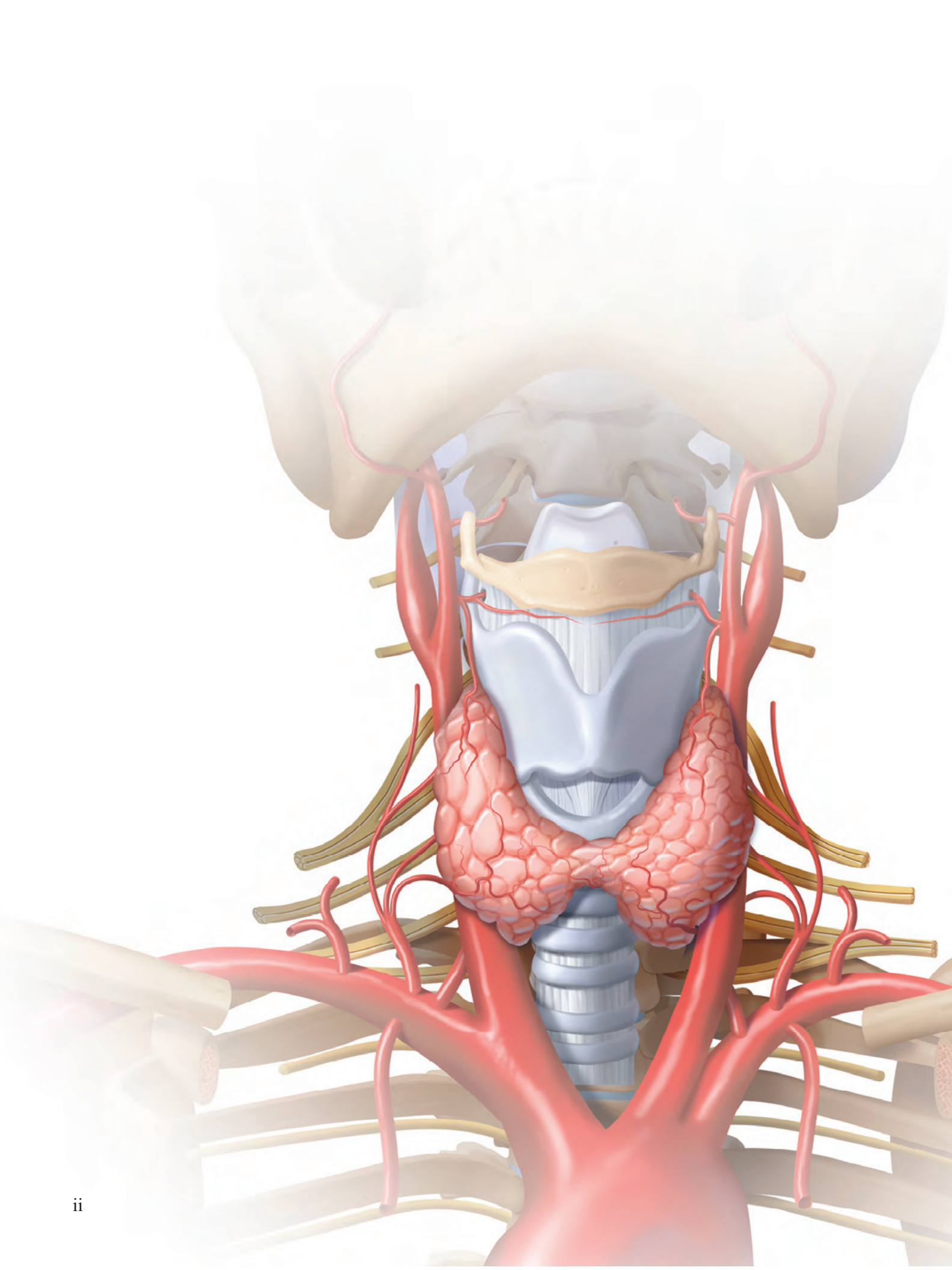

Diagnostic Ultrasound

Head and Neck

Anil T. Ahuja

MBBS (Bom), MD (Bom), FRCR, FHKCR, FHKAM (Radiology)

Professor of Imaging & Interventional Radiology
Chairman, Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China

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First Edition

Printed in Canada by Friesens, Altona, Manitoba, Canada

ISBN: 978-1-937242-16-9

Notice and Disclaimer

Publisher Cataloging-in-Publication Data

Diagnostic ultrasound : head and neck / [edited by] Anil T. Ahuja.
pages ; cm
Head and neck
Includes bibliographical references and index.
ISBN 978-1-937242-16-9 (hardback)

1. Diagnostic ultrasonic imaging. 2. Head--Anatomy. 3. Neck--Anatomy. I. Ahuja, Anil. T.
II. Title: Head and neck.
[DNLM: 1. Head--ultrasonography--Atlases. 2. Neck--ultrasonography--Atlases.
3. Head--anatomy & histology--Atlases. 4. Neck--anatomy & histology--Atlases. WN 208]

RC78.7.U4 D515 2014
616.07543--dc23

To my late mum and dad, I owe it all to them. I have been blessed!

To Anita, no sister could have sacrificed more for the success of her brother. The rock in our lives.

To the three girls who make it all worthwhile: My precious wife, Reann, for her love, support, patience, and tolerance of my many imperfections; my lovely daughters, Sanjali and Tiana, for the sheer love, joy, happiness, and meaning they bring to our lives.

ATA

I dedicate my work on this book to the Head and Neck Imaging team in PWH. I could not have completed the task without the hard work and collaborative effort of each of the radiologists and technologists who helped me during this project.

To Anil, my mentor and friend, for his selfless sharing of knowledge and his leadership through this process and throughout the many years that I have known him.

I especially want to thank Dr. Ric Harnsberger and Dr. Donald Resnick for their mentoring, encouragement, and for serving as my inspiration.

Finally, to my mother and siblings, without whose love and support I certainly could not have accomplished this.

YYPL

To my beloved wife, Anna, lovely kids, Mike, Audrey, and Chloe, who bring happiness, hope, and courage to my life.

To my teacher of radiology, Anil, who instilled in me the love and passion for my specialty.

To ultrasound colleagues in my department, whose work has contributed so much to the progress in ultrasound.

KTW

Contributing Authors

Yolanda Y. P. Lee

MBChB, FRCR, FHKCR, FHKAM (Radiology)

Associate Consultant & Clinical Associate Professor (honorary)
Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China

K. T. Wong

MBChB, FRCR, FHKCR, FHKAM (Radiology)

Consultant & Clinical Associate Professor (honorary)
Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China

Carmen C. M. Cho

MBBS, FRCR, FHKCR, FHKAM (Radiology)

Associate Consultant & Clinical Assistant Professor (honorary)
Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China

Kunwar S. S. Bhatia

B Med Sci, BMBS, MRCS, DLO, FRCR

Assistant Professor
Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China

H. Y. Yuen

MBChB, FRCR, FHKCR, FHKAM (Radiology), MPH

Associate Consultant & Clinical Associate Professor (honorary)
Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China

Stella Sin Yee Ho

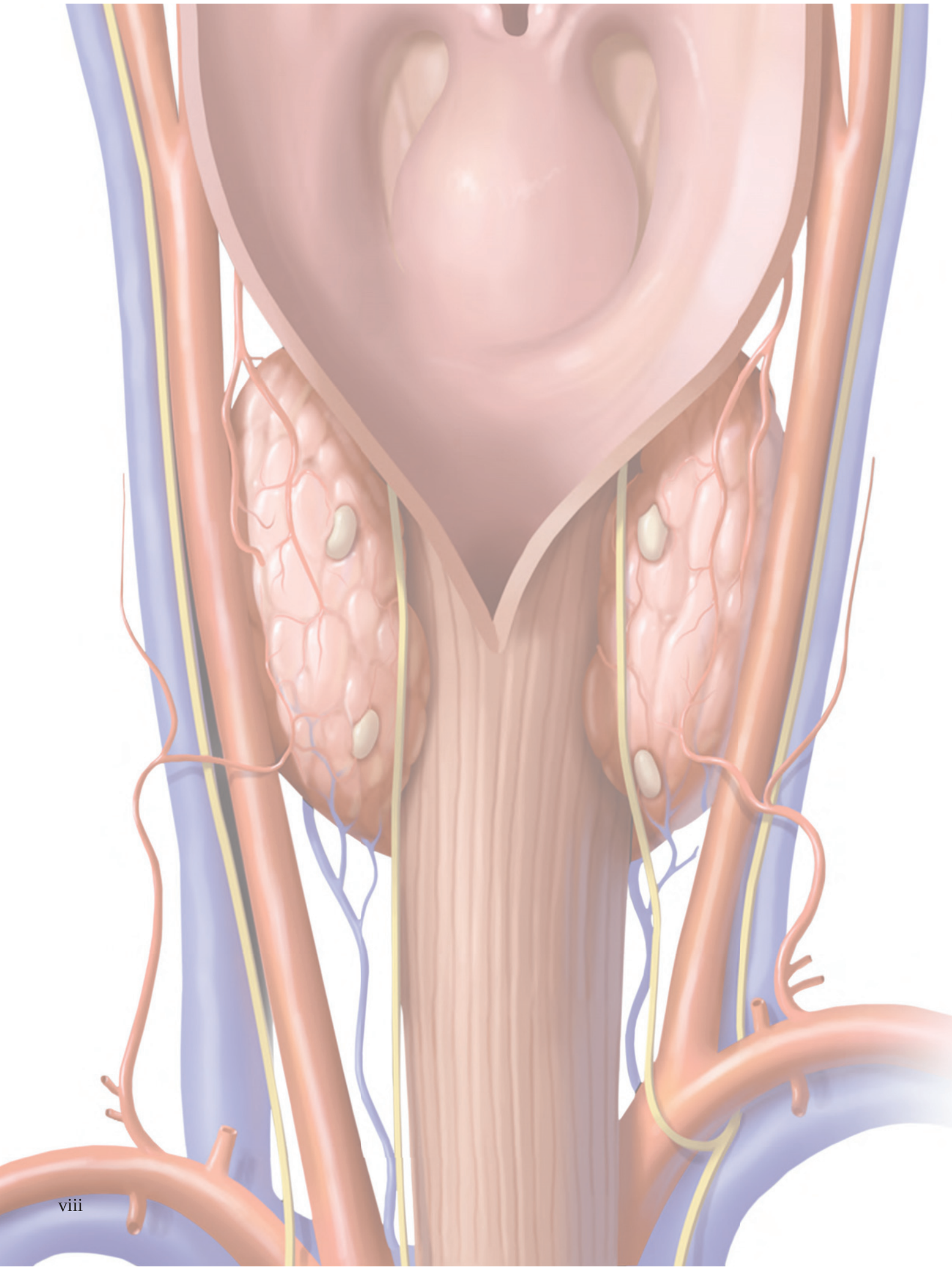
RDMS, RVT, PhD

Adjunct Associate Professor
Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China

Simon S. M. Ho

MBBS, FRCR

Clinical Associate Professor (honorary)
Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China



Preface

Ultrasound is a key imaging modality in the head and neck, both as a primary imaging tool and in other instances complementary to CT, MR, and nuclear medicine. Its role over the years has significantly expanded, and its practice is no longer restricted to imaging/radiology/ultrasound departments. Endocrinologists and head and neck surgeons use ultrasound extensively in their clinical practice as an initial localizing and diagnostic tool because it is more sensitive than palpation and accurately characterizes many lesions in head and neck. They also use it to safely guide confirmatory needle biopsy or therapy (radiofrequency ablation, ethanol injection, etc.) and for routine patient follow-up. This book was written to provide essential information to all practicing "sonologists" and to those who may be considering taking up head and neck ultrasound.

Diagnostic Ultrasound: Head and Neck is divided into three parts: Anatomy, diagnoses, and differential diagnosis. The first part, anatomy, covers relevant sonographic anatomy in the head and neck, with complementary images from CT and MR. The second part, diagnoses, the core content of the book, provides detailed sonographic descriptions of common head and neck lesions, key clinical information, and practical scanning tips for identifying the wide spectrum of diseases in this region. The third and final part provides differential diagnoses for common sonographic signs and appearances. Although the book focuses on ultrasound, readers will find images from other imaging modalities so as to highlight the importance of multimodality imaging in modern clinical practice.

This book is a compilation of the head and neck sections of three previous books published by Amirsys, namely *Diagnostic Imaging: Ultrasound*; *Diagnostic and Surgical Imaging Anatomy: Ultrasound*; and *Expertddx: Ultrasound*. The text and 400-plus images in the anatomy section remain relatively unchanged from the earlier book. The diagnoses section includes 20 diagnoses from the earlier books and 21 new diagnoses/chapters. This section also contains 1,000-plus images, almost all of which are new and accompanied by comprehensive annotation, including illustrative images of shearwave elastography and strain imaging. The key facts feature has been retained in this book and is ideal for quick review. The differential diagnosis section of this book features 250-plus images, more than half of which are new, and includes key references.

Any book of this nature involves hard work, but the opportunity to work with friends with similar interests makes it fun. It gives us all a platform to share our experience, images, and knowledge as well as learn from each other as well as test our levels of patience and tolerance. We remain indebted to all the authors, coauthors, sonographers, and medical editors, and to the Amirsys team who have gently cajoled and patiently guided us along the entire process, despite being in a different part of the world. Finally, we would like to thank Dr. Ric Harnsberger and Dr. Paula Woodward for their unflinching support over the years.

We hope our efforts in some small way help you in your routine clinical practice.

Anil T. Ahuja

MBBS (Bom), MD (Bom), FRCR, FHKCR, FHKAM (Radiology)

Professor of Imaging & Interventional Radiology
Chairman, Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China

Yolanda Y. P. Lee

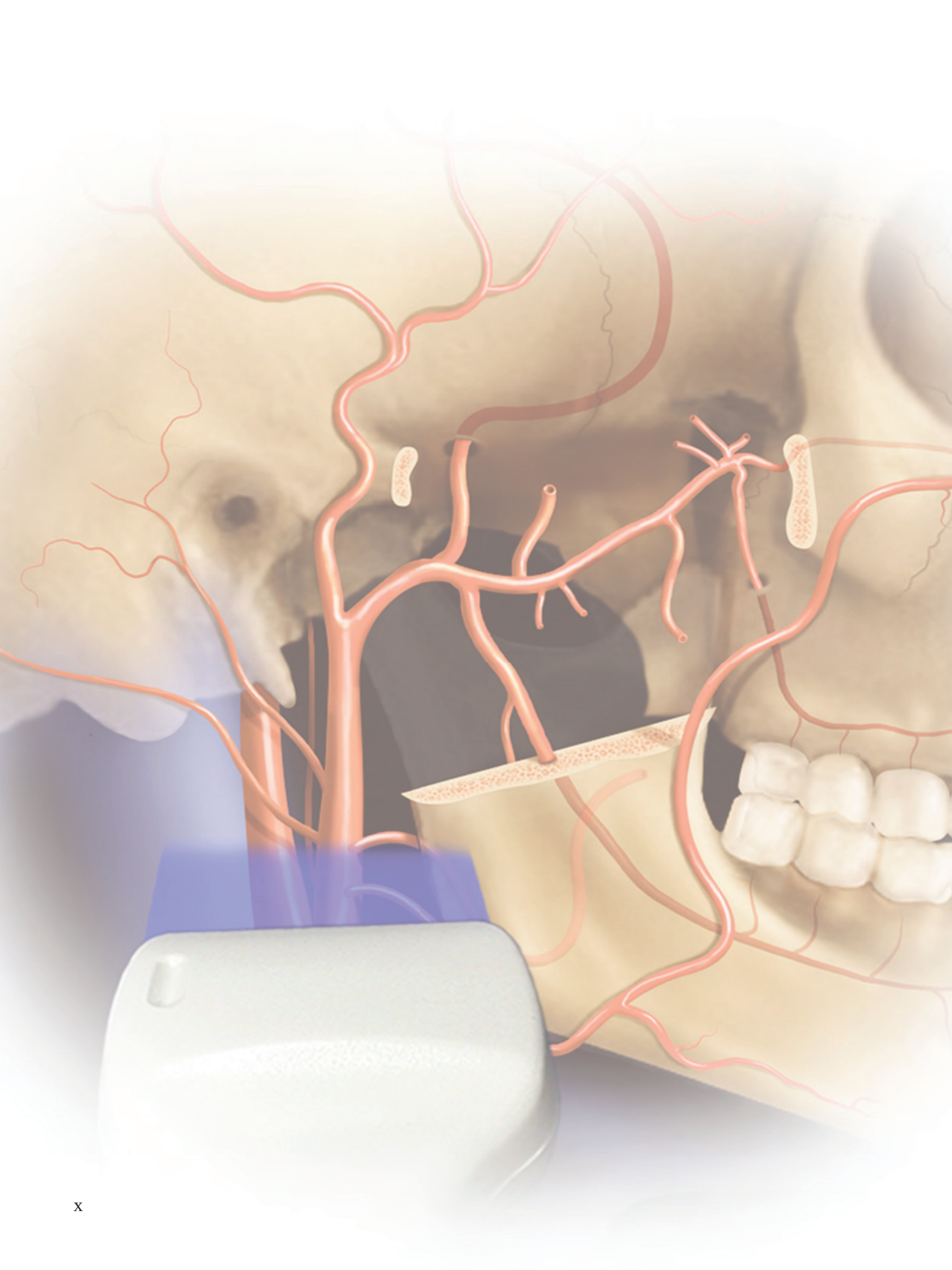
MBChB, FRCR, FHKCR, FHKAM (Radiology)

Associate Consultant & Clinical Associate Professor (honorary)
Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China

K. T. Wong

MBChB, FRCR, FHKCR, FHKAM (Radiology)

Consultant & Clinical Associate Professor (honorary)
Department of Imaging & Interventional Radiology
Prince of Wales Hospital
Faculty of Medicine
The Chinese University of Hong Kong
Hong Kong (SAR), China



Acknowledgements

Text Editing

Dave L. Chance, MA, ELS
Angela M. Green Terry, BA
Sarah J. Connor, BA
Tricia L. Cannon, BA

Image Editing

Jeffrey J. Marmorstone, BS
Lisa A. M. Steadman, BS
Kevin Lo Hoi Nga

Medical Editing

Ryan Chi Hang Nung, MBChB(H.K.), FRCR
Jacqueline Ching Man Sitt, MBBS(H.K.), FRCR
Simon Sin Man Wong, MBBS(H.K.), FRCR
Janice Wong Li Yu, MBBS(H.K.), FRCR

Illustrations

Richard Coombs, MS
Lane R. Bennion, MS
Laura C. Sesto, MA

Art Direction and Design

Laura C. Sesto, MA
Tom M. Olson, BA

Lead Editor

Arthur G. Gelsinger, MA

Publishing Leads

Katherine L. Riser, MA
Rebecca L. Hutchinson, BA

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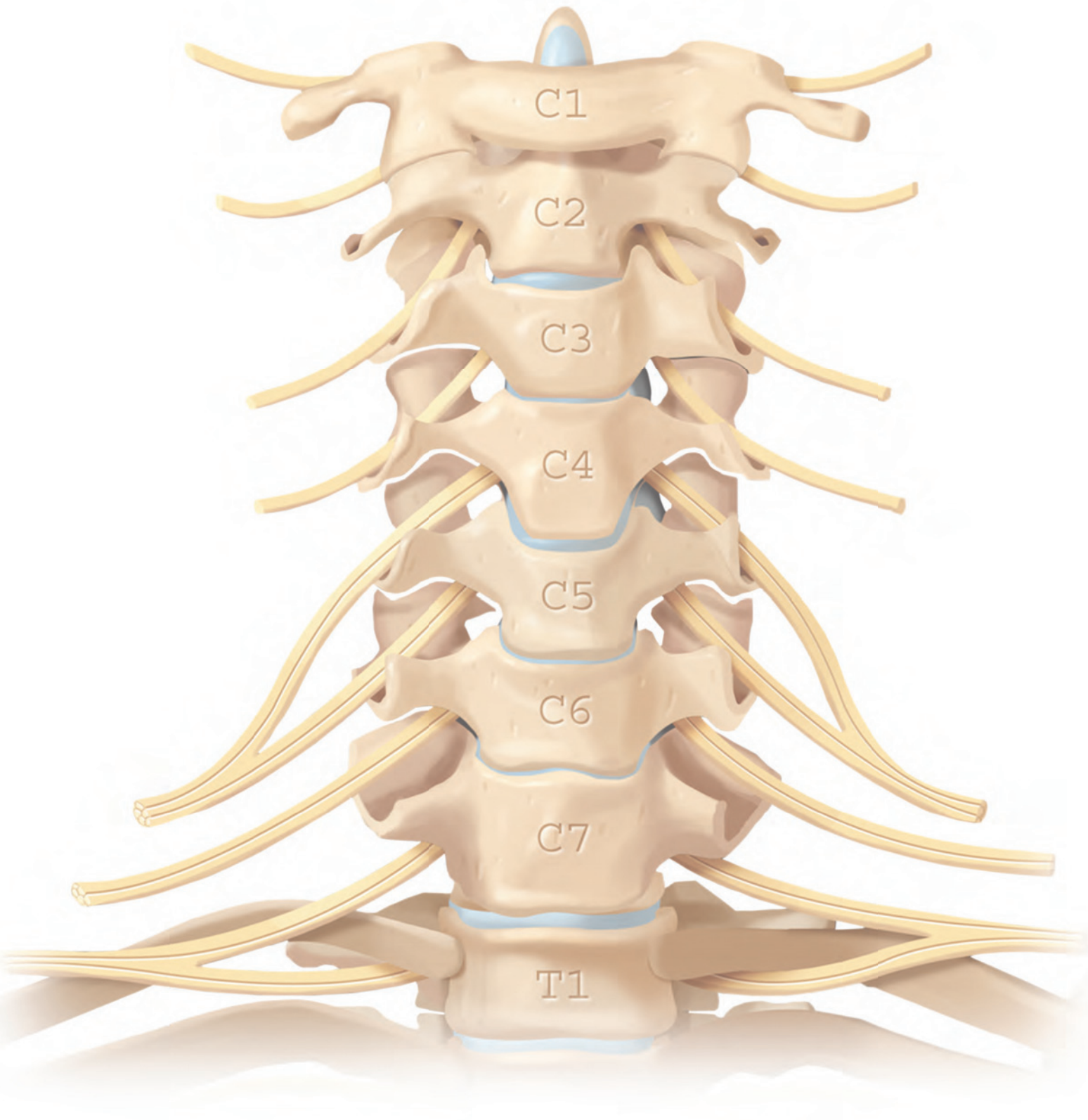
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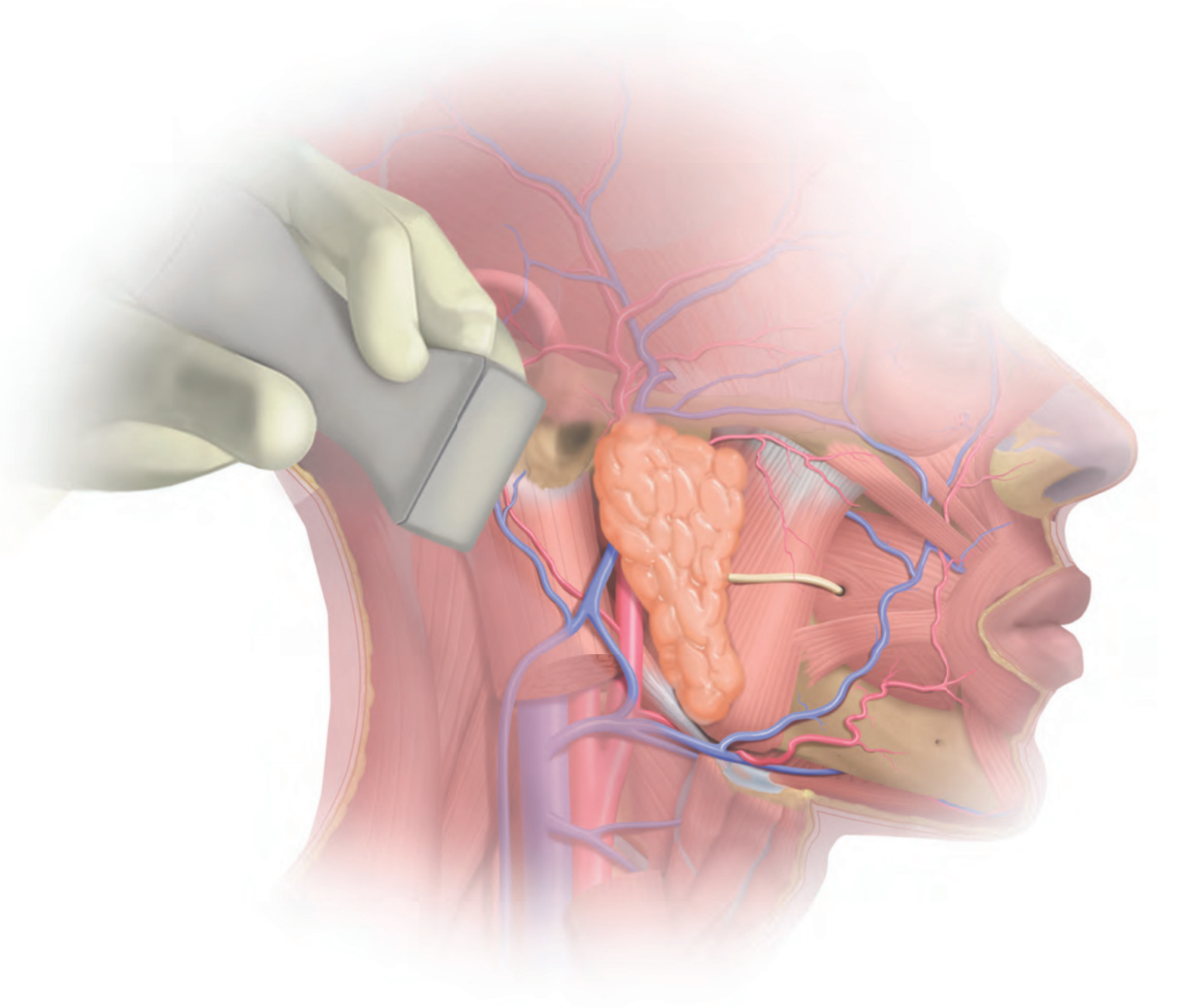
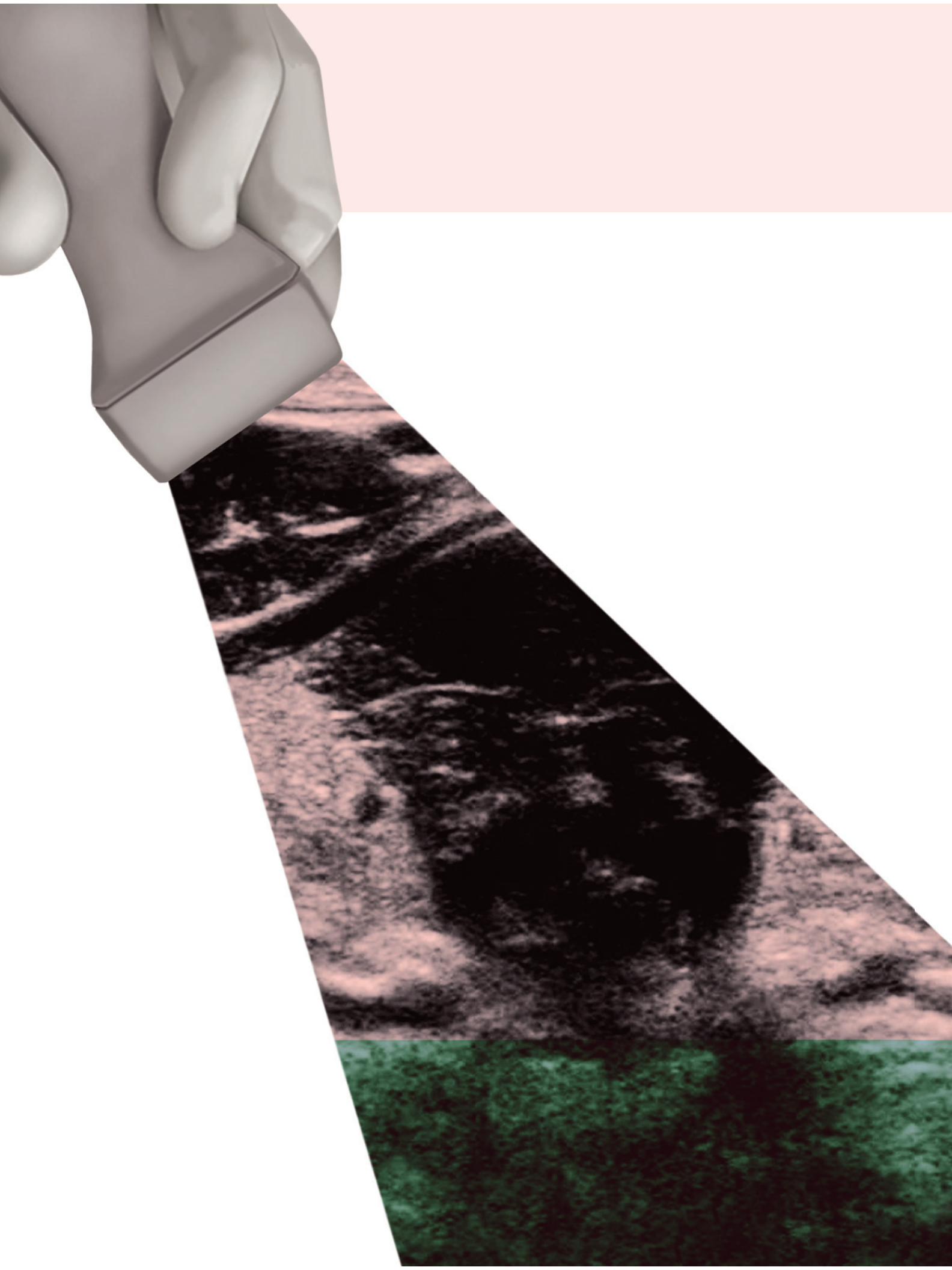
Diagnostic Ultrasound

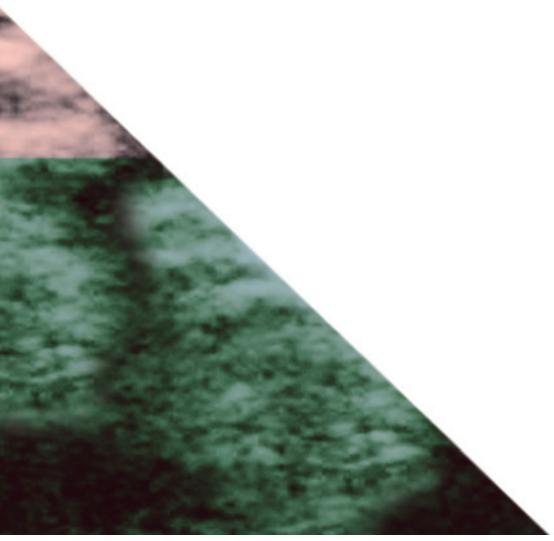
Head and Neck





SECTION 1

Head and Neck



NECK

TERMINOLOGY

Abbreviations
- Suprahyoid neck (SHN)
- Infrahyoid neck (IHN)

Definitions
- SHN: Spaces from skull base to hyoid bone (excluding orbits, paranasal sinuses, and oral cavity) including parapharyngeal (PPS), pharyngeal mucosal (PMS), masticator (MS), parotid (PS), carotid (CS), buccal (BS), retropharyngeal (RPS), and perivertebral (PVS) spaces
- IHN: Spaces below hyoid bone to thoracic inlet, including visceral space (VS), posterior cervical space (PCS), anterior cervical space (ACS), CS, RPS, and PVS

IMAGING ANATOMY

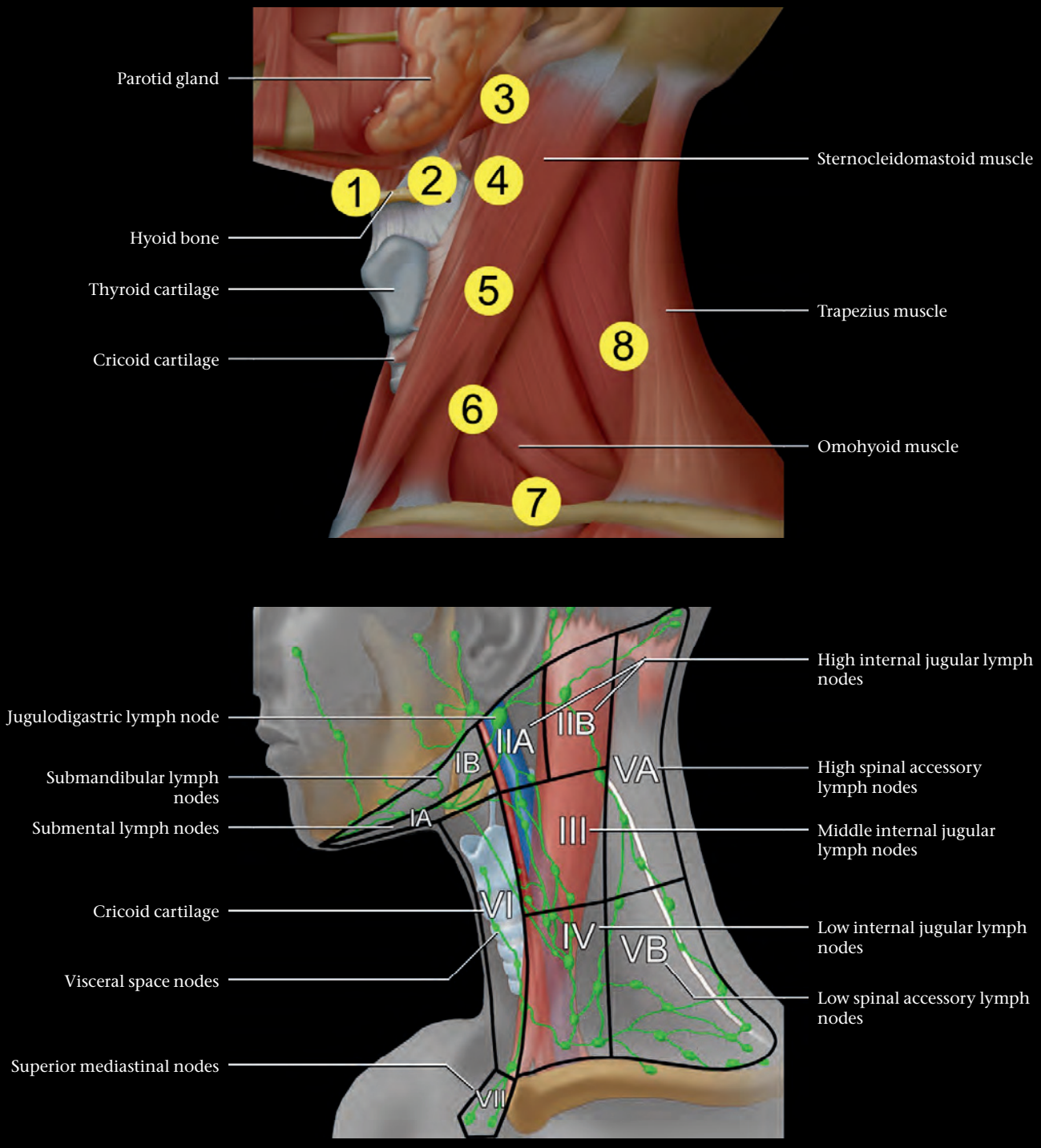
Overview
- Fascial spaces of SHN and IHN are key for cross-sectional imaging
  - Concept is difficult to apply with ultrasound
- Ultrasound anatomy is based on division of neck into anterior and posterior triangles
  - Anterior triangle: Bounded anteriorly by midline and posteriorly by posterior margin of sternomastoid muscle
    - Further divided into suprahyoid and infrahyoid portions
    - Suprahyoid portion: Divided by anterior belly of digastric muscle into submental and submandibular triangles
    - Infrahyoid portion: Divided by superior belly of omohyoid muscle into muscular and carotid triangles
  - Posterior triangle: Bound anteriorly by posterior margin of sternomastoid muscle and posteriorly by anterior border of trapezius muscle
    - Apex formed by mastoid process, base of triangle formed by clavicle
    - Subdivided by posterior belly of omohyoid muscle into occipital triangle (superior) and supraclavicular triangle (inferior)
- Submental region
  - Key structures include anterior belly of digastric muscle, mylohyoid, genioglossus and geniohyoid muscles, sublingual glands, and lingual artery
- Submandibular region
  - Key structures include submandibular gland, mylohyoid muscle, hyoglossus muscle, anterior and posterior bellies of digastric muscle, facial vein, and anterior division of retromandibular vein (RMV)
- Parotid region
  - Key structures include parotid gland, masseter and buccinator muscles, RMV, and external carotid artery (ECA)
- Cervical region
  - Upper cervical region: Skull base to hyoid bone/carotid bifurcation
    - Key structures include internal jugular vein (IJV), carotid bifurcation, jugulodigastric node, and posterior belly of digastric muscle
  - Mid cervical region: Hyoid bone to cricoid cartilage
    - Key structures include IJV, common carotid artery (CCA), vagus nerve, and lymph nodes
  - Lower cervical region: Cricoid cartilage to clavicle
    - Key structures include IJV, CCA, superior belly of omohyoid, and lymph nodes
- Supraclavicular fossa
  - Key structures include trapezius, sternomastoid, omohyoid muscles, brachial plexus elements, and transverse cervical nodes
- Posterior triangle
  - Bordered anteriorly by sternomastoid muscle and posteriorly by trapezius muscle
  - Floor formed by scalene muscles, levator scapulae, and splenius capitis muscles
- Midline
  - Key structures include hyoid bone, strap muscles, thyroid, larynx, and tracheal rings

ANATOMY IMAGING ISSUES

Imaging Recommendations
- Use of high-resolution transducers is essential
- Color/power Doppler examination provides useful supplementary information to grayscale ultrasound
- US is very sensitive in identifying abnormalities (and in characterizing many head and neck soft tissue lesions)
  - Combination with FNAC provides specificity and increased diagnostic accuracy
- US + FNAC usually provides adequate information for patient management
- Cross-sectional imaging (CT, MR) may be required for
  - Large mass, when detailed anatomical extent is not fully examined by US
  - Deep-seated lesion with suboptimal US visualization and evaluation
  - Preoperative assessment of relevant adjacent structures (e.g., bone involvement)

Imaging Approaches
- Ultrasound imaging protocol
  - Start in submental region by scanning in transverse plane
  - Next, scan the submandibular region in transverse and longitudinal/oblique planes
  - Then scan parotid region in transverse and longitudinal planes
  - Now examine upper cervical, mid cervical, and lower cervical regions in transverse plane
  - Then examine supraclavicular fossa with transducer held transversely
  - Now scan posterior triangle transversely along a line drawn from mastoid process to ipsilateral acromion
  - Finally, scan midline and thyroid gland in both transverse and longitudinal planes
- This protocol is robust and can be tailored to suit individual clinical conditions
- Transverse scans quickly identify normal anatomy and detect abnormalities
- Any abnormality identified is further examined in longitudinal/oblique planes (grayscale and Doppler)
- In restless children, it may not be possible to follow the above protocol
  - It would therefore be best to evaluate primary area of interest 1st, before the child becomes uncooperative

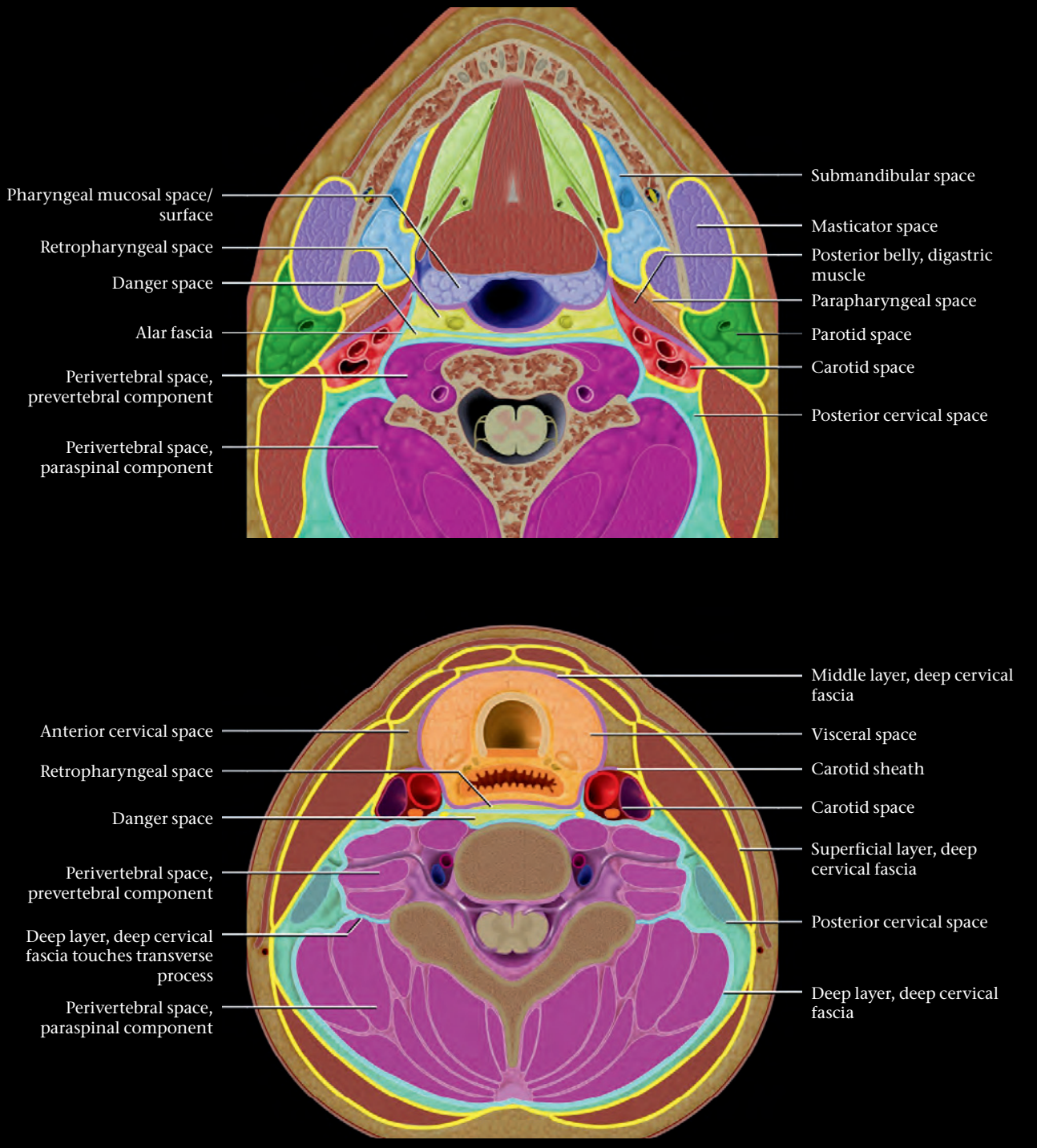
GRAPHICS



(Top) *Schematic diagram shows the protocol for ultrasound examination of the neck with 8 regions scanned in order: (1) submental region, (2) submandibular region, (3) parotid region, (4) upper cervical region, (5) mid cervical region, (6) lower cervical region, (7) supraclavicular fossa, and (8) posterior triangle. The above protocol is robust and helps to adequately evaluate the neck for common clinical conditions. Note that deep structures cannot be adequately assessed by ultrasound.* ***(Bottom)*** *Lateral oblique graphic of the neck shows the anatomic locations of the major nodal groups of the neck. Division of the internal jugular nodal chain into high, middle, and low regions is defined by the level of the hyoid bone and cricoid cartilage. Similarly, the spinal accessory nodal chain is divided into high & low regions by the level of the cricoid cartilage.*

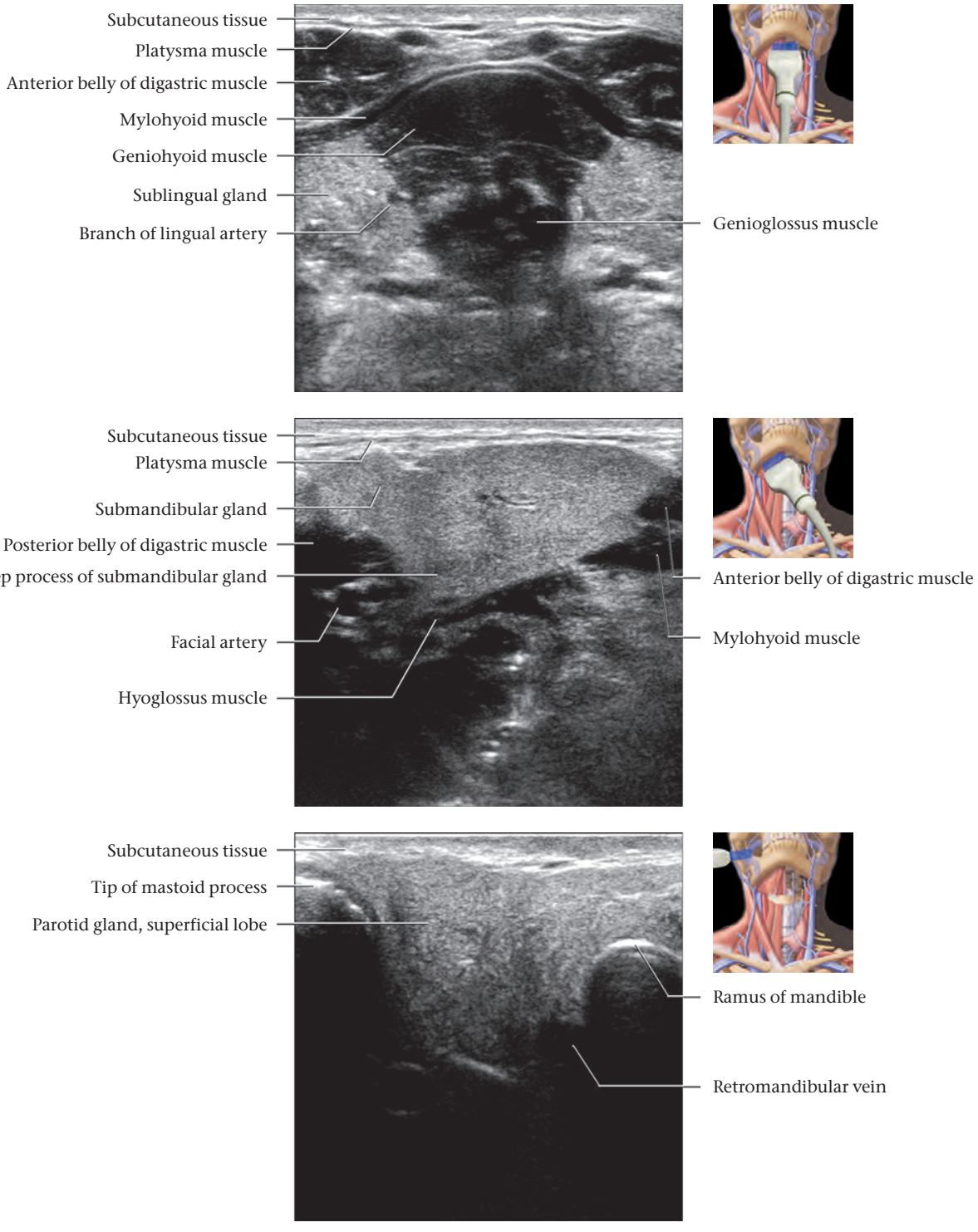
NECK

GRAPHICS



(Top) *Axial graphic shows the suprahyoid neck spaces at the level of the oropharynx. The superficial (yellow line), middle (pink line), and deep (turquoise line) layers of deep cervical fascia (DCF) outline the suprahyoid neck spaces. Notice the lateral borders of the retropharyngeal & danger spaces are called the alar fascia and represent a slip of the deep layer of DCF.* ***(Bottom)*** *Axial graphic depicts the fascia and spaces of the infrahyoid neck. The 3 layers of DCF are present in the suprahyoid and infrahyoid neck. The carotid sheath is made up of all 3 layers of DCF (tricolor line around carotid space). Notice the deep layer completely circles the perivertebral space, diving in laterally to divide it into prevertebral and a paraspinal components. Although the spaces are not adequately demonstrated by US, it is important to be familiar with the concept in order to understand neck anatomy.*

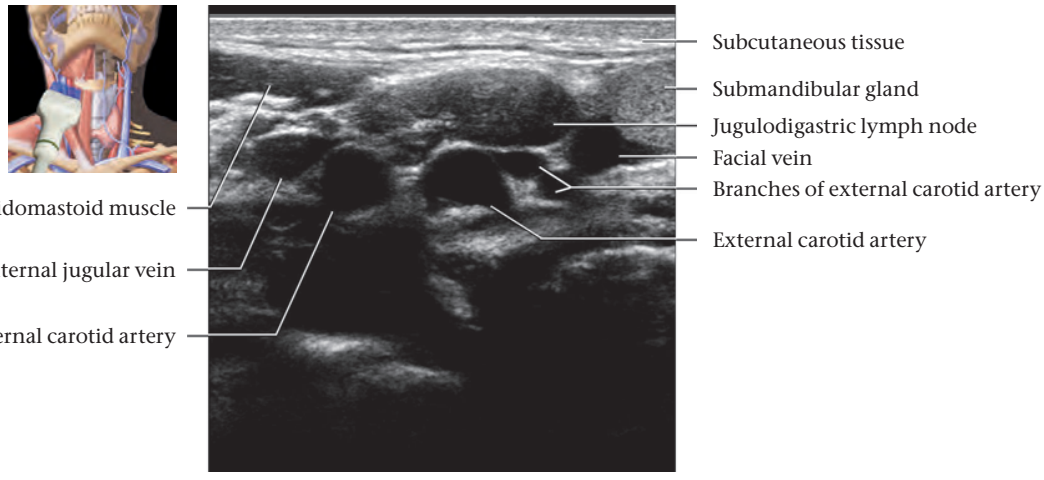
TRANSVERSE ULTRASOUND

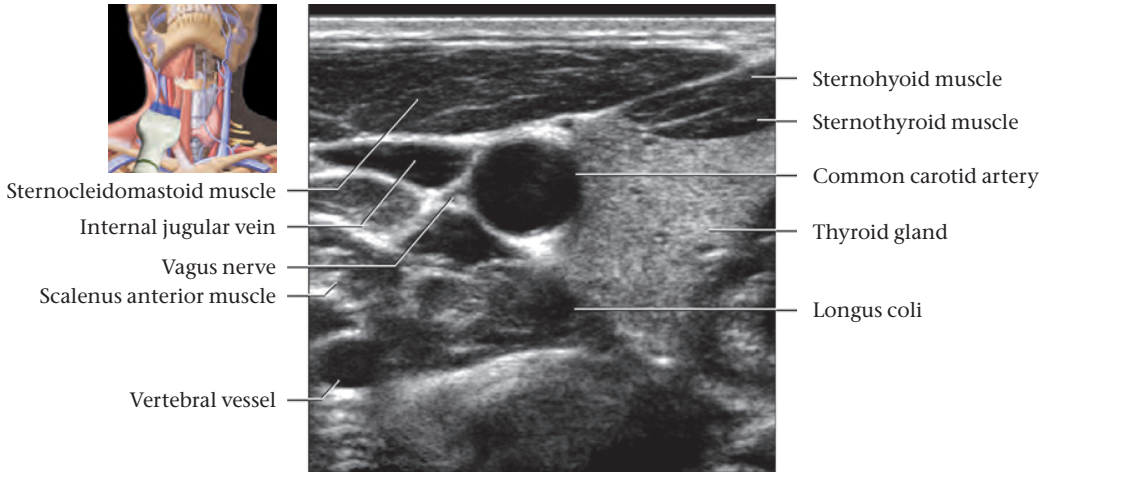


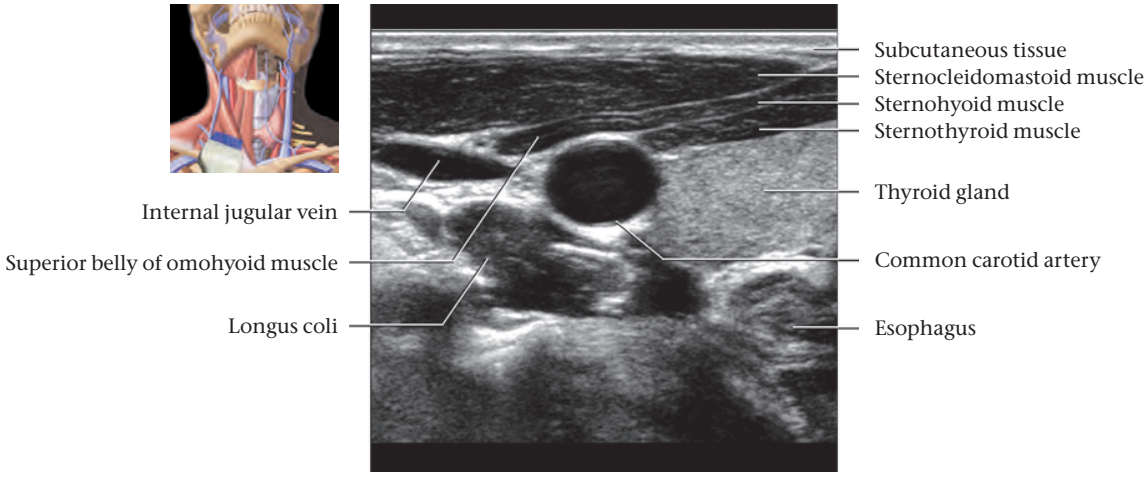
(Top) *Standard transverse grayscale ultrasound image shows the submental region. The mylohyoid muscle is an important landmark for the division of the sublingual (deep to mylohyoid muscle) and submandibular (superficial to mylohyoid muscle) spaces. Part of the extrinsic muscles of the tongue, including the geniohyoid and genioglossus, are visualized.* ***(Middle)*** *Standard transverse grayscale ultrasound image shows the submandibular region. The submandibular gland is the key structure with its homogeneous echotexture. The gland sits astride the mylohyoid and posterior belly of the digastric muscles.* ***(Bottom)*** *Standard transverse grayscale ultrasound image shows the parotid region. Note that the deep lobe is obscured by shadowing from the mandible and cannot be evaluated. The retromandibular vein serves as a landmark for the intraparotid facial nerve.*

NECK

TRANSVERSE ULTRASOUND

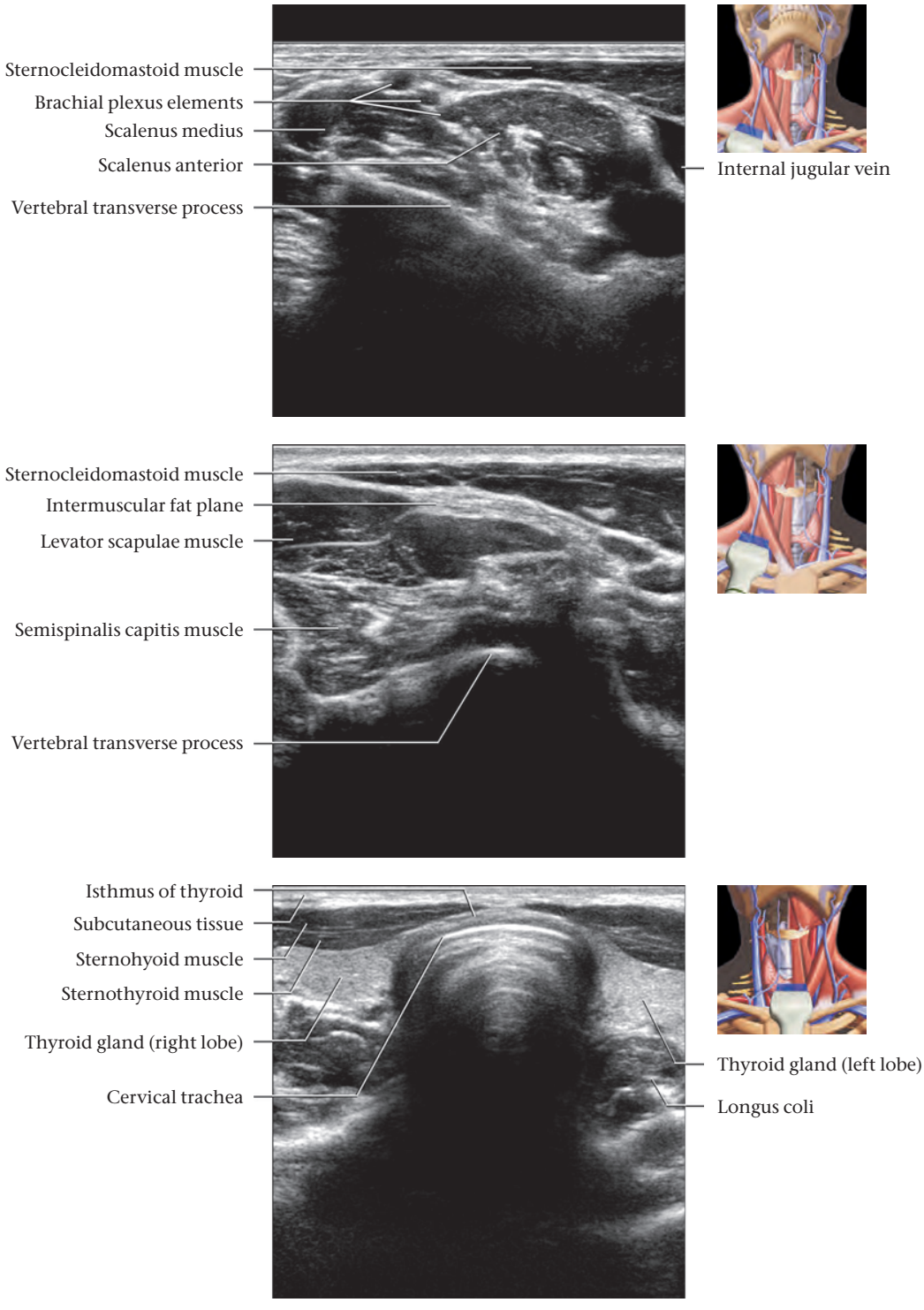






(Top) *Standard transverse grayscale ultrasound image shows the upper cervical level. Key structures include the internal jugular vein, the proximal internal and external carotid arteries, and the jugular chain lymph nodes. The jugulodigastric node is the most prominent and consistently seen on ultrasound.* ***(Middle)*** *Standard grayscale ultrasound image shows the mid cervical level. Note the vagus nerve is clearly seen on ultrasound.* ***(Bottom)*** *Standard grayscale ultrasound image shows the lower cervical level. The thyroid gland is related to the common carotid and internal jugular vein laterally. The anterior strap muscles (including the sternohyoid and sternothyroid muscles) and the superior belly of the omohyoid are clearly visualized.*

TRANSVERSE ULTRASOUND



(Top) *Standard grayscale ultrasound image shows the supraclavicular fossa. Note that the trunks of the brachial plexus are consistently seen on high-resolution ultrasound at this site.* ***(Middle)*** *Standard transverse grayscale ultrasound image shows the posterior triangle. Note that the intermuscular fat plane is visible. The spinal accessory nerve and lymph nodes are important contents of the posterior triangle.* ***(Bottom)*** *Standard transverse grayscale ultrasound image shows the midline of the lower anterior neck. The isthmus of the thyroid gland, the trachea, and the longus coli are key structures to be identified.*

SUBLINGUAL/SUBMENTAL REGION

TERMINOLOGY

Synonyms
- Sublingual space (SLS), submental triangle

Definitions
- Sublingual region (SLR): Paired nonfascial-lined spaces of oral cavity in deep oral tongue, above floor of mouth, superomedial to mylohyoid muscle

IMAGING ANATOMY

Overview
- Borders of submental triangle are readily defined on ultrasound
  - Floor is formed by mylohyoid muscle
  - Apex is limited anteriorly by symphysis menti
  - Base is bounded posteriorly by hyoid bone
  - Anterior belly of digastric muscle represents sides of triangle
- SLS is deep space of oral cavity superomedial to mylohyoid muscles
  - Contains key neurovascular structures of oral cavity
  - Includes glossopharyngeal nerve (CN9), hypoglossal nerve (CN12), lingual nerve (branch of V3), lingual artery and vein

Anatomy Relationships
- SLS relationships
  - SLS in deep oral tongue superomedial to mylohyoid muscle and lateral to genioglossus-geniohyoid muscles
  - Communication between sublingual spaces occurs in midline anteriorly as a narrow isthmus beneath frenulum
  - SLS communicates with submandibular space (SMS) and inferior parapharyngeal space (PPS) at posterior margin of mylohyoid muscle
    - There is no fascia dividing posterior SLS from adjacent SMS
    - Therefore, there is direct communication with SMS and PPS in this location

Internal Contents
- Major muscles forming borders of submental triangle
  - Anterior belly of digastric muscle
    - Marks lateral border of the submental triangle
  - Mylohyoid muscle
    - Muscle of the floor of mouth
    - Muscular sling between medial aspect of mandibular bodies
    - Anterior attachment to mandible inferior to origins of genial muscles
    - Separates SLS (deep to mylohyoid muscle plane) from SMS (superficial to mylohyoid muscle)
  - Genioglossus and geniohyoid muscles
    - Form root of tongue
    - Together with hyoglossus muscle, they make up major extrinsic muscles of tongue
- Posterior aspect of SLS is divided into medial and lateral compartments by hyoglossus muscle
- Lateral compartment contents
  - Hypoglossal nerve
    - Motor to intrinsic and extrinsic muscles of tongue
    - Intrinsic muscles of tongue include inferior lingual, vertical, and transverse muscles
  - Lingual nerve: Branch of mandibular division of trigeminal nerve (CNV3) combined with chorda tympani branch of facial nerve
    - Lingual nerve branch of CNV3: Sensation to anterior 2/3 of oral tongue
    - Chorda tympani branch of facial nerve: Anterior 2/3 of tongue taste and parasympathetic secreto-motor fibers to submandibular ganglion/gland
  - Sublingual glands and ducts
    - Lie in anterior SLS bilaterally
    - ~ 5 small ducts open under oral tongue into oral cavity
    - With age, sublingual glands atrophy, becoming difficult to see on imaging
  - Submandibular glands and submandibular ducts
    - Submandibular gland deep margin extends into posterior opening of SLS
    - Submandibular duct runs anteriorly to papillae in anteromedial subfrenular mucosa
- Medial compartment contents
  - Glossopharyngeal nerve (CN9)
    - Provides sensation to posterior 1/3 of tongue
    - Carries taste input from posterior 1/3 of tongue
    - Located more cephalad in medial compartment compared to lingual artery and vein
  - Lingual artery and vein
    - Vascular supply to oral tongue
    - Seen running just lateral to genioglossus muscle

ANATOMY IMAGING ISSUES

Questions
- What defines a mass as primary to SLS?
  - Center of lesion is superomedial to mylohyoid muscle and lateral to genioglossus muscle
- Common lesions in submental region include
  - Congenital lesions: Epidermoid/dermoid cyst
  - Enlarged lymph node: Reactive, inflammatory or neoplastic (metastatic/lymphomatous nodes)
  - Inflammatory conditions: Ranula, abscess
  - Sublingual gland lesions: Sialadenitis, calculus, benign/malignant salivary gland tumor

Imaging Recommendations
- High-resolution ultrasound is ideal imaging tool for evaluating submental masses
- Major structures are best seen on transverse scans with patient's neck in slight hyperextension
- For more deep-seated lesions (e.g., deep to root of tongue), MR is necessary for better anatomical assessment
  - Ultrasound may help in directing a needle for guided biopsy of such lesions

RELATED REFERENCES

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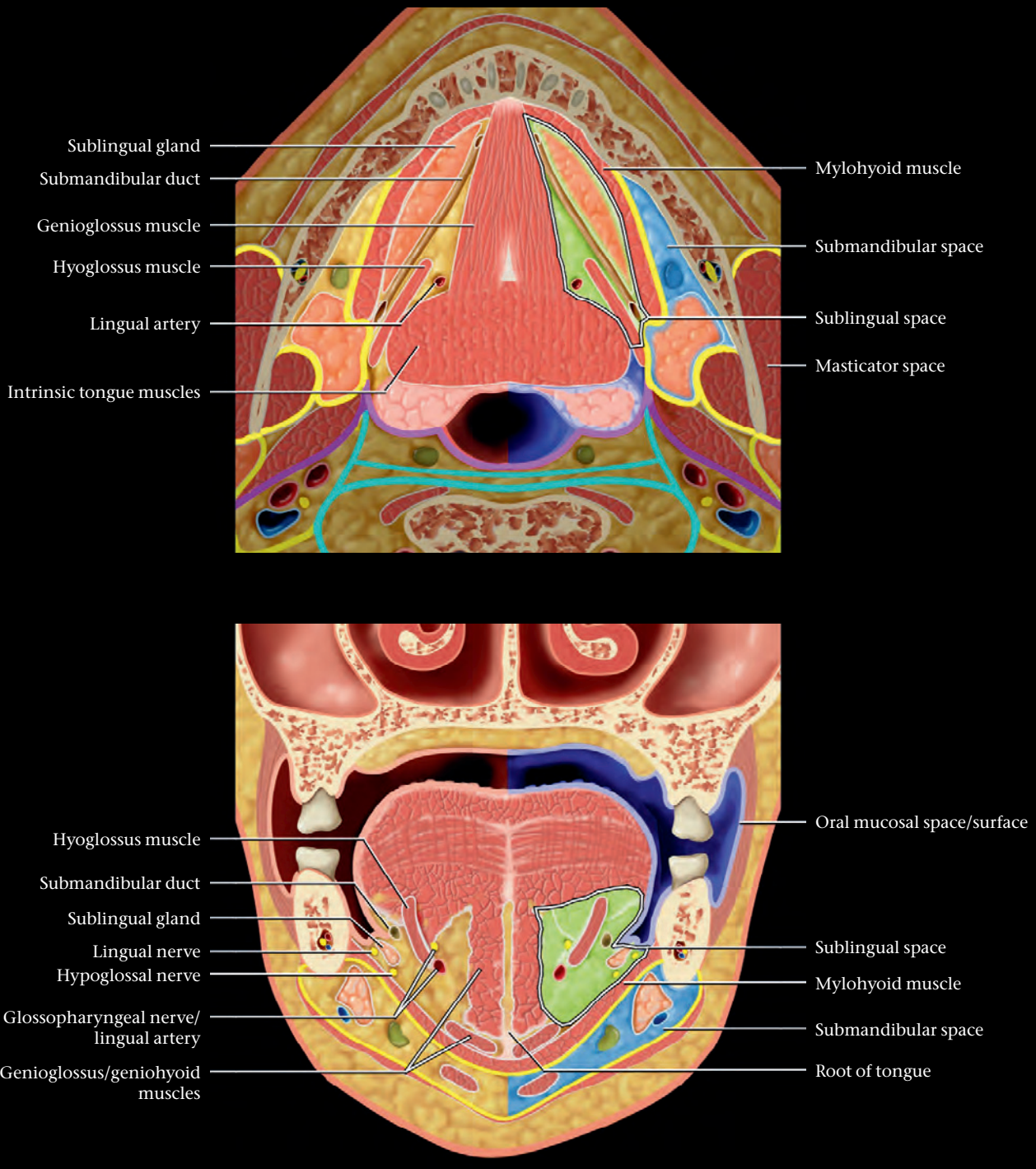
2. Ahuja AT et al: Practical Head & Neck Ultrasound. London: Greenwich Medical Media, 2000

SUBLINGUAL/SUBMENTAL REGION

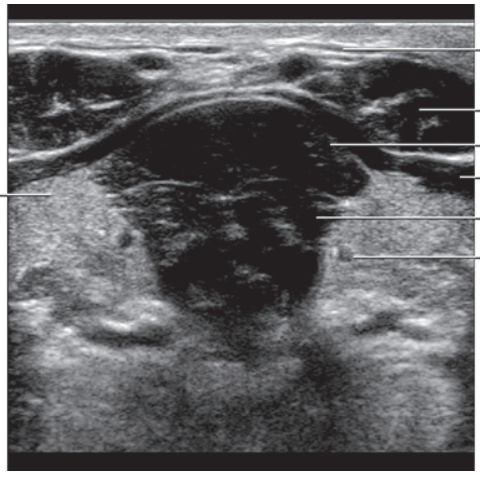
GRAPHICS

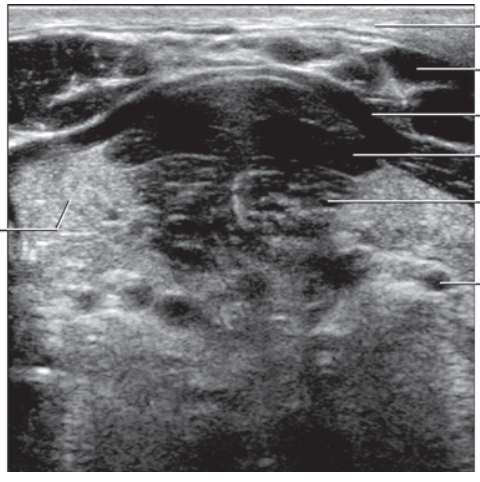


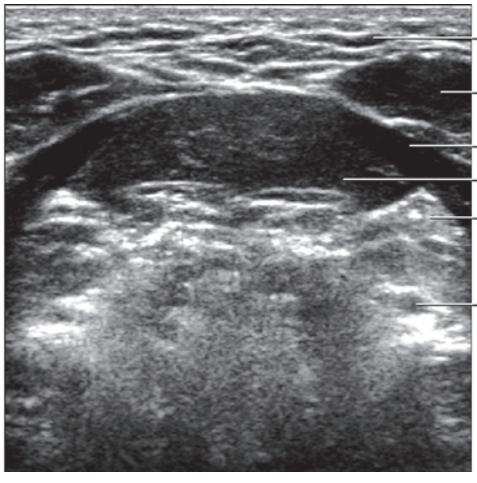
(Top) *Axial graphic through the body of the mandible shows the sublingual space (on patient's left, shaded in green) situated superomedial to the mylohyoid muscle and lateral to the genioglossus muscle. Notice the absence of fascia surrounding the sublingual space. The yellow line represents the superficial layer of deep cervical fascia.* ***(Bottom)*** *Coronal graphic through the oral cavity shows position of the mylohyoid muscle, which is the landmark in this area. The sublingual space (SLS) is shaded in green. The medial SLS compartment contains the glossopharyngeal nerve (CN9) and lingual artery/vein, and the lateral SLS compartment contains the submandibular duct, sublingual gland, lingual nerve, and hypoglossal nerve (CN12). The fascia-lined (yellow line) submandibular space is inferolateral to the mylohyoid muscle.*

SUBLINGUAL/SUBMENTAL REGION

TRANSVERSE ULTRASOUND



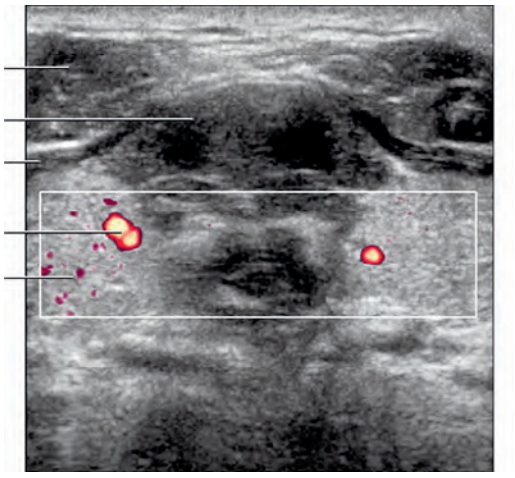


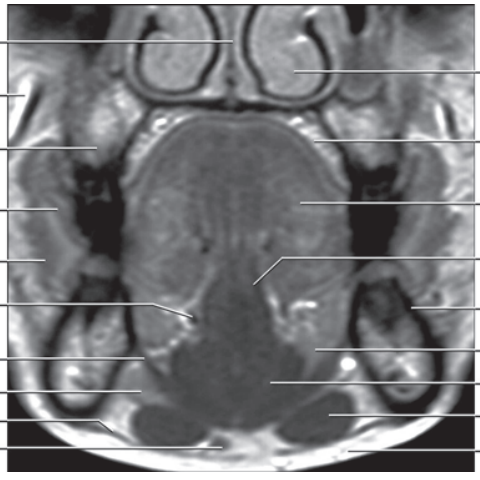


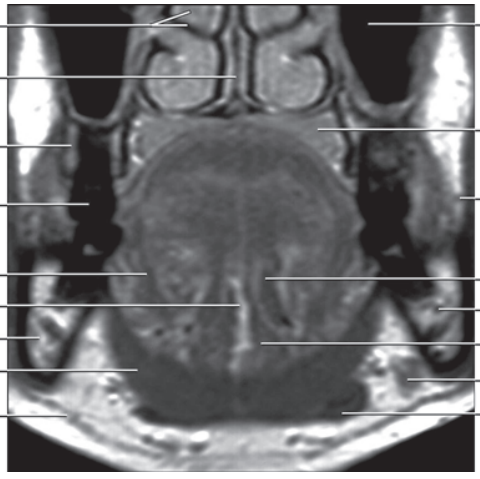
(Top) *More anterior transverse grayscale ultrasound of the submental and sublingual region is shown. The mylohyoid muscle is the landmark for division of sublingual space (deep to the mylohyoid plane) and submandibular space (superficial to the muscle plane). The sublingual gland appears as homogeneous, hyperechoic structures lateral to the geniohyoid/genioglossus muscle. Branches of lingual artery can be easily picked up on transverse plane. The submandibular duct sits alongside the lingual vessels, and a submandibular calculus may impact at this site.* ***(Middle)*** *More posterior transverse grayscale ultrasound allows the clear depiction of extrinsic muscles of the tongue at the root.* ***(Bottom)*** *Transverse grayscale ultrasound shows the submental region in a more posterior location.*

SUBLINGUAL/SUBMENTAL REGION

POWER DOPPLER ULTRASOUND AND CORONAL MR



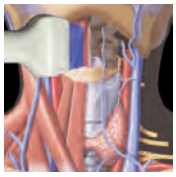


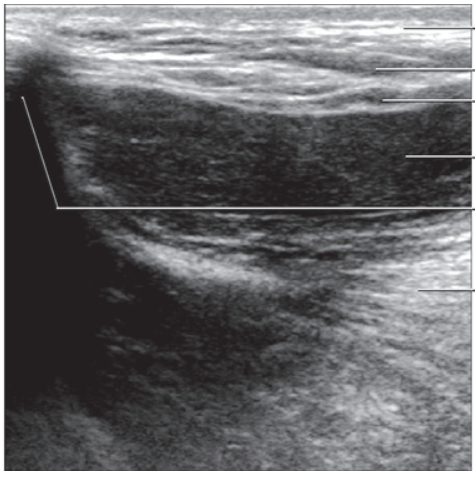


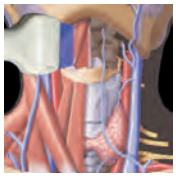
(Top) *Power Doppler ultrasound of the submental region shows the presence of color flow within the branches of the lingual artery. The use of Doppler examination aids in differentiation from the dilated submandibular duct.* ***(Middle)*** *Correlative coronal T1WI MR shows the floor of the mouth and tongue. The mylohyoid muscle is the landmark separating the sublingual and submandibular spaces.* ***(Bottom)*** *Correlative coronal T1WI MR shows the floor of the mouth and tongue in a location more posterior to the previous image. For optimal use of ultrasound, the operator must also be familiar with the correlative anatomy on other imaging modalities.*

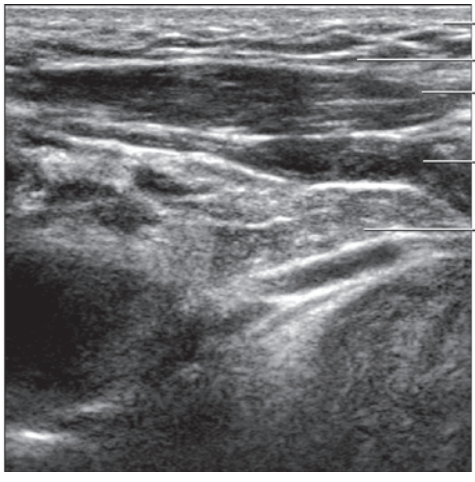
SUBLINGUAL/SUBMENTAL REGION

LONGITUDINAL AND TRANSVERSE ULTRASOUND



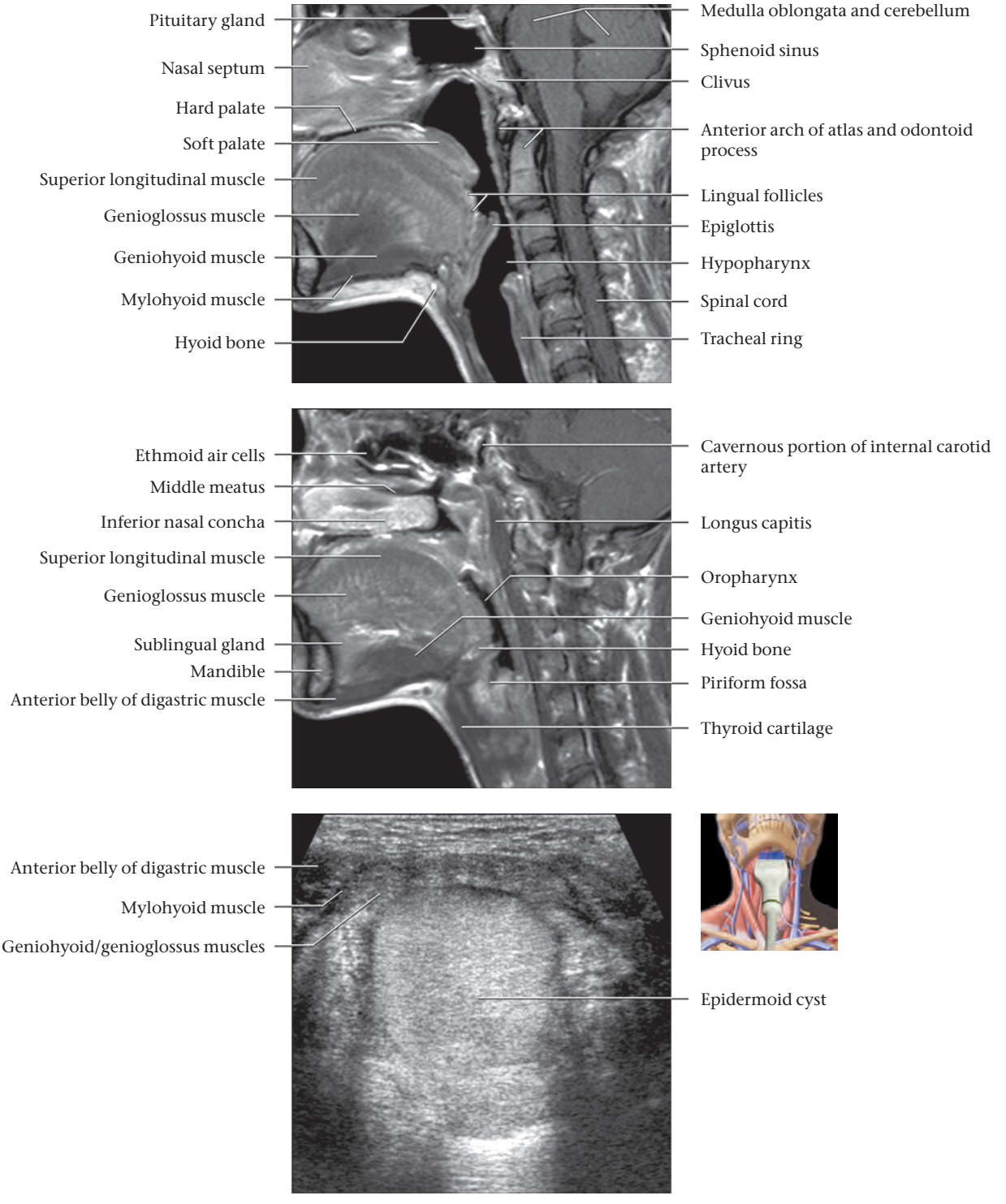






(Top) *Longitudinal grayscale ultrasound of the submental region shows the relationship of the mylohyoid, geniohyoid, and genioglossus muscles. Note that scanning just off the midline will show more of the anterior belly of the digastric muscle rather than the mylohyoid muscle anteriorly.* ***(Middle)*** *Parasagittal longitudinal grayscale ultrasound shows the submental region. The sublingual gland is visualized within the sublingual space (deep to the mylohyoid muscle) underneath the anterior belly of the digastric and mylohyoid muscles.* ***(Bottom)*** *Transverse grayscale ultrasound shows a well-circumscribed, anechoic, cystic lesion in the left sublingual space (i.e., deep to the mylohyoid muscle plane). The appearance is suggestive of a ranula; relationship to the mylohyoid determines whether it is a simple or diving ranula.*

SAGITTAL MR AND TRANSVERSE ULTRASOUND



(Top) *Correlative sagittal T1WI MR shows the floor of the mouth close to the midline. Note the positions of the mylohyoid and geniohyoid muscles between the mandible anteriorly and hyoid bone posteriorly.* ***(Middle)*** *Sagittal T1WI MR shows the floor of the mouth in the paramedian plane. Note that the anterior belly of the digastric muscle is now seen as it extends anteromedially to insert on the inner cortex of the mandible.* ***(Bottom)*** *Transverse grayscale ultrasound of the submental region shows a well-circumscribed, homogeneous, hyperechoic, midline mass deep to the mylohyoid, geniohyoid, and genioglossus muscles. The appearances and anatomical location of the lesion are suggestive of an epidermoid cyst. Congenital lesions in the neck are site specific, and familiarity with the correlative anatomy is often the best clue to their diagnosis.*

SUBMANDIBULAR REGION

TERMINOLOGY

Abbreviations
- Submandibular space (SMS)

Definitions
- Fascial-lined space inferolateral to mylohyoid muscle, containing submandibular gland, lymph nodes, and anterior belly of digastric muscles

IMAGING ANATOMY

Overview
- One of the distinct locations within the oral cavity that may be used to develop location-specific differential diagnoses
  - Other locations include oral mucosal space/surface, sublingual space, and root of tongue

Anatomy Relationships
- Inferolateral to mylohyoid muscle
- Deep to platysma muscle
- Cephalad to hyoid bone
- Communicates posteriorly with sublingual space and inferior parapharyngeal space at posterior margin of mylohyoid muscle
- Continues inferiorly into infrahyoid neck as anterior cervical space

Internal Contents
- Submandibular gland
  - 1 of 3 major salivary glands
  - Divided anatomically into superficial and deep lobes by the mylohyoid muscle
  - Superficial lobe is larger and in SMS itself
    - Superficial layer, deep cervical fascia (SL-DCF) forms submandibular gland capsule
    - Crossed by facial vein and cervical branches of facial nerve (marginal mandibular branch)
  - Smaller deep lobe, often called deep "process"
    - Tongue-like extension of gland that wraps around posterior aspect of mylohyoid muscle
    - Projects into posterior aspect of sublingual space
    - Submandibular duct projects off deep lobe into sublingual space
  - Submandibular gland innervation
    - Parasympathetic secretomotor supply from chorda tympani branch of facial nerve
    - Comes via lingual branch of CNV3
- Submental (level IA) and submandibular (level IB) nodal groups
  - Receive lymphatic drainage from anterior facial region
    - Including oral cavity, anterior sinonasal, and orbital areas
  - A few elliptical lymph nodes with preserved internal architecture is a constant normal finding
- Anterior belly of digastric muscle
  - Divides suprahyoid portion into submental and submandibular triangles
- Hyoglossus muscle
  - Deep to mylohyoid muscle; marks anterior margin of submandibular gland
  - Submandibular duct runs between hyoglossus muscle and mylohyoid muscle
- Facial vein and artery pass through SMS
  - Facial vein courses anteriorly and superiorly to submandibular gland
- Anterior division of retromandibular vein (RMV)
  - Outlines posterior border of submandibular gland
- Caudal loop of CN12
  - Passes through SMS before looping anteriorly and cephalad into tongue muscle
- Tail of parotid gland may "hang down" into posterior submandibular space

ANATOMY IMAGING ISSUES

Questions
- Major clinical-radiological question when mass is present in SMS: Is lesion nodal or submandibular gland in origin?
  - If "beaking" of submandibular gland tissue around lesion margin is present, and lesion is completely surrounded by glandular parenchyma, lesion origin is in submandibular gland
  - Fatty cleavage plane between mass and submandibular gland identifies lesion as nodal in origin
  - Internal architecture (e.g., presence of echogenic hilum) helps to identify lymph node
- Consider major differential diagnoses for mass in submandibular region
  - Congenital lesion: Epidermoid cyst, cystic hygroma
  - Inflammatory condition: Submandibular gland sialadenitis/abscess, diving ranula, chronic sclerosing siadenitis (Kuttner tumor), Sj□gren syndrome
  - Lymph node enlargement: Reactive, inflammatory, or neoplastic (secondary or lymphomatous)
  - Benign salivary gland tumor, lipoma
  - Malignant salivary gland tumor

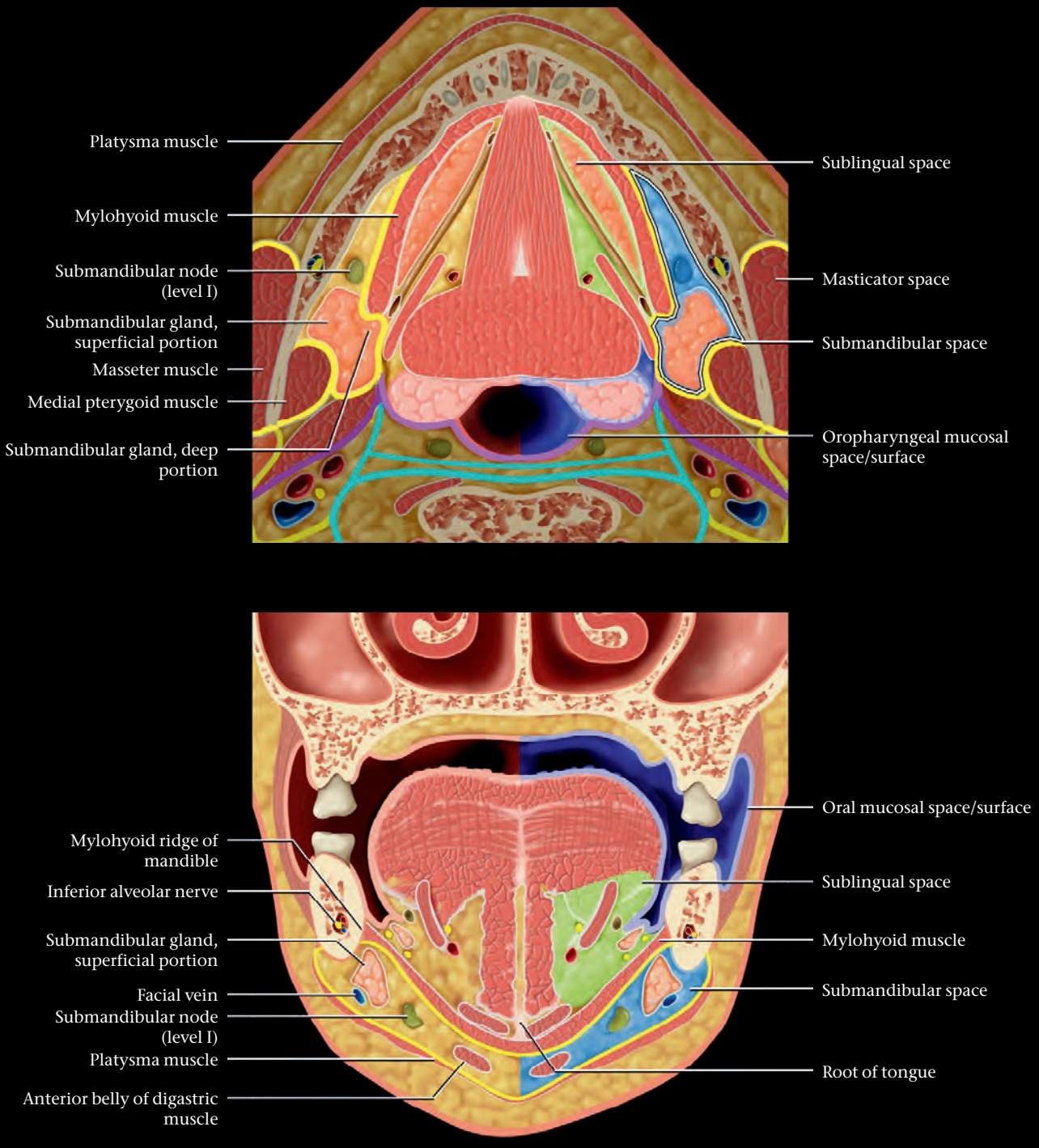
Imaging Recommendations
- Scan submandibular region in transverse and longitudinal/oblique planes, as these best demonstrate floor of submandibular region, hyoglossus, and mylohyoid muscles
- Always establish origin of mass (i.e., submandibular glandular or extraglandular mass), as this will help to narrow differential diagnosis
- Remember to evaluate glandular/extraglandular ductal dilatation and lymph nodes at this location

Imaging Pitfalls
- Distinction between submandibular glandular mass and enlarged lymph node can be difficult, especially if mass is large
- Lesions of parotid tail may appear in posterior submandibular region clinically
- Coronal MR helps to evaluate and localize large masses at this site

RELATED REFERENCES

1. Agarwal AK et al: Submandibular and sublingual spaces: diagnostic imaging and evaluation. Otolaryngol Clin North Am. 45(6):1311-23, 2012

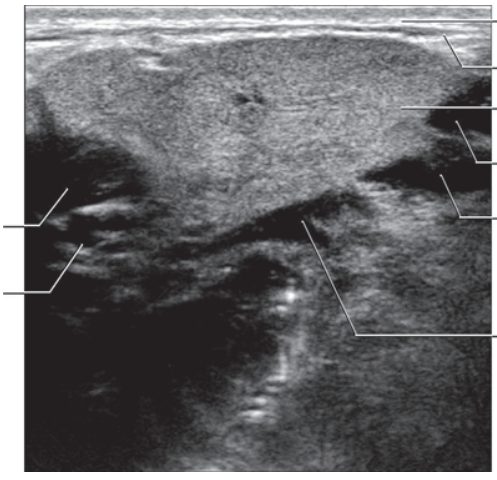
GRAPHICS

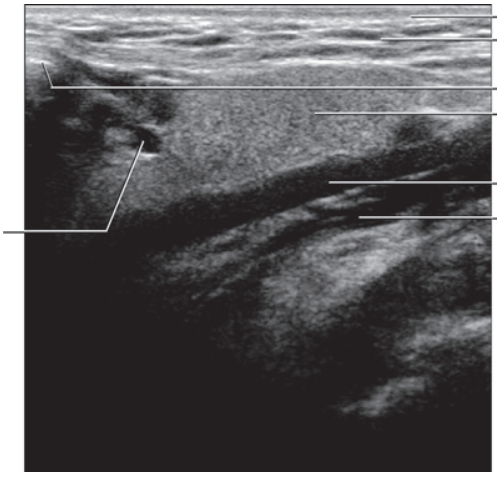


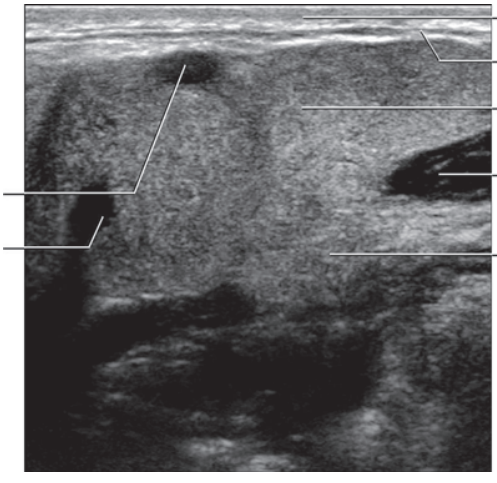
(Top) *Axial graphic shows the oral cavity with emphasis on the submandibular space (SMS), shaded in light blue on the patient's left. The SMS is inferolateral to the mylohyoid muscle. Note that the principal structures of the SMS are the submandibular gland and lymph nodes.* ***(Bottom)*** *In this coronal graphic through the oral cavity, the SMS is shaded in light blue. The superficial layer of the deep cervical fascia (yellow line) is seen lining the vertical horseshoe-shaped SMS inferolateral to the mylohyoid muscle. The contents of the SMS are the anterior belly of the digastric muscle, submandibular nodes, submandibular gland, and facial vein. Note that the platysma muscle forms the superficial margin of the SMS.*

SUBMANDIBULAR REGION

TRANSVERSE ULTRASOUND

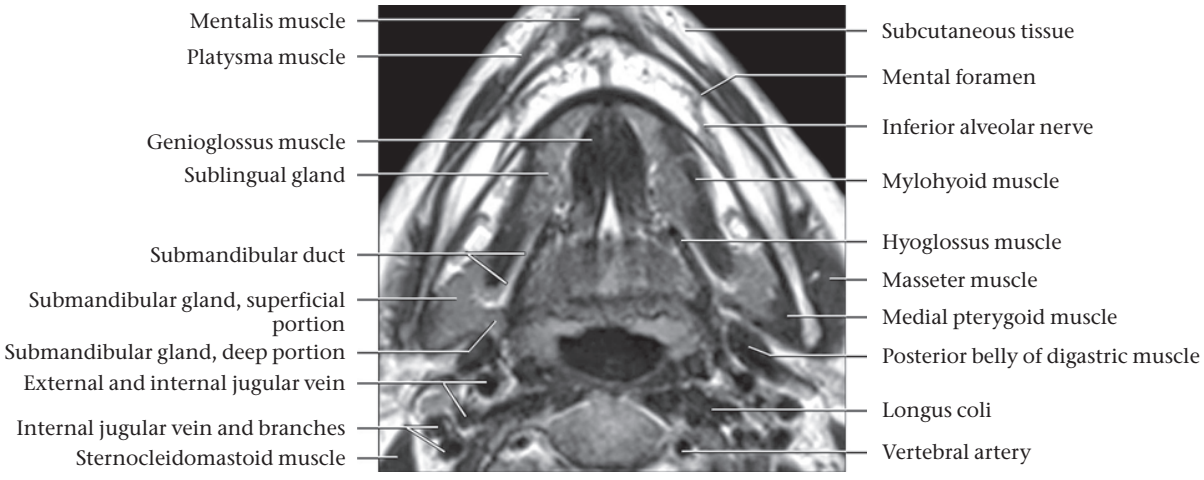


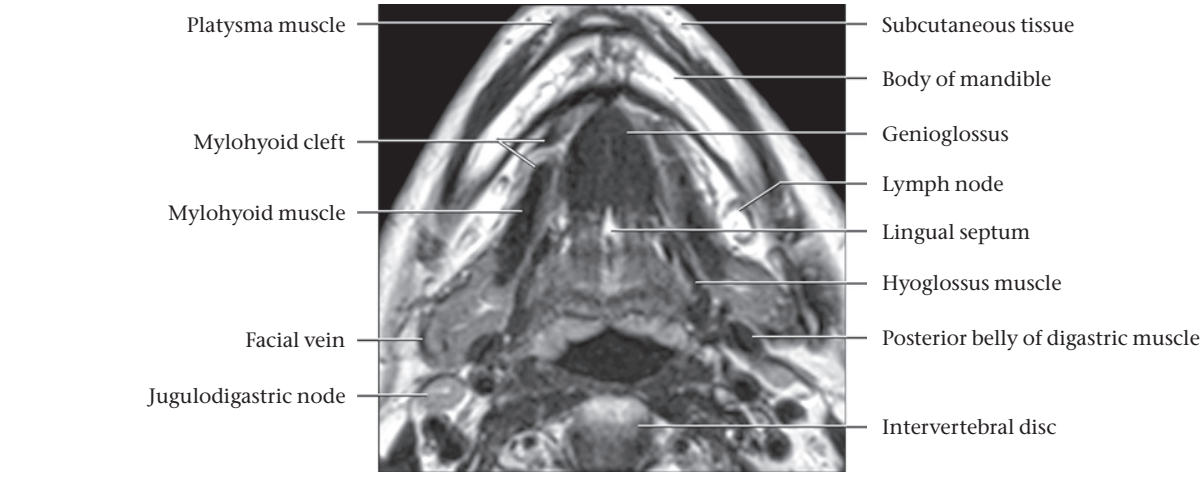


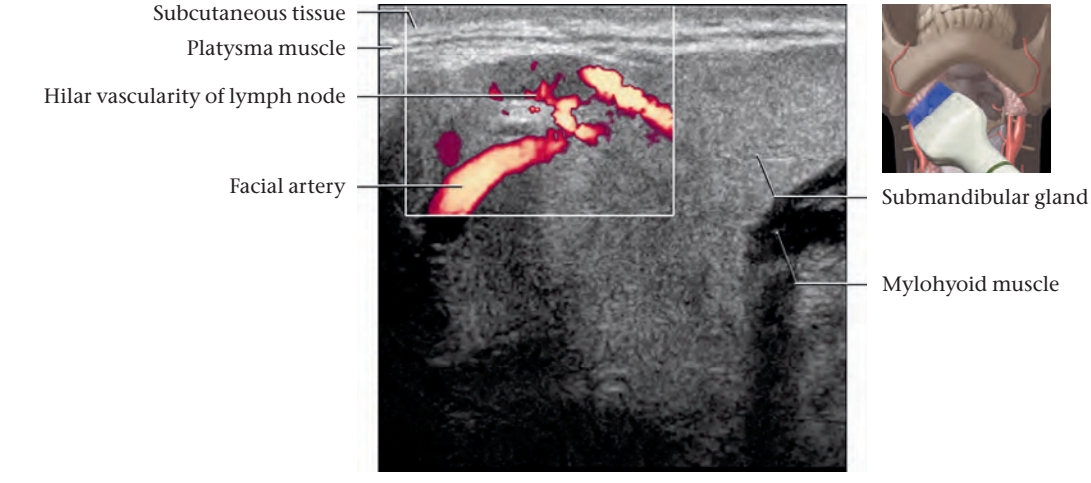


(Top) *Transverse grayscale ultrasound shows the submandibular region. The submandibular gland sits astride the posterior belly of the digastric and mylohyoid muscles. The hyoglossus muscle is seen deep to the submandibular gland.* ***(Middle)*** *Transverse grayscale ultrasound of the submandibular region (slightly more posterior scan) shows the consistent relationship of the submandibular gland superficial to the mylohyoid and hyoglossus muscles. The submandibular duct runs between these 2 muscles.* ***(Bottom)*** *Transverse grayscale ultrasound shows the submandibular gland. The gland is divided into superficial and deep lobes, demarcated by the free posterior edge of the mylohyoid muscle. Normal lymph nodes are a constant finding in this region.*

AXIAL MR AND POWER DOPPLER ULTRASOUND



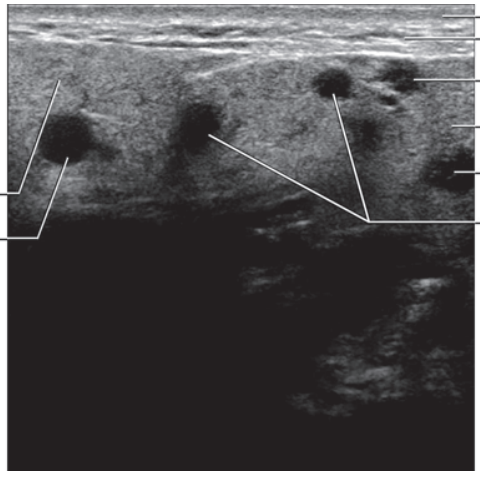


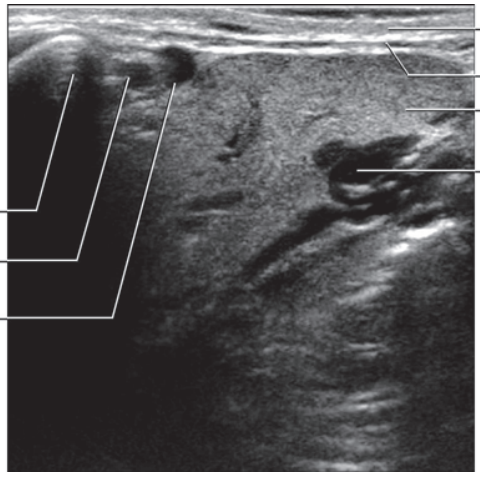


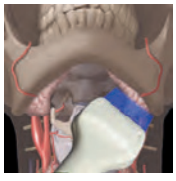
(Top) *Axial T2WI MR shows the floor of the mouth. The SMS contains submandibular glands, fat, and lymph nodes. Note the high-signal submandibular ducts entering the posterior aspect of sublingual spaces bilaterally.* ***(Middle)*** *In a more inferior image, both submandibular glands are seen wrapping around the posterior margins of the mylohyoid muscles. The neurovascular pedicle to each side of the tongue is closely related to the hyoglossus muscle.* ***(Bottom)*** *Transverse power Doppler ultrasound of submandibular gland shows vascular flow within the facial artery. Note the presence of normal hilar vascularity within the lymph node.*

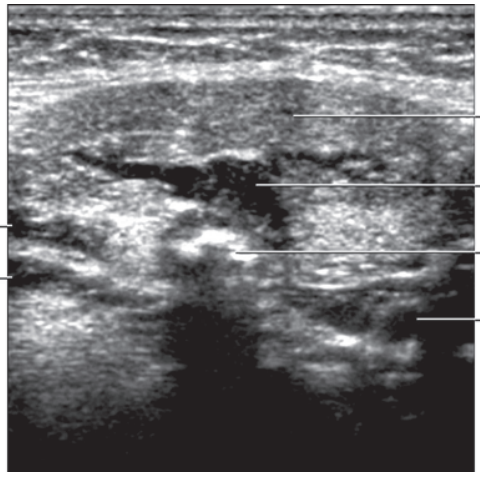
SUBMANDIBULAR REGION

TRANSVERSE ULTRASOUND



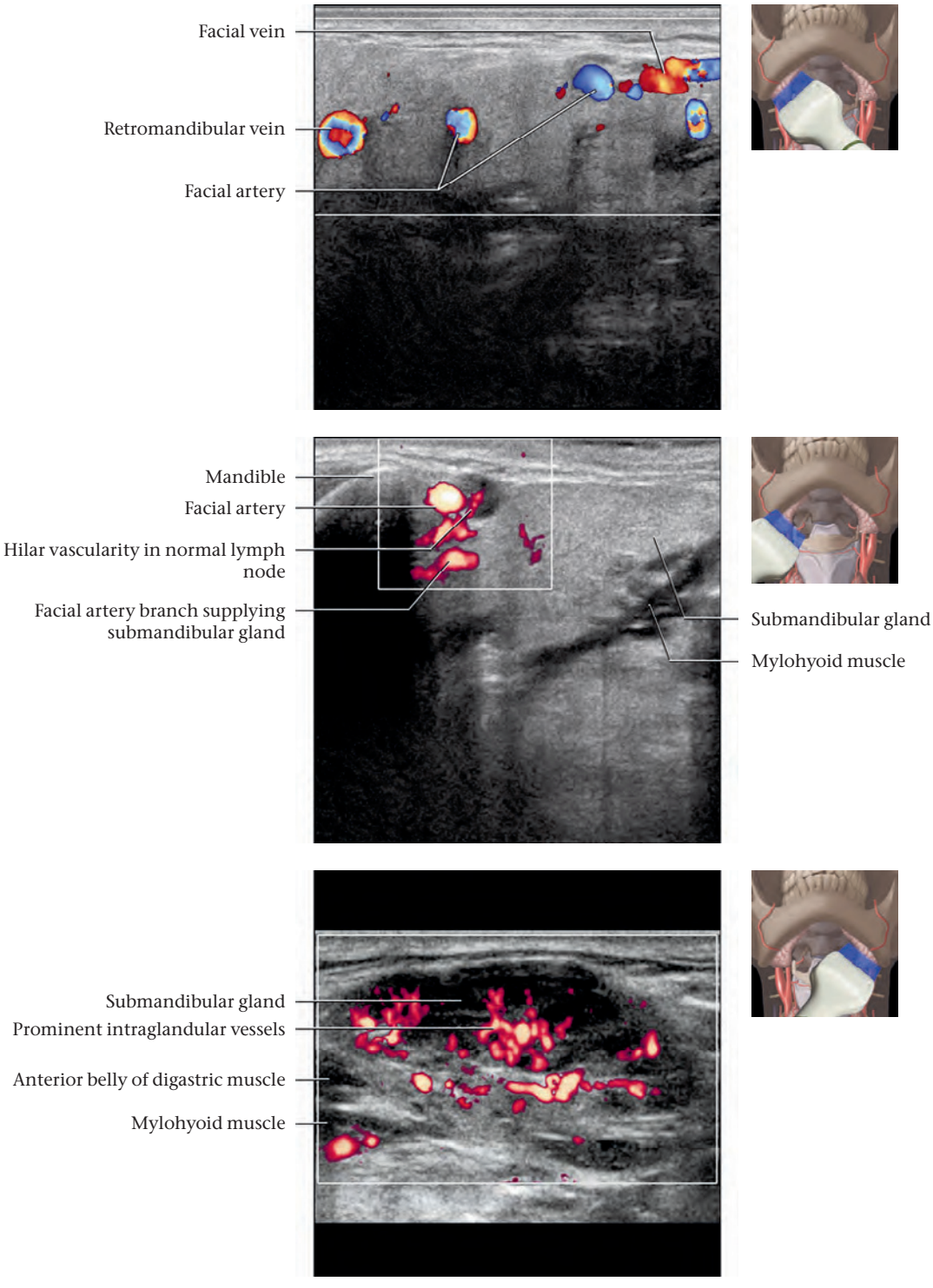






(Top) *Transverse grayscale ultrasound shows the posterior submandibular region. Note the close proximity of the submandibular gland to the tail of the parotid gland. On ultrasound, it may be difficult to localize the origin of large lesions at this site. Displacement of vessels often provides the clue.* ***(Middle)*** *Longitudinal grayscale ultrasound shows the submandibular region. The submandibular gland is located inferior and posterior to the mandible and superficial to the mylohyoid muscle.* ***(Bottom)*** *Transverse grayscale ultrasound of the left submandibular gland shows a large obstructing calculus with intraglandular ductal dilatation. Note the glandular parenchyma appears heterogeneous and hypoechoic, compatible with sialadenitis secondary to obstruction.*

POWER DOPPLER ULTRASOUND AND PATHOLOGY



(Top) *Transverse color Doppler ultrasound helps to identify and confirm important vascular landmarks in the posterior submandibular region, including the retromandibular vein and facial artery.* ***(Middle)*** *Longitudinal power Doppler ultrasound of the submandibular region shows the relationship of the facial artery to the superficial portion of the submandibular gland. The hilar vascularity of a normal lymph node and the vessels supplying the submandibular gland are seen.* ***(Bottom)*** *Transverse power Doppler ultrasound of the left submandibular gland shows an enlarged, heterogeneous submandibular gland with patchy hypoechoic "nodular" areas. Note, prominent intraglandular vessels running through "nodules" with no mass effect/displacement. No ductal dilatation or calculus is seen. These changes are also present in the contralateral gland (not shown), suggesting chronic sclerosing sialadenitis (Kuttner tumor).*

PAROTID REGION

TERMINOLOGY

Abbreviations
- Parotid space (PS)

Definitions
- Paired lateral suprahyoid neck spaces enclosed by superficial layer of deep cervical fascia containing parotid glands, nodes, and extracranial facial nerve branches

IMAGING ANATOMY

Extent
- Extends from external auditory canal (EAC) and mastoid tip superiorly to below angle of mandible (parotid tail)

Internal Contents
- Parotid gland
  - Divided anatomically into superficial lobe and deep lobe by extracranial facial nerve
    - Superficial lobe: Constitutes ~ 2/3 of parotid glandular parenchyma
    - Deep lobe: Smaller component, projects into lateral parapharyngeal space (PPS)
- Extracranial facial nerve (CN7)
  - Exits stylomastoid foramen as single trunk; ramifies within PS lateral to retromandibular vein
  - Ramifying intraparotid facial nerve creates surgical plane between superficial and deep lobes
- External carotid artery (ECA)
  - Medial and smaller of the 2 vessels seen just behind mandibular ramus in PS
- Retromandibular vein (RMV)
  - Lateral and larger of the 2 vessels seen just behind mandibular ramus in parotid
  - Formed by union of superficial temporal vein and maxillary vein
  - Intraparotid facial nerve branches course just lateral to RMV
- Intraparotid lymph nodes
  - ~ 20 lymph nodes found in each parotid gland
  - Parotid nodes are 1st-order drainage for EAC, pinna, and surrounding scalp
- Parotid duct
  - Emerges from anterior PS, runs along surface of masseter muscle
  - Duct then arches through buccal space to pierce buccinator muscle at level of upper 2nd molar
- Accessory parotid glands
  - Project over surface of masseter muscle
  - Present in ~ 20% of normal anatomic dissections
- Masseter muscle
  - Muscle of mastication related to outer surface of mandibular ramus
  - Parotid duct runs anteriorly on its surface
- Buccinator muscle
  - Deep muscle of buccal space, extends anteriorly and just medially to anterior margin of masseter muscle
    - Parotid duct pierces to enter buccal mucosa at upper 2nd molar level

ANATOMY IMAGING ISSUES

Questions
- Is deep lobe of parotid gland involved?
  - For a parotid mass, it is important to determine location and extent of involvement in relation to extracranial facial nerve (i.e., superficial/deep lobe involvement)
    - Difference in surgical approach and risk of perioperative facial nerve injury
  - Intraparotid facial nerve is not visible with USG, CT, or MR, except proximally with high-resolution MR
  - On ultrasound, RMV is used as a marker for division of parotid gland into superficial and deep lobes (due to close proximity to CN7)

Imaging Approaches
- Scan in both transverse and longitudinal planes
  - Transverse scans define anatomic location of salivary gland masses in relation to ECA and RMV
  - Longitudinal scans help to better evaluate lesions in parotid tail and for Doppler examination
- USG cannot evaluate deep lobe mass or deep extension of superficial masses
  - Lower frequency transducer (e.g., 5 MHz) with gel block/standoff pad helps to evaluate large parotid mass with suspicious deep lobe extension
  - MR/CT is required for full anatomical delineation
  - US helps to direct needle for guided biopsy
- Always evaluate masseter muscle as its lesions clinically mimic parotid pathology
- Normal intraglandular ducts are seen as echogenic streaks within parotid parenchyma
  - When dilated, seen as 2 bright lines separated by fluid within
  - Extraglandular portion of duct is seen on US only if it is dilated

CLINICAL IMPLICATIONS

Clinical Importance
- Although US cannot visualize parotid deep lobe, it is still an ideal initial imaging modality to evaluate parotid masses, as most are located in superficial lobe
  - US characterizes common salivary masses and safely guides fine-needle aspiration cytology (FNAC)/biopsy for confirmation

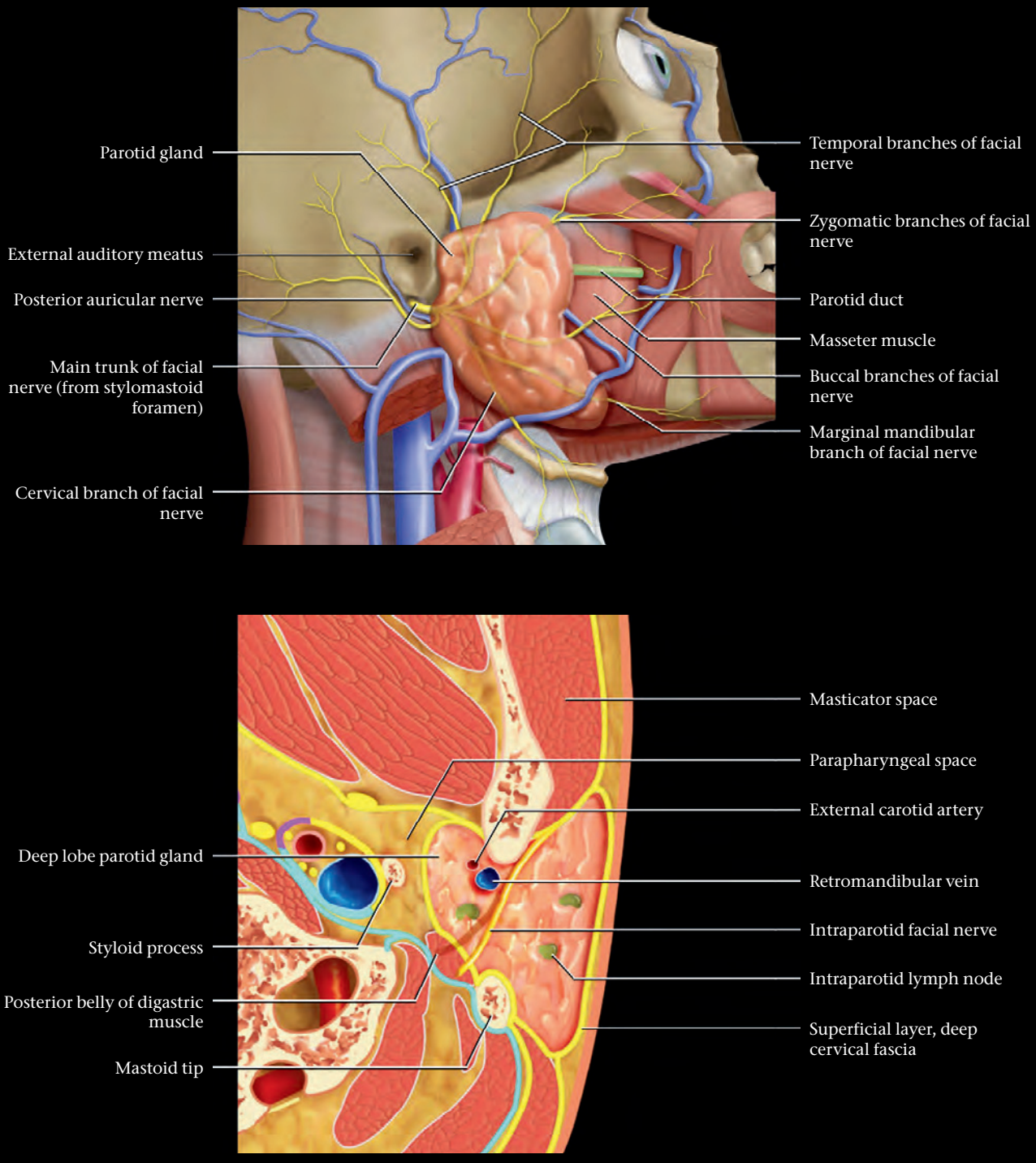
EMBRYOLOGY

Embryologic Events
- Parotid space undergoes late encapsulation in embryogenesis

Practical Implications
- Late encapsulation results in intraparotid lymph nodes
- Warthin tumor arises within this lymphoid tissue (intraparotid > > periparotid > upper cervical)
- Parotid nodes are 1st-order drainage for malignancies of adjacent scalp, EAC, pinna, and deep face
- No such nodes in submandibular gland due to early encapsulation; therefore, no Warthin tumor or nodal metastases in submandibular gland (SMG)

PAROTID REGION

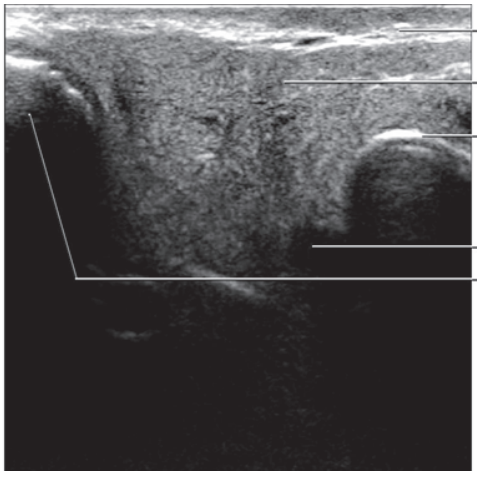
GRAPHICS

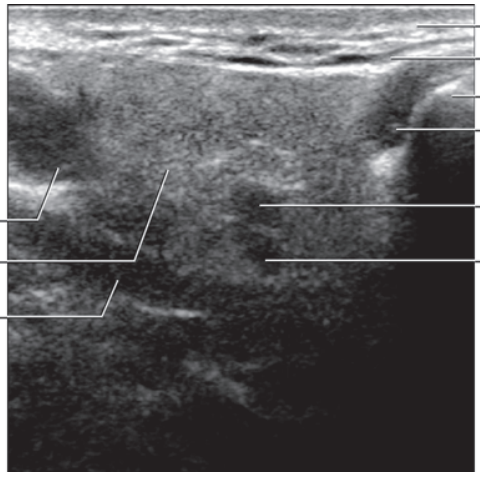


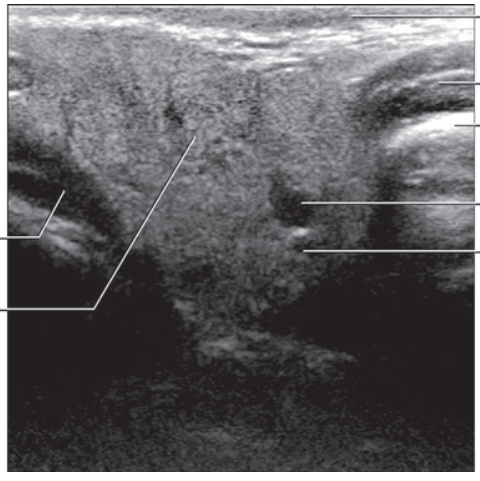
(Top) *Lateral schematic diagram shows the parotid region. The parotid gland is situated in front of the external auditory meatus and below the zygomatic arch. The parotid duct emerges from the anterior margin and passes superficial to the masseter muscle. The facial nerve, after emerging from the stylomastoid foramen, enters the parotid gland and divides into terminal branches to supply muscles of facial expression.* ***(Bottom)*** *Axial graphic shows the parotid space (PS) at the level of C1 vertebral body. The intraparotid course of the facial nerve extends from just medial to the mastoid tip to a position just lateral to the retromandibular vein, dividing the parotid gland into superficial and deep lobes.*

PAROTID REGION

TRANSVERSE ULTRASOUND







(Top) *Transverse grayscale ultrasound shows the parotid region. Note its relationship to the mastoid process and the mandibular ramus. The glandular parenchyma shows a homogeneous, hyperechoic pattern. The retromandibular vein is visualized as a round, anechoic structure within the parotid gland.* ***(Middle)*** *Transverse grayscale ultrasound shows the parotid tail region. The sternocleidomastoid muscle and the posterior belly of the digastric muscle are related to the posterior margin of the parotid tail. The retromandibular vein and external carotid artery serve as markers to infer the location of CN7.* ***(Bottom)*** *Transverse grayscale ultrasound shows the parotid gland. The retromandibular vein is usually larger and lateral to the external carotid artery within the parotid gland. Note that the deep lobe is obscured by shadowing from the mandibular ramus.*