Radiology and Sleep

Finding Common Ground Between Infrequent Bedfellows

Ryan T. Fitzgerald MD

Sleep Professionals of Arkansas
Annual Educational Meeting
March 8th-9th, 2024

Accreditation Statement

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of The American Academy of Sleep Medicine and the Sleep Professionals of Arkansas & Washington Regional Center for Sleep Disorders. The American Academy of Sleep Medicine is accredited by the ACCME to provide continuing medical education for physicians.

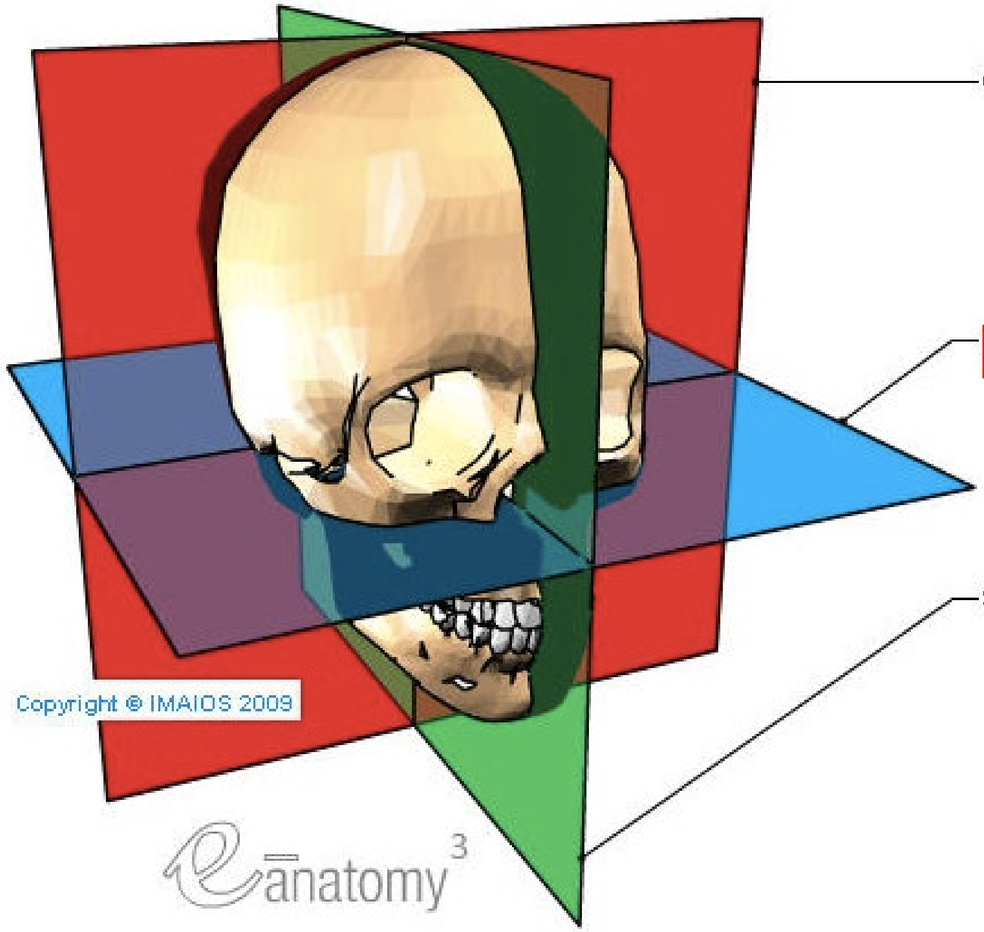
Conflict of Interest Disclosures for Speakers

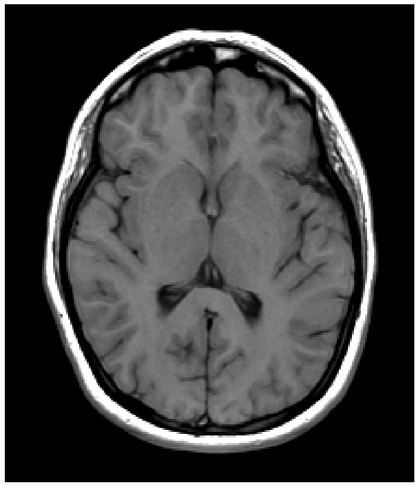
Ryan T. Fitzgerald, MD has no relevant financial relationships with ineligible companies to disclose.

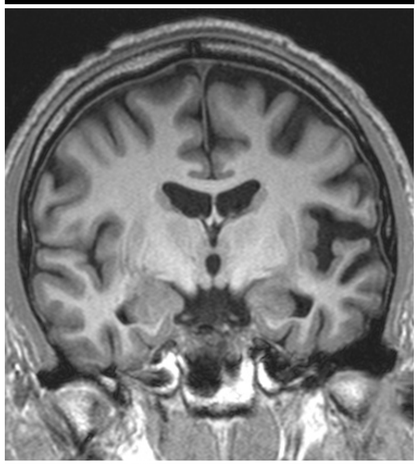
Learning Objectives

- Upon completion of this course, attendees should be able to…
  - Provide an overview of the role of imaging for the assessment of the airway and other sleep-related anatomic structures.
  - Discuss the anatomical basis and implications of chiropractic treatments and orofacial myofunctional therapy for OSA.
  - Explore potential applications of imaging for sleep clinicians.

Imaging Basics







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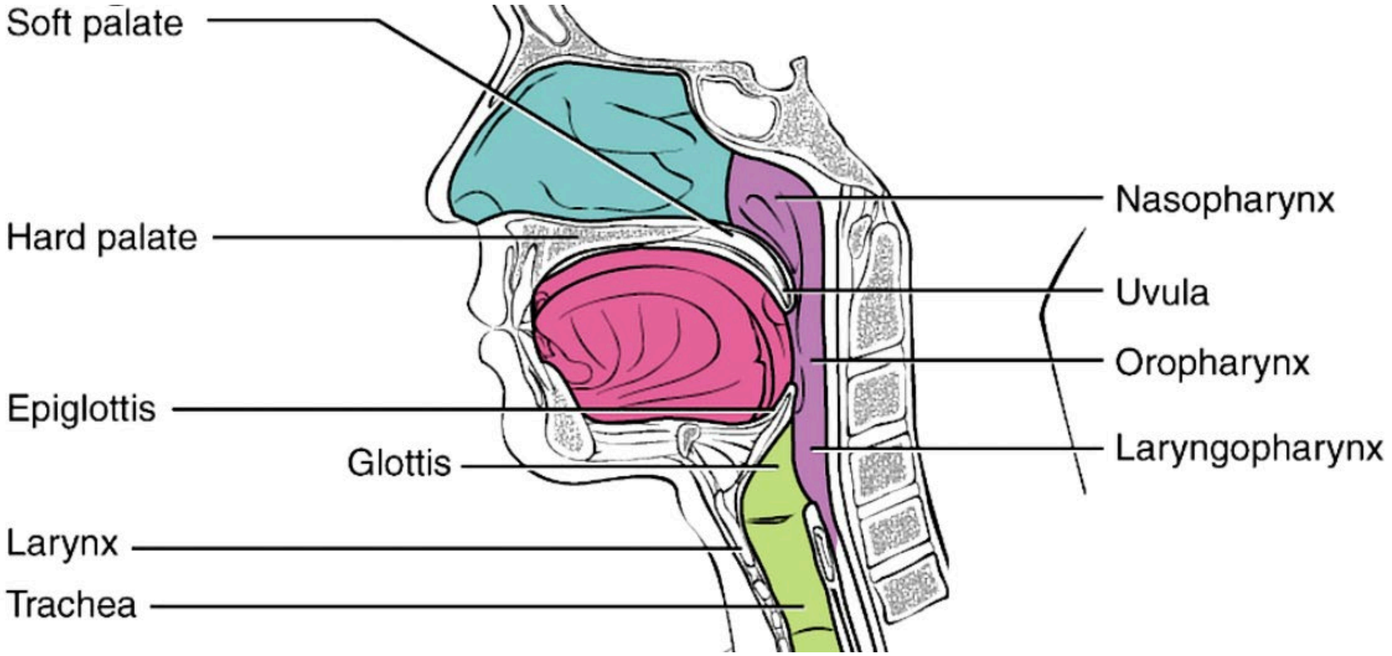
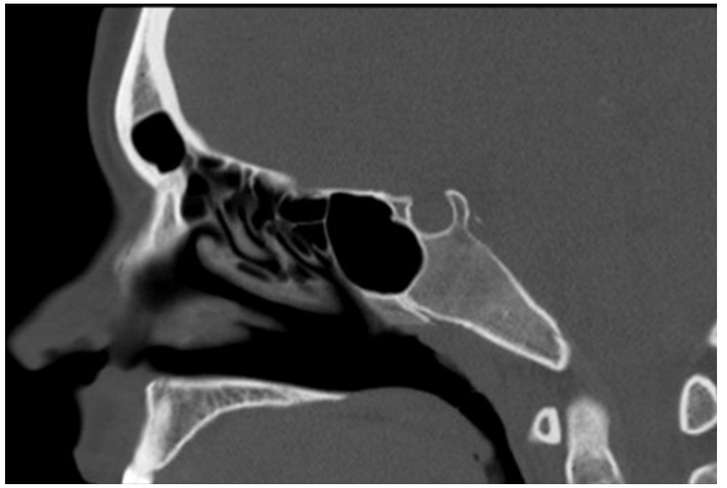
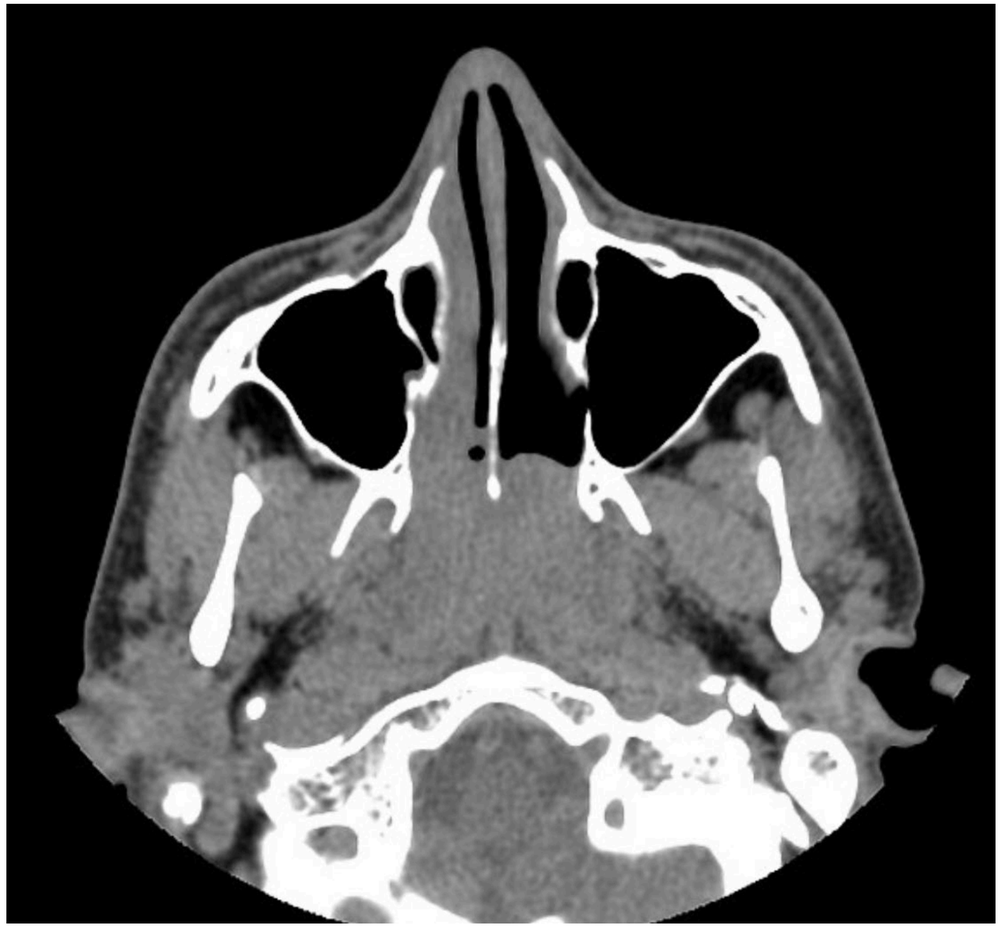
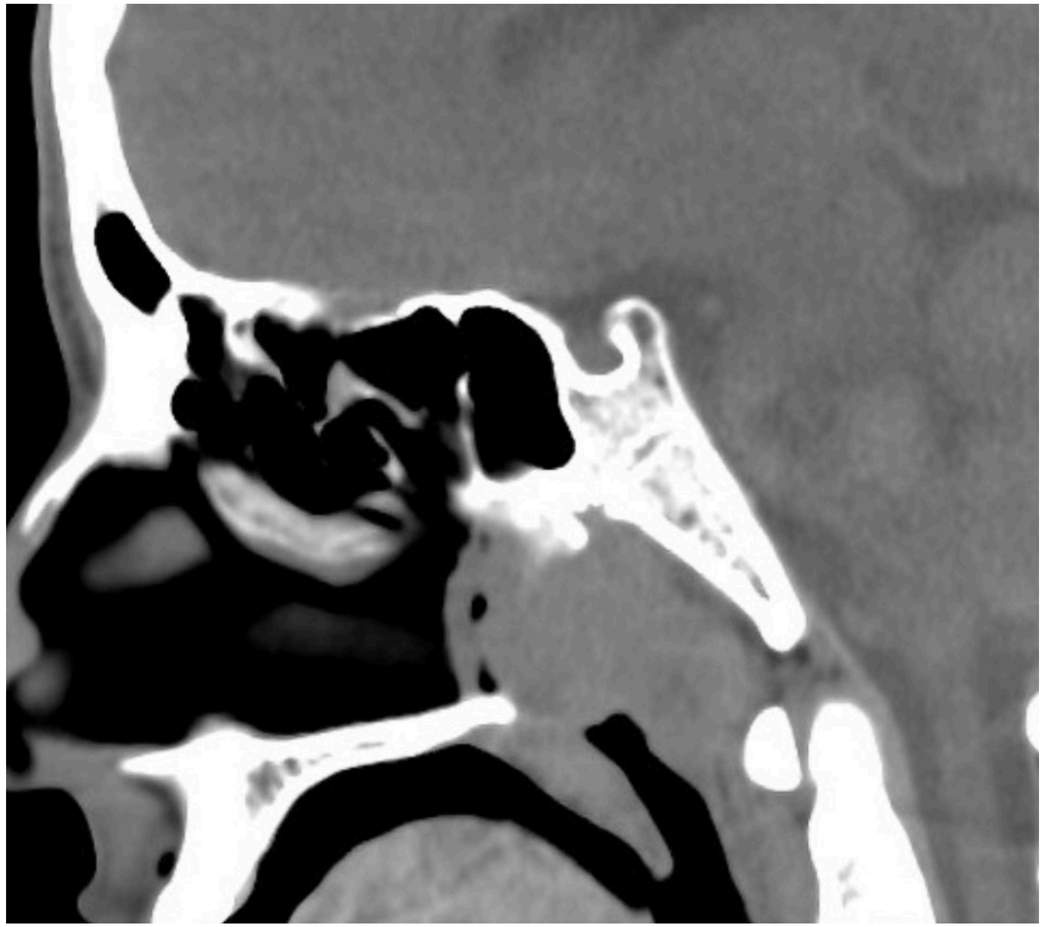




Imaging Assessment of the Airway

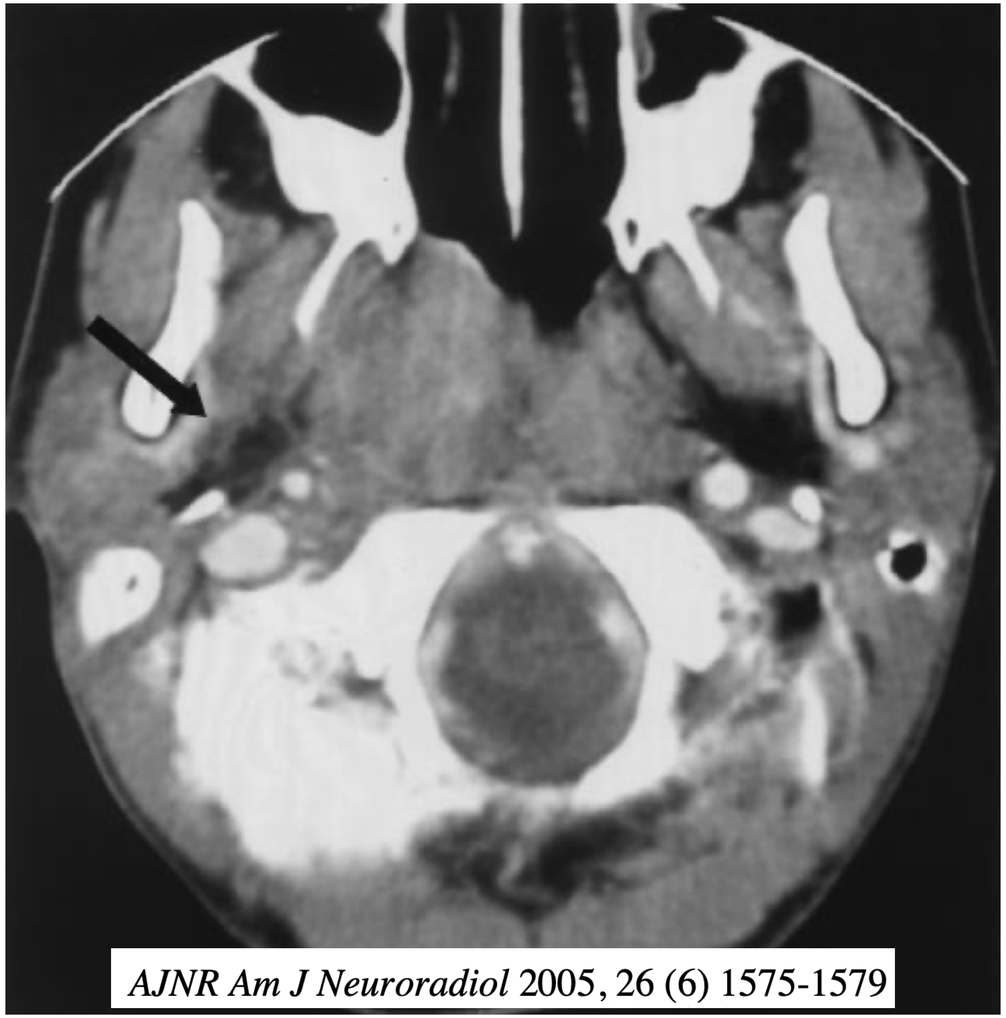
Nasal cavity and nasopharynx





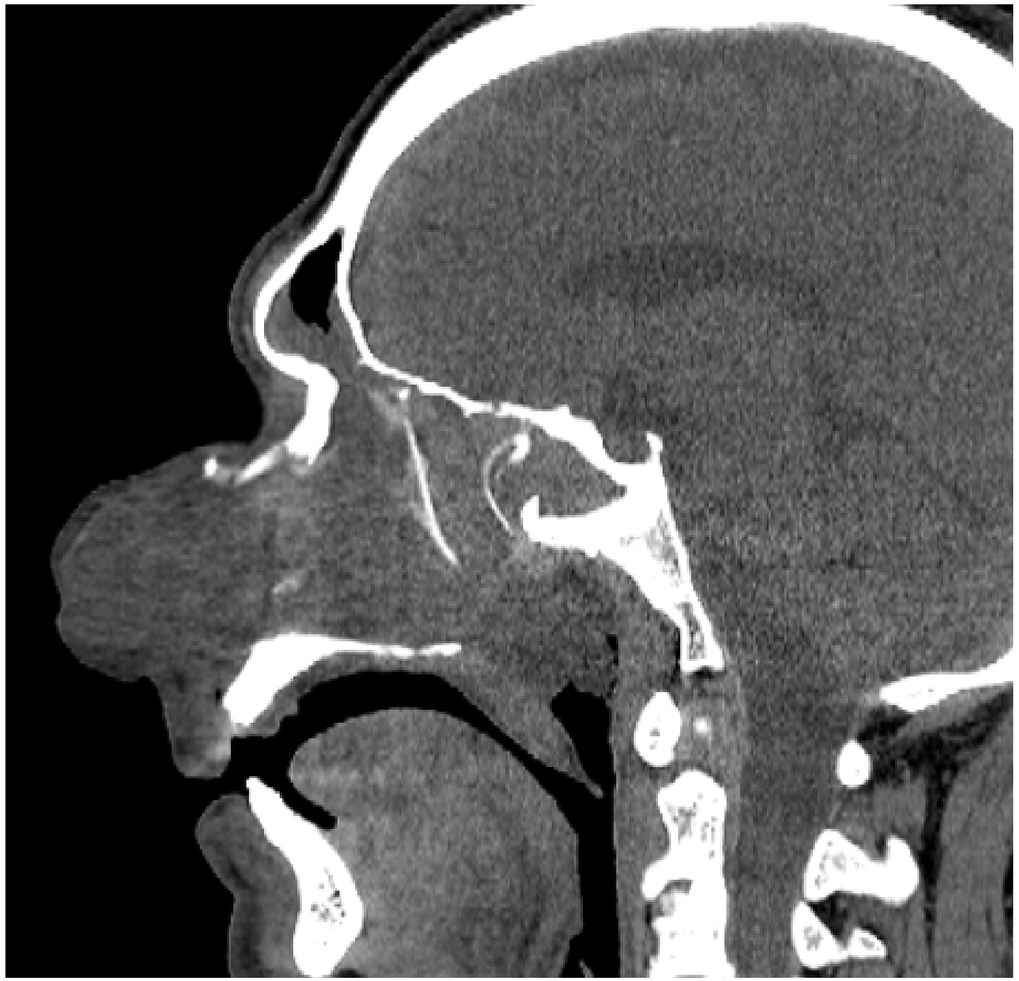
Imaging Assessment of the Airway

Nasal cavity and nasopharynx



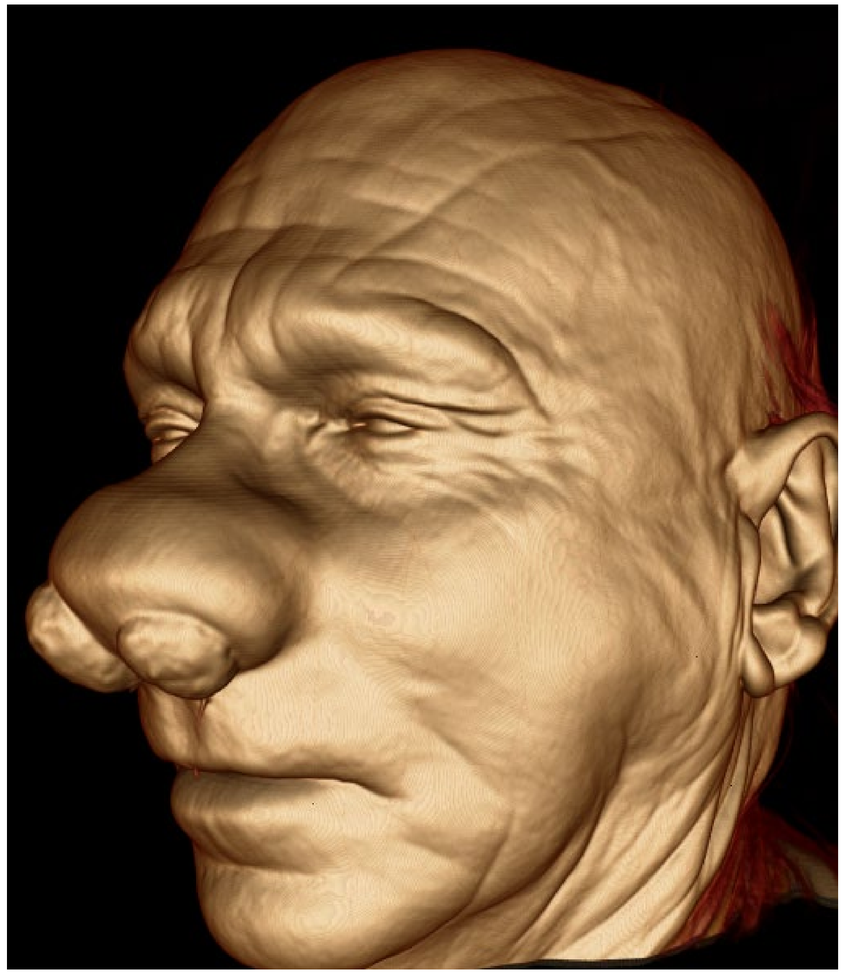
Imaging Assessment of the Airway

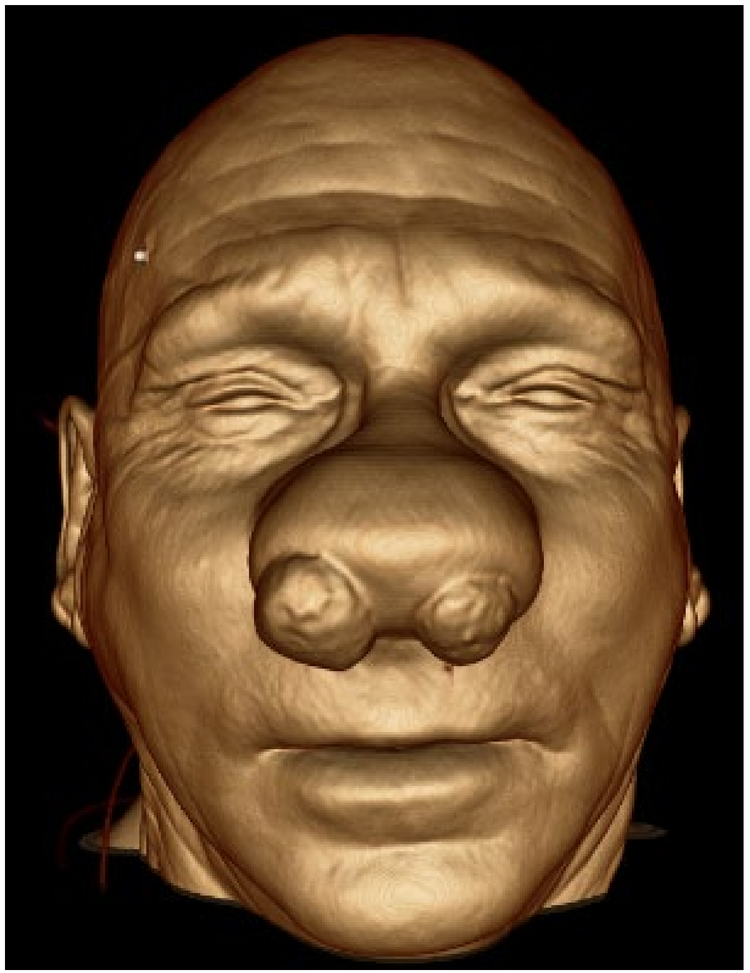
Nasal cavity and nasopharynx



Imaging Assessment of the Airway

Nasal cavity and nasopharynx





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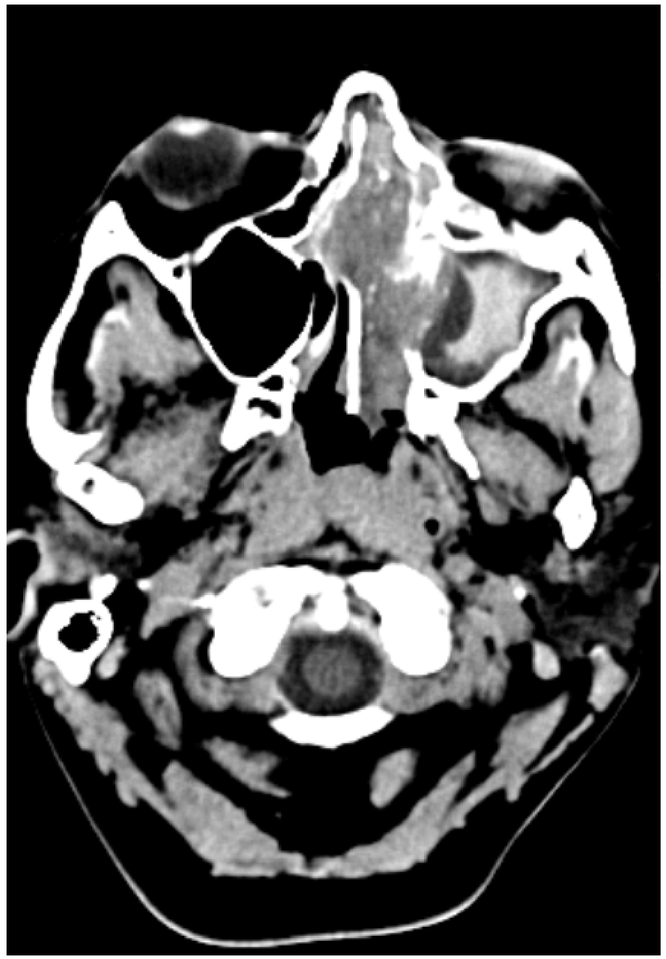
Nasal cavity

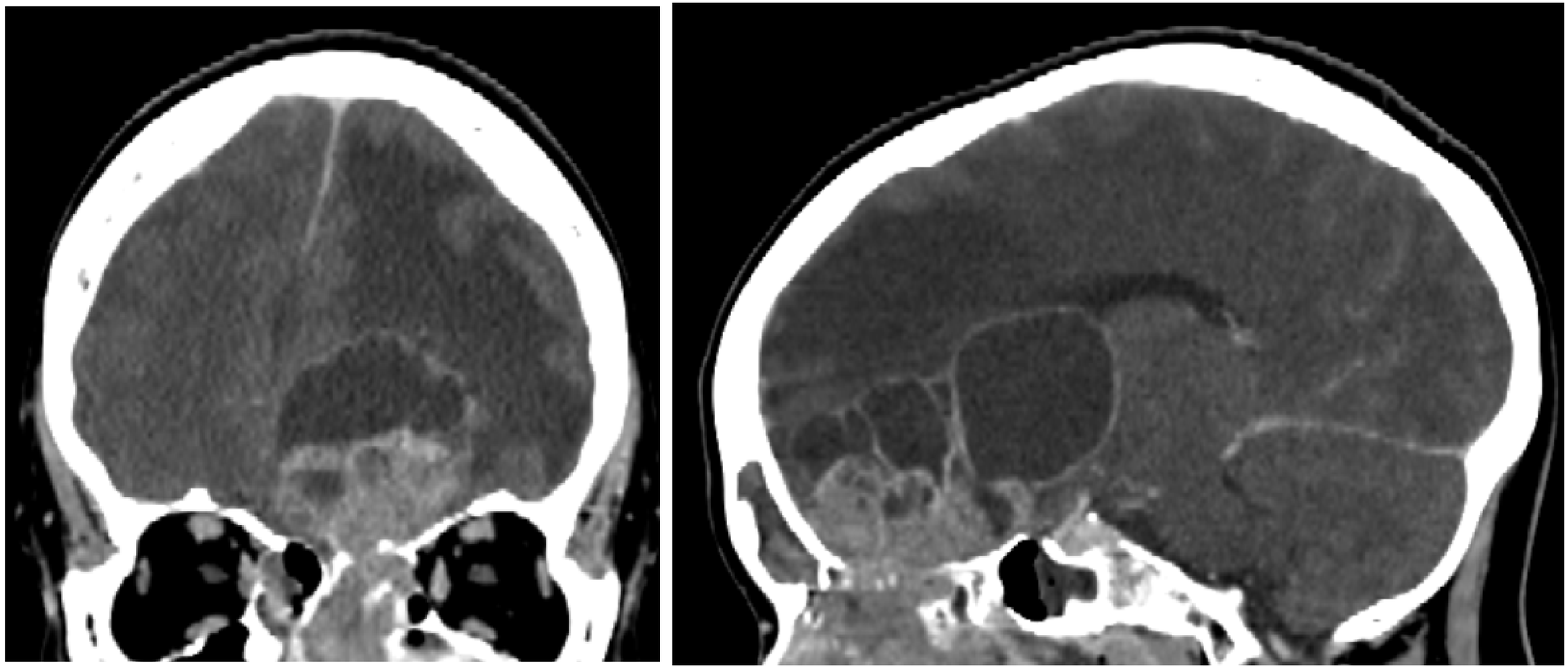


Imaging Assessment of the Airway

Nasal cavity

Imaging Assessment of the Airway

Nasal cavity



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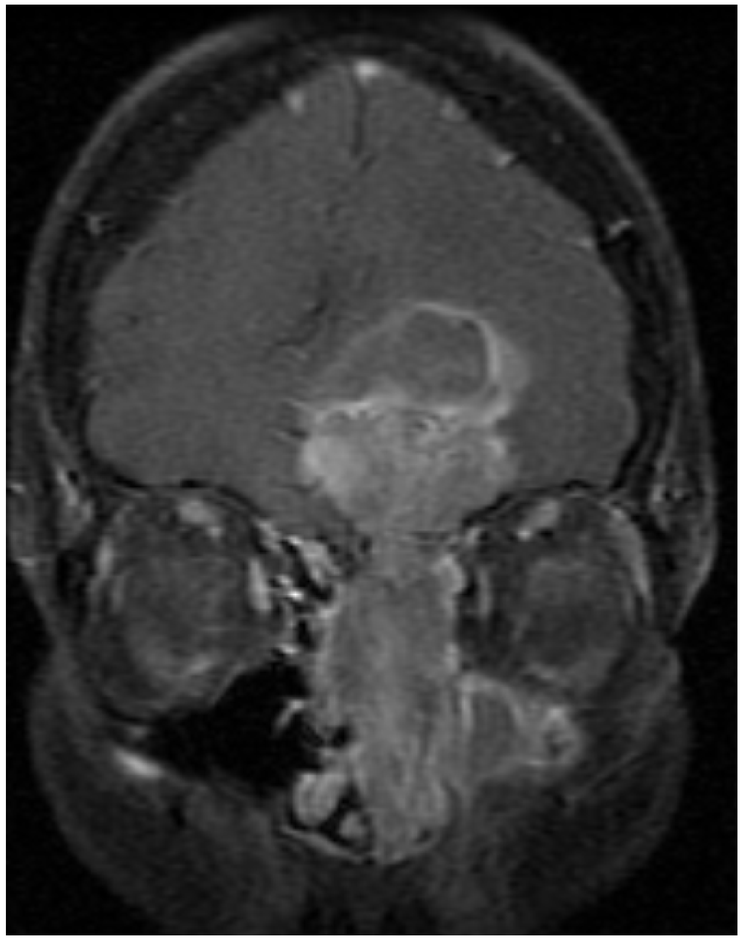
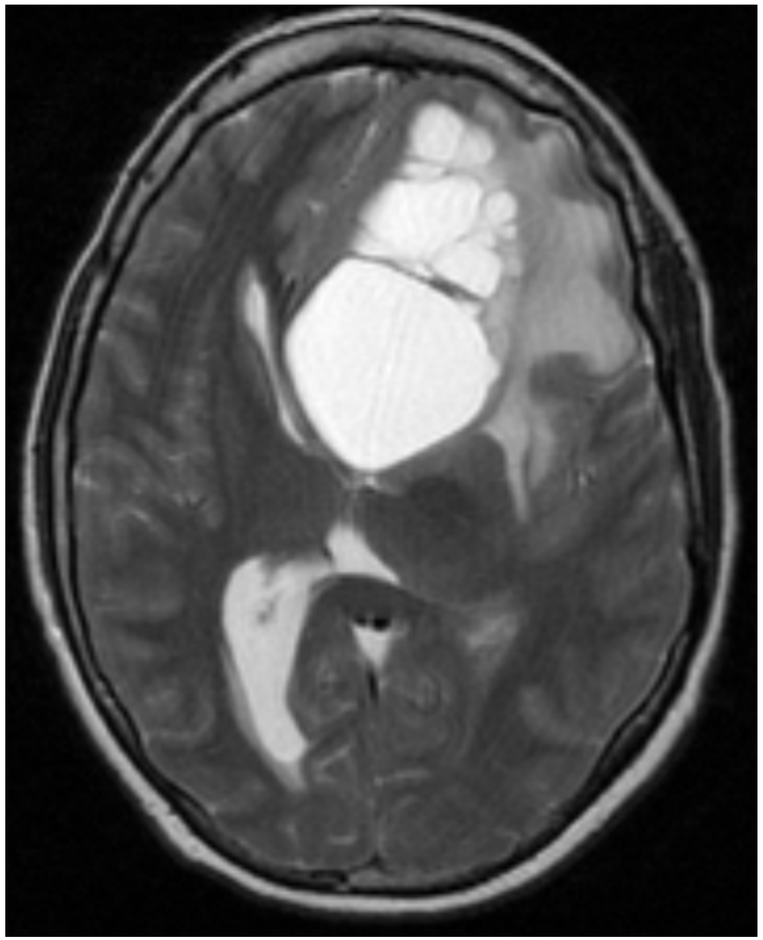
Nasal cavity





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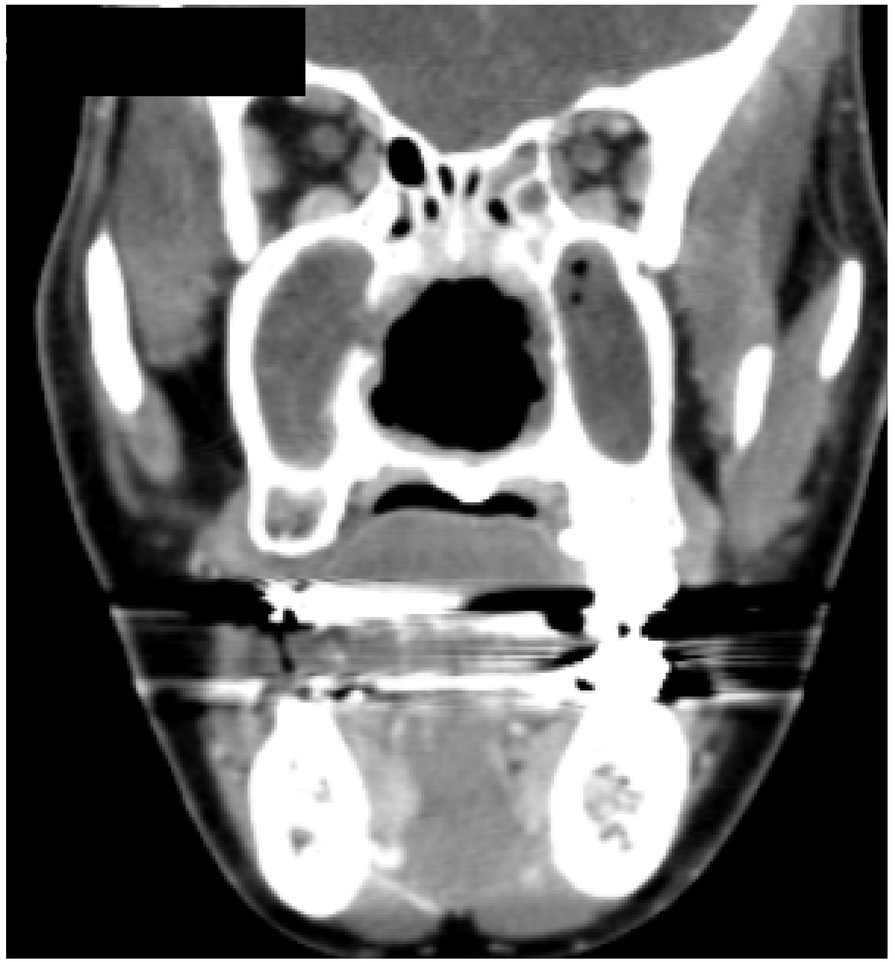
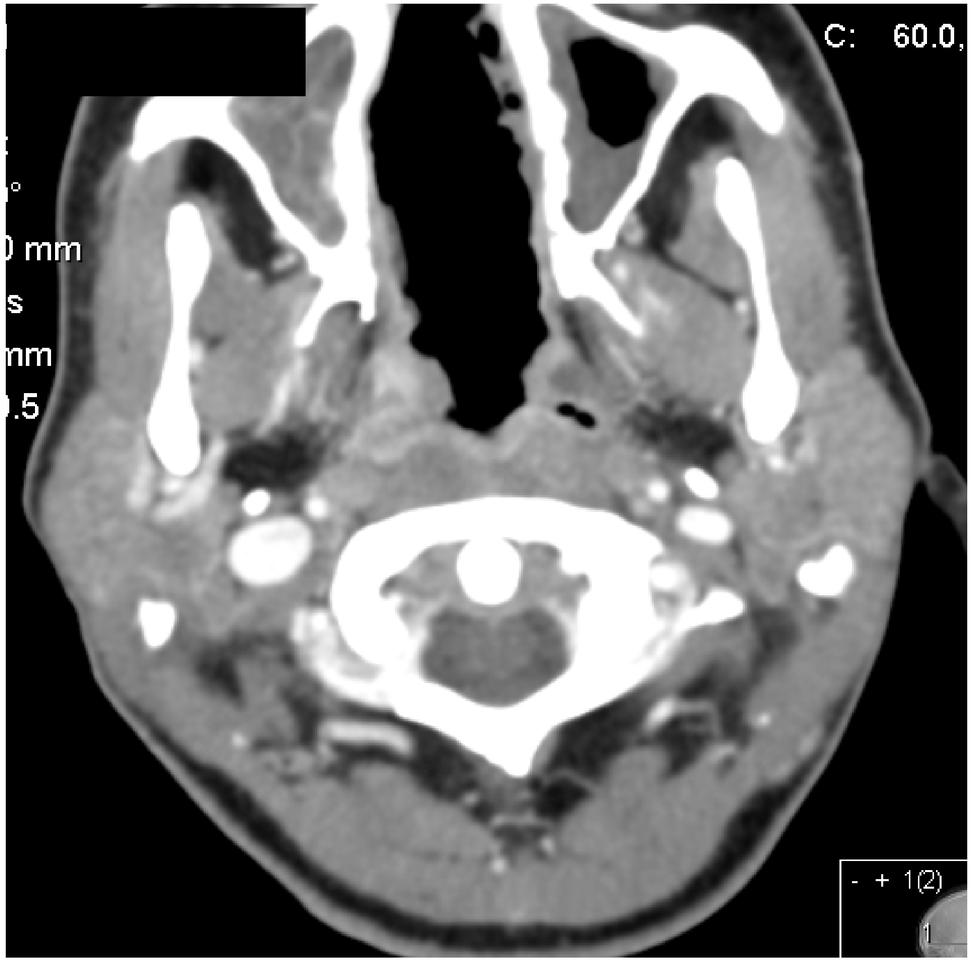
Nasal cavity





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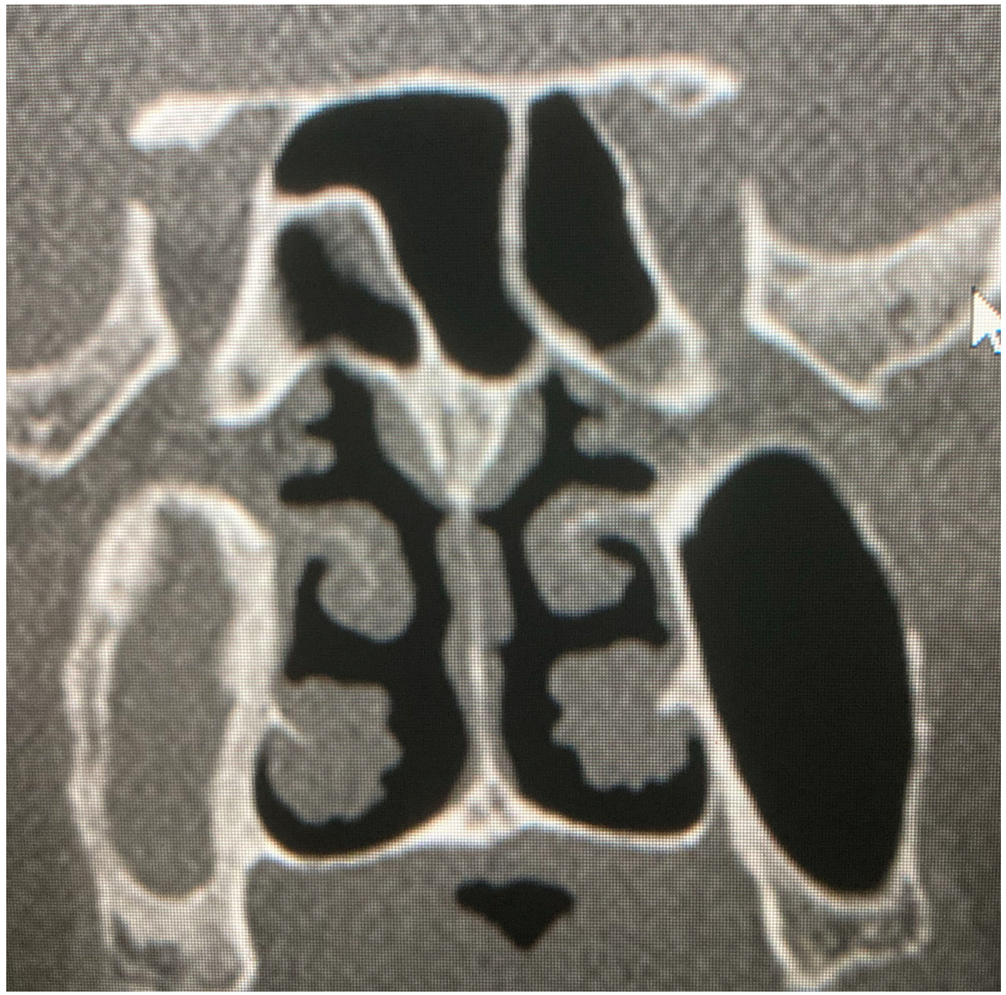
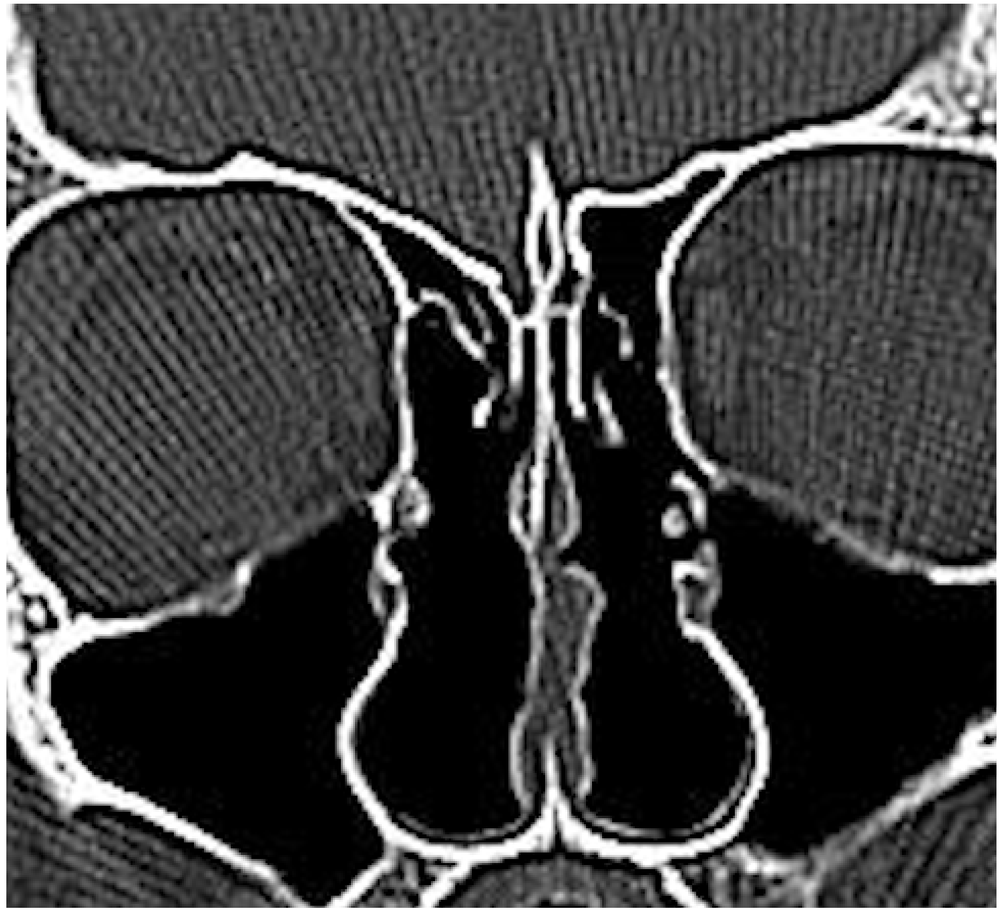
Nasal cavity



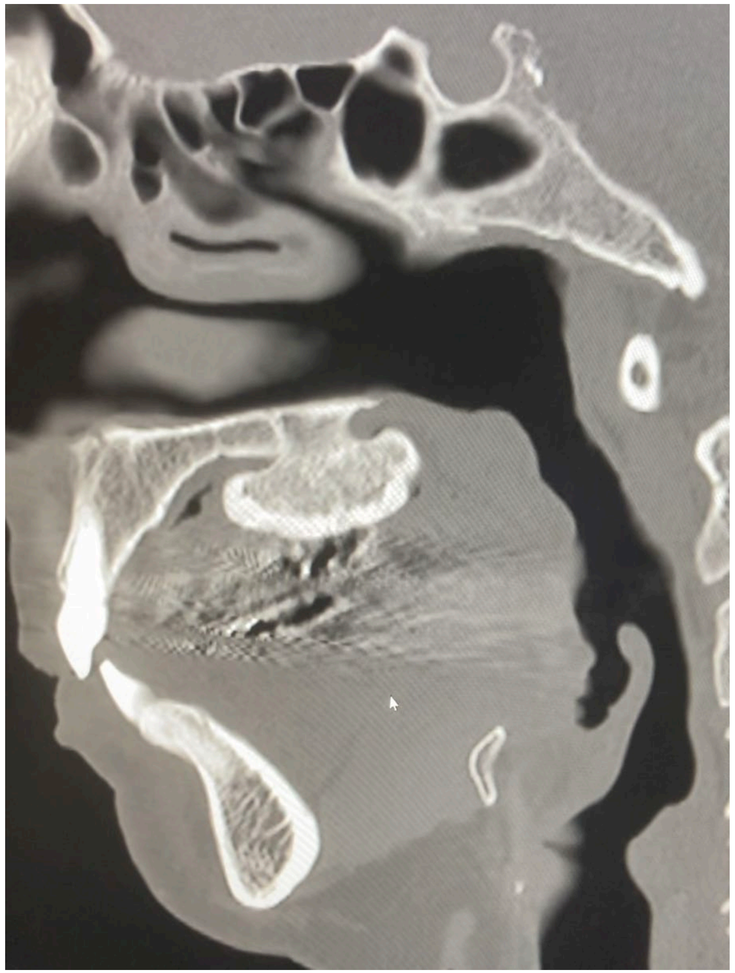
Imaging Assessment of the Airway

Nasal cavity



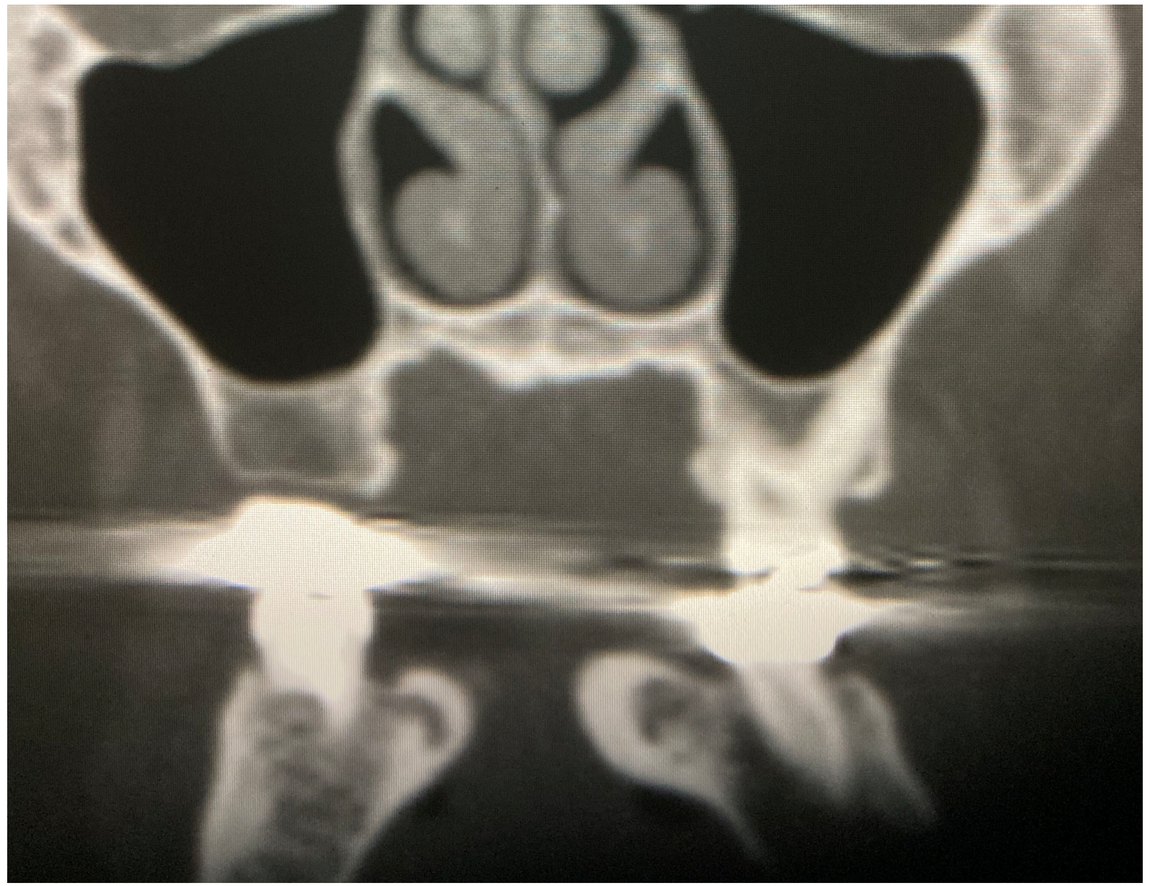
Imaging Assessment of the Airway

Palate and oral cavity



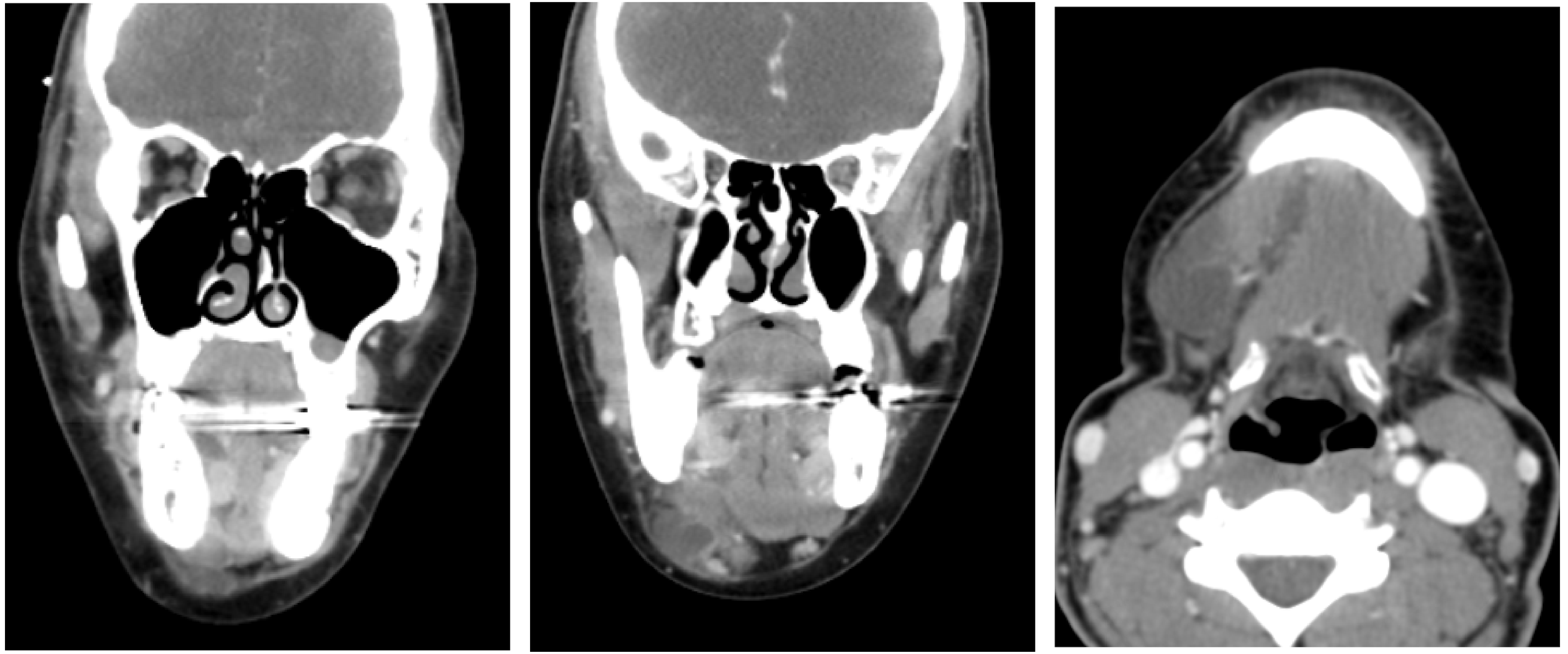
Imaging Assessment of the Airway

Palate and oral cavity



Imaging Assessment of the Airway

Oral cavity

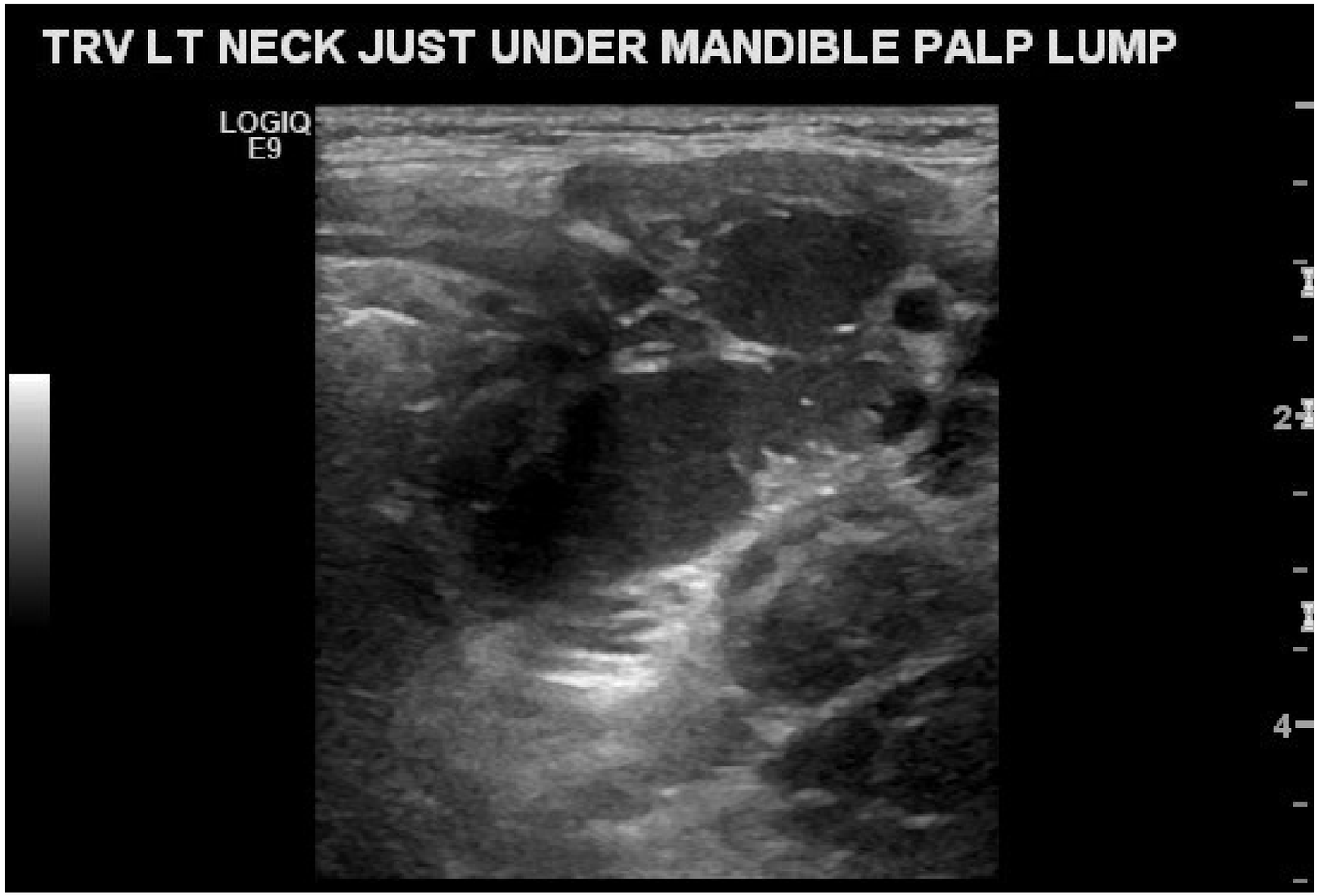


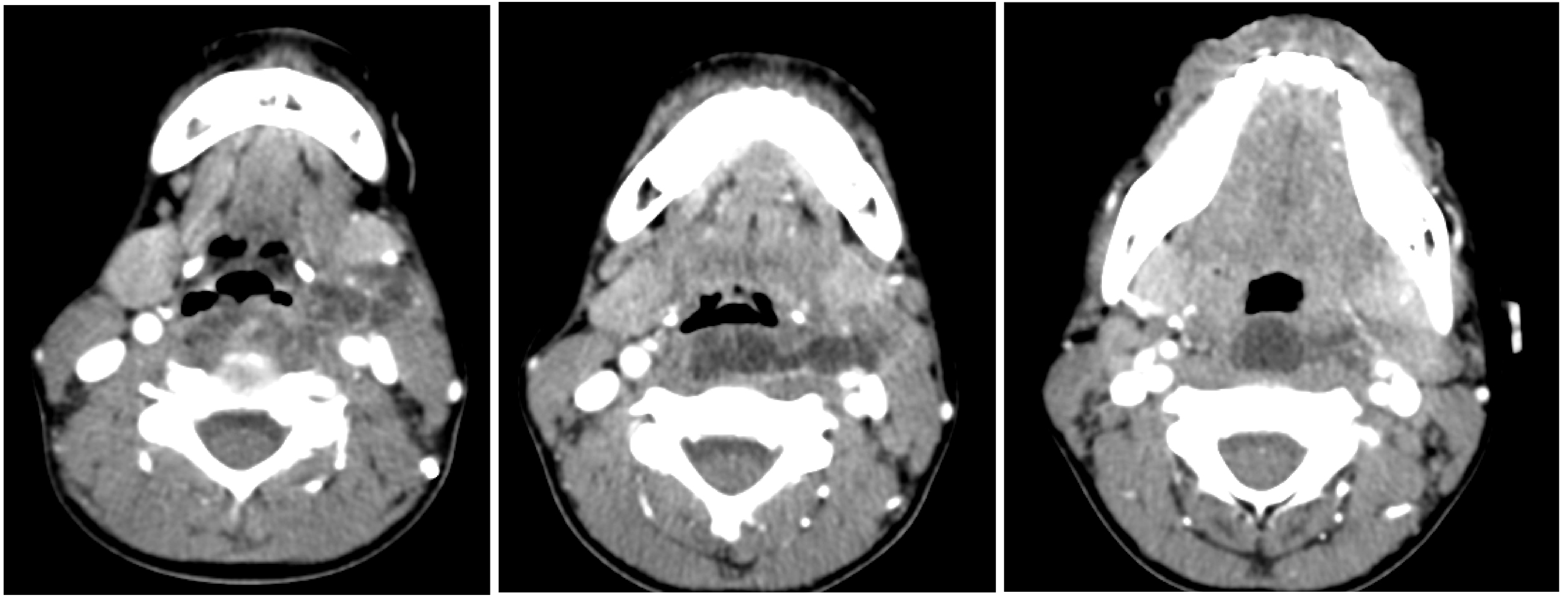
Imaging Assessment of the Airway

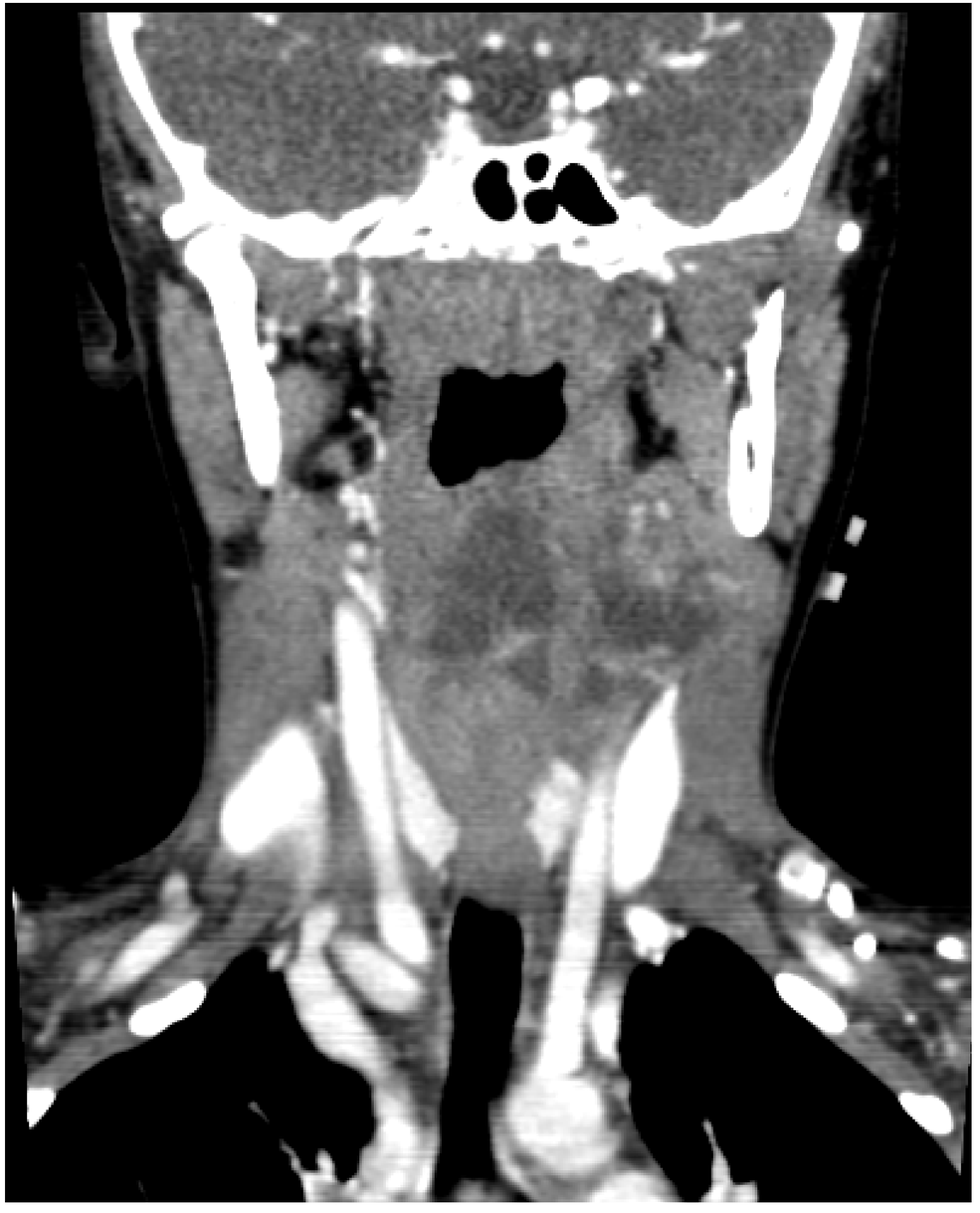
Oropharynx

Imaging Assessment of the Airway

Pharynx and Hypopharynx

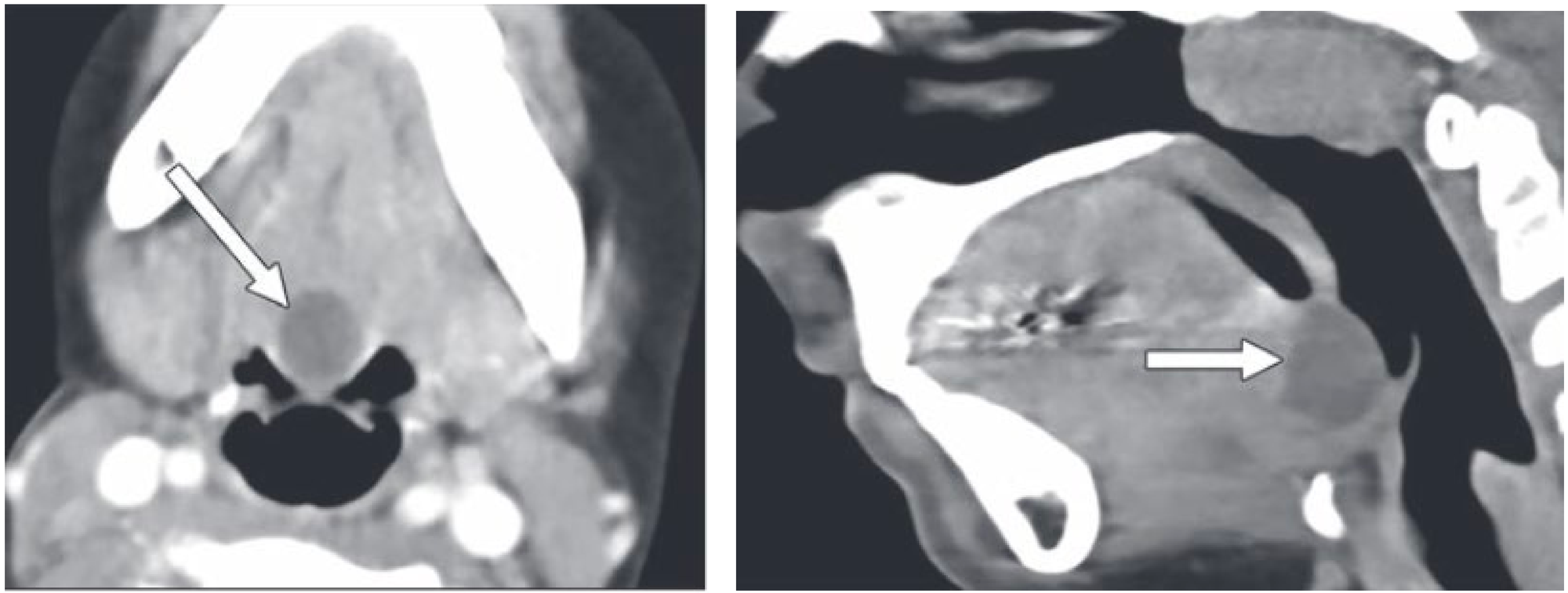






Imaging Assessment of the Airway

Pharynx and Hypopharynx

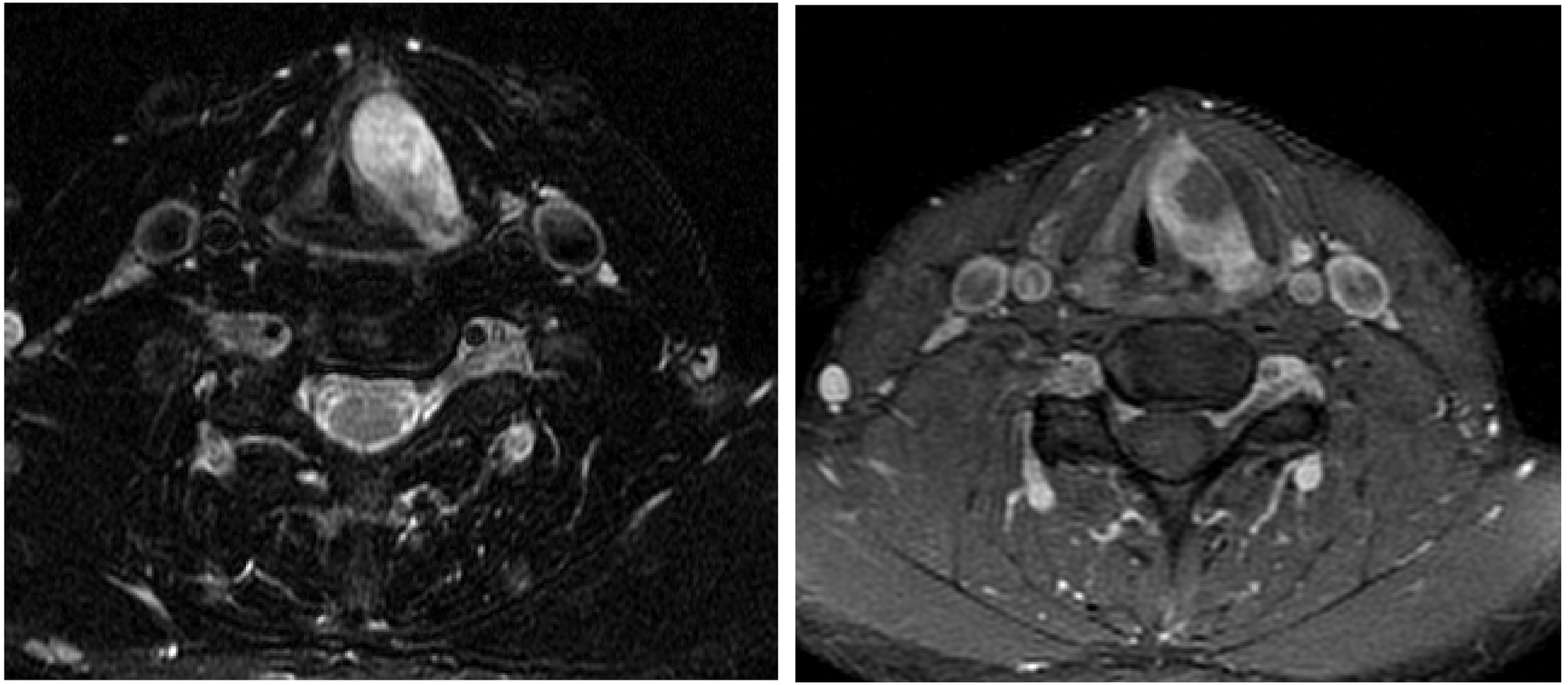


5 y/o with recurrent URI and sleep apnea

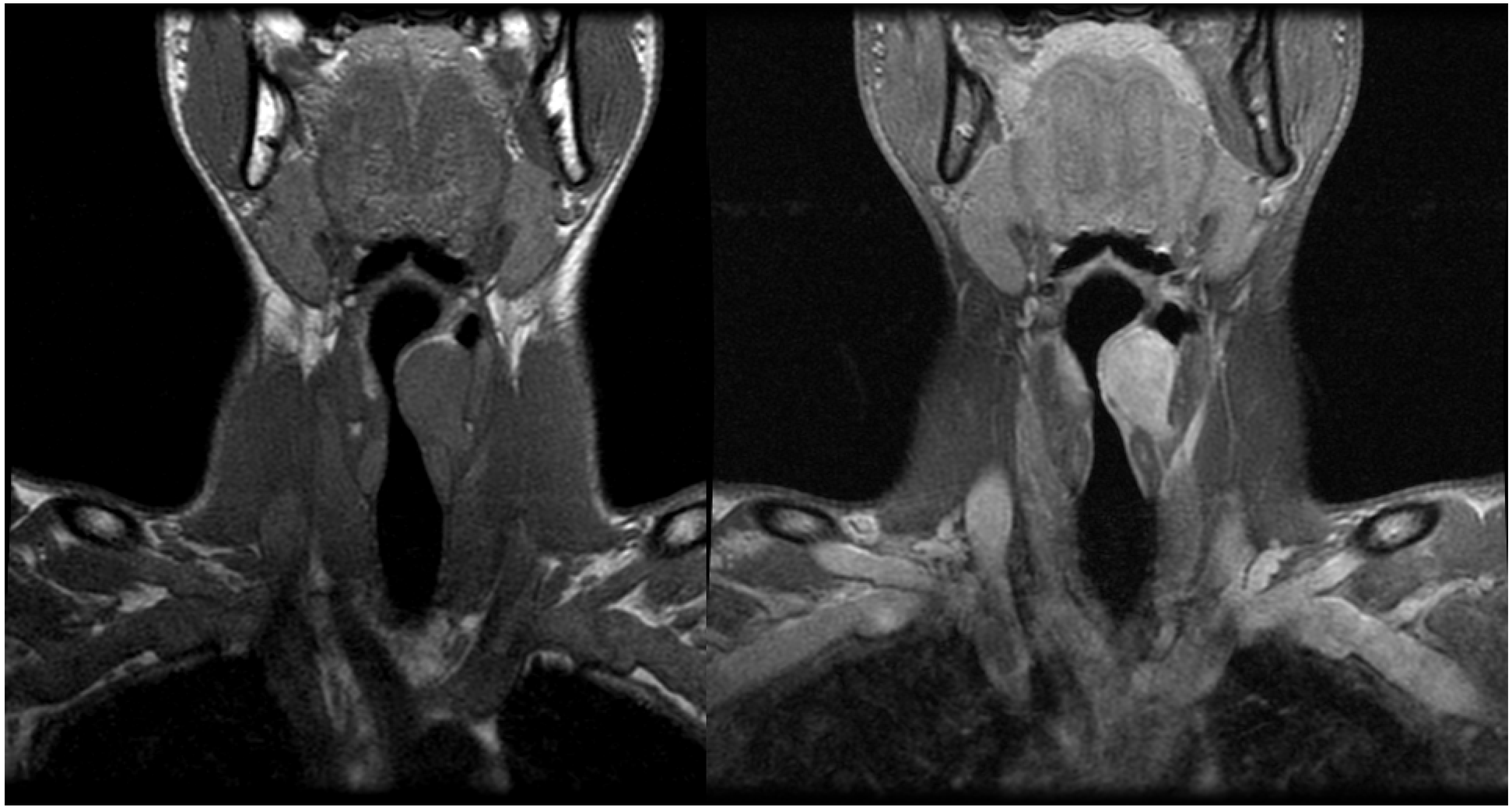
AJR 2020; 214:1008–1018

Imaging Assessment of the Airway

Larynx



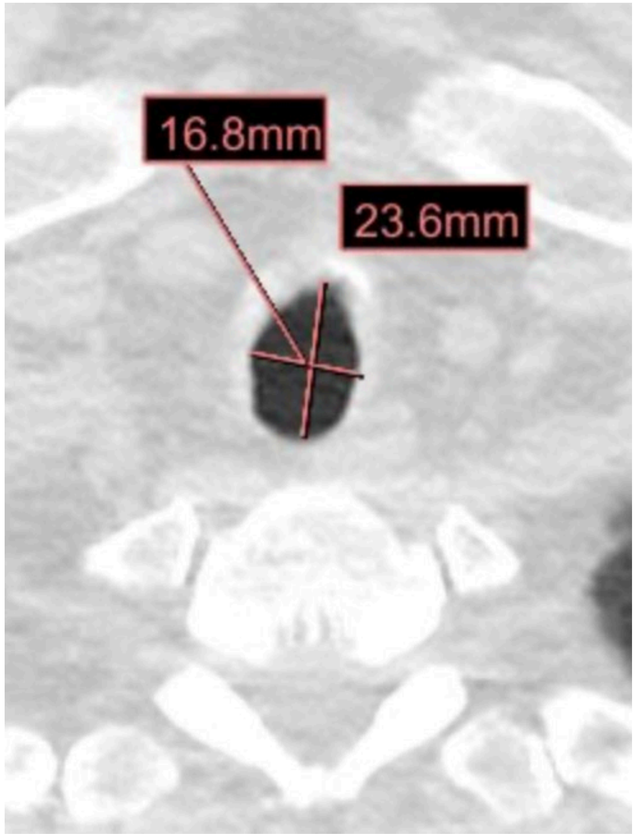
19/ y.o with hoarseness and strider



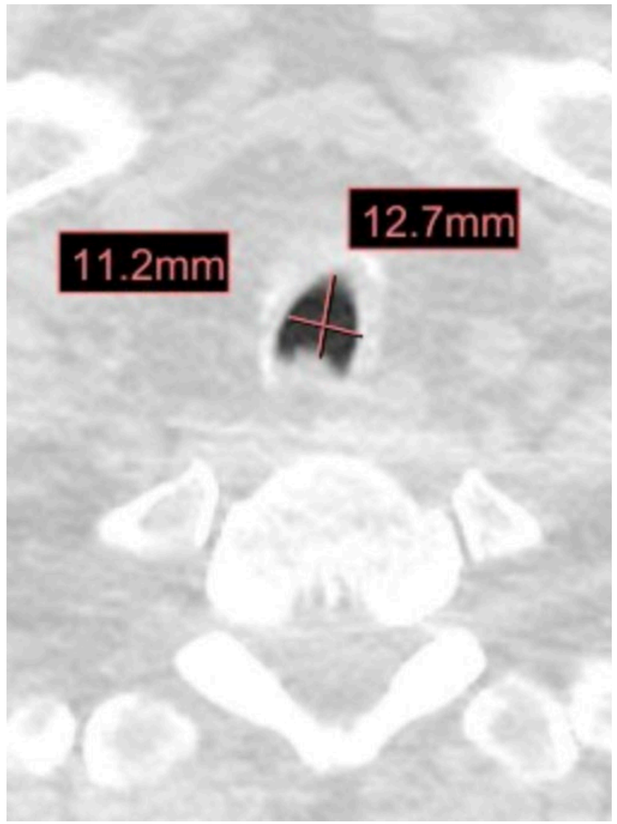
Imaging Assessment of the Airway

Trachea

Inspiratory



Expiratory



Imaging Assessment of the Airway

Trachea

Inspiratory

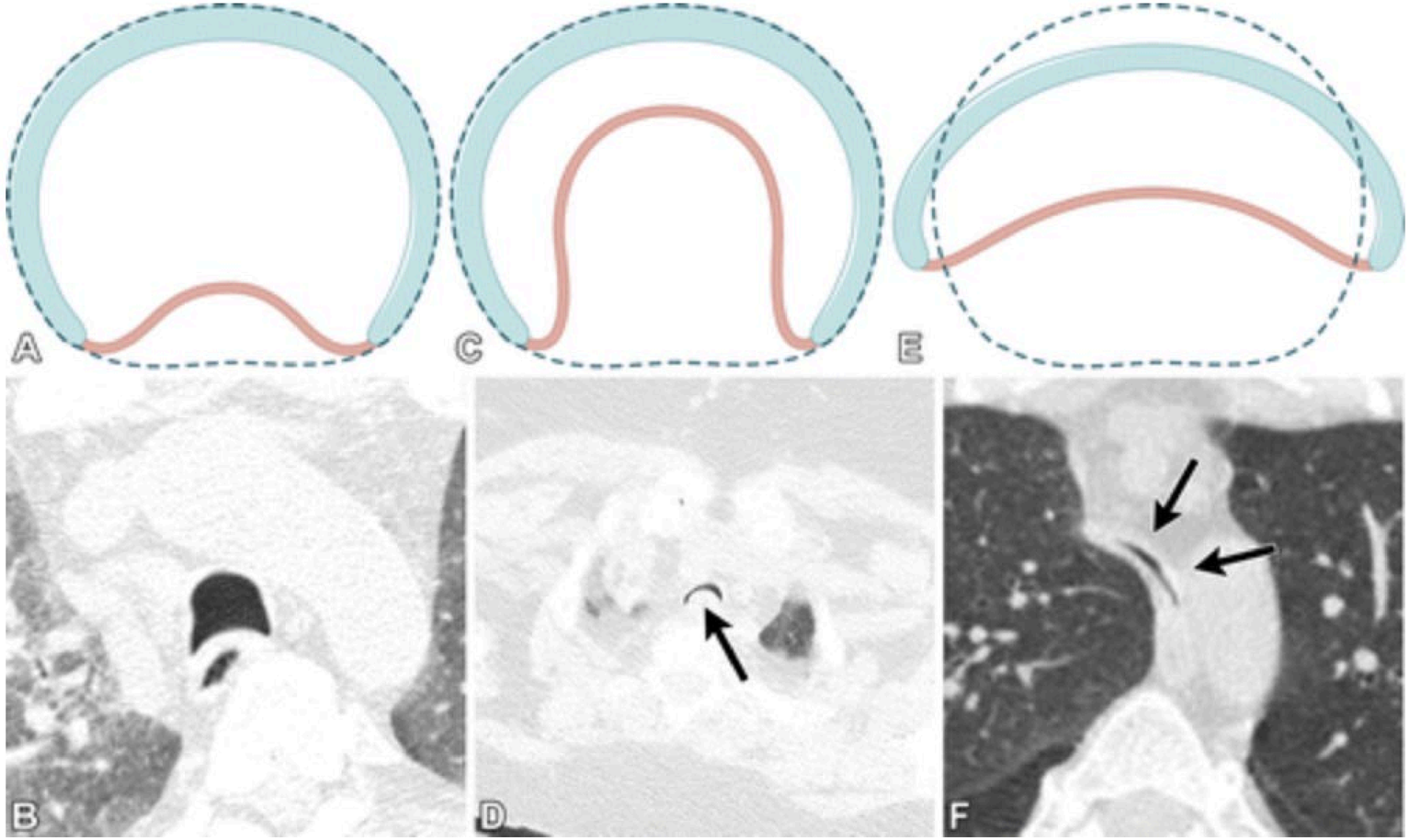
Expiratory

Imaging Assessment of the Airway

Trachea

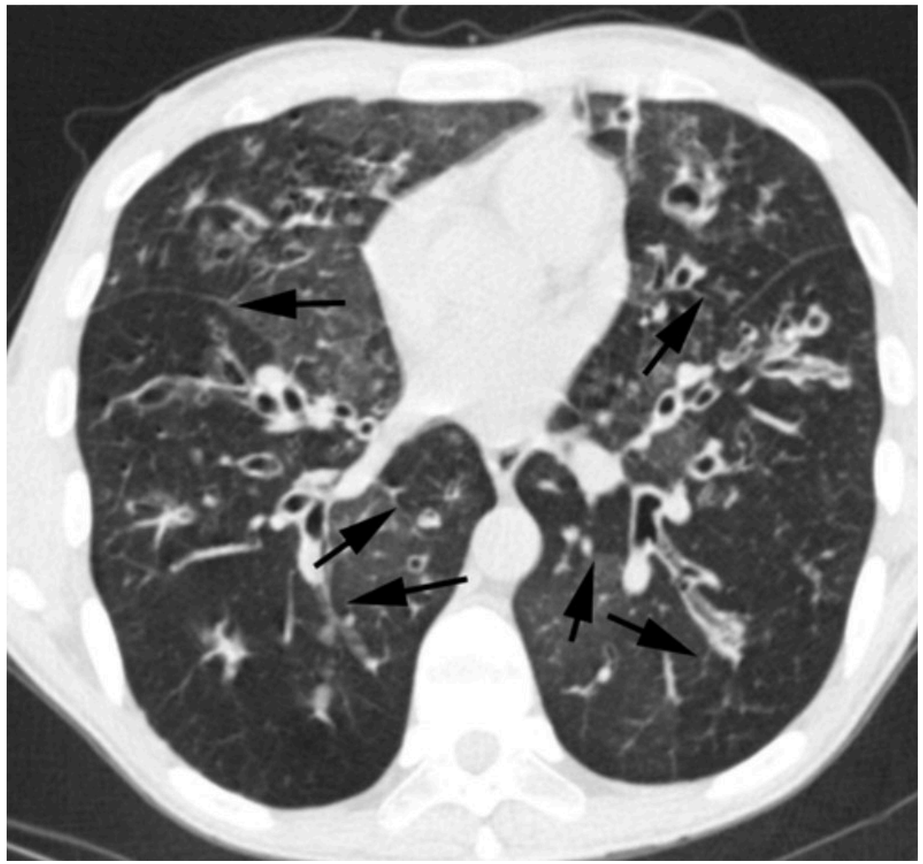
Vol. 42, No. 4

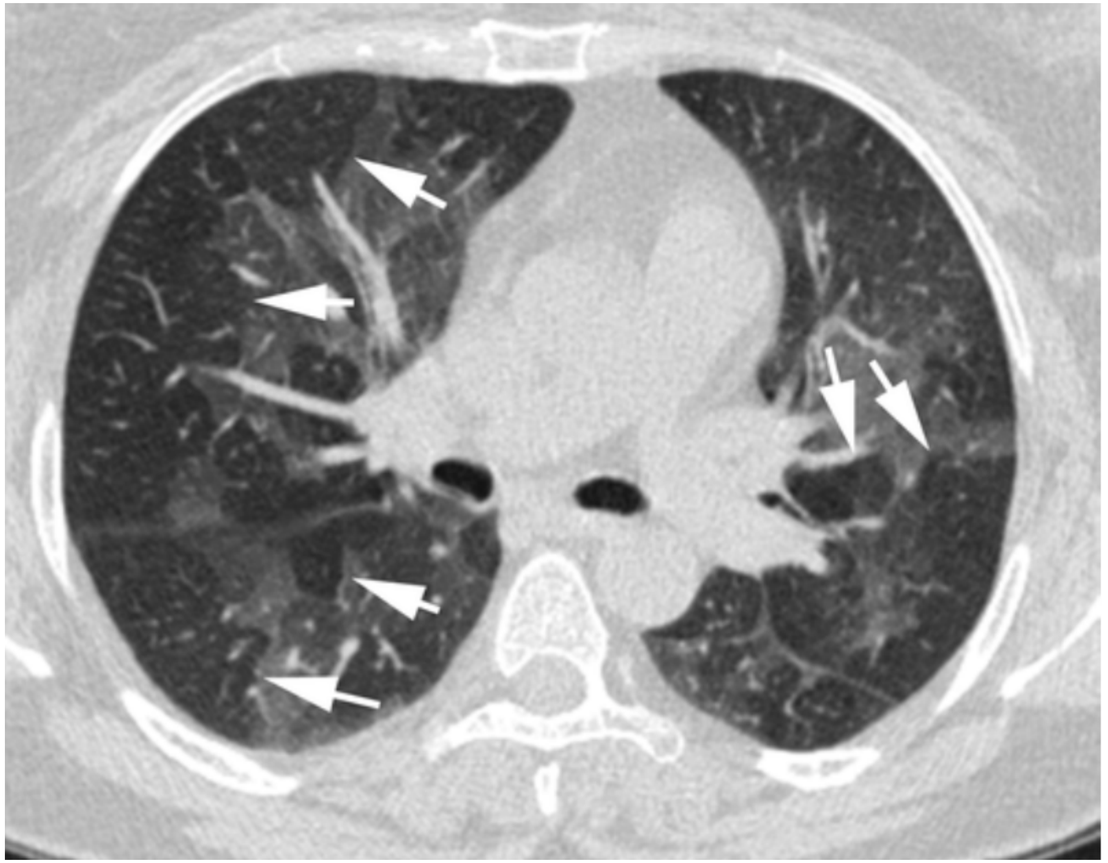
Tracheobronchomalacia and Excessive Dynamic Airway Collapse: Current Concepts and Future Directions



Imaging Assessment of the Airway

Pulmonary





Expiratory Air Trapping on Thoracic Computed Tomography
A Diagnostic Subclassification

Wallace T. Miller, Jr.[1], Jonathan Chatzkel[2], and Michael G. Hewitt[1]

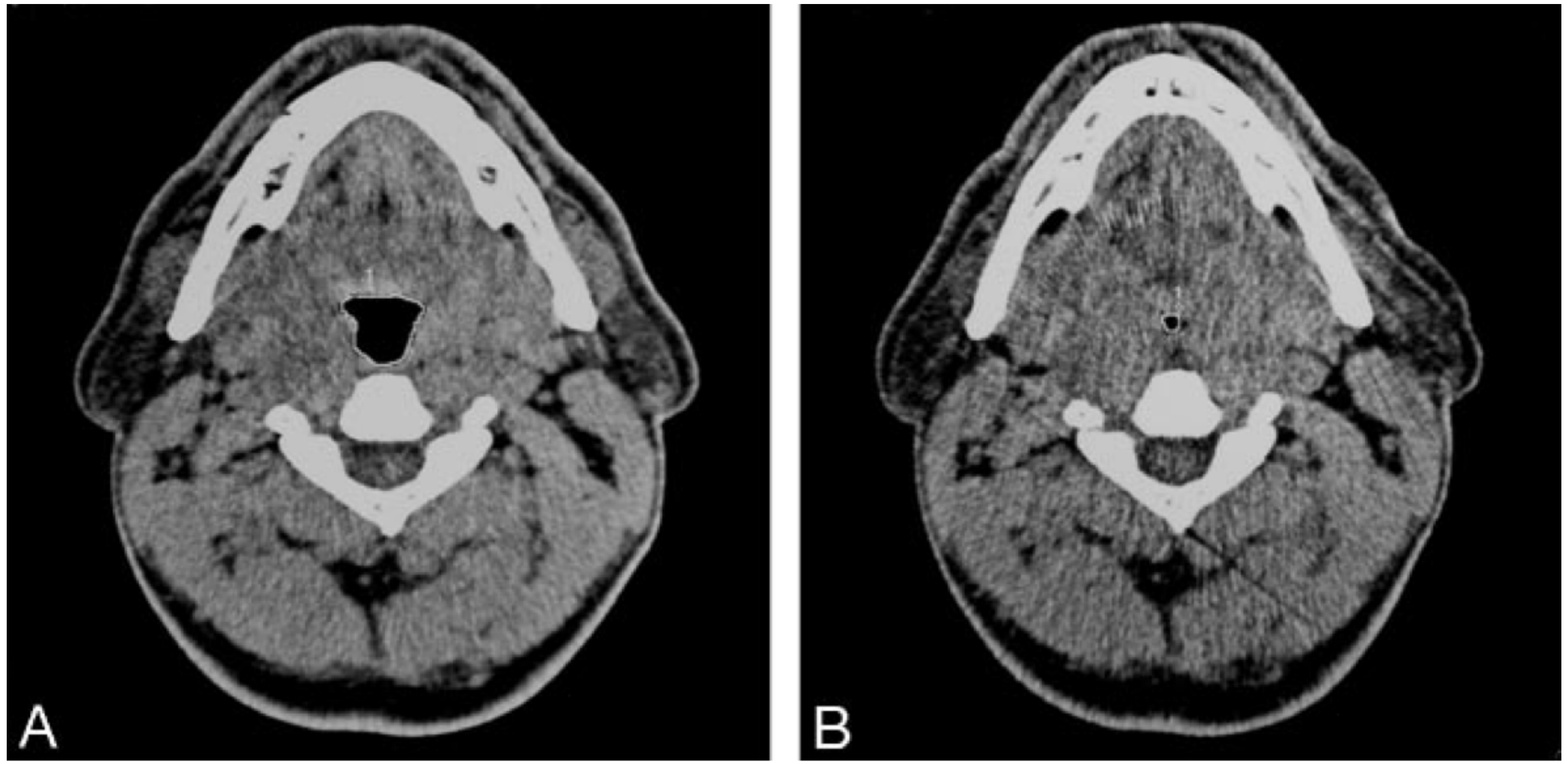
Inspiratory vs. Expiratory Imaging

Evaluation of the Upper Airway Cross-sectional Area Changes in Different Degrees of Severity of Obstructive Sleep Apnea Syndrome: Cephalometric and Dynamic CT Study

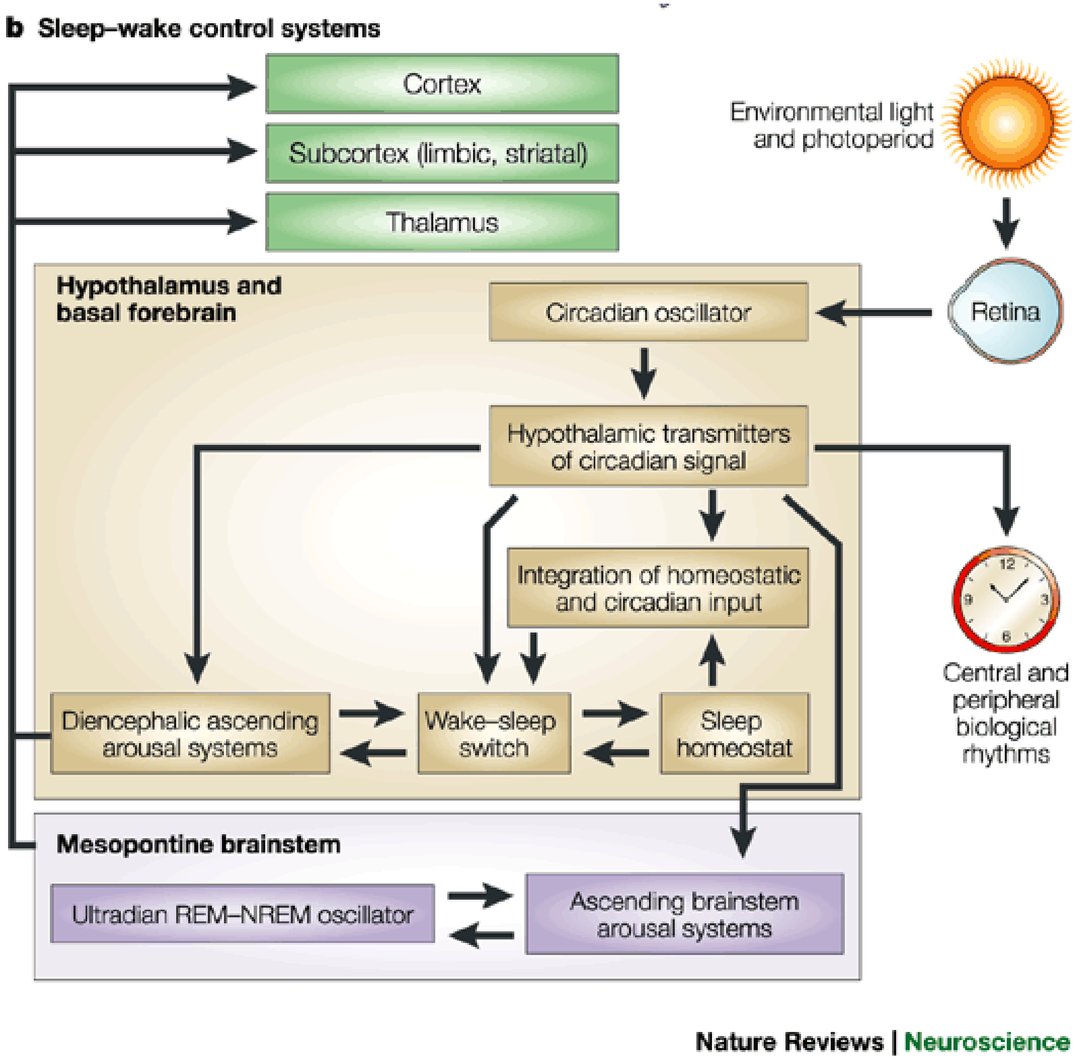
Aylin Yucel, Mehmet Unlu, Alpay Haktanir, Murat Acar and Fatma Fidan

AJNR Am J Neuroradiol 2005, 26 (10) 2624-2629
http://www.ajnr.org/content/26/10/2624

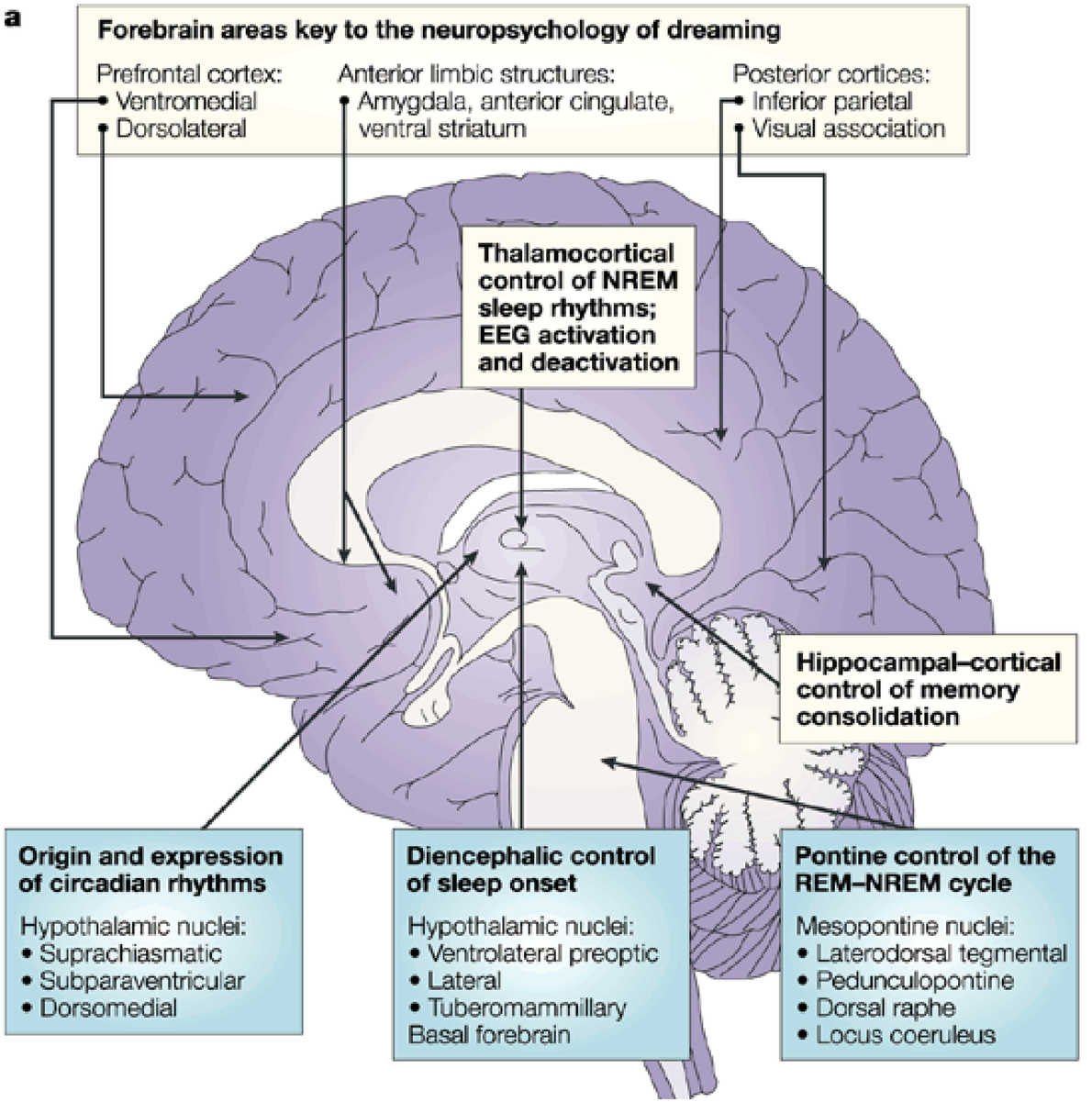
AJNR



Imaging Assessment of Other Sleep-Related Structures

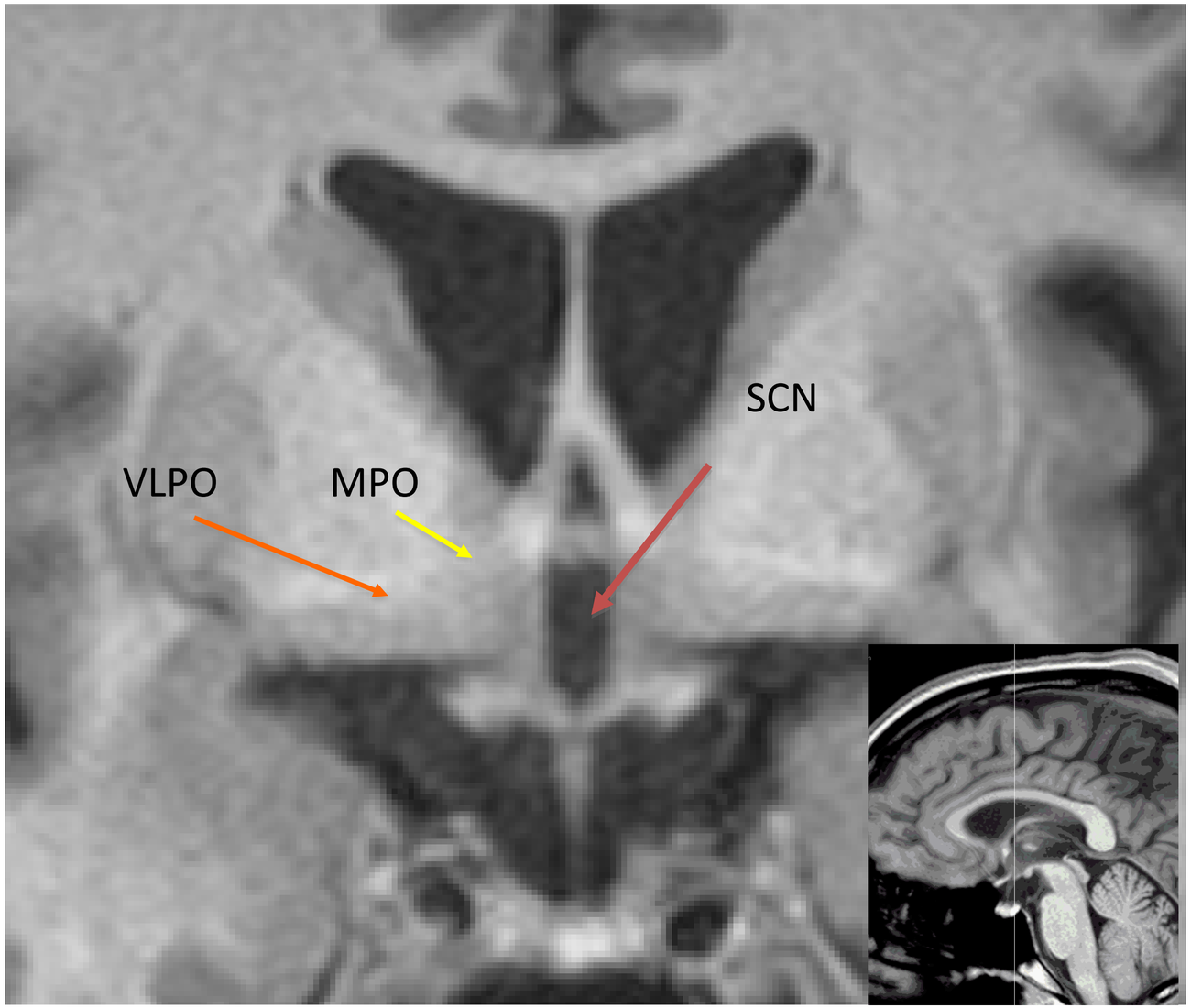


Pace-Schott EF, Hobson JA. The Neurobiology of Sleep: Genetics, cellular physiology and subcortical networks. Nat Rev Neurosci 2002; 3: 591-605.



Pace-Schott EF, Hobson JA. The Neurobiology of Sleep: Genetics, cellular physiology and subcortical networks. Nat Rev Neurosci 2002; 3: 591-605.

Anterior Hypothalamus



Is sleep apnea associated with abnormalities of the cervical spine?

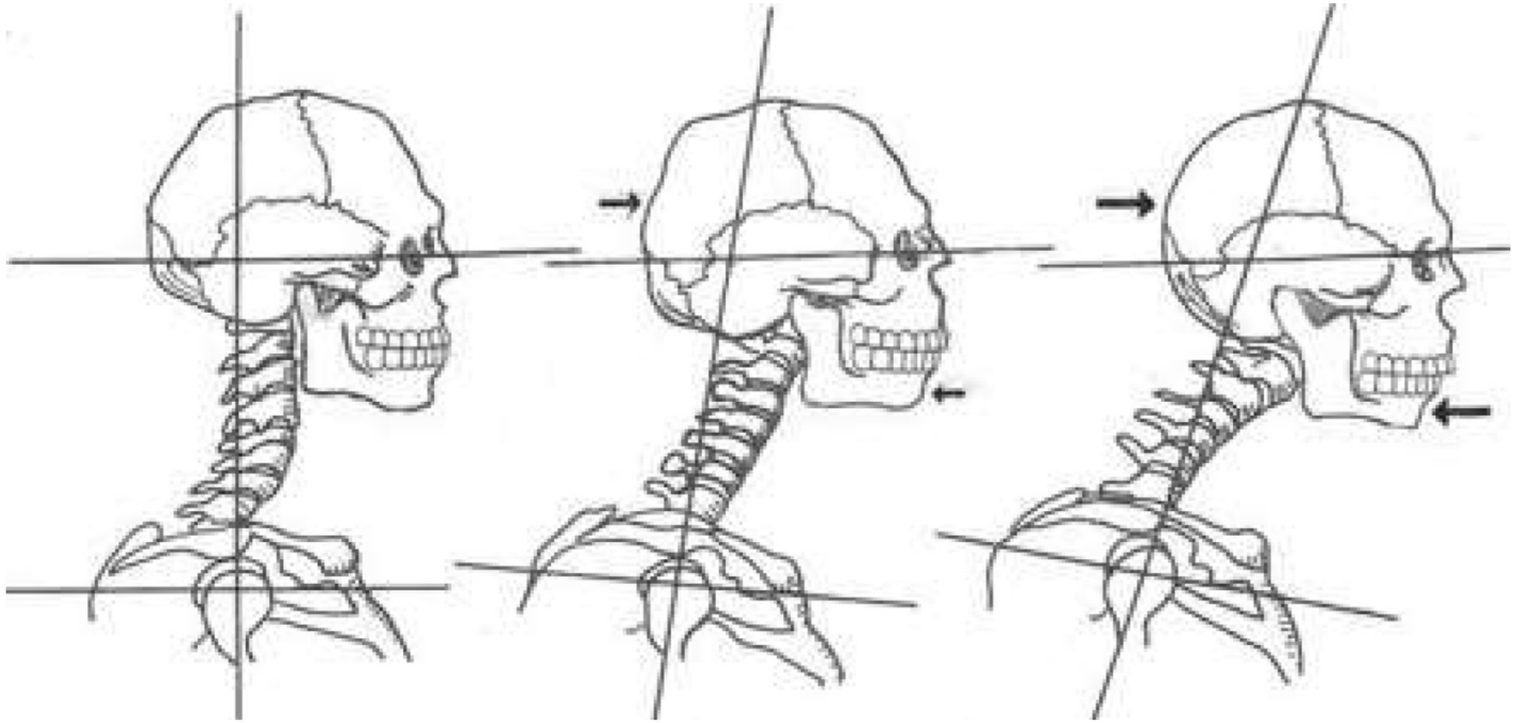
Contents lists available at ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Original Article

Obstructive sleep Apnea's association with the cervical spine abnormalities, posture, and pain: a systematic review

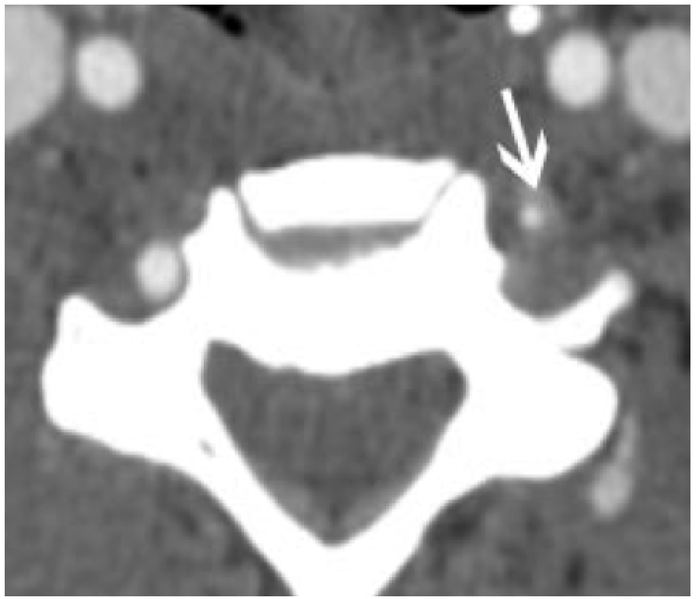


Chiropractic Treatments for OSA

- OSA may be associated with forward head posture, excessive cranio-cervical extension, open mouth breathing and thoracic hyperkyphosis

Journal of Chiropractic Medicine
Volume 22, Issue 3, September 2023, Pages 234-238

Conservative Treatment Using Chiropractic Care and Orofacial Myofunctional Therapy for Obstructive Sleep Apnea: A Case Report



Chiropractic Treatments for OSA

- Reported incidence ranges from 1 in 20K to 1 in 1.8M
- Survey responses of 177 neurologists
- Asked about patients evaluated over the preceding 2 years who suffered a neurologic complication within 24 hours of a chiropractic manipulation
  - 55 strokes (majority posterior circulation)

Orofacial Myofunctional Therapy for OSA

- OMT is a program used to correct breathing, swallowing, and chewing disorders, normalize freeway space, help stabilize the bite, and eliminate noxious oral habits such as tongue-thrusting and thumb-sucking.
- OMT stabilizes orthodontic, surgical, and dental results.

AOMT
ACADEMY *of* OROFACIAL MYOFUNCTIONAL THERAPY

MYOFUNCTIONAL THERAPY TO TREAT OSA: REVIEW AND META-ANALYSIS

Myofunctional Therapy to Treat Obstructive Sleep Apnea: A Systematic Review and Meta-analysis

Macario Camacho, MD[1]; Victor Certal, MD[2]; Jose Abdullatif, MD[3]; Soroush Zaghi, MD[4]; Chad M. Ruoff, MD, RPSGT[1]; Robson Capasso, MD[5]; Clete A. Kushida, MD, PhD[1]

[1]Department of Psychiatry, Division of Sleep Medicine, Stanford Hospital and Clinics, Redwood City, CA; [2]Department of Otorhinolaryngology/ Sleep Medicine Centre, Hospital CUF Porto; CINTESIS, Center for Research in Health Technologies and Information Systems, University of Porto, Porto, Portugal; [3]Department of Otorhinolaryngology, Hospital Bernardino Rivadavia, Buenos Aires, Argentina; [4]Department of Head and Neck Surgery, University of California, Los Angeles, CA; [5]Department of Otolaryngology, Head and Neck Surgery, Sleep Surgery Division, Stanford University Medical Center, Stanford, CA

Sleep 2015

- MT provides a reduction in AHI of approximately 50% in adults and 62% in children
  - Pre- and post-MT AHI for adults decreased from 24.5 ± 14.3/h to 12.3 ± 11.8/h
  - In pediatric patients AHI decreased from 4.87 ± 3.0/h to 1.84 ± 3.2/h
- MT decreases snoring both subjectively and objectively. Polysomnography demonstrated a 72.4% reduction in snoring pre- versus post- MT (14.05 ± 4.89% to 3.87 ± 4.12%, before and after, respectively), $P < 0.001$.
- Subjective sleepiness also improves post-MT as demonstrated by a clear reduction in ESS score for the 93 patients in which it was administered, with a reduction from 14.8 ± 3.5 to 8.2 ± 4.1

Applications of Imaging for Sleep Medicine

- Identification of OSA risk factors and/or contributors
- Expand our understanding of the role of sleep for optimum health
- Explore the how sleep dysfunction results in and contributes to some common pathologic conditions

Sleep Apnea Risk Factors and Management

PAPER

Chiari malformation and sleep related breathing disorders

Y Dauvilliers, V Stal, B Abril, P Coubes, S Bobin, J Touchon, P Escourrou, F Parker, P Bourgin

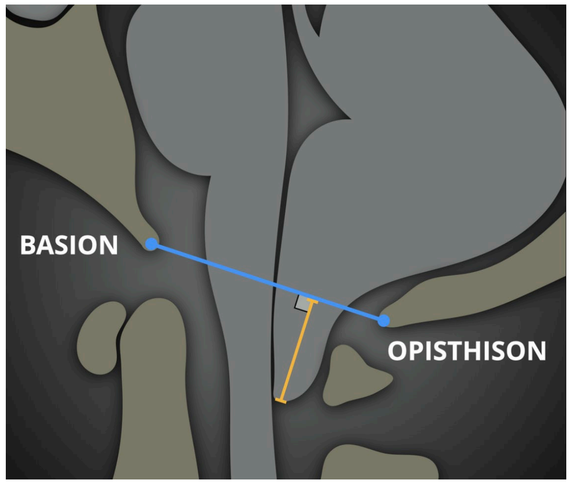
J Neurol Neurosurg Psychiatry 2007;**78**:1344–1348. doi: 10.1136/jnnp.2006.108779

Table 2 Polysomnographical data of 46 patients with Chiari malformation divided into three age groups

Characteristic	⩽18 years (n = 20)	19–30 years (n = 10)	⩾31 years (n = 16)	p Value
Polysomnography				
Total sleep time	481.9 (21.5)	395.8 (30.2)	313.7 (21)	<0.001
Sleep onset latency	20.8 (4.3)	23.0 (7.7)	18.7 (6.3)	NS
% Sleep efficiency	89.1 (3.0)	74.8 (7.8)	76.8 (3.6)	0.05
% Stage 2	47.0 (2.1)	55.2 (1.9)	54.3 (3.6)	NS
% SWS	26.2 (1.4)	18.9 (0.9)	18.8 (1.7)	<0.005
% REM	19.5 (1.3)	16.3 (2.3)	11.5 (1.5)	<0.01
SAS diagnosis (%)				
SAS	60	60	81	0.05
OSAS	35	40	69	<0.01
Severe OSAS	0	0	31	<0.05
CSAS	25	20	13	NS
Severe CSAS	0	0	6	NS
Respiratory events				
AHI	2.6 (0.5)	5.64 (1.6)	26.4 (6.6)	<0.001
OAI	0.2 (0.07)	0.48 (0.2)	6.7 (2.4)	<0.005
HI	1.6 (0.4)	3.84 (1.5)	16.4 (4.6)	<0.005
CAI	0.8 (0.2)	1.31 (0.8)	3.3 (1.7)	NS
O_2 saturation				
O_2 mean saturation	97.0 (0.2)	96.15 (0.4)	92.9 (0.9)	<0.001
O_2 min saturation	84.7 (2.1)	89.08 (1.6)	80.7 (2.7)	NS
TTS (%) with SaO_2 <90%	1.0 (0.5)	0.4 (0.3)	13.1 (5.3)	0.05

AHI, apnoea hypopnoea index; CAI, central apnoea index; CSAS, central sleep apnoea syndrome; HI, hypopnoea index; OAI, obstructive apnoea index; OSAS, obstructive sleep apnoea syndrome; REM, rapid eye movements; SAS, sleep apnoea syndrome; SWS, slow wave sleep.
Results are expressed as mean (SEM) or %.

Sleep Apnea Risk Factors and Management
Chiari Malformations



Sleep Apnea Risk Factors and Management

Mandibular width as a novel anthropometric measure for assessing obstructive sleep apnea risk

Hillel S. Maresky, MD[a,b], Miriam M. Klar, BA[a,*], Jaron Tepper, MD[a], Haim Gavriel, MD[c], Tomer Ziv Baran, PhD[d], Colin M. Shapiro, MD[e], Sigal Tal, MD[a]

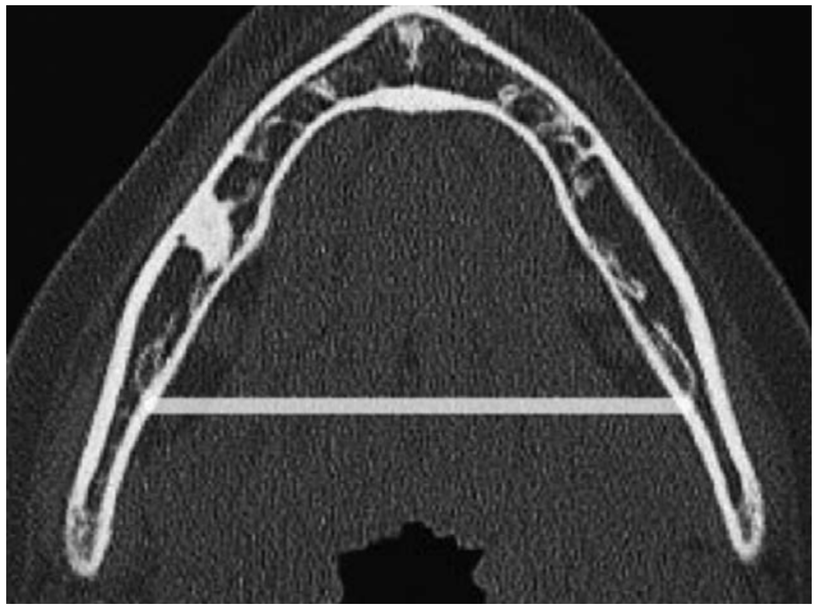
Medicine (2019) 98:4(e14040)

Table 3

Comparison of associations for various factors.

Study parameter	Descriptive parameters Mean ± SD or median (IQR)	Correlation to STOP-BANG	
		R	*P*
Mandible width	80.26 +/− 4.76	0.416	<.001
Neck circumference	17374.07 +/− 3397.63	0.726	<.001
Airway volume	24.15 (20.15–30.45)	0.057	.238
Neck fat volume	742.60 (554.30–943.00)	0.562	<.001
NFV:AWV ratio	29.38 (20.22–41.92)	0.391	<.001

AWV = airway volume, NFV = neck fat volume.



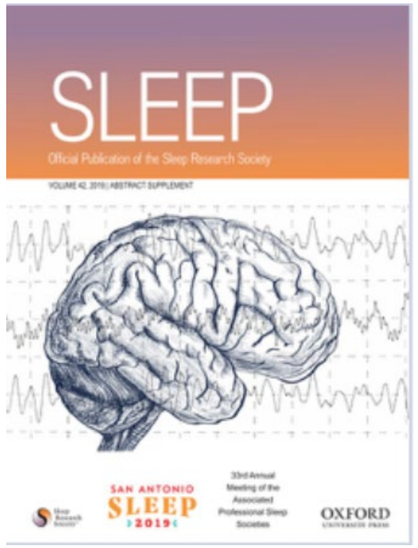
Sleep Apnea Risk Factors and Management

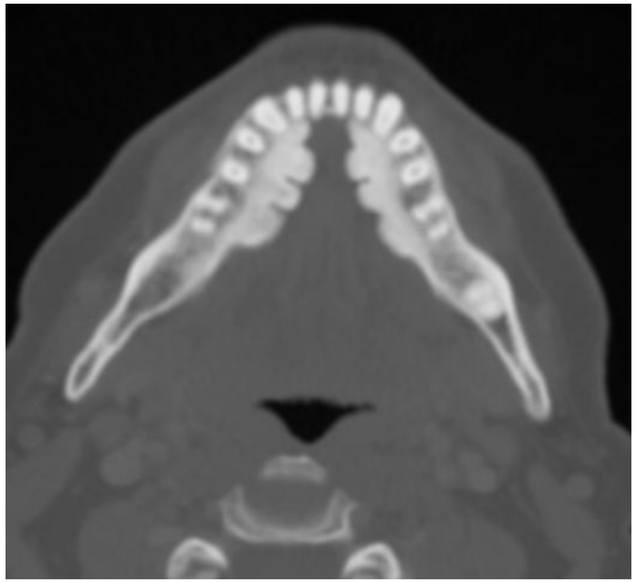
JOURNAL ARTICLE

1066 Obstructive sleep apnea in the setting of large mandibular tori, intolerant to positive airway pressure through full-face mask, responsive to positive pressure therapy through nasal mask FREE

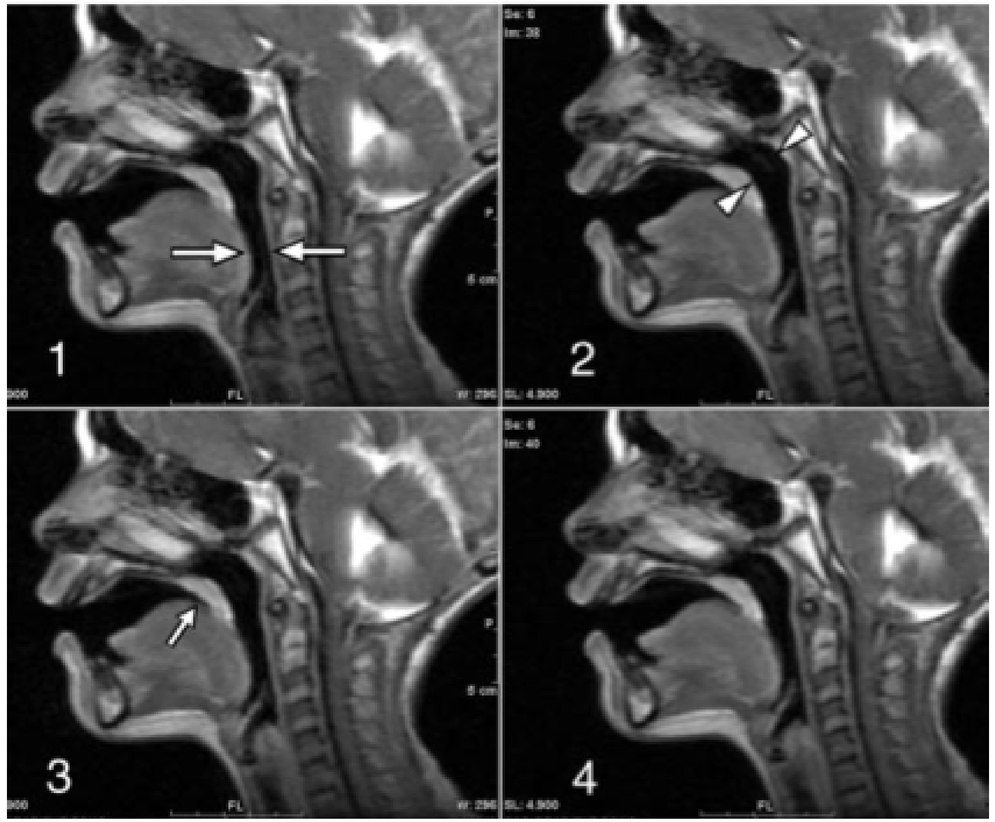
Faisal Zahiruddin, DO, Romy Hoque, MD

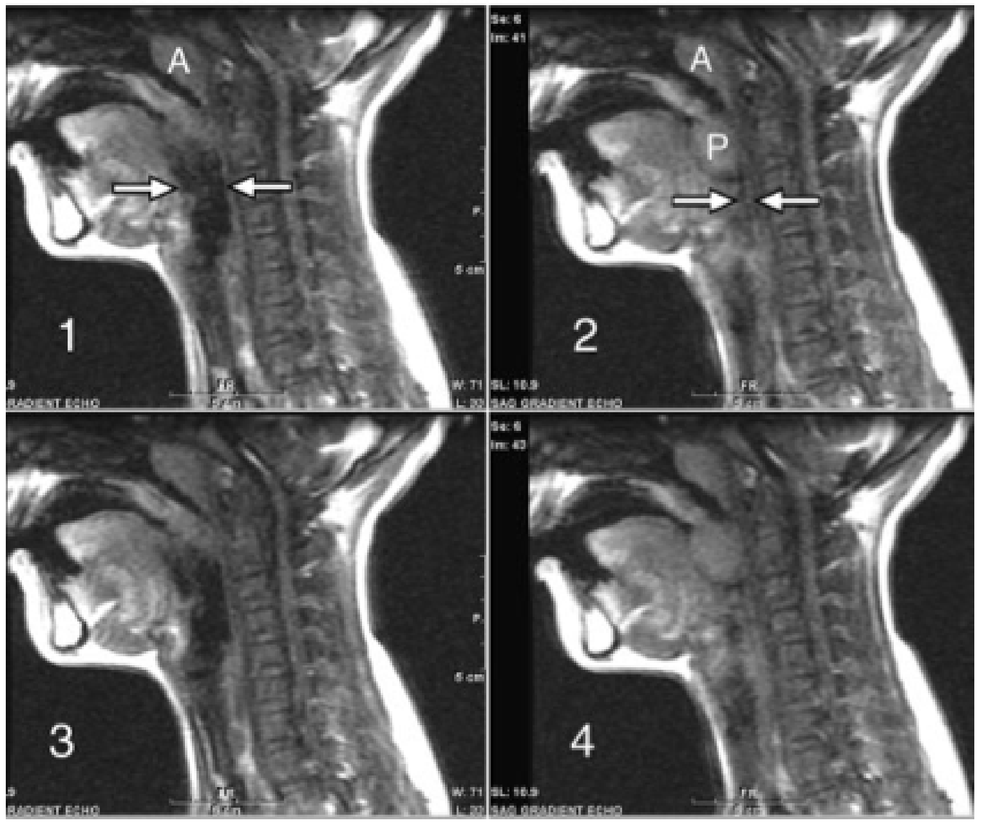
Sleep, Volume 42, Issue Supplement_1, April 2019, Page A427,
https://doi.org/10.1093/sleep/zsz069.1063
Published: 12 April 2019





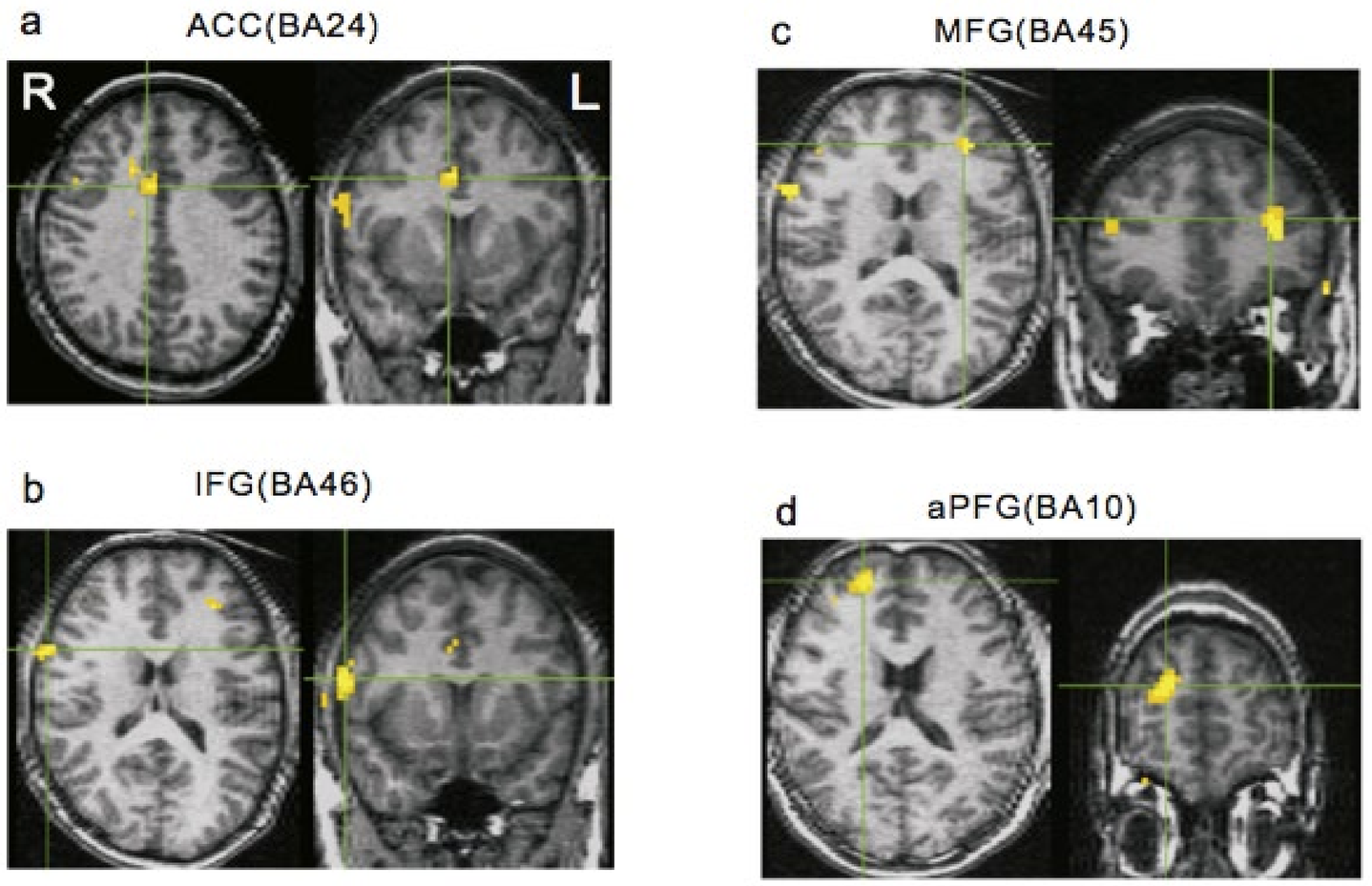
Upper Airway Motion Assessment by Cine MR Imaging Performed during Sleep





- Donnelly, L. F., Surdulescu, V., Chini, B. A., Casper, K. A., Poe, S. A., & Amin, R. S. (2003). Upper airway motion depicted at cine MR imaging performed during sleep: comparison between young Patients with and those without obstructive sleep apnea Radiology, 227(1), 239-245. doi:10.1148/radiol.2271020198

Functional MRI evaluation of frontal dysfunction in patients with severe obstructive sleep apnea



X. Zhang et al. / Sleep Medicine 12 (2011) 335–340

Leukoaraiosis and Sleep Dysfunction

Annals of NEUROLOGY

An Official
the Americ
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Child Neur

Brief Communication

Are acute infarcts the cause of leukoaraiosis? Brain mapping for 16 consecutive weeks

John Conklin MD, MSc[1], Frank L. Silver MD[2], David J. Mikulis MD[1,3] and Daniel M. Mandell MD, PhD[1,3,*]

Article first published online: 30 OCT 2014

DOI: 10.1002/ana.24285

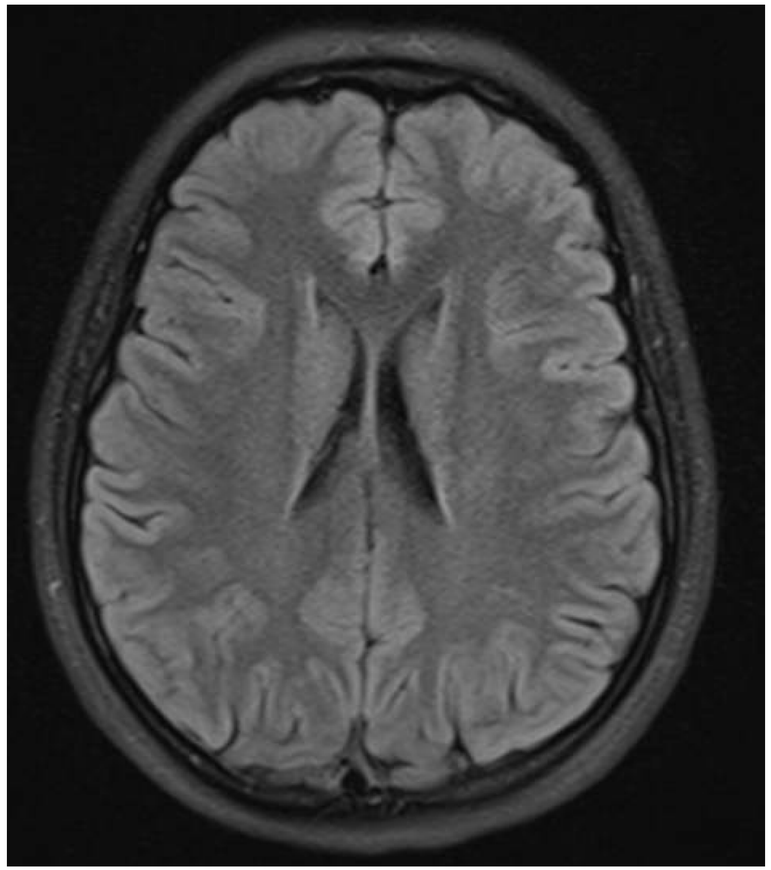
Issue

Annals of Neurology

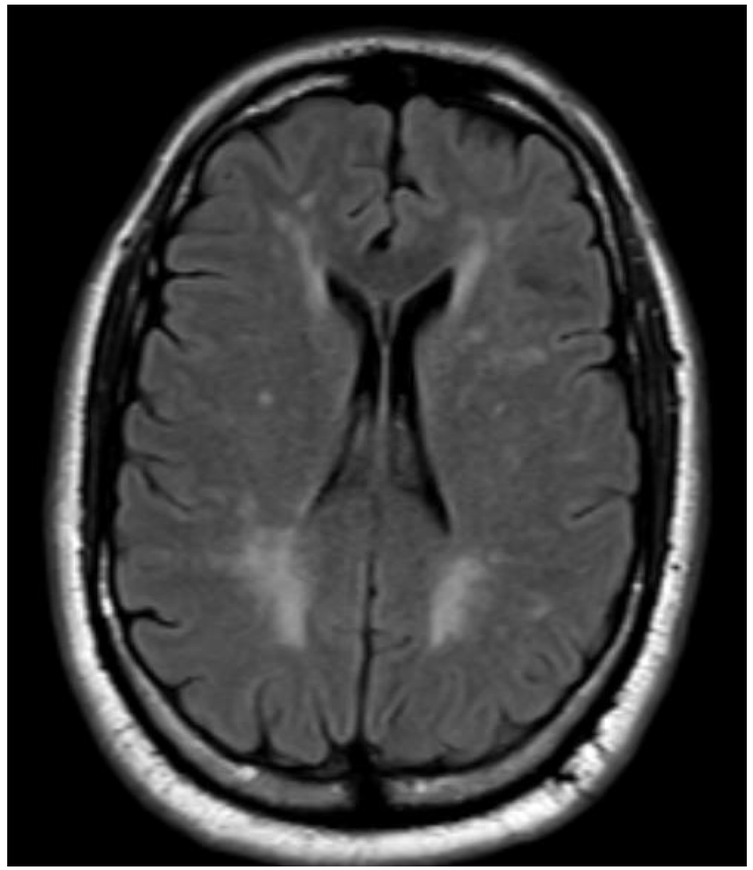
Volume 76, Issue 6, pages 899–904, December 2014

Leukoaraiosis and Sleep Dysfunction

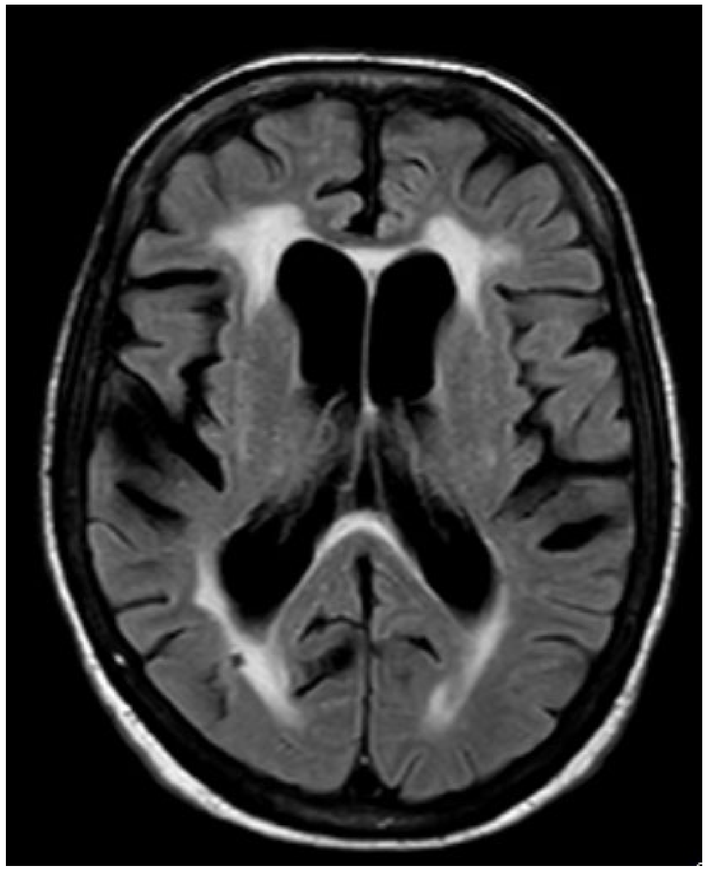
16 years



56 years

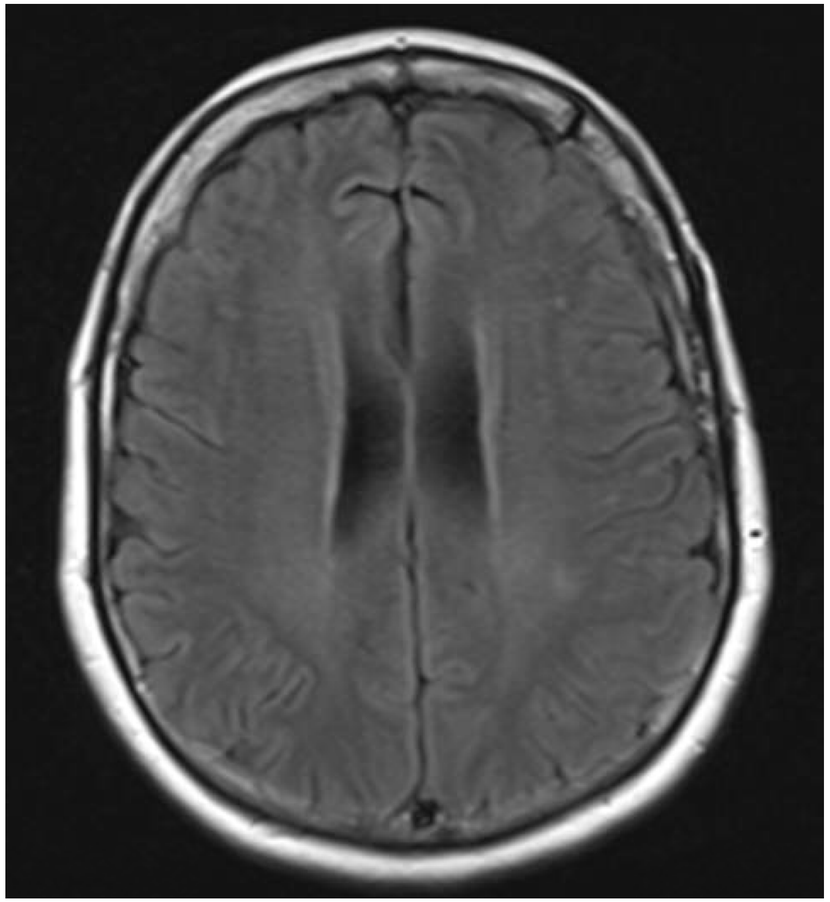


83 years

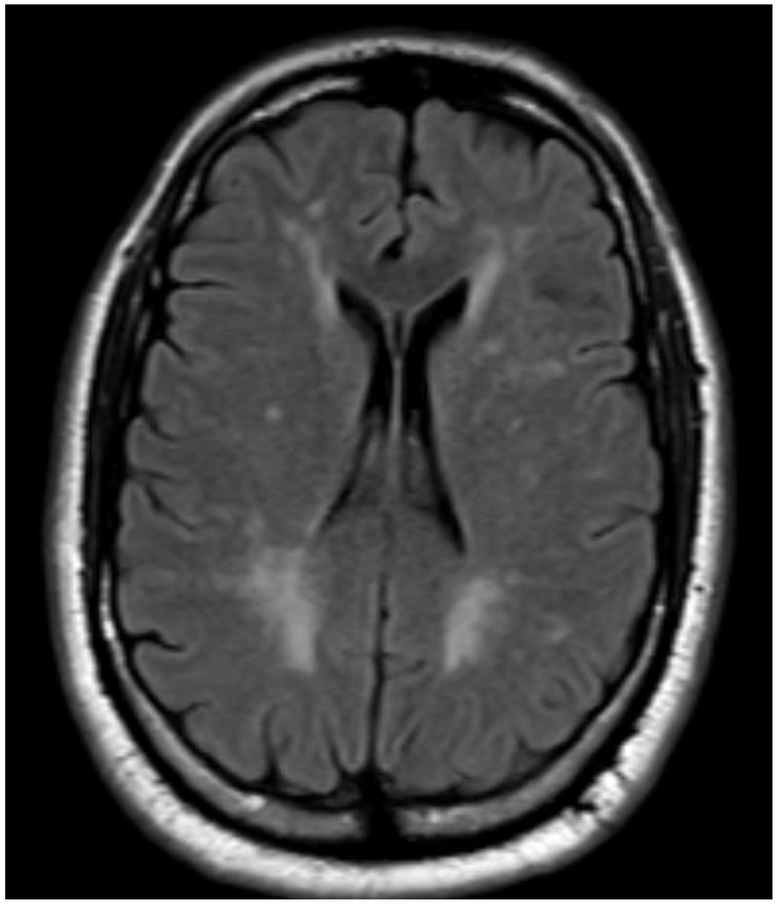


Leukoaraiosis and Sleep Dysfunction

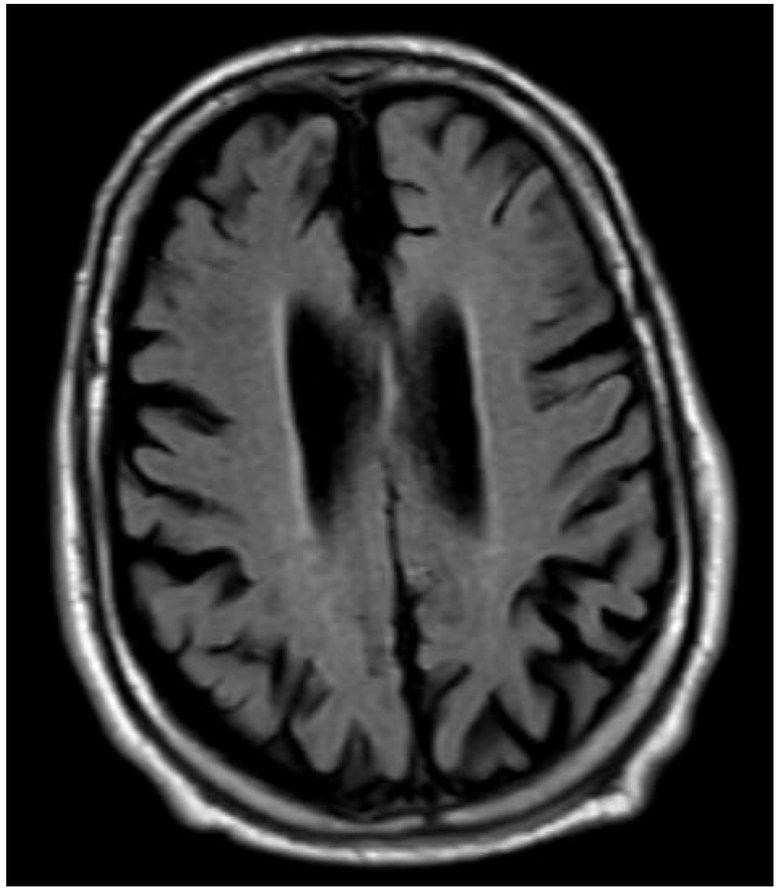
56 years



56 years



91 years



Leukoaraiosis and Sleep Dysfunction

JAMA Network | Open™

Original Investigation | Neurology

Association Between Obstructive Sleep Apnea and Brain White Matter Hyperintensities in a Population-Based Cohort in Germany

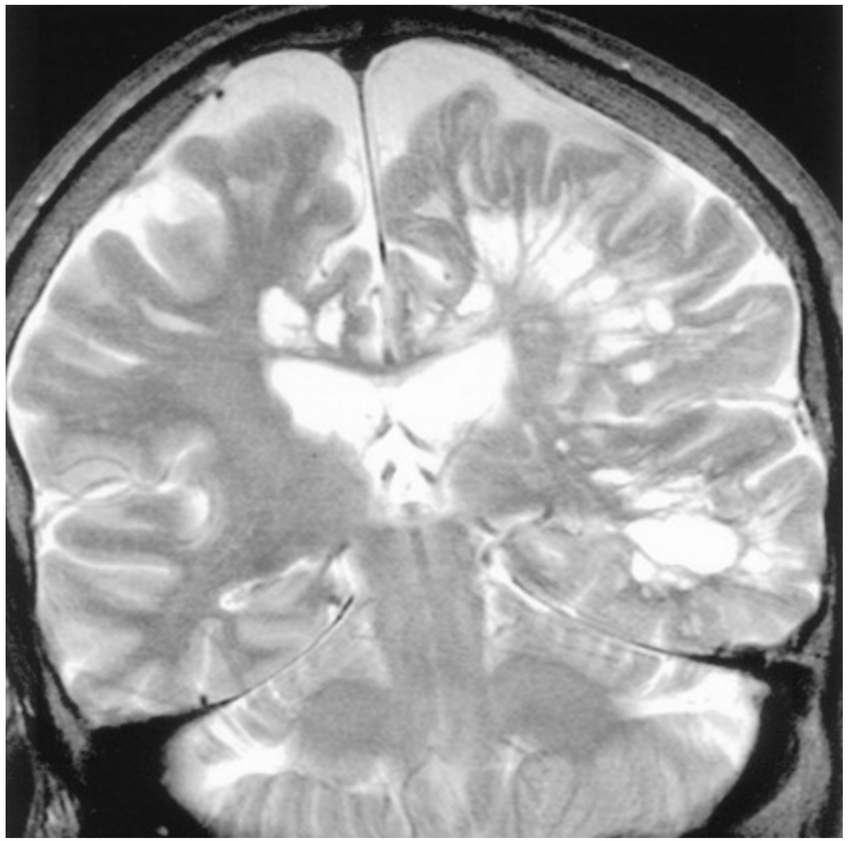
Enlarged Perivascular Spaces, Sleep Dysfunction, and Autism

JAMA Network | Open™

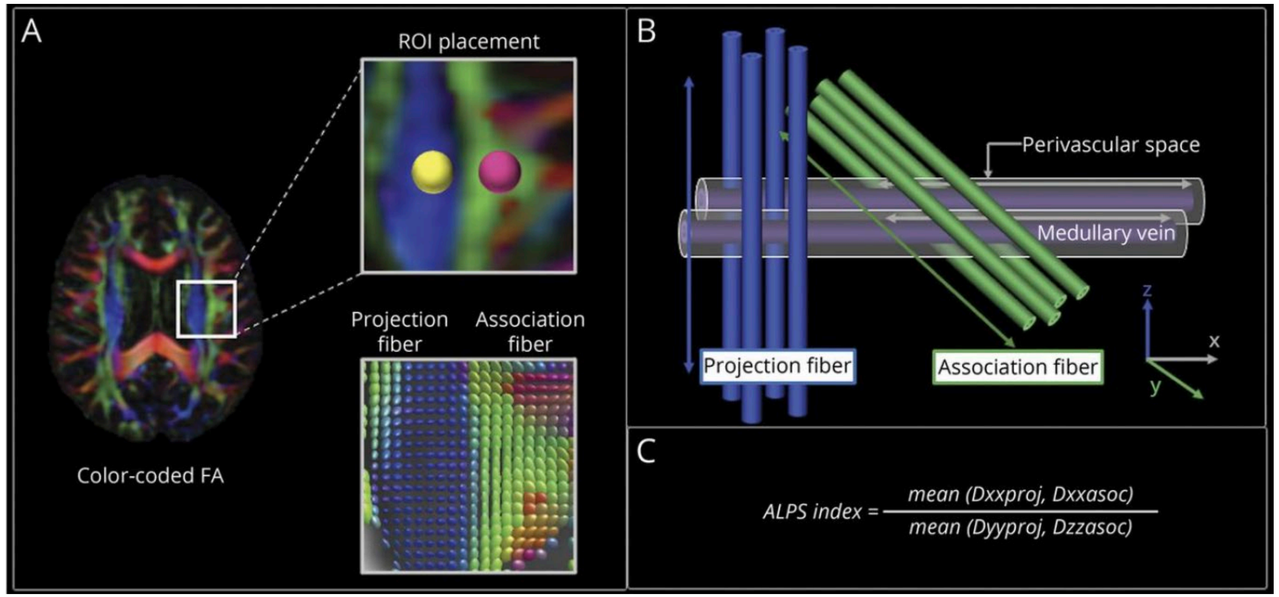
Original Investigation | Psychiatry

Enlarged Perivascular Spaces in Infancy and Autism Diagnosis, Cerebrospinal Fluid Volume, and Later Sleep Problems

Dea Garic, PhD; Robert C. McKinstry, MD, PhD; Joshua Rutsohn, MS, MPH; Rebecca Slomowitz, MA; Jason Wolff, PhD; Leigh C. MacIntyre, BSc; Leigh Anne H. Weisenfeld, MA; Sun Hyung Kim, PhD; Juhi Pandey, PhD; Tanya St. John, PhD; Annette M. Estes, PhD; Robert T. Schultz, PhD; Heather C. Hazlett, PhD; Stephen R. Dager, MD; Kelly N. Botteron, MD; Martin Styner, PhD; Joseph Piven, MD; Mark D. Shen, PhD; for the Infant Brain Imaging Study (IBIS) Network



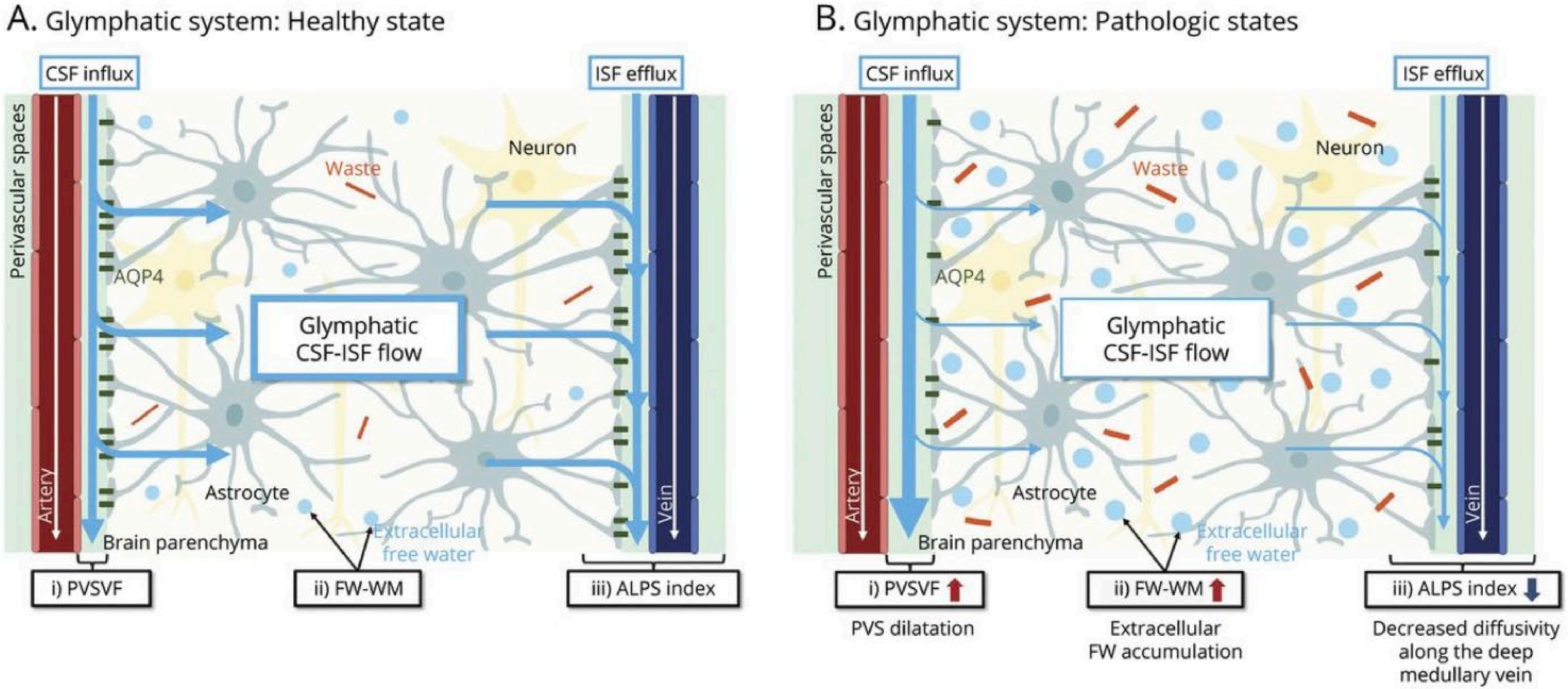
Imaging of the Glymphatic System



Volume 99 | Number 24

December 13, 2022

Imaging of the Glymphatic System




: 180 mm
e: 1000 ms
e: 3 mm
: 9.54276
c: CT_FACE
C30
mA


ce: 1.97902 mm
s: 0
S

Learning Objectives

- Upon completion of this course, attendees should be able to…
  - Provide an overview of the role of imaging for the assessment of the airway and other sleep-related anatomic structures.
  - Discuss the anatomical basis and implications of chiropractic treatments and orofacial myofunctional therapy for OSA.
  - Explore potential applications of imaging for sleep clinicians.

Radiology and Sleep

Finding Common Ground Between Infrequent Bedfellows

Ryan T. Fitzgerald MD

Thank you!

fitzgeraldryant@gmail.com

Sleep Professionals of Arkansas
Annual Educational Meeting
March 8th-9th, 2024