Artificial Intelligence (AI) Potential to Shorten Learning Time with Computed Tomography (CT) Images for Head and Neck Organs at Risk (OAR)

Michael C. Larkins

Collaborative Team Members

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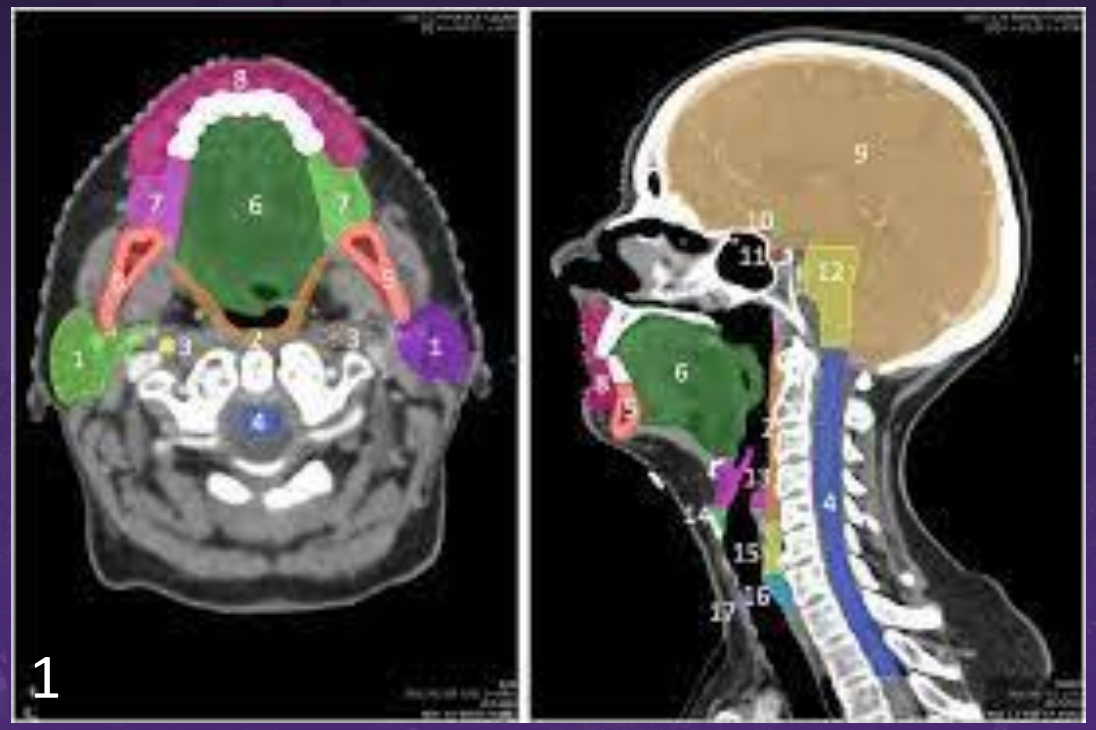
- David B. Meyer, BS, ECU BSOM, CT Contouring Specialist
- Brandon H. Karimian, BS, ECU BSOM, CT Contouring Specialist
- Robert Corns, PhD, ECU BSOM Radiation Oncology Dept., Data Analyst and AI Coordinator
- Andrew W. Ju, MD, ECU BSOM Radiation Oncology Dept., Faculty Investigator

Rationale/Need

Contouring computed tomography (CT) images is the process of denoting the boundaries of an organ/structure in 3D space. This allows structures to be targeted or avoided during radiotherapy planning.



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Rationale/Need

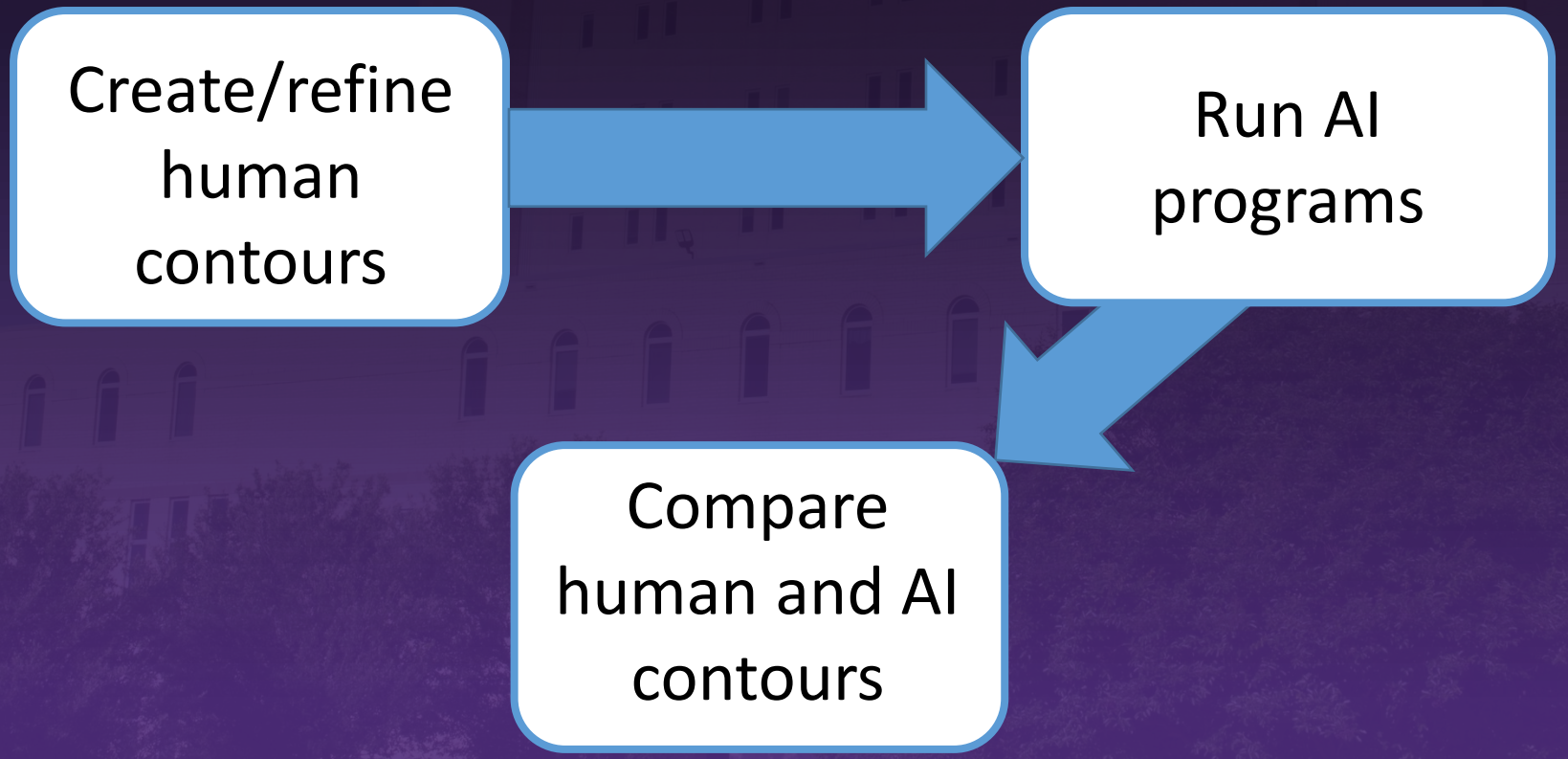
Traditionally contouring is done by manually highlighting structures (e.g. Organs at Risk, or OAR). This is a time and labor-intensive process, requiring strong anatomical knowledge.[1]

Can commercially available artificial intelligence (AI) programs supplement the education of those learning to contour?


A

Methods/Description

AI Contouring Workflow

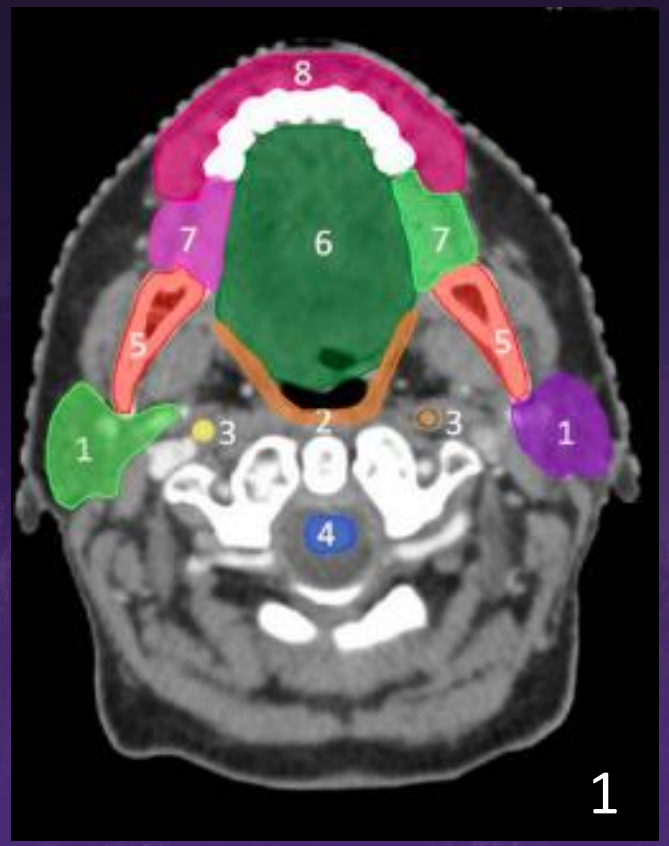


Methods/Description

- Five OAR were contoured manually across three patient CT sets.
- Contours were generated by a medical student and board-certified radiation oncologist team. These were considered the “Ground Truth,” or refence contours.
- New contours for the same five OAR were then generated using two different commercially available AI programs (dubbed V1 and V2).
- The human-made and AI-made contours were then compared using a metric called the Dice Similarity Coefficient (DSC).

Methods/Description

OAR Contoured (Examples)



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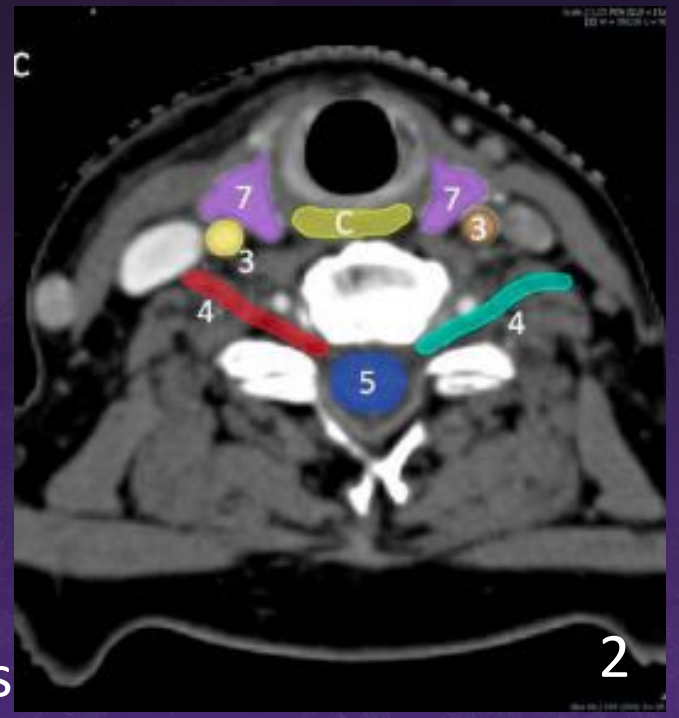
5 – Mandible
1 – Parotid Glands
4 – Spinal Cord
2 – Muscular Constrictors



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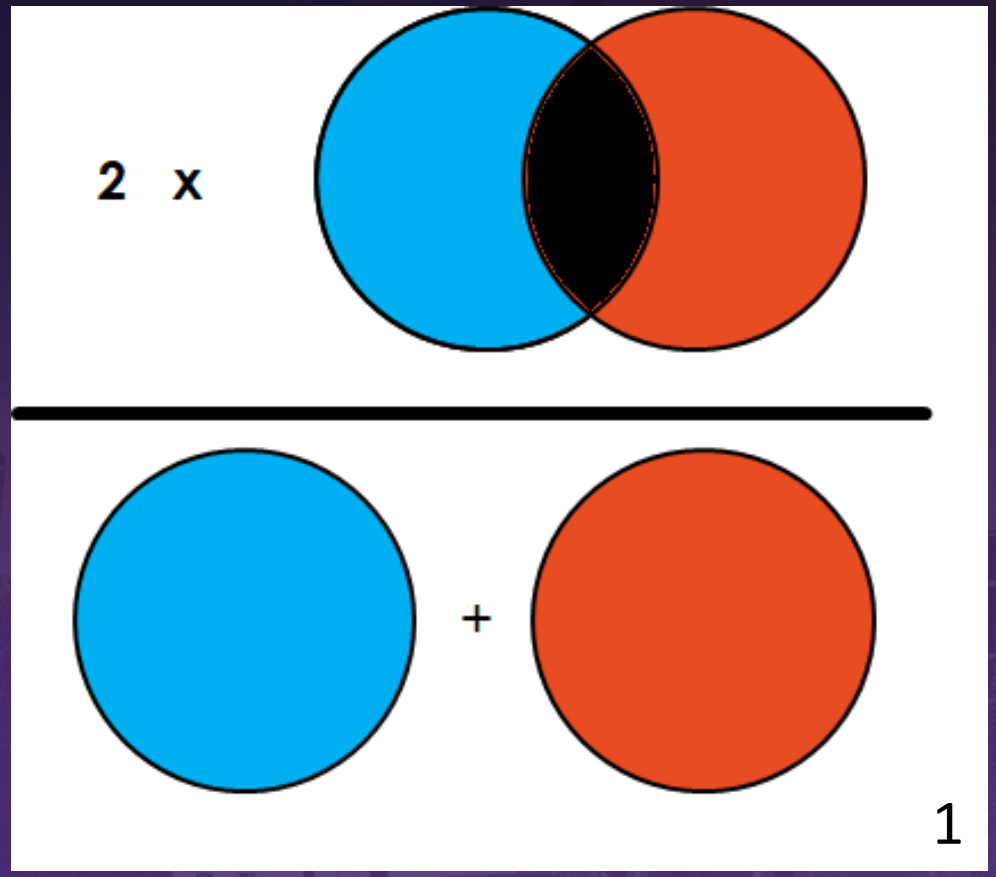
4 – Brachial Plexus

Methods/Description

Dice Similarity Coefficient (DSC)



Higher DSC α Better contour

Results

- DSC Results by OAR

Contour Type	OAR	Average DSC (%)
V1	Mandible	84.7
	Brachial Plexus	33.4
	Parotids	80.8
	Spinal Cord	74.3
V2	Mandible	83.8
	Brachial Plexus	25.5
	Parotids	80.8
	Spinal Cord	73.0

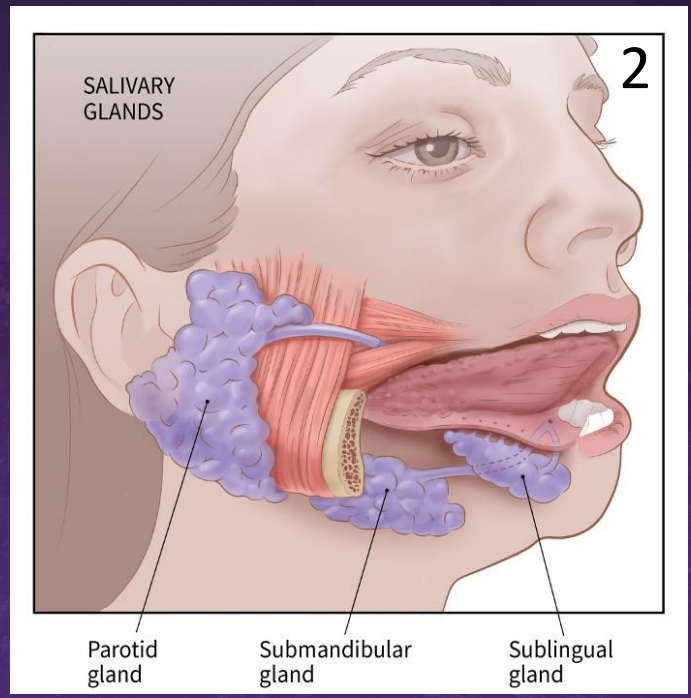
Note: Muscular Constrictors were only contoured in the V2 software package (average DSC = 58%)

Discussion

- Best OAR Contours:
  - Mandible (DSC = 83 to 85%)
  - Bilateral Parotid Glands (DSC = ~81%)
- Worst OAR Contours:
  - Bilateral Brachial Plexus (DSC = 25 to 33%)
- In general:

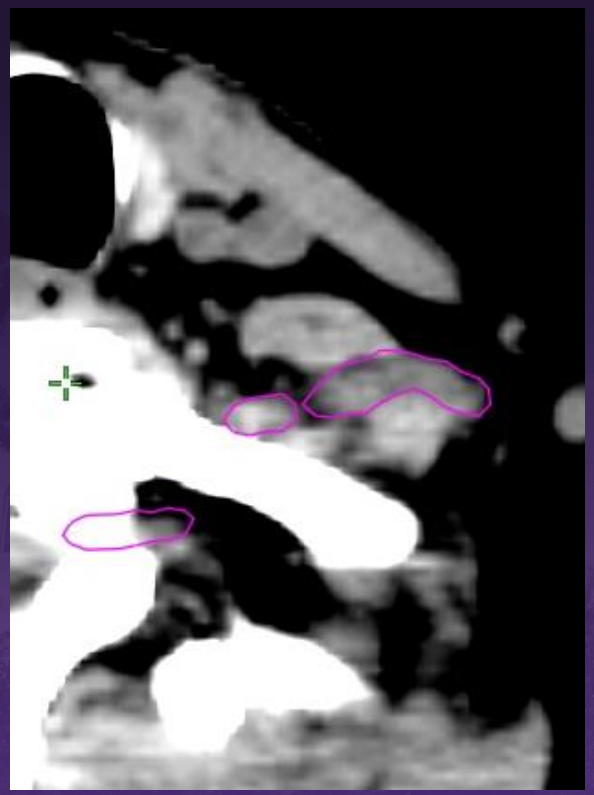
less complexity = better contour

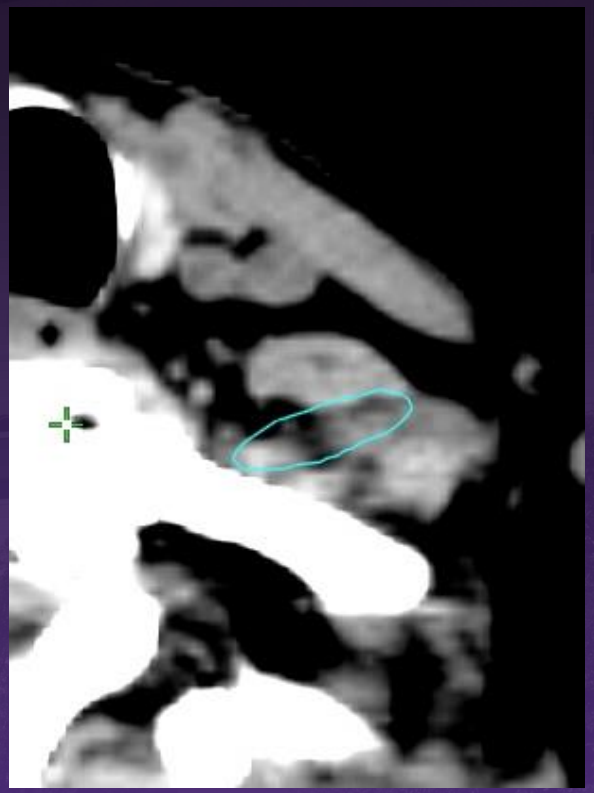

1

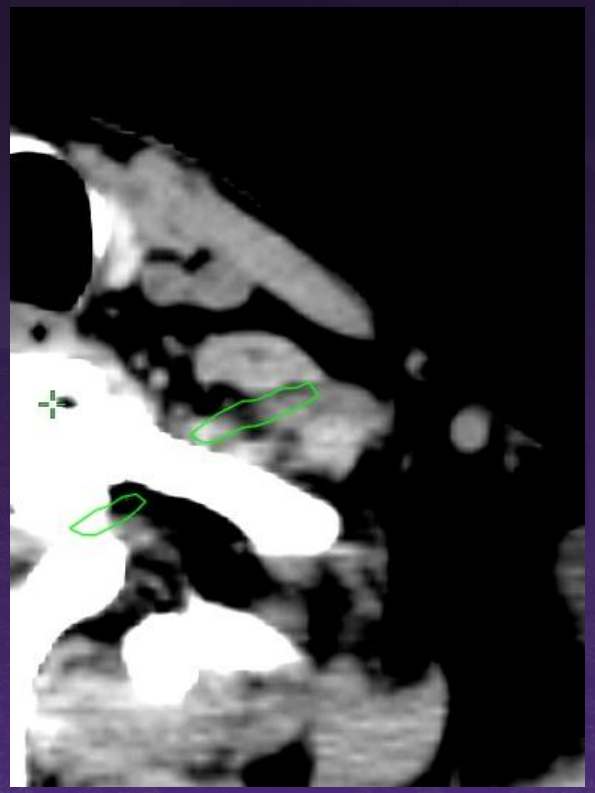


Discussion

Examples – Brachial Plexus (T1 Nerve)

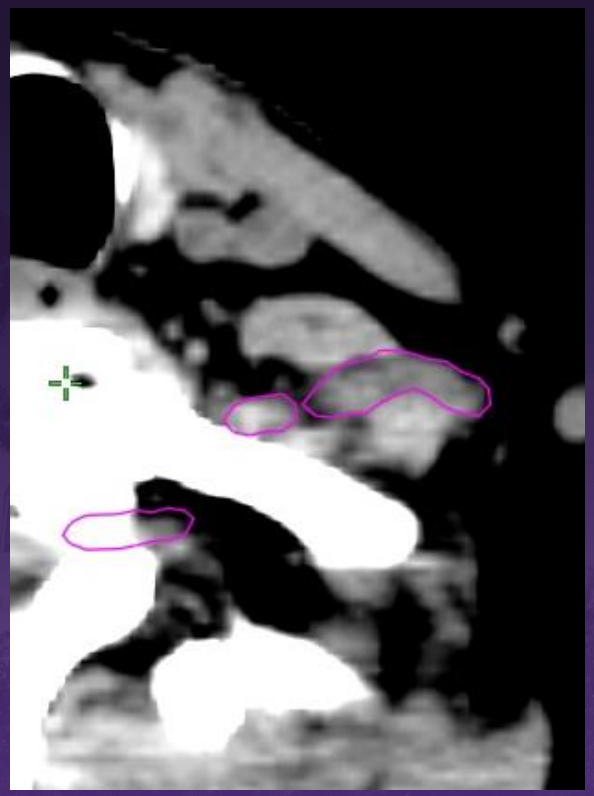




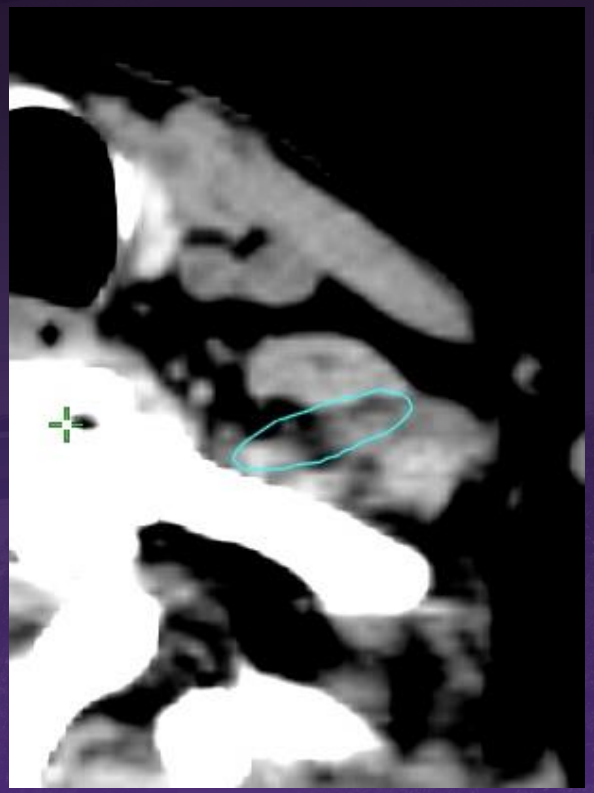


Discussion

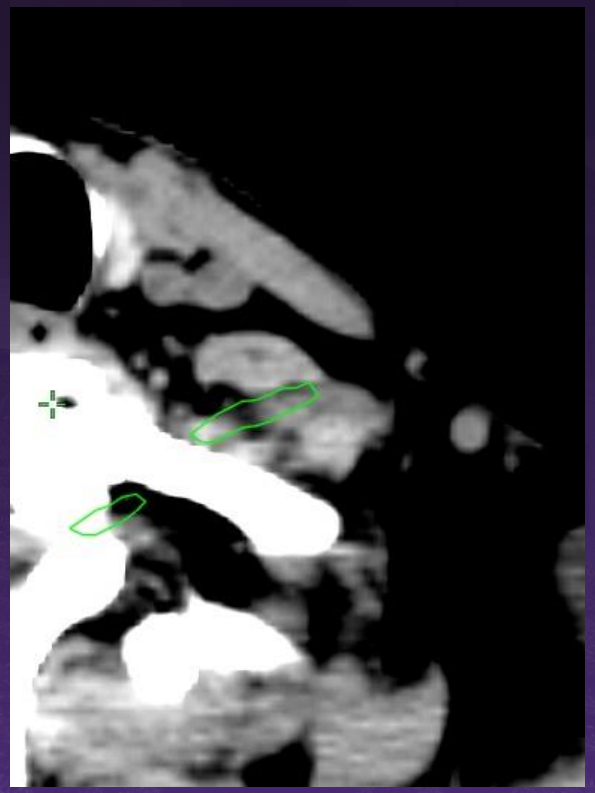
Examples – Brachial Plexus (T1 Nerve)



Human-made



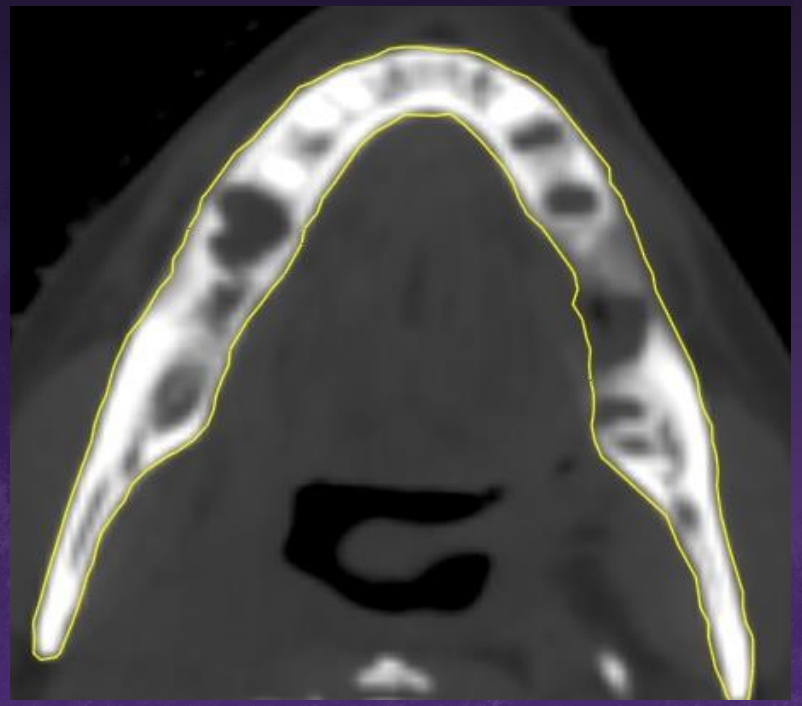
V1

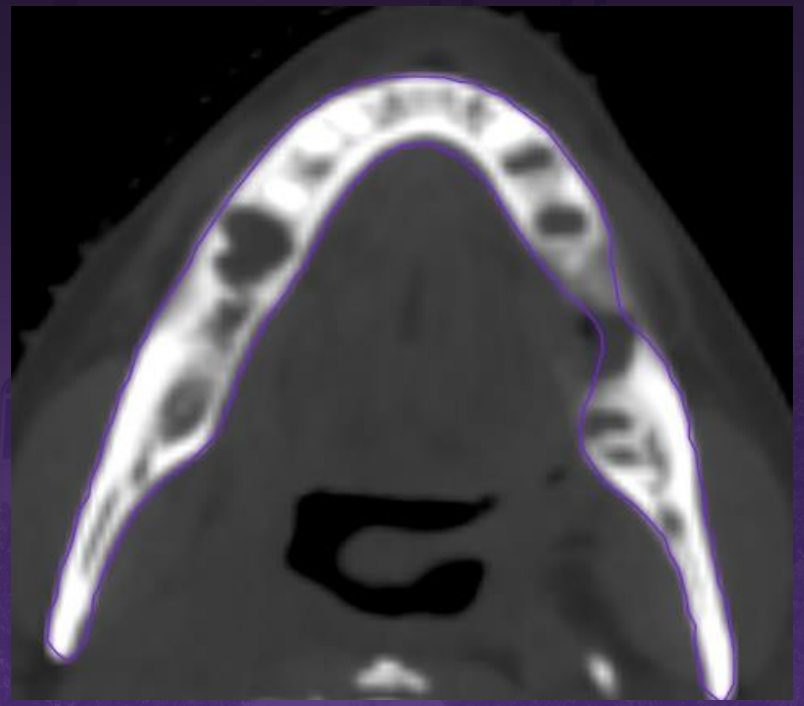


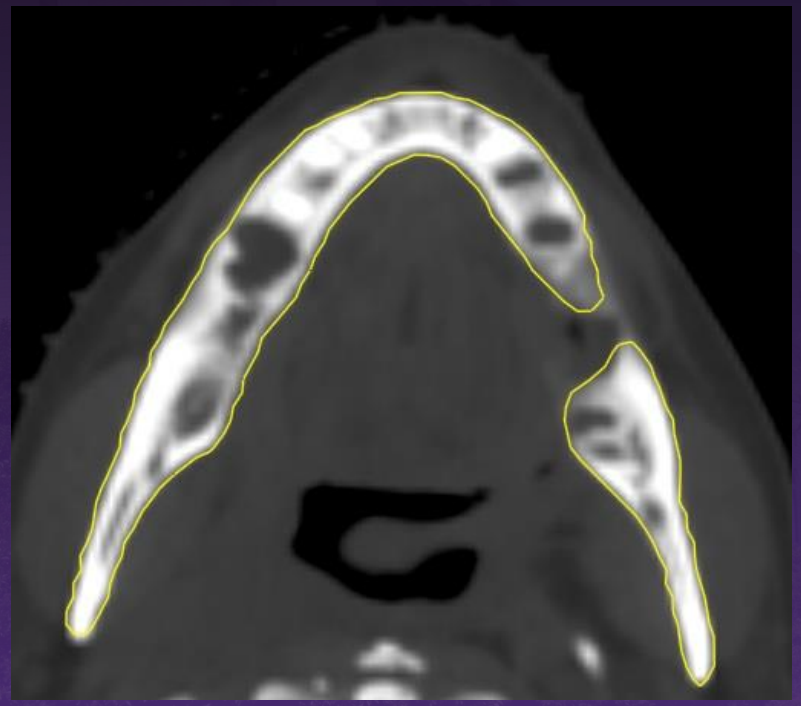
V2

Discussion

Examples – Mandible

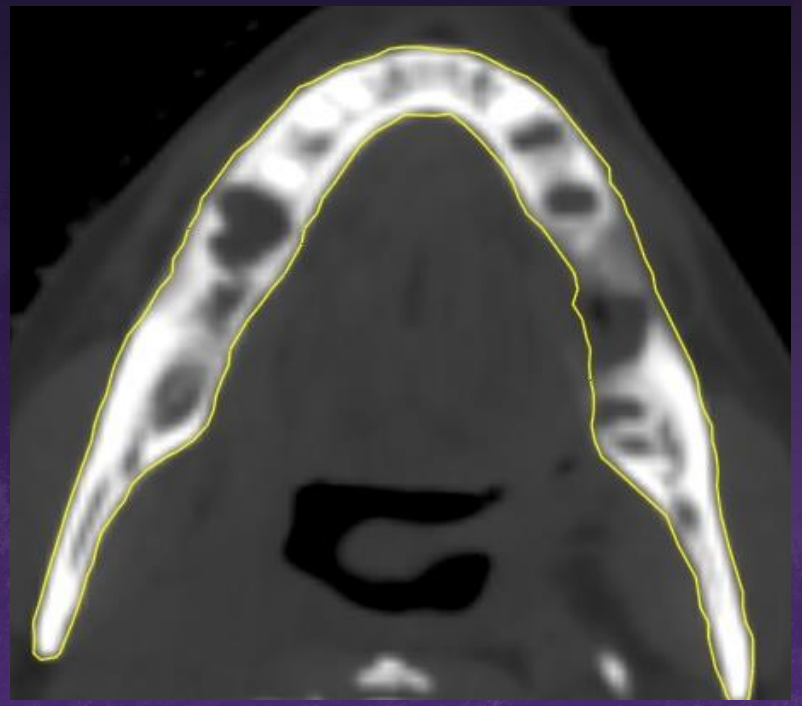




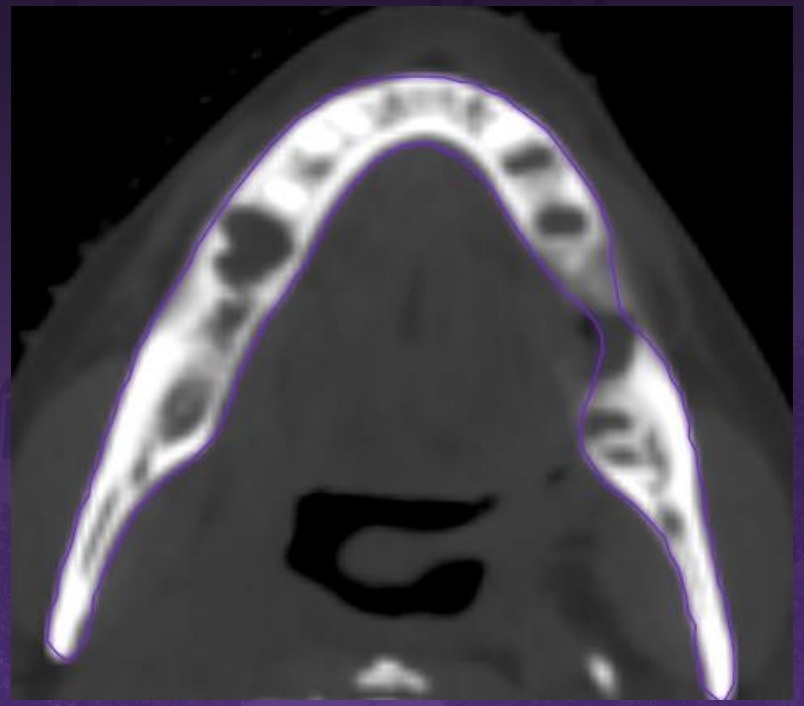


Discussion

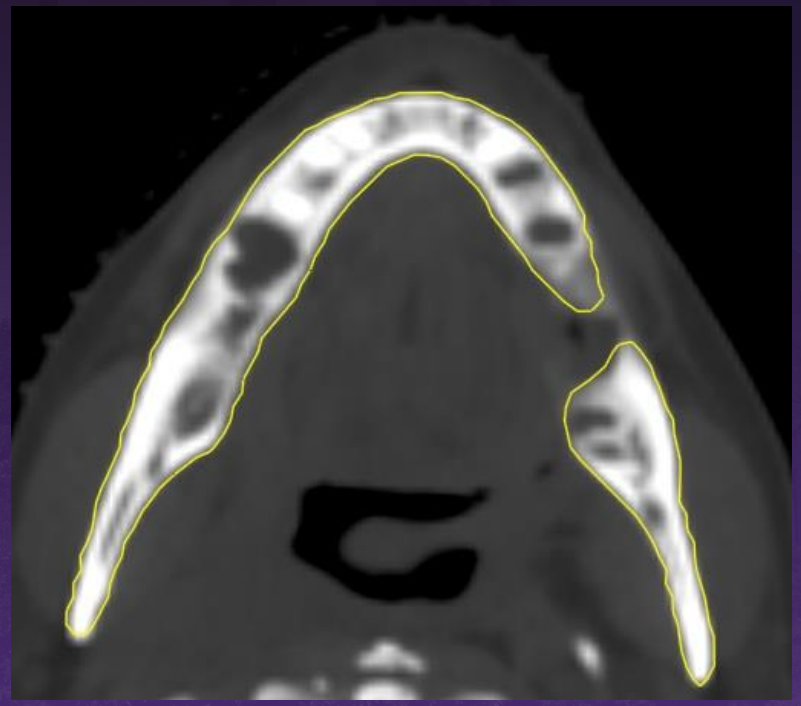
Examples – Mandible



Human-made



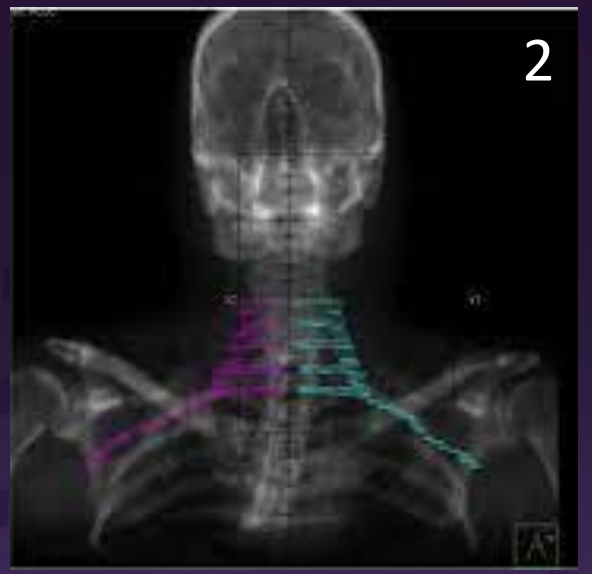
V1

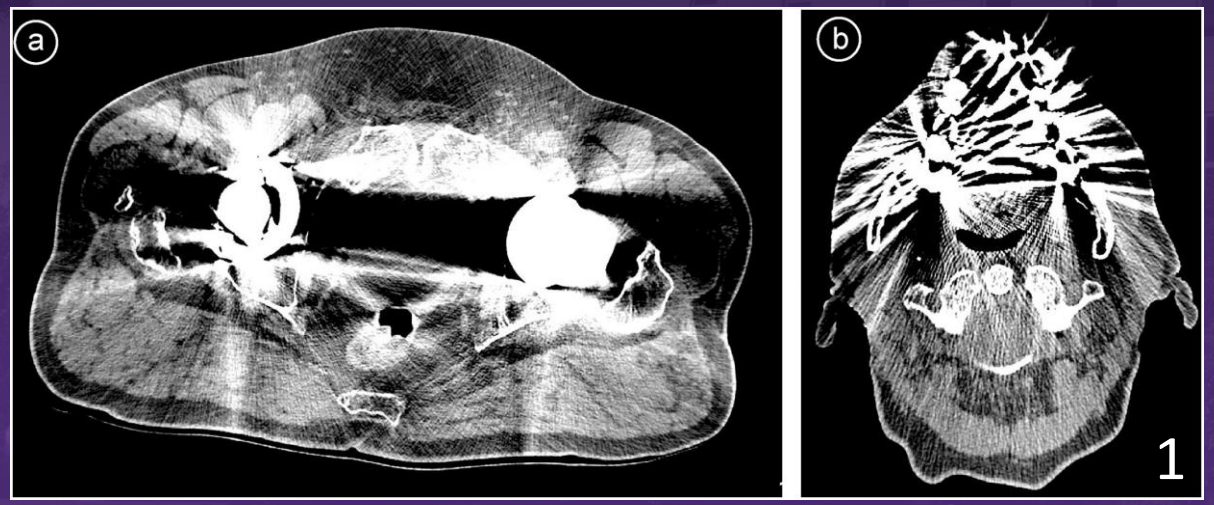


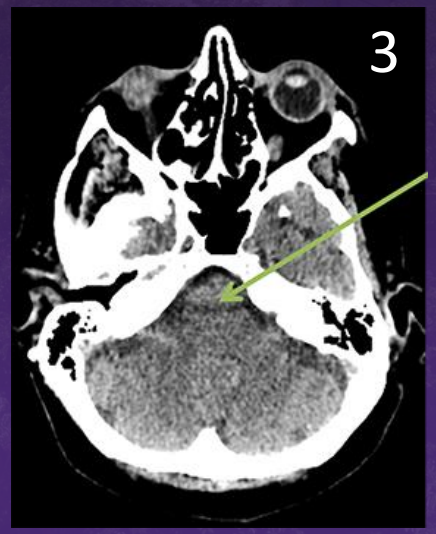
V2

Discussion

- Impact Factors on OAR Contours:
  - Complexity
  - Size
  - CT Quality
    - Artifacts
    - Slice Size

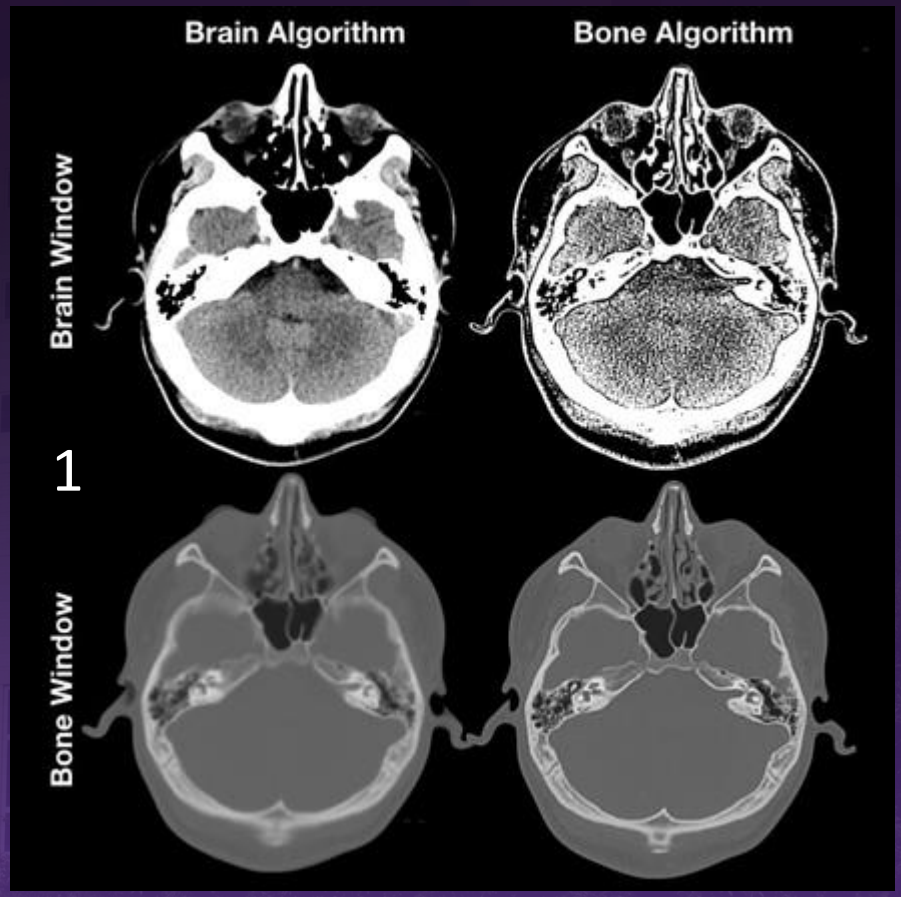






Discussion

- AI Advantages
  - Speed
  - Repeatability
  - No need for window levels



Challenges

- Contouring = Hard
  - Time-intensive
  - Anatomy-intensive
  - Variation patient-to-patient

Next Steps

- This small-scale analysis of five OAR across three patients is the beginning of an expanded analysis of >30 unique OAR across nine patients.
- Subjective scoring will also be utilized to add clinical relevance and perspective.

Acknowledgements

- We thank Gary Cobb with the ECU BSOM Radiation Oncology Dept. for his help facilitating access to the Varian Medical Training Software.