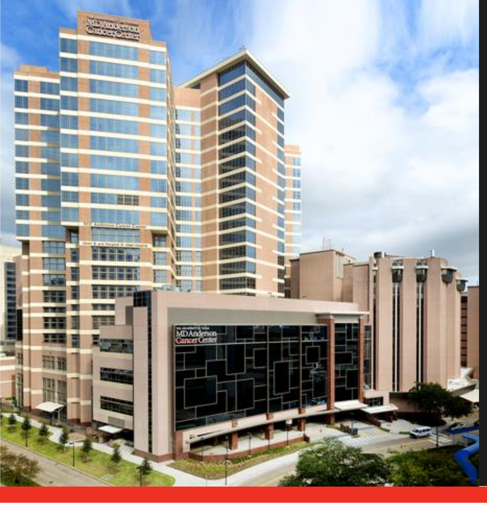

Deep Learning for Head and Neck Segmentation in MR: A Tool for MR-Guided Radiotherapy

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Introduction

The National Cancer Institute estimates there were approximately 65,000 new cases of head and neck cancer in 2017, which constitutes 4% of the overall new cases of cancer.

External beam radiation therapy is a common treatment technique for these patients. Unfortunately, with radiation therapy in the head and neck region there is a risk of xerostomia, or chronic dry mouth, should the salivary glands receive sufficient dose.

To reduce the amount of complications post-treatment, normal tissue structures such as the parotid and other salivary glands are segmented as organs at risk, with the goal being to reduce the dose received sufficiently for the normal tissue to recover after treatment.

Deep learning neural network techniques has shown great flexibility with varying imaging enhancement not impinging upon their ability to segment robustly. There are already several architectures being implemented in medical physics research specifically for rapid segmentation.

Rapid segmentation of these normal tissues can facilitate dose tracking, and enable patient position modification in case of anatomical movement.

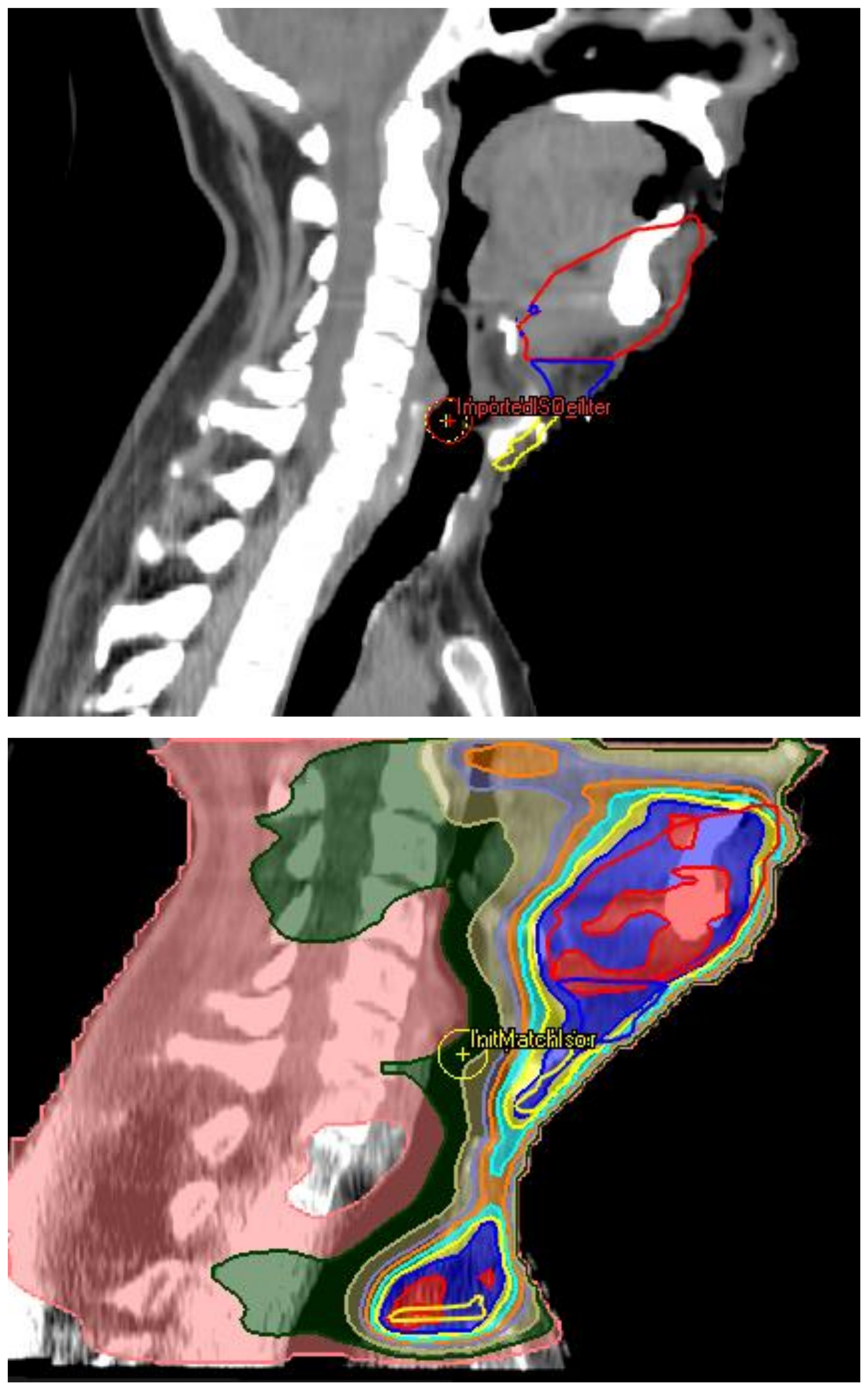

Fig. 1: (Top) Saggital image of CT where gross disease has been contoured and (bottom) dose distribution, where dose lines travel through parotid glands

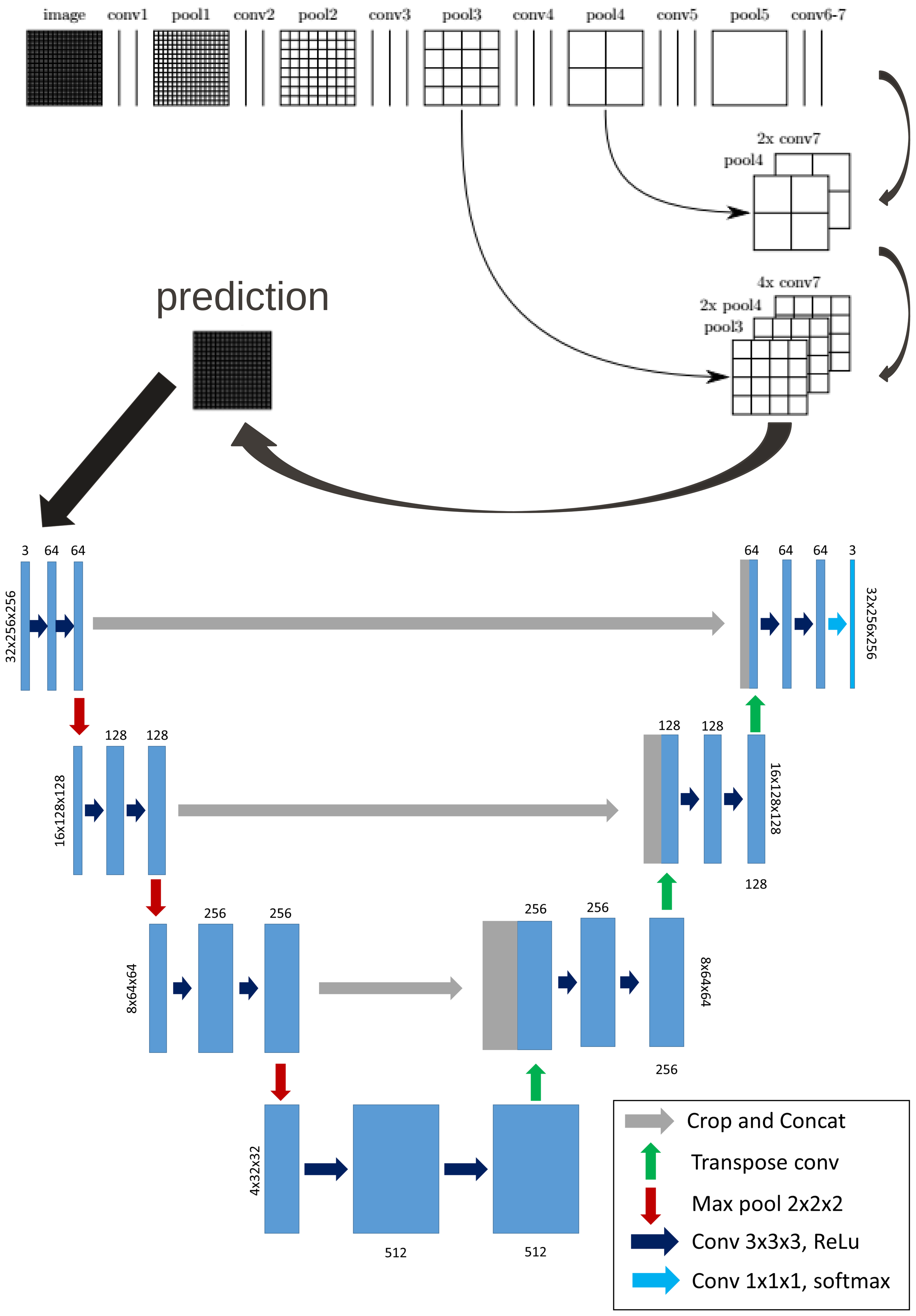

Fig. 2: (Top) Expansion on VGG-19 network performed by *Long, et. al* [1] where prediction is fed into 3rd channel of 3D UNet

Materials and Methods

- Retrospectively obtained 113 patients with manually contoured parotid glands, submandibular glands, sublingual, and mandible
- All patients were imported into Raystation (Raystation 5.0.2, RaySearch Laboratories, Stockholm, Sweden)
- Deep Learning method included VGG-19 pre-trained layers and skip-layers for semantic segmentation
- For improved 3D identification, predictions from the VGG-19 network were input as a channel into the 3D U-Net
- The inclusion of the 3D UNet is meant to facilitate global 3D information, improving otherwise 2D segmentation

Results

Twenty patients were maintained from the training/testing as a final validation set. Metrics of the dice similarity coefficient, mean surface distance, and false negative were used to determine contour validity.

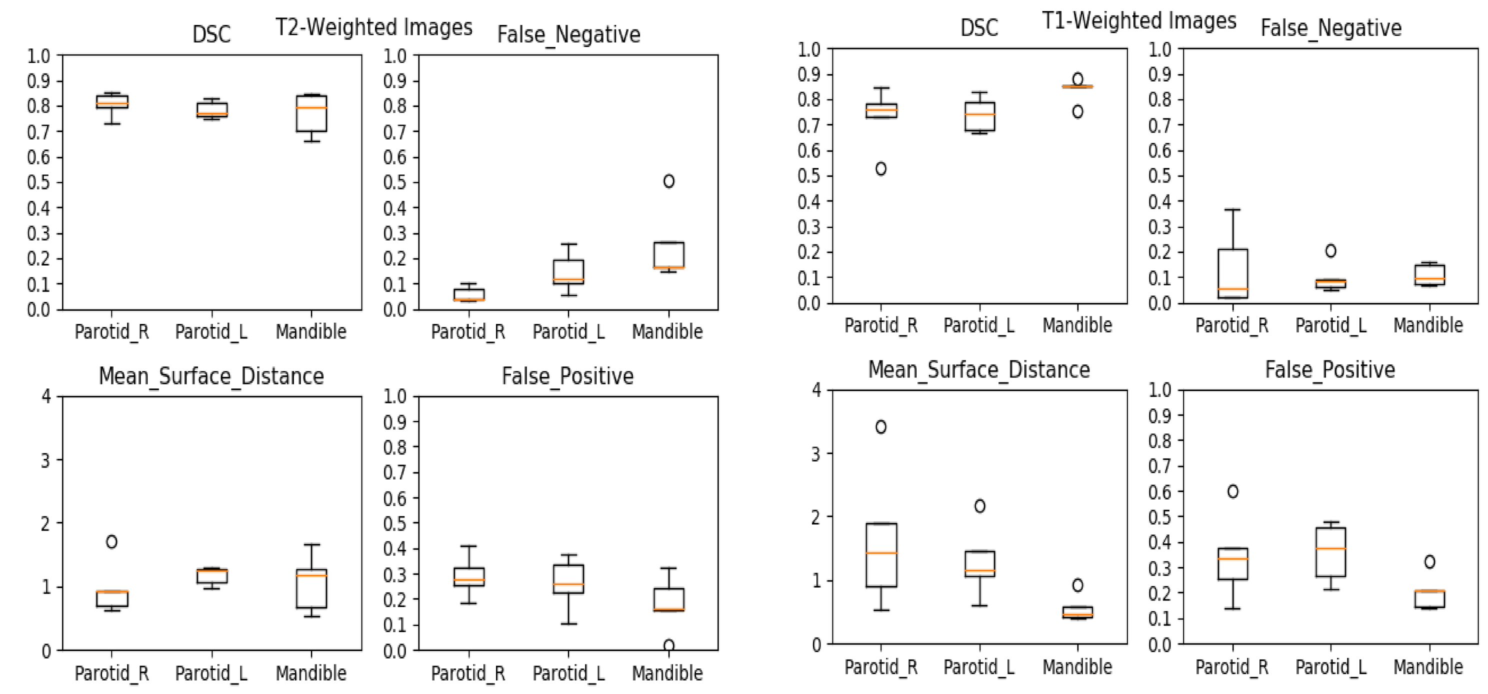

Fig. 3: Results for DSC, false negative, mean surface distance, and false positive can be seen for T2-weighted images (left) and T1-weighted images (right)

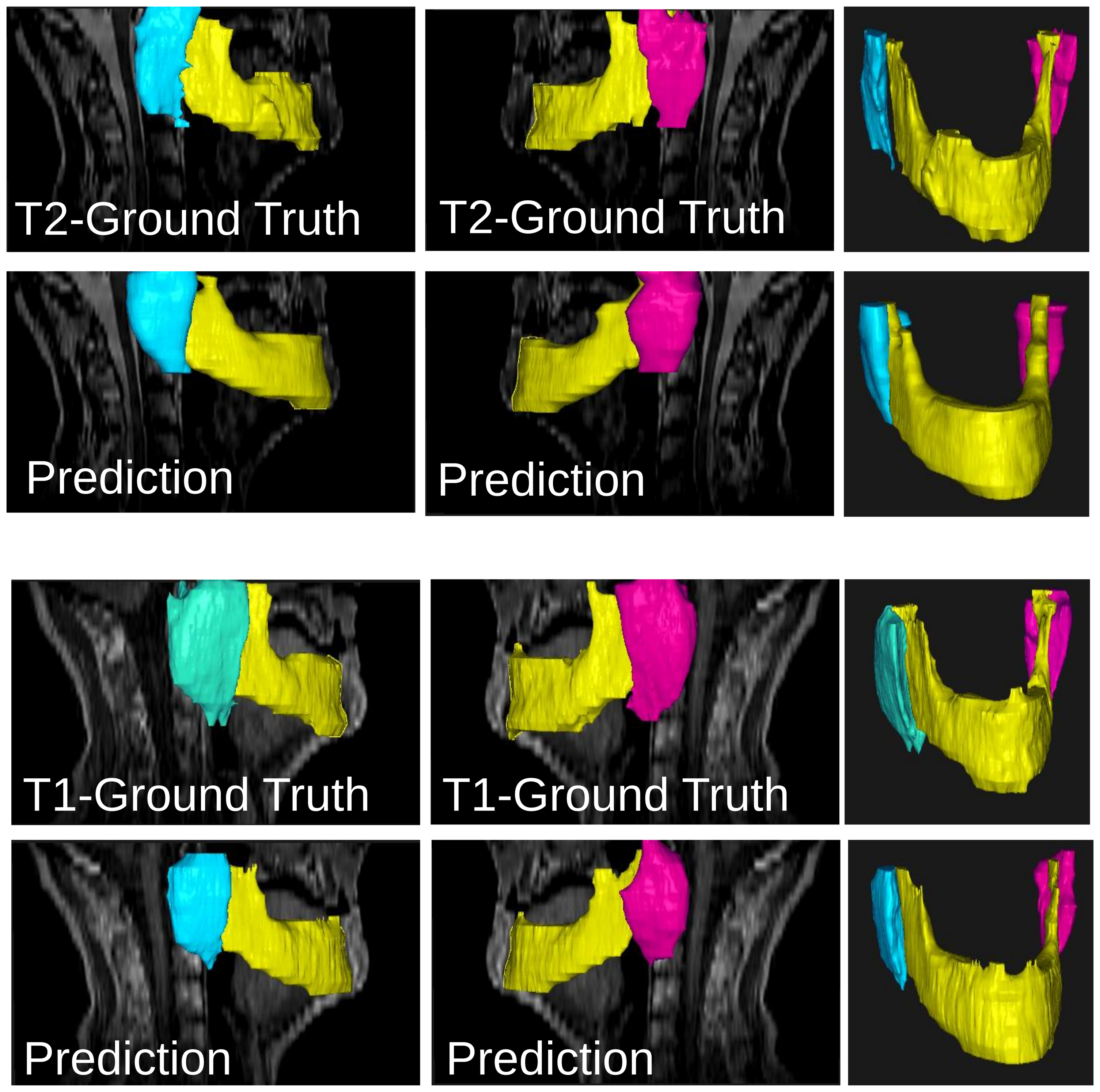

Fig. 4: Predictions for right parotid (teal), left parotid (pink) and mandible (gold) on ground truth vs predictions for T2-weighted images (top) and T1-weighted images (bottom)

Conclusion

Combined deep learning techniques are capable of identifying normal structures on both T1- and T2-weighted MR images. Further investigation is warranted, especially with technology such as the MR-Linac.

References

1) J. Long, E. Shelhamer, and T. Darrell, "Fully Convolutional Networks for Semantic Segmentation." pp. 3431–3440, 2015.