Artificial Intelligence-Driven CBCT Analysis for Segmentation of Inferior Alveolar Nerve for Standardized Interpretation and Enhanced Patient Safety

Negin Soghli[1], Aminollah Khormali[2], Patricia A. Miguez[3]

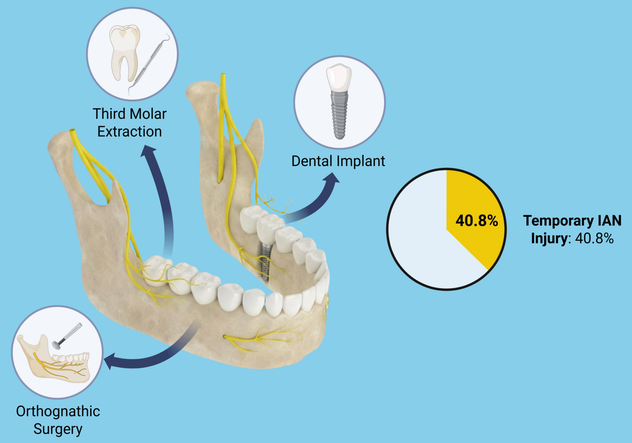
[1] Department of Biomedical Sciences, Adams School of Dentistry, The University of North Carolina at Chapel Hill
[2] Adams School of Dentistry, The University of North Carolina at Chapel Hill
[3] Department of Periodontology, Endodontics and Dental Hygiene, Adams School of Dentistry, The University of North Carolina at Chapel Hill

Poster Number: P179

Backgrounds & Clinical Needs:

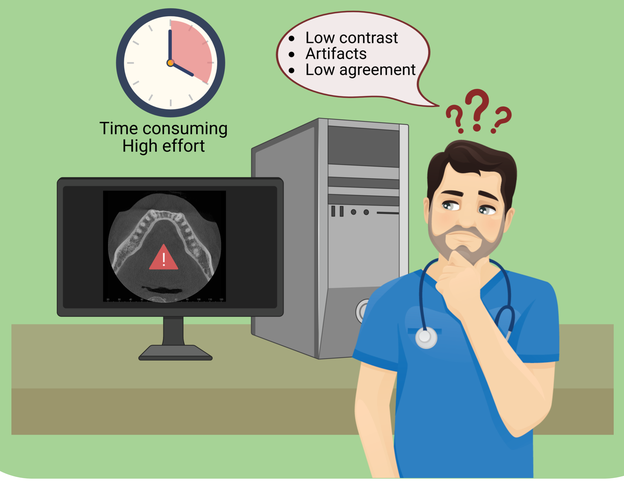
Clinical Problem:

- **Inferior alveolar nerve (IAN) injury** can occur during:
  - Third molar extraction
  - Mandibular implant placement
  - Orthognathic surgery
- **Consequences:**
  - Permanent paresthesia or dysesthesia
  - Chronic pain
  - Significant medico-legal risk



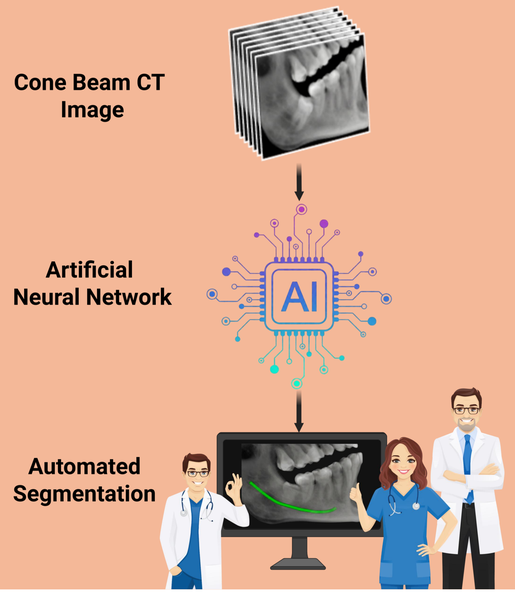
Motivation:

- **Manual tracing:**
  - Technically difficult
  - Time Consuming
  - Highly operator-dependent
- Low contrast between IAC and trabecular bone
- Metal artifact obscure canal borders



Study Aim:

- To develop and validate an advanced deep learning model for **automated IAN segmentation**
- Evaluate its **clinical impact** on inter-operator agreement and planning time across different expertise levels



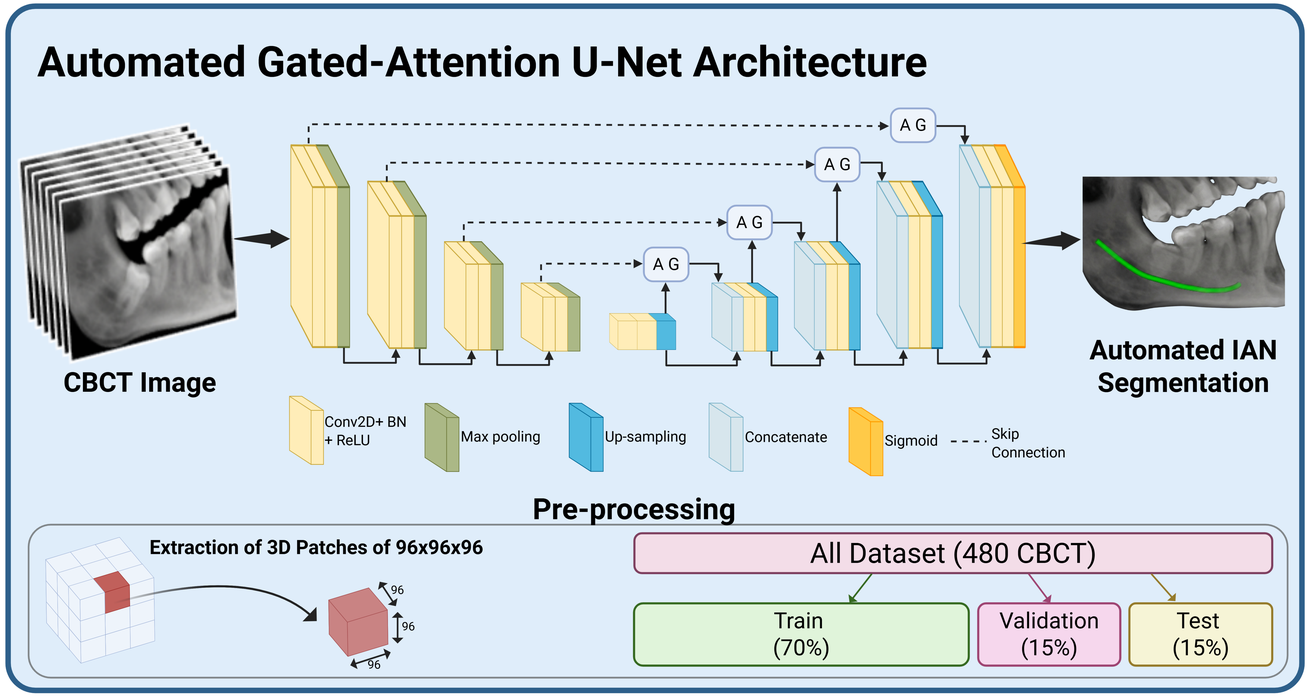
Materials and Methods:

Dataset:

- Tooth Fairy 2 dataset (480 expertly annotated CBCT volumes)
- Diverse anatomy, image quality, and metal artifacts
- Standardized voxel spacing (0.117 mm^3)

Model Architecture:

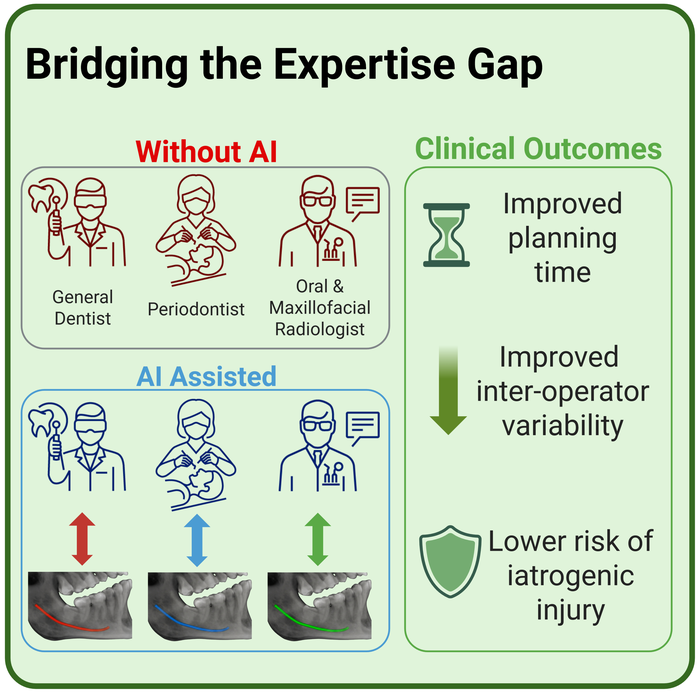
- Gated-Attention U-Net architecture
- Multi-scale feature fusion
- Metrics: Dice similarity coefficient (DSC), IoU



Clinical Validation (Ongoing):

Prospective multi-reader study

- 9 clinicians:
  - 3 General Dentists
  - 3 Periodontology Residents
  - 3 Radiology Residents



Results and Comparisons:

Comparison with state of the art:

- High-Precision nerve segmentation with clinical relevance
- Outperformed standard U-Net and attention variants
- Maintained continuity near mental foramen

Clinical Performance:

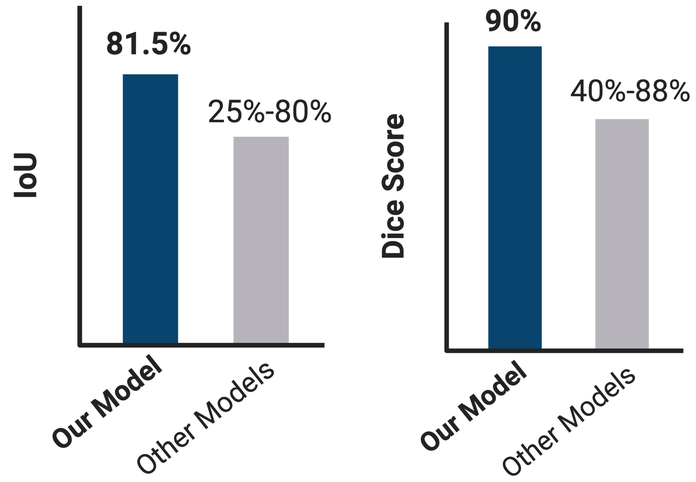
- Reduced planning time
- Maintained high precision in low-contrast regions
- Robust to metal artifacts and thin cortical boundaries

Study	Model/ Method	Dice (%)	IoU (%)
Zhou et al., 2018	U-Net++	88.70 ± 6.16	80.13 ± 8.29
Oktay et al., 2018	Attention U-Net	85.06 ± 8.35	74.72 ± 10.10
Kwak et al., 2020	U-Net	87.98 ± 6.37	79.01 ± 8.45
Jaskari et al., 2020	Jaskari's model	87.85 ± 6.35	78.79 ± 8.34
Hatamizadeh et al., 2021	SwinUNETR	40.47 ± 11.36	25.98 ± 8.83
Hatamizadeh et al., 2022	UNETR	73.84 ± 11.21	59.62 ± 12.69
Liu et al., 2024	Liu's model	88.37 ± 4.90	79.45 ± 6.60
Our Model	Gated Attention U-Net	89.72 ± 4.28	81.47 ± 5.34

Comparative Performance:

Superior to:

- U-Net
- U-Net++
- Attention U-Net
- Transformer Models (UNETR, SwinUNETR):



Discussion and Conclusion:

Toward safer and more standardized mandibular surgeries:

Gated attention deep learning enables:

- Accurate IAN segmentation
- Reliable nerve continuity
- Explainable uncertainty visualization

AI assistance:

- Reduces planning time (bridging the expertise gap)
- Improves agreement across various experience levels

Clinical Significance:

- **Supports safer:**
  - Implant placement
  - Third molar extraction
  - Mandibular surgeries
- Provides **explainable AI** features through probability maps

Future directions:

- Integration into implant planning software
- Expansion to diverse CBCT platforms

AI –assisted IAN visualization leads to standardized care, reduced variability, and lower risk of avoidable nerve injury!

Negin Soghli
DDS, PhD Candidate

Aminollah Khormali
PhD, DDS Candidate

Patricia A. Miguez
DDS, MS, PhD