A Brachial Plexus Contouring Guide

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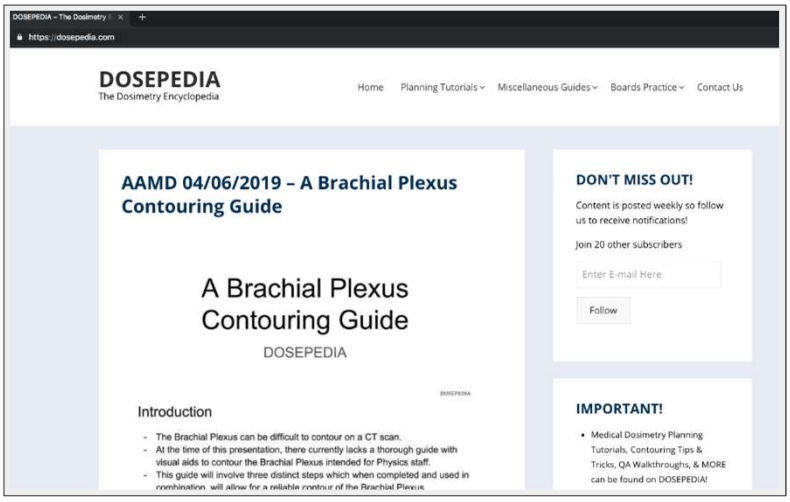
1

Introduction



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Introduction Cont.

- The Brachial Plexus can be difficult to contour on a CT scan.
- At the time of this presentation, there currently lacks a thorough guide with visual aids to contour the Brachial Plexus intended for Physics staff.
- This guide will involve three distinct steps which when completed and used in combination, will allow for a reliable contour of the Brachial Plexus.
    1. Contouring the Anterior and Middle Scalene Muscles.
    2. Using the Timmerman Technique.
    3. Following RTOG's 'Brachial Plexus Contouring Atlas'.
- However, if you can see it on the CT, then contour it!
- Slice-by-slice contouring can be found at the end of the presentation.

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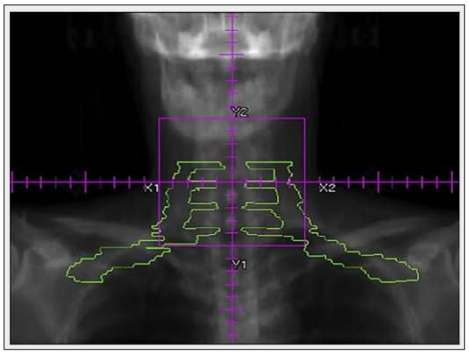
Brachial Plexus Contour Overview

- The plexus extends from the spinal cord and is comprised of nerves: C5, C6, C7, C8, & T1.
- On the frontal view, the nerves appear to extend from in between the vertebral bodies (VB):
    - VBC4 - C5 - VBC5
    - VBC5 - C6 - VBC6
    - VBC6 - C7 - VBC7
    - VBC7 - C8 - VBT1
    - VBT1 - T1 - VBT2
- RTOG's 'Brachial Plexus Contouring Atlas': 4 nerves.



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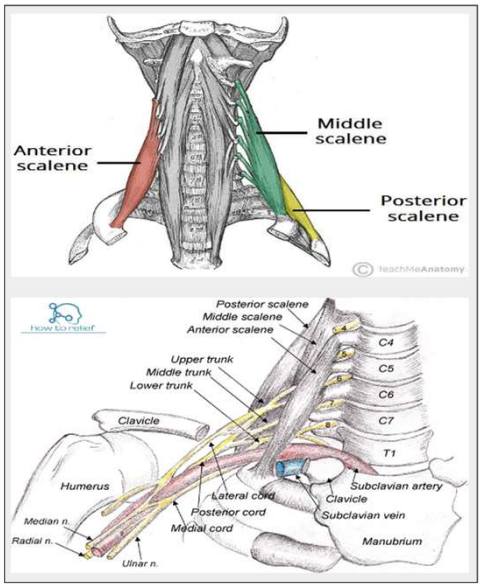
Step 1: Contouring the Scalene Muscles

- Anterior scalene muscle (ASM):
  - Inserts into the scalene tubercle of the first rib.
  - Arises from the anterior tubercles of the transverse processes of C3 to C6.
- Middle scalene muscle (MSM):
  - Inserts into the upper surface of the first rib.
  - Arises from the posterior tubercles of the transverse processes of C2 to C7
- Use the frontal view to contour.
  - Reference the axial view to tweak contours.



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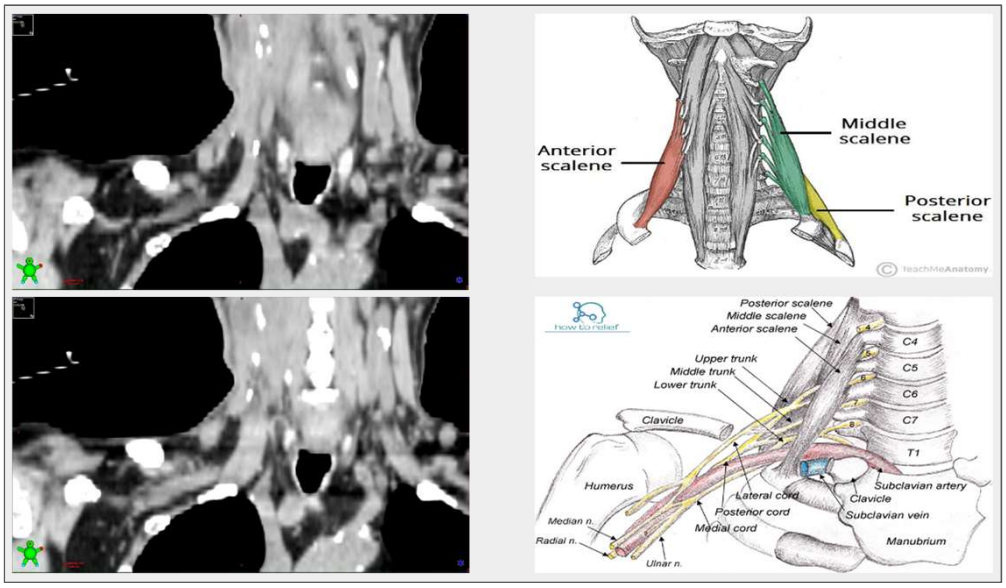
Step 1: Anterior Scalene Muscle



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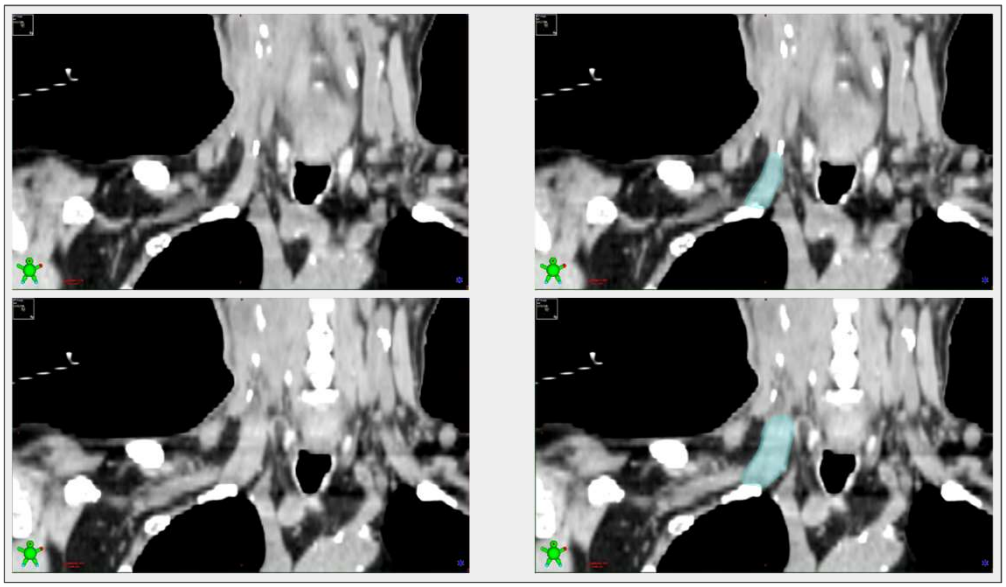
Step 1: Anterior Scalene Muscle Cont.



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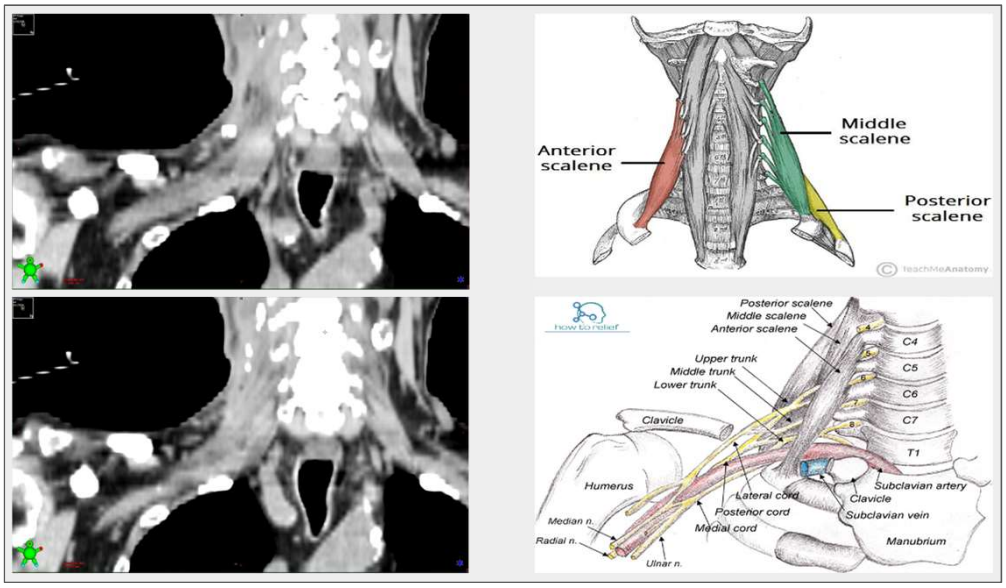
Step 1: Anterior Scalene Muscle Cont.



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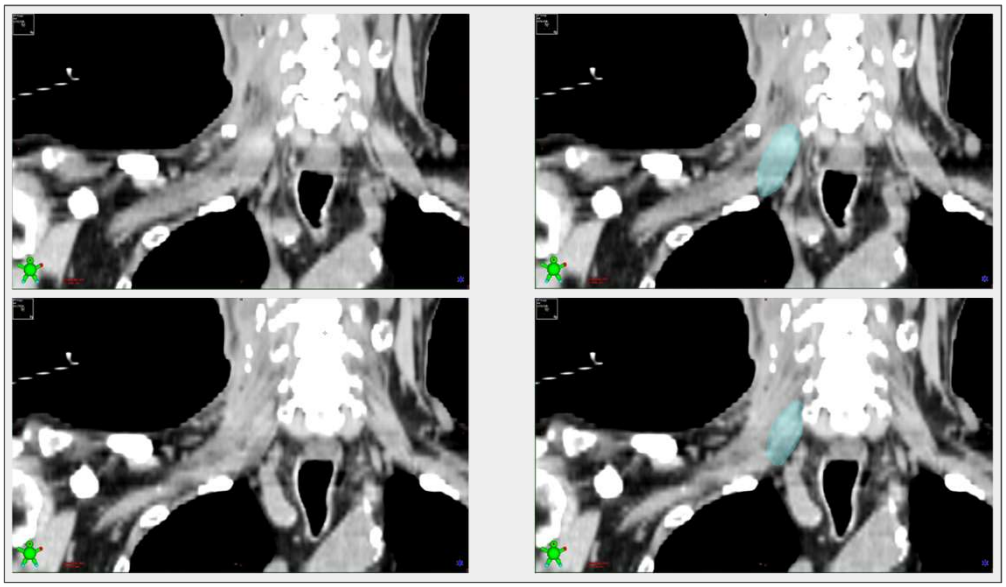
Step 1: Anterior Scalene Muscle Cont.



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Step 1: Anterior Scalene Muscle Cont.

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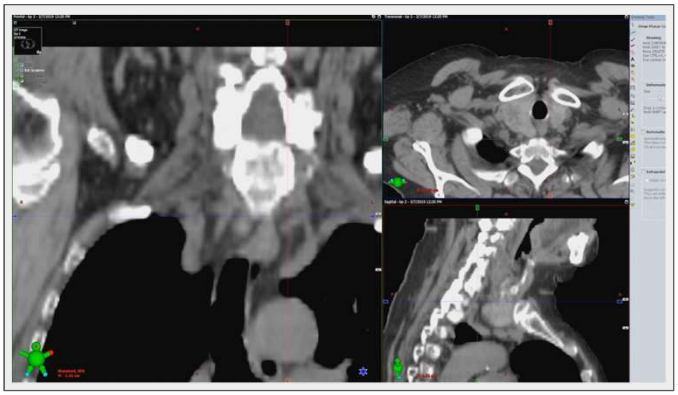
Step 1: Anterior Scalene Muscle Cont.



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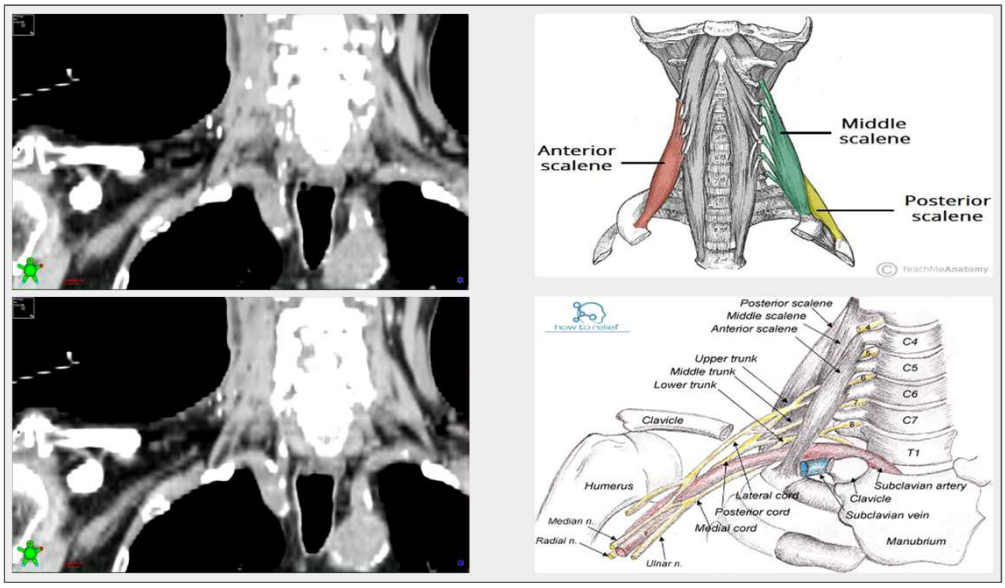
Step 1: Middle Scalene Muscle



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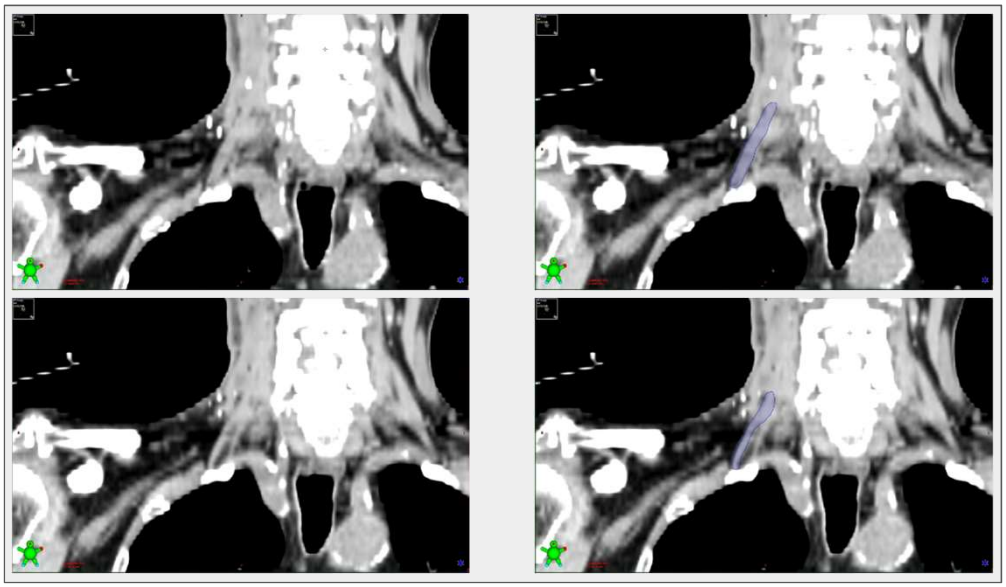
Step 1: Middle Scalene Muscle Cont.



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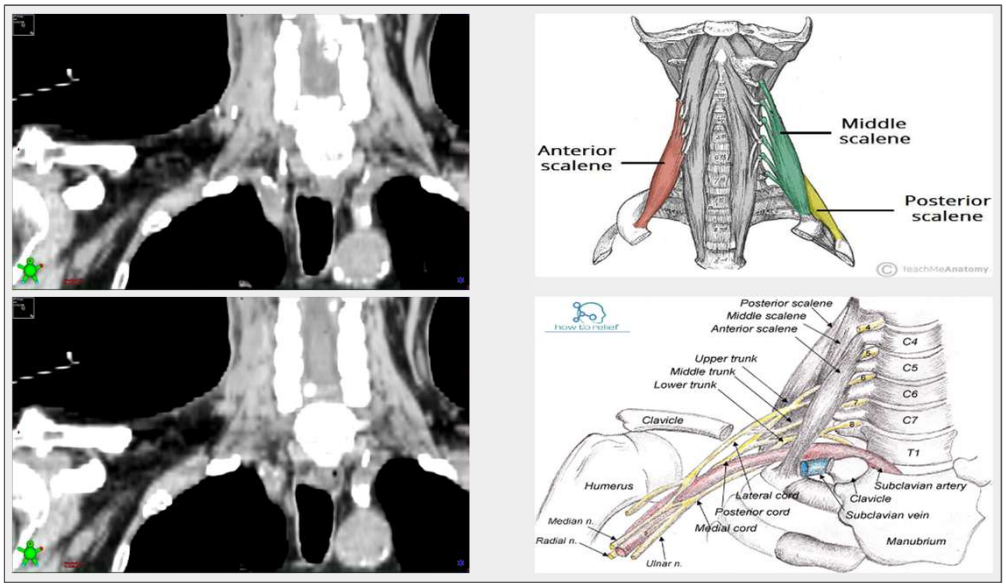
Step 1: Middle Scalene Muscle Cont.



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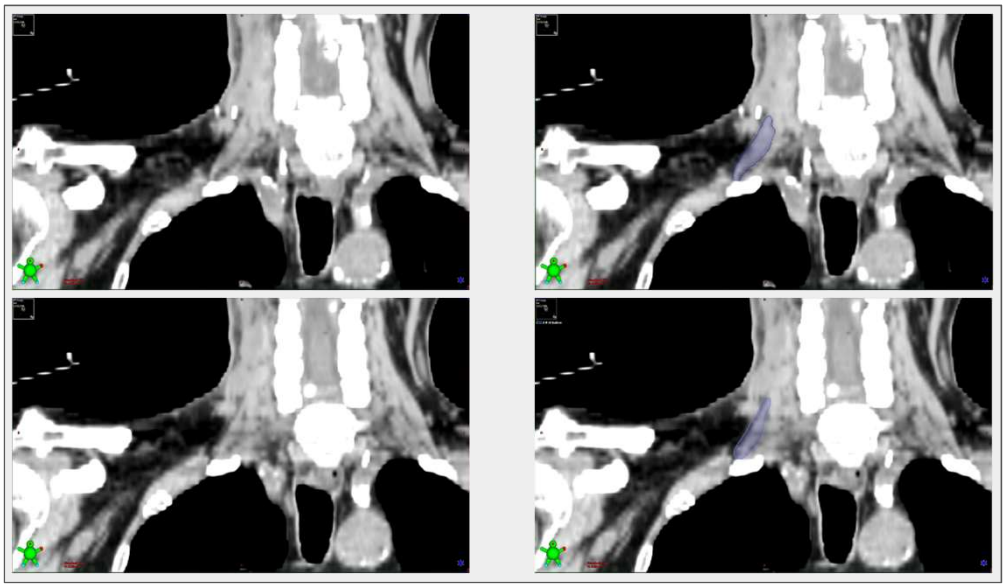
Step 1: Middle Scalene Muscle Cont.



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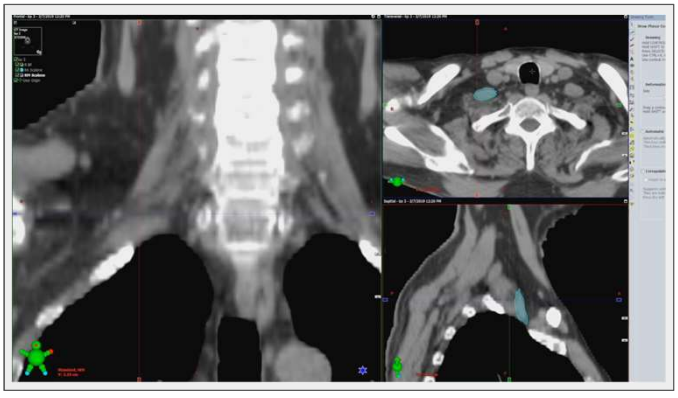
Step 1: Middle Scalene Muscle Cont.



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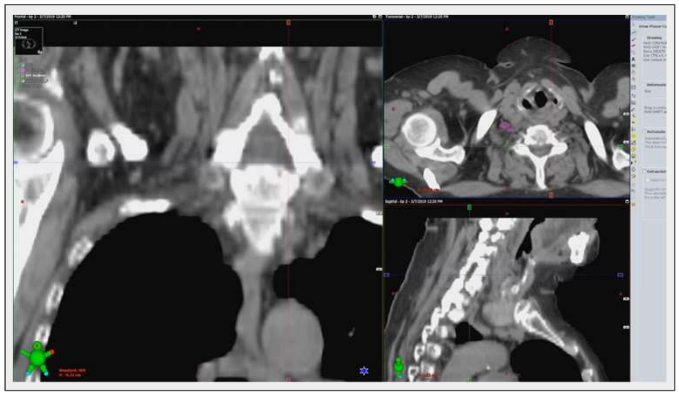
Step 1: Middle Scalene Muscle Cont.



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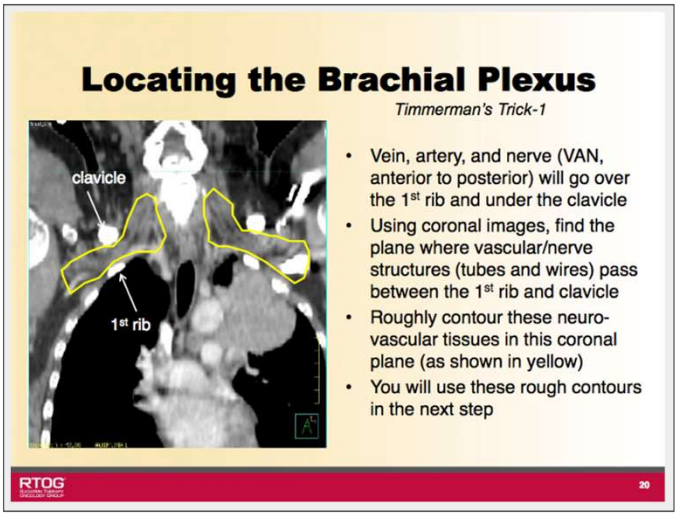
Step 2: Using the Timmerman Technique



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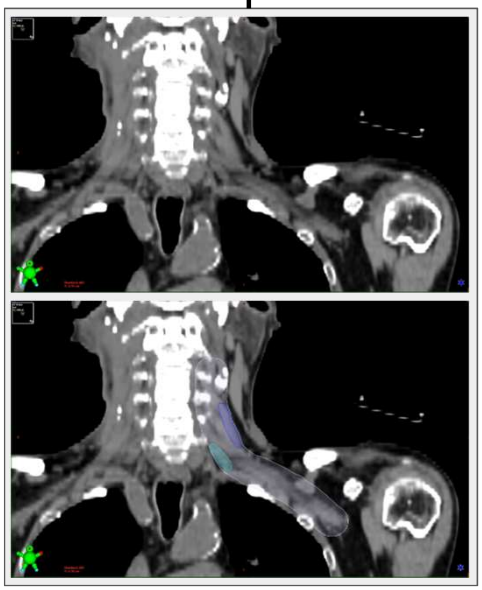
Step 2: Using the Timmerman Technique Cont.

- Approximates for the path of the nerve roots.
- Use the frontal view to contour.
  - Parallel to the vertebral column.
  - Along the arc of the chest wall.
- Using a static 3D-Brush, contour on the slice where both scalene muscles are present.
- Reference the axial view to verify that the contour is reasonable.



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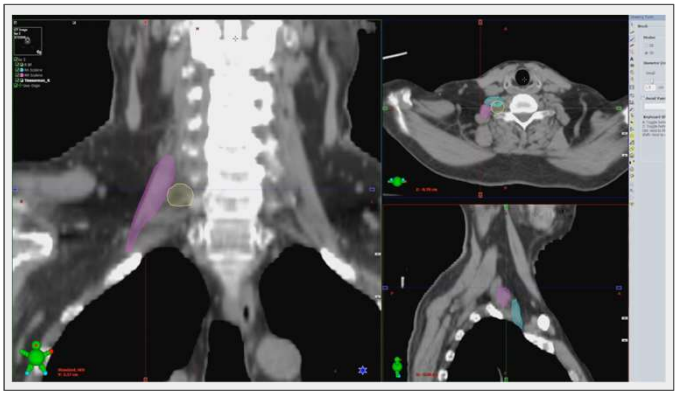
Step 2: Using the Timmerman Technique Cont.



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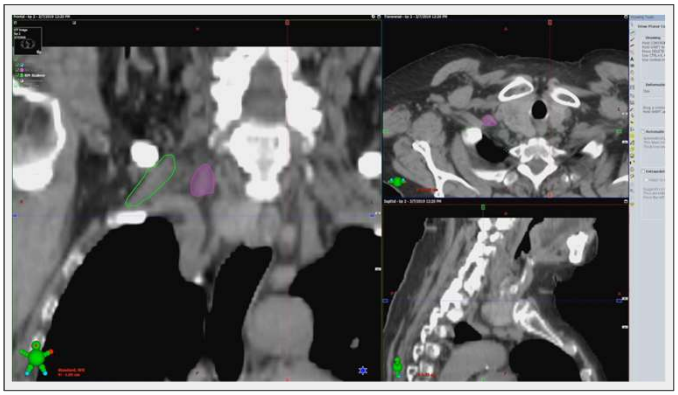
Step 2: Using the Timmerman Technique Cont.



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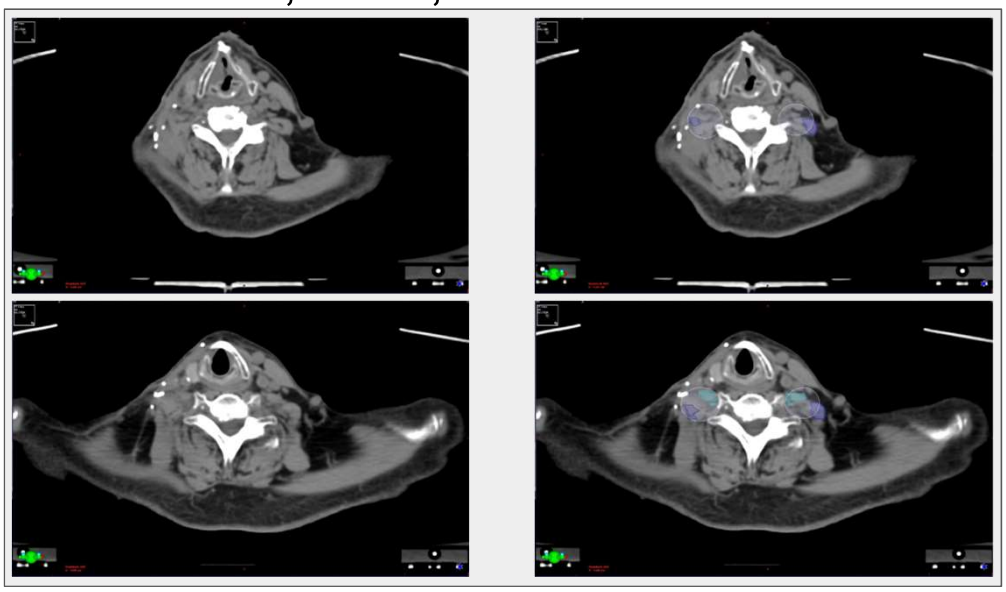
Step 1 & 2: ASM, MSM, & Timmerman Tech.



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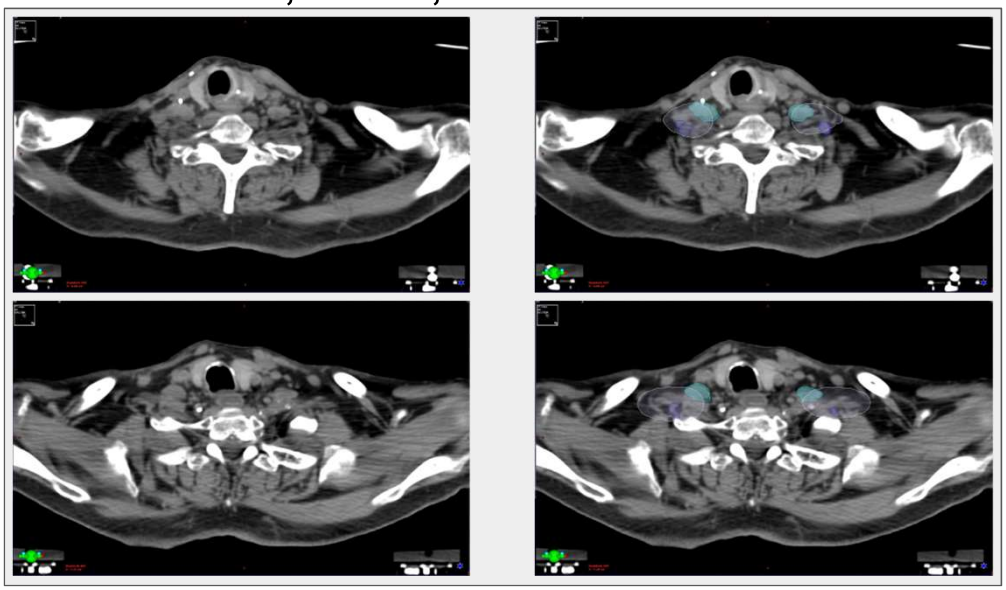
Step 1 & 2: ASM, MSM, & Timmerman Tech. Cont.



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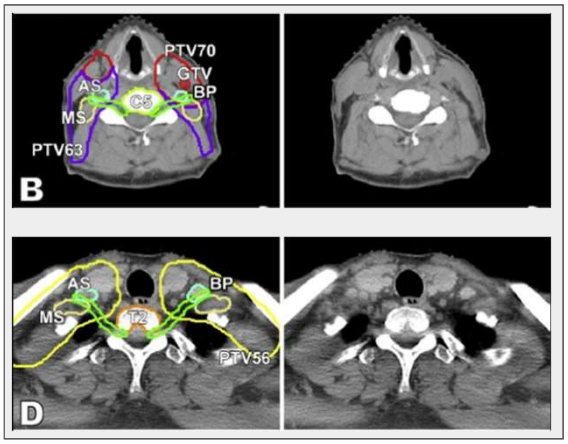
Step 3: Contouring via RTOG Guidelines

"...

- Identify and contour C5, T1, and T2.
- Identify and contour the subclavian and axillary neurovascular bundle.
- Identify and contour anterior and middle scalene muscles from C5 to insertion onto the first rib.
- To contour the brachial plexus OAR use a 5-mm diameter paint tool.
- Start at the neural foramina from C5 to T1; this (BP) should extend from the lateral aspect of the spinal canal to the small space between the anterior and middle scalene muscles.



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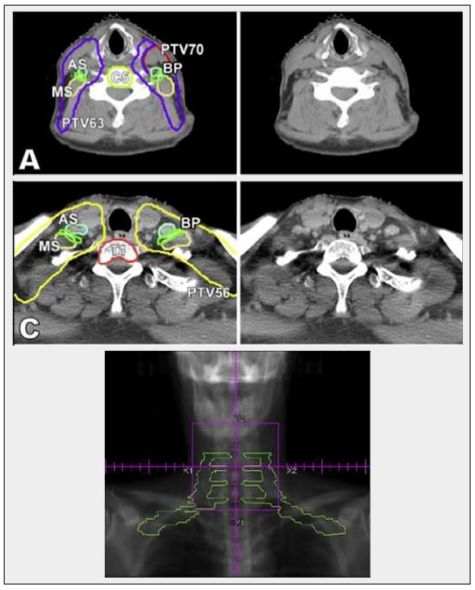
Step 3: Contouring via RTOG Guidelines Cont.

- For CT slices, where no neural foramen is present, contour only the space between the anterior and middle scalene muscles.
- Continue to contour the space between the anterior and middle scalene muscles; eventually the middle scalene will end in the region of the subclavian neurovascular bundle.
- Contour the brachial plexus as the posterior aspect of the neurovascular bundle inferiorly and laterally to one to two CT slices below the clavicular head.
- The first and second ribs serve as the medial limit of the OAR contour.

…"



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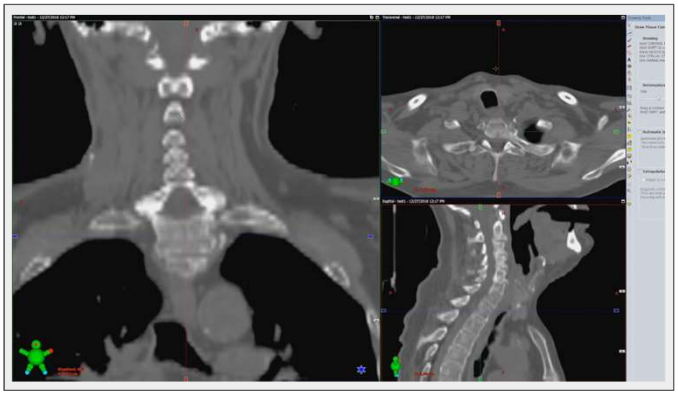
Step 3: Contouring via RTOG Guidelines

"…

- Identify and contour C5, T1, and T2

…"



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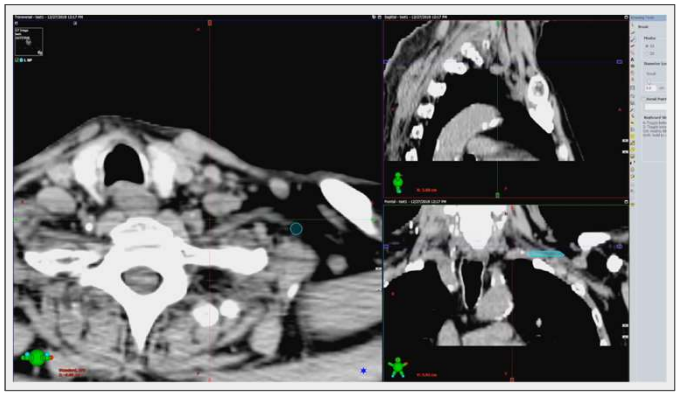
Step 3: Contouring via RTOG Guidelines Cont.

"…

- Start at the neural foramina, and extend from the spinal canal to the space between the ASM & MSM

…"



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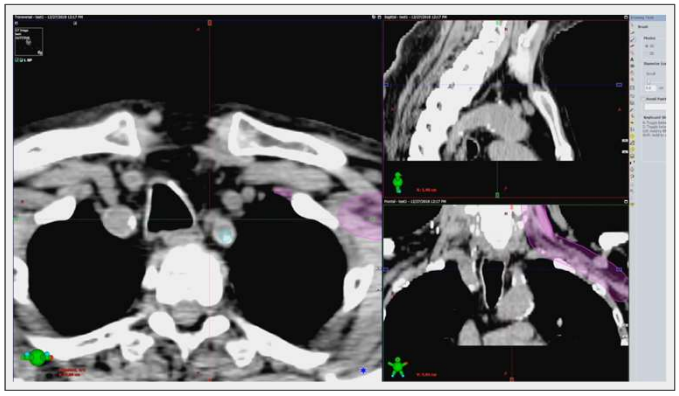
Step 3: Contouring via RTOG Guidelines Cont.

"…

- Where no neural foramen is present, contour only the space between the ASM & MSM

…"



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Eclipse Shortcut Keys, & Contouring Tips & Tricks

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Contouring Shortcut Keys

- Rotate through different plane views.
  - 'control' key & 'r'.

- 'control' key - pinky
- 'r' - index

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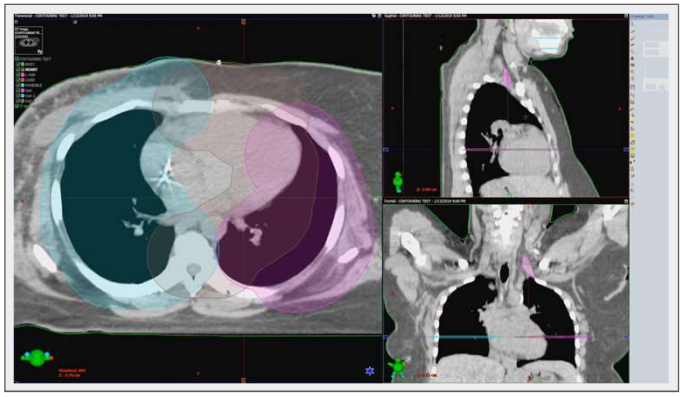
Contouring Shortcut Keys Cont.

- Hide all contours other than the highlighted structure.
  - Hold 'h'.



- 'h' - index

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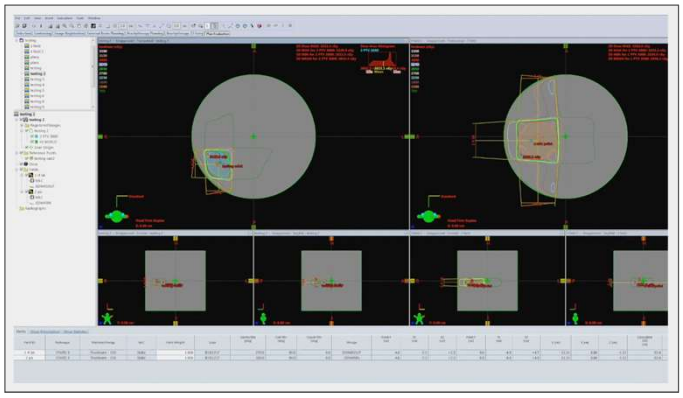
Contouring Shortcut Keys Cont.

- 'control' key + 'shift' key + '1/2/6/7'.
- Compare top right screens in External Beam Planning in Plan Evaluation (2).
- View a plan as if in External Beam Planning in Plan Evaluation (6).
- Present up to 6 plans and their respective DVHs simultaneously (7).



- 'control' key - pinky
- 'shift' key - ring

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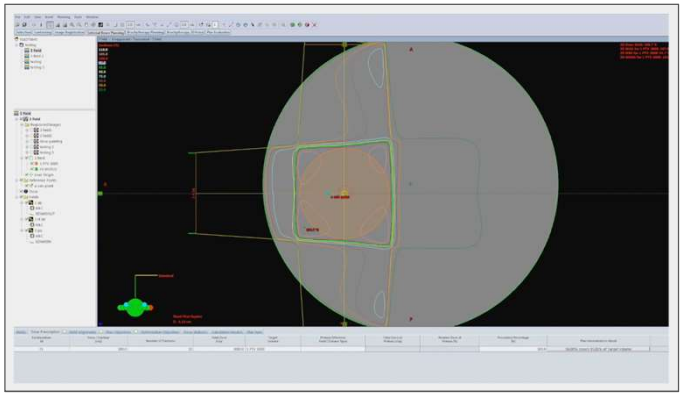
Contouring Shortcut Keys Cont.

- Reload all.
  - 'alt' key → 'f' → 'r'.

- 'alt' key - thumb
- 'f' - index
- 'r' - middle



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Contouring Shortcut Keys Cont.

- Scroll through CT while skipping slices.
  - Hold 'alt' key & Scroll 'mouse wheel'.

- 'alt' key - thumb
- 'scroll' - right middle

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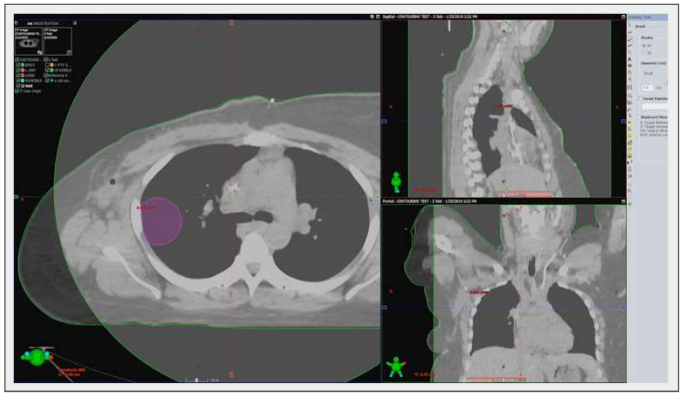
Contouring Shortcut Keys Cont.

- Following an image fusion, blend fusion to favor the CT or fused image without the slider.
  - Hold 'control' key & 'a'.
  - The image blend must be initially set to a percentage other than 50%, and doing so will change the current blend to the complement of the initial blend percentage.



- 'control' key - pinky
- 'a' - ring or middle

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Contouring Shortcut Keys Cont.

- Create a new structure.
  - Display the screen to create a new structure.
    - 'alt' key → 's' → 'enter' key.
  - Fill in structure information.
    - 'down' key → 'tab' key → Type Structure Name → 'enter' key.

- 'alt' key - thumb
- 's' - ring
- 'down' key - pinky
- 'tab' key - right ring or pinky

- Display window level.
  - 'alt' key → 'v' →'enter' key.

- 'alt' key - thumb
- 'v' - index
- 'enter' key - right thumb

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Contouring Shortcut Keys Cont.

- Change window level without the slider by using only the mouse cursor.
  - Select Mouse Cursor Tool → Hold 'shift' key & Move Mouse Cursor.
    - Left/Right: Tighten/widen contrast boundaries.
    - Up/Down: Translate contrast boundaries.
    - Diagonal: Combination.

  - 'shift' key - pinky or ring

- Auto window level adjustment, and useful as a contrast reset.
  - 'alt' key → 'v' →'a'.

    - 'alt' key - thumb
    - 'v' - index
    - 'a' - pinky

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Contouring Shortcut Keys Cont.

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Adaptive Brush Contouring

- This method involves manipulating the window level to better define the boundaries of the structure relative to its surroundings.
- Use Post Processing to smoothen and fill in cavities.
- The following shortcut keys may be helpful in reducing contouring time.
  - '2' to toggle between 2D/3D-brush.
  - 'a' to toggle between static/adaptive brush.
  - Hold the 'shift' key to use brush as an eraser.
  - Press down on the 'mouse wheel' & move the mouse to the left/right to decrease/increase brush diameter.
- Copy and Paste a contour on a slice by switching to a pencil tool.
  - Select Pencil Tool → 'control' key + 'c' → 'control' key + 'v'.
- Delete contour on current plane.
  - Select Pencil Tool → 'delete' key.
- Switch between mouse cursor, pencil, brush, and eraser tool.
  - Highlight Structure → 'right click' on desired tool.

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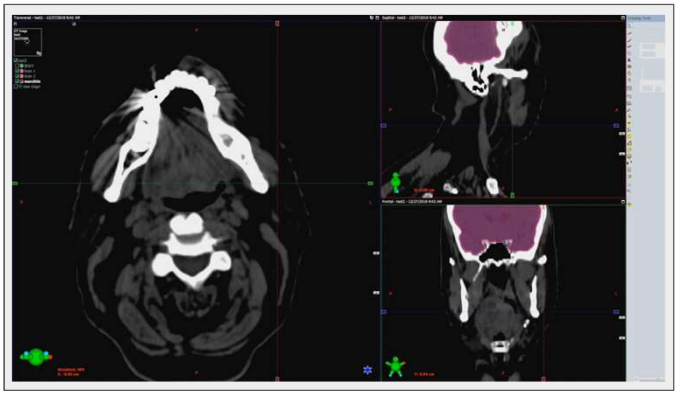
Adaptive Brush Contouring Cont.



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Adaptive Brush Contouring Cont.

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Brachial Plexus
Axial Slice-by-Slice

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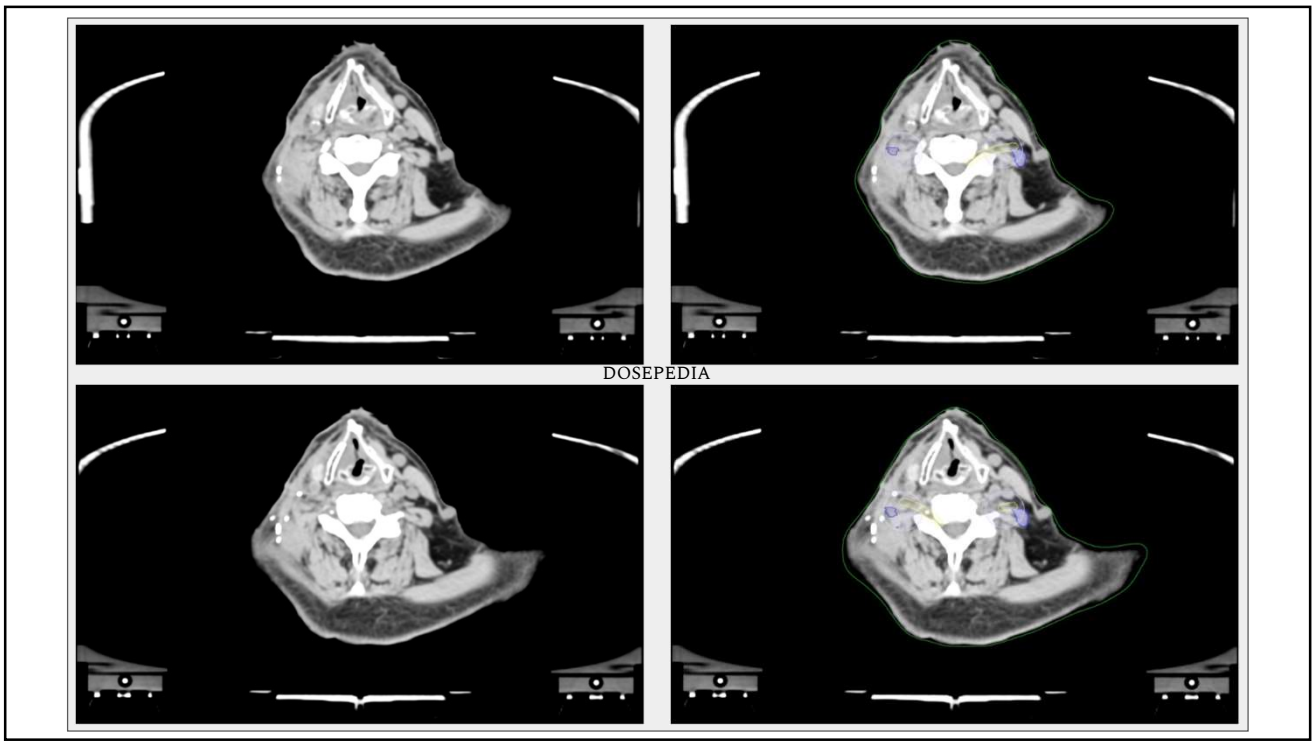

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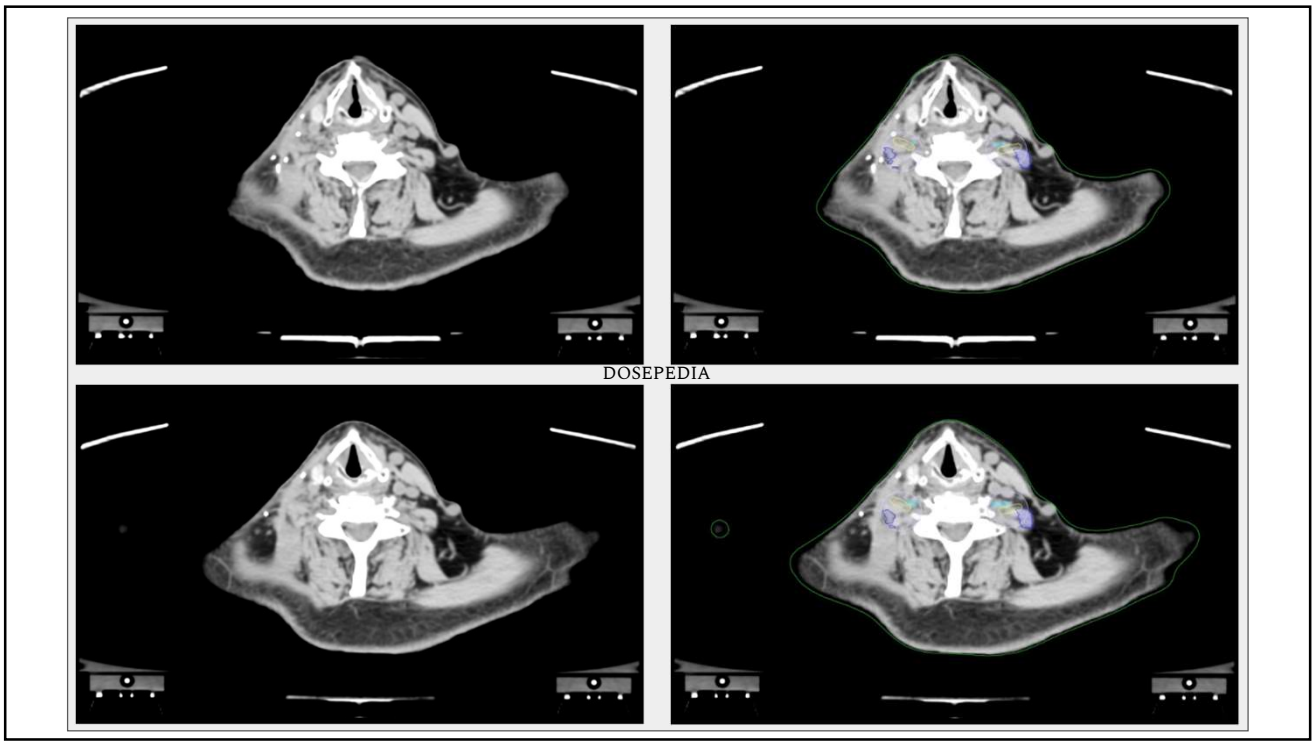

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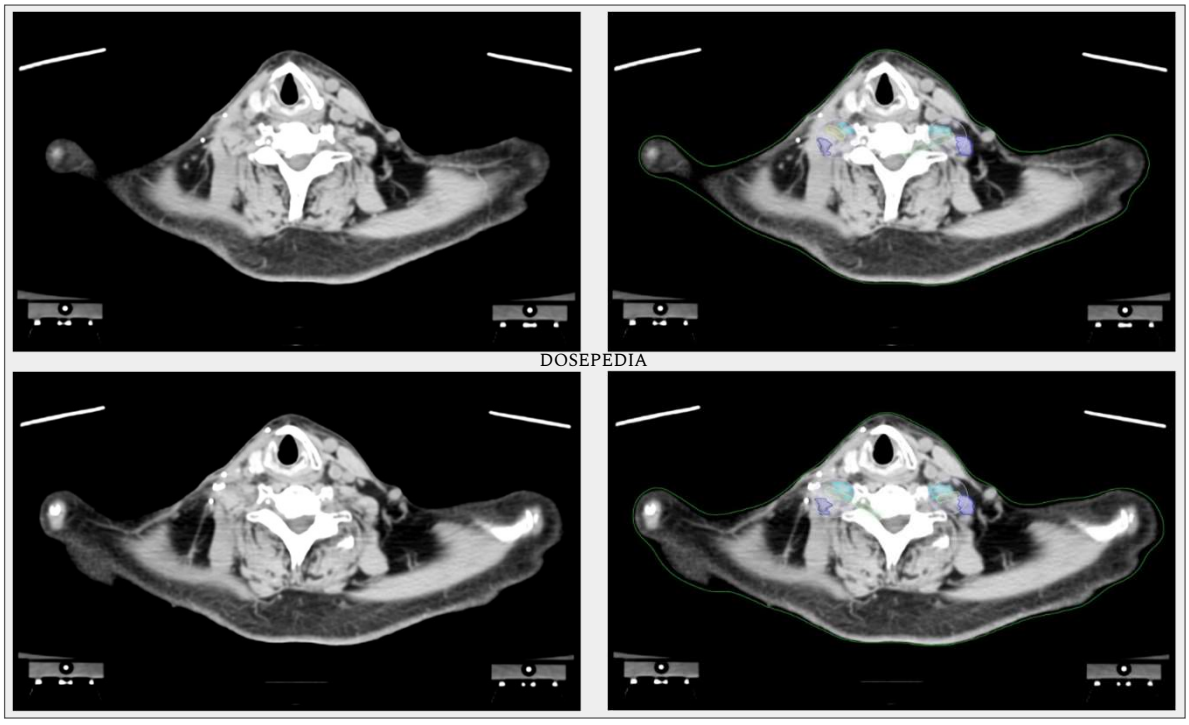

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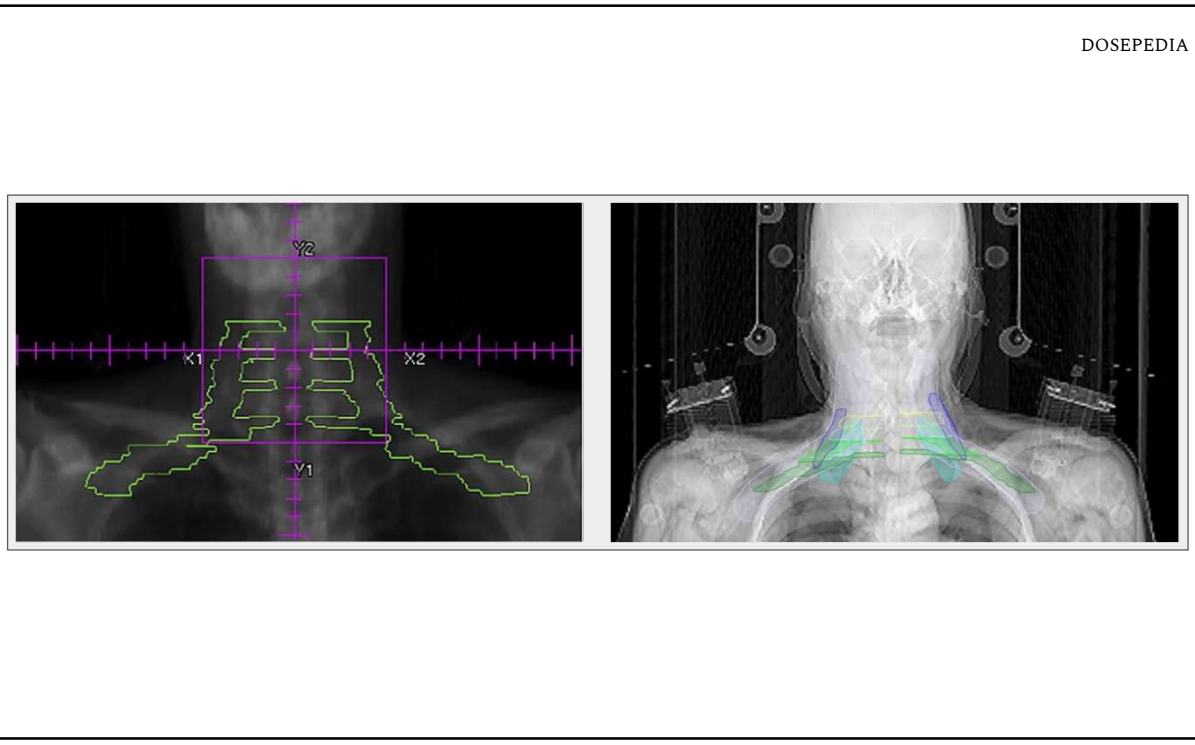

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ASM & MSM
Axial Slice-by-Slice

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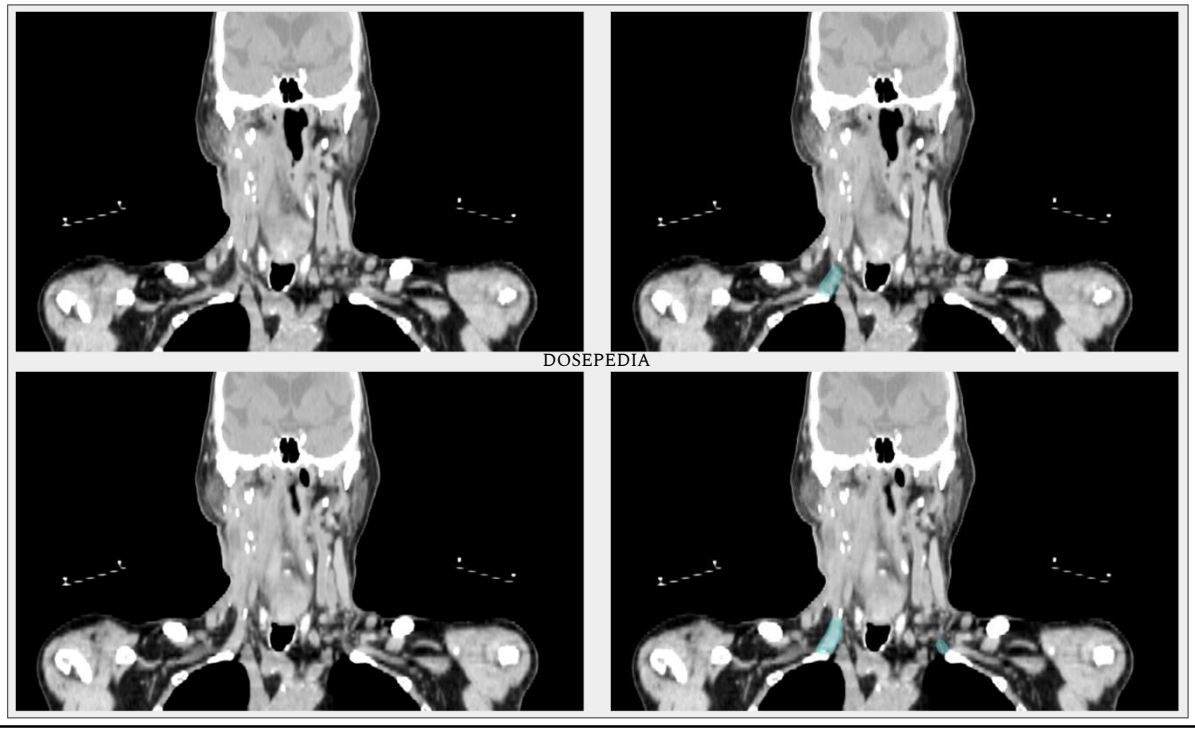

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Thank You

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