Segmental Approach to High Resolution MRI of the Cranial Nerves

Ari M. Blitz, MD
Associate Professor of Radiology and Neurosurgery
Director, Skull Base Imaging
Johns Hopkins University
ablitz1@jhmi.edu

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- Medical legal consulting
- Lead radiologist, Adult Hydrocephalus Research Network (AHCRN)
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Objectives
- By the end of this talk the participant will be able to:
  1. List the segments of the cranial nerves
  2. Describe methods of visualization of each segment including high resolution 3D MR imaging.
  3. Identify imaging features of primary tumors arising from the cranial nerves as well as perineural spread of disease on cross sectional imaging.

Outline
- Introduction
  - Segmental nomenclature
  - General technique MRI
- Cranial nerves by segment
  - Imaging approach
  - Anatomic images
  - Pathologic cases
- Summary

Cranial Nerve Segments
An Imaging Classification
- a. nuclear
- b. parenchymal fascicular
- c. cisternal
- d. dural cave
- e. interdural
- f. foraminal
- g. extra-foraminal

(can be referred to in short hand as CN #.x where x is the segment)
Cranial Nerve Segments
An Imaging Classification

- Provides a concise, standard and specific means of communication with clinicians
- Has implications for DDX
- Alters approach to imaging

Protocol for Visualization of the CN Segments

3D Isotropic Imaging

Skull Base Protocol (as hung for interpretation)

Skull Base Protocol Parameters

Imaging Nuclear (a) and Parenchymal fascicular (b) Segments

- Surrounded by brainstem parenchyma
- Not directly visualized
- The location of the CN.a and CN.b segments is deduced with respect to known anatomic landmarks
- Imaged with standard head MRI (and/or DTI)
Acute onset right superior oblique palsy

Photo: L. Gregg, Finger: A. Blitz

Imaging Cisternal (c) and Dural Cave (d) Segments
- Surrounded by cerebral spinal fluid (CSF)
- Well visualized on thin section T2 weighted images
- 3D SSFP or T2 SPACE

High Resolution Imaging Informs Our Knowledge in Other Cases CN III.c

Example of Enhancement on CISS CN III.c-e Pathology
The Relationship of CN to Adjacent Structures on CISS

CN II.c Pathology

Imaging the Interdural (e) Segment
- Between inner (meningeal) and outer (periostial) layers of dura
- Surrounded by venous blood
- Not well visualized on traditional T2-weighted images
- Use contrast enhanced images
- Contrast enhanced SSFP images are

Cavernous sinus
- CN III.e
- CN IV.e
- CN VI.e
- CN V.1.e
- CN V.2.e

Following CN VI.c through CN VI.e

Utility for Surgical Planning

CN VI.c-e
Visualization beyond the Subarachnoid Space

CN VI.e

Blitz et al.

Trigeminal neuralgia
(Outside films submitted by referring physician)

T1 (VIBE) CISS
T1 fs + GAD

CN V.2.e Pathology Perineural spread of adenoid cystic carcinoma producing trigeminal neuralgia

Imaging the Foraminal(f) Segment
- Surrounded by venous blood and bone
- Not well visualized on traditional T2-weighted images
- Again, use contrast enhanced images
- Contrast enhanced SSFP images are ideal

CN III.f

History of Optic Neuritis

IMPRESSSION: ...compatible with optic neuritis...
Distinguishing Between Intrinsic and Extrinsic Abnormalities

Meningioma

Imaging the Extra-foraminal(g) Segment

• Surrounded by muscle, fat, etc...

CN III.g

Axial (A) and coronal (B) and (C) precontrast CISS images obtained with surface coil and 0.4 mm isotropic resolution.

Note individual nerve fibers of the CN III inferior division inserting at the junction of the posterior third and the anterior two thirds of the medial rectus muscle.

Clarification of Origin of Mass CN III.g
Key Points

- We divide the cranial nerves into segments based on their environment and each segment has different imaging strategies.
- Imaging technique varies by segment.
- Balanced SSFP/CISS is the heart of this approach, due to high spatial resolution and SNR, CSF flow suppression, and mixed T2/T1 weighting.
- Our high resolution 3D skull base protocol with contrast allows for visualization of each CN segment and skull base layers.
- The exam can be tailored by the technologist and takes ~25 minutes.
- Direct visualization of CNs.
- May detect abnormalities not seen on standard imaging.
- Relationship of mass to CN may aid in DDX.

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Further reading/ citations


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