2026 JULY 19–22 VANCOUVER, BC
JOINT AAPM | COMP MEETING

Feasibility of Extraoral 3D Ultrasound for Detection of MRI-Occult Oral Squamous Cell Carcinoma

David Tessier[1,2], Tiana Trumpour[3], Claire K.S. Park[4], Aaron Fenster[1,2], Jane Topple[5], Adrian Mendez[6]

[1]Western University, Canada; [2]Robarts Research Institute, Canada; [3]Arthur J.E Child Comprehensive Cancer Centre, Canada, [4]Harvard University, USA; [5]St. Joseph Healthcare, Canada; [6]London Health Sciences Centre, Canada

INTRODUCTION

- Oral squamous cell carcinoma (OSCC) represents > 90% of all oral cavity malignancies[1]
  - Lack of effective screening → late-stage diagnoses with a 5-year survival rate of approximately 30%[1]
- Diagnostic imaging may consist of any combination of computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), or ultrasound (US)[2]
  - Each modality has unique limitations and may not be an accurate representation of OSCC at the time of surgical resection

Clinical need for an alternative, accessible imaging modality to accurately assess OSCC tumor volumes and locations at the time of surgery

- Three-dimensional ultrasound (3D US) is an inexpensive, portable, and non-invasive quantification technique[3]
  - Promising alternative imaging modality for localization and quantification of tumors at the time of operation

Goal: Evaluate extraoral 3D ultrasound imaging in healthy volunteers and a clinical patient cohort for OSCC tumor delineation and volume quantification

HEALTHY VOLUNTEER STUDY

- Determine optimal imaging protocol for 3D US acquisition and gold-standard MRI imaging (Fig. 1)
- Compared an in-house mechatronic device to commercial volumetric 3D US transducers
  - Image quality and workflow feasibility assessed by an ultrasonographer and radiologist
- Extraoral submental and submandibular 3D US acquired with commercial transducers
- Custom oral cavity MRI protocol developed for 3T scanner

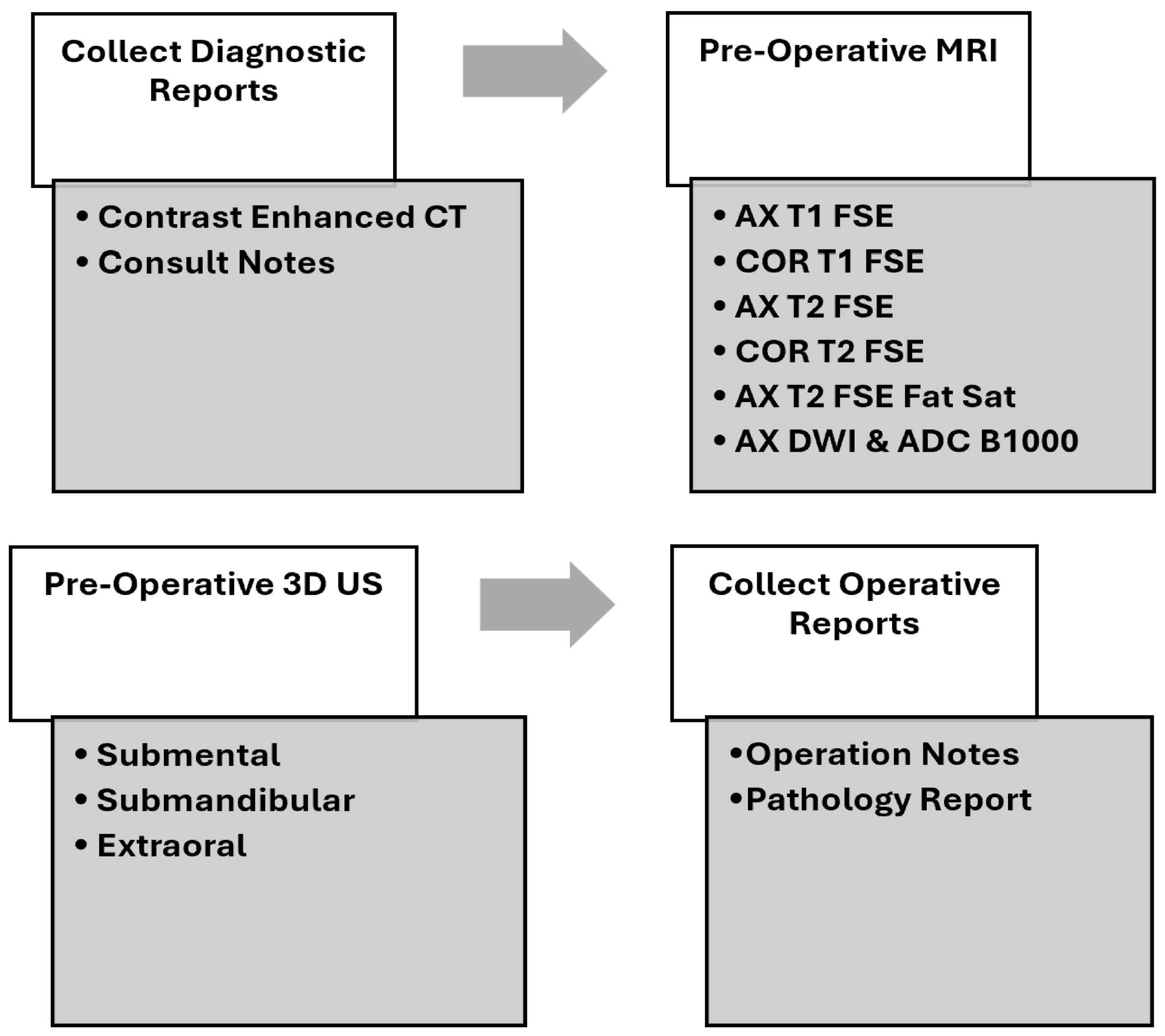

Fig. 1 Workflow of clinical OSCC image acquisitions

PATIENT STUDY

- Ethics approval for imaging of N=40 patients, with N=10 patients currently imaged
  - N=9 patients tested with custom in-house device, N=1 imaged with updated protocol and commercial transducers
- Patient diagnostic CT reports reviewed by imaging technologists beforehand to understand approximate tumor location
- Patients imaged within a week prior to surgical resection, with 3D US completed immediately following MRI
  - Post-operative pathology reports collected for comparison
- If visible on MRI and 3D US, a radiologist and trained observer reviewed the images and performed tumor segmentation
  - Comparison completed using 95% Hausdorff distance and Dice-Sorensen similarity coefficient
  - Quantitative comparison between tumor delineation and pathology report completed

RESULTS

PROTOCOL OPTIMIZATION

- Before protocol optimization, using the custom in-house device, tumors detected on MRI and 3D US in only two cases (Table. 1)
- After protocol optimization with healthy volunteers, the radiologist confirmed relevant anatomy and key structures clearly visualized in healthy volunteer MRI and 3D US images (Fig. 2 and Fig. 3)

Patient	Tumor Visibility	Exclusion Reason
1	No	MRI signal too low
2	No	Patient refused MRI
3	No	Retromolar trigone position
4	Yes	Tumor too posterior for 3D US
5	No	No primary tumor identified on 3D US
6	No	Anterior third of tongue position
7	No	No primary tumor identified on imaging
8	No	Anterior third of tongue position
9	Yes	Primary tumor too large for 3D US sweep

Table.1 Clinical patient exclusions leading to healthy volunteer study

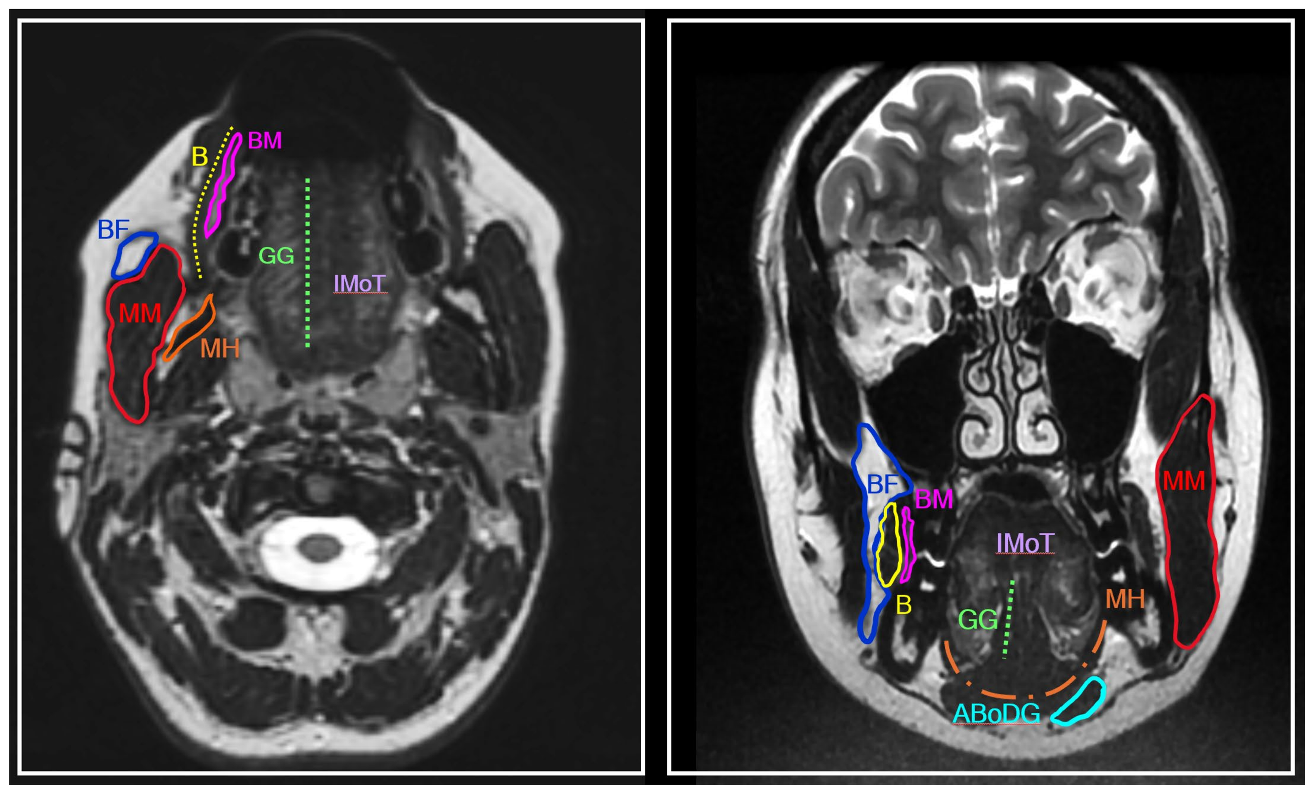

Fig.2 Healthy volunteer MRI. Left) Axial T2 sequence; Right) Coronal T1 sequence. Annotations: B - Buccinator Muscle, BM - Buccal Mucosa, BF - Buccal Fat, IMoT – Intrinsic Muscles of Tongue; GG - Genioglossus, ABoDG - Anterior Body of Digastric, MH - Mylohyoid, MM - Masseter Muscle.

RESULTS

PROTOCOL OPTIMIZATION

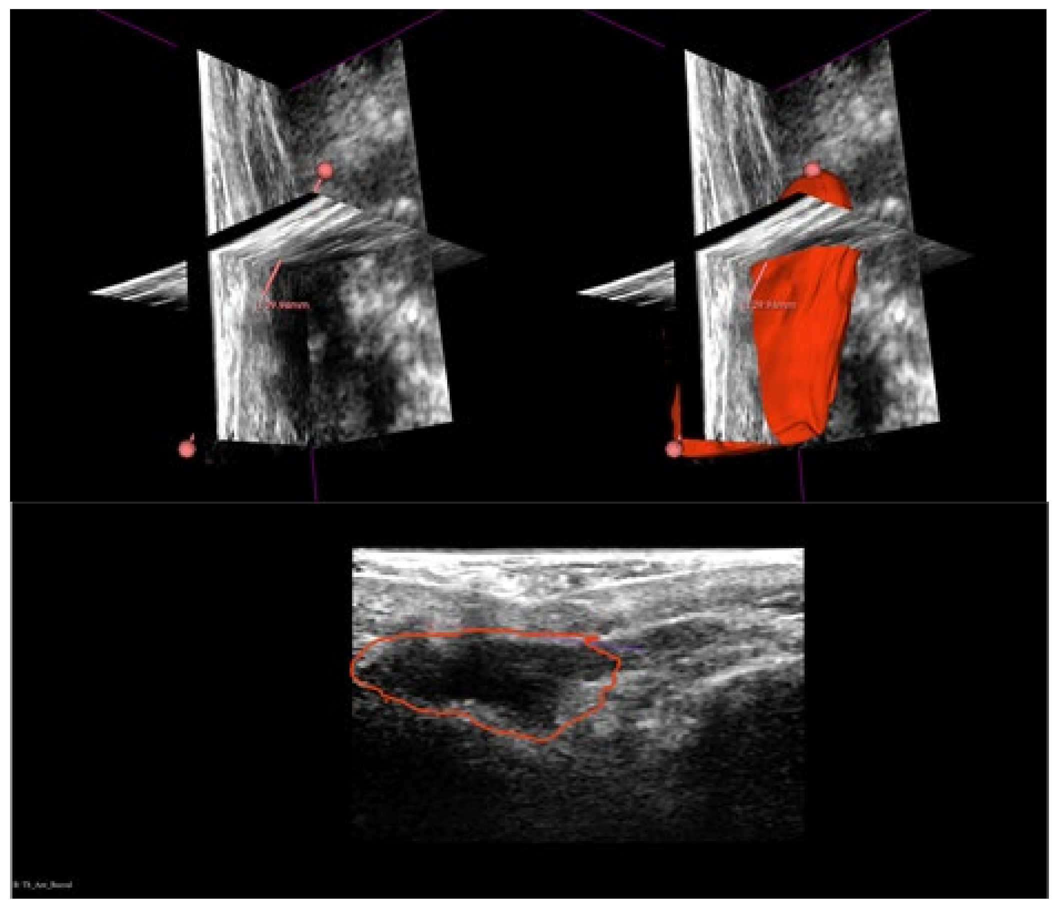

Fig.3 Three-dimensional ultrasound (3DUS) visualization of a 2.5 cm squamous cell carcinoma in the right floor of the mouth. (A) Volumetric rendering of the submental scan data visualized in 3D Slicer. (B) Corresponding 3D view with the solid surface segmentation applied, delineating the tumor's extension across the midline. (C) Oblique cross-sectional view revealing the tumor as a distinct hypoechoic (dark) region, which served as the anatomical basis for the volumetric quantification.

PATIENT STUDY

- N=1 patient successfully imaged with updated protocol
  - Diagnostic CT indicated T2N0M0 OSCC on the floor of mouth
  - Radiologist identified primary tumor on 3D US image set, but not on MRI

Segmentation volume: 2.4 cm^3
Largest segmentation dimension: 2.9 cm
Post-op largest dimension: 2.2 cm
Post-op excision margins: 0.6 cm

CONCLUSIONS

1. **Validated the use of extraoral and submental 3D US to measure OSCC tumors**
2. **Optimized MRI and 3D US imaging protocol for OSCC**
3. **Imaged and reviewed N=10 patients, ethics approved for N=40 patients total**

- Projected outcomes for remaining trial participants include quantifying tumor volumes in wider clinical population
- 3D US is a promising modality for tumor quantification at time of surgical resection, and may be promising to visualize MRI-invisible tumors

REFERENCES

1. Montero, P.H. and Patel, S.G, Cancer of the Oral Cavity, *Surgical oncology clinics of North America* **24**(3), 2015
2. Yao, C.M. et al, Contemporary approach to locally advanced oral cavity squamous cell carcinoma, *Current oncology reports* **21**(11), 2019
3. Fenster, A. et al., Three-dimensional ultrasound imaging, *Physics in Medicine & Biology* **46**(5), 2001

NSERC CRSNG
CIHR IRSC Canadian Institutes of Health Research Instituts de recherche en santé du Canada