

# Supervised learning approach for the automated segmentation of epidural and subdural hematoma on computer tomography (CT) imaging following traumatic brain injury (TBI)

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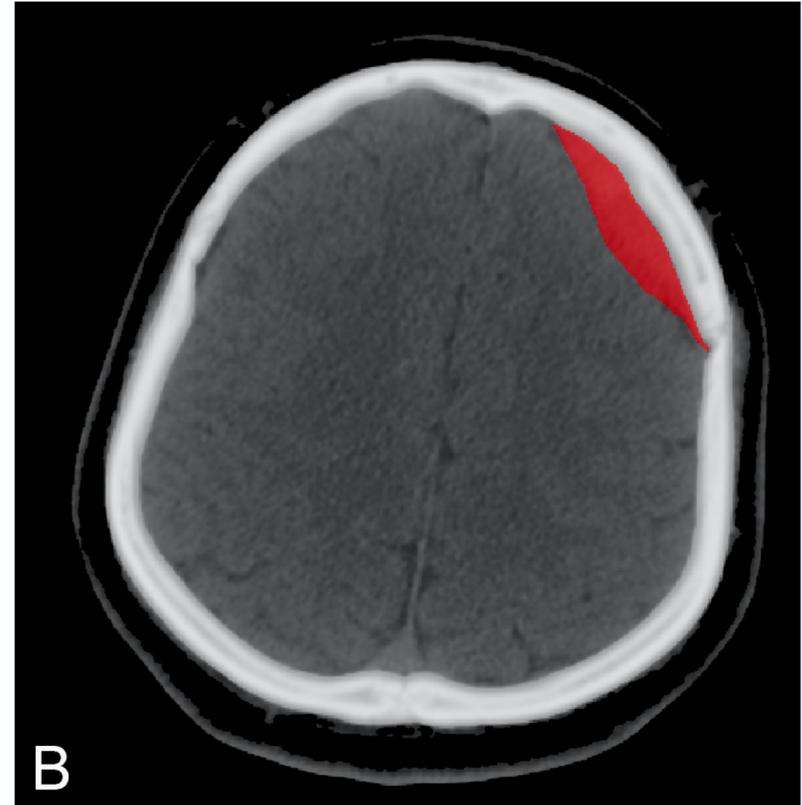
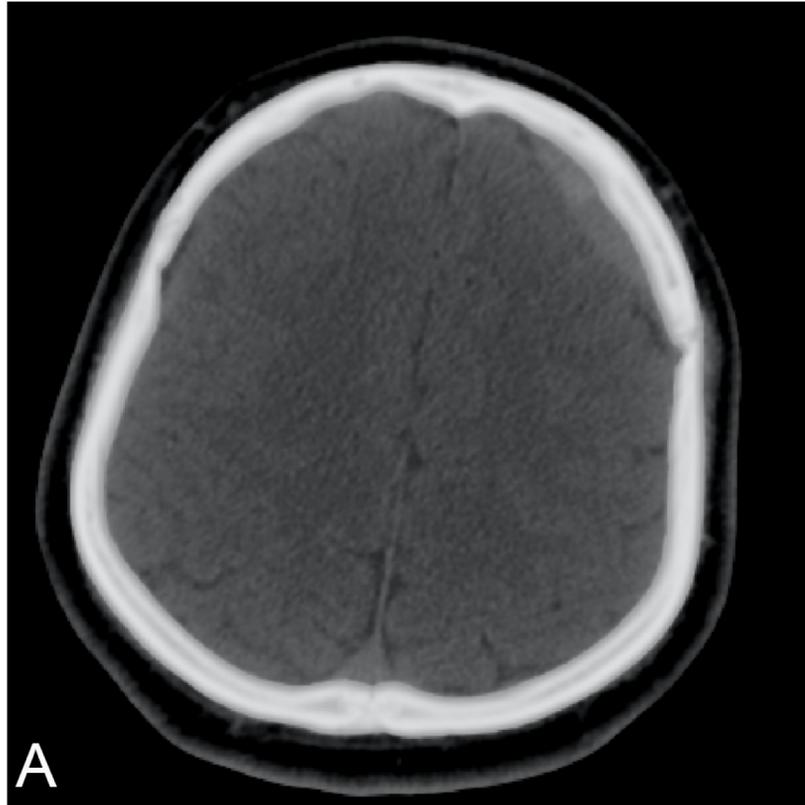
- No Disclosures

# Purpose

- Traumatic brain injury (TBI) is a leading cause of morbidity and mortality.
- Medical imaging plays a key role in the management of this condition, particularly when intracranial lesions require urgent neurosurgical management.
- Automated detection methods may speed the surgical and clinical management of these patients.
- The purpose of this study is to develop and apply automated segmentation methods for the detection of epidural hemorrhage (EH) and subdural hemorrhage (SDH) in TBI.

# Methods

- The Clinical Data Repository (CDR) was used to perform a retrospective chart review on patients at our institution diagnosed with TBI or concussion by ICD-9 or ICD-10 codes and CPT codes consistent with receipt of a CT or MRI scan
- All patients were over 18 years of age
- Imaging studies were performed between January 1, 2008 and November 1, 2016
- Regions of interest (ROIs) for this study included EH and SDH
  - Manual segmentation of these ROIs informs the automated segmentation approach.
- Using a deep learning patch-based framework, extracted images are used to train tailored convolutional networks for the automated identification of ROIs that are commonly associated with TBI pathology
- The resulting code will be made available on the open source Advanced Normalization Tools (ANTs) and ANTsR toolkits for widespread usage



A: Left frontal hyperdense, lenticular lesion is demonstrated, consistent with acute epidural hematoma in the setting of trauma.

B: Manual segmentation of this lesions is shown, which informs the automated segmentation algorithm.

# Results

- The CDR review resulted in the identification of 2,319 patients with a total of 4,271 scans
  - 684 scans had the findings of SDH
  - 118 scans were found to have changes consistent with EH
  - Fifty-five scans had EH without evidence of SDH
  - 619 scans were found to exclusively have SDH
  - Fifty-six scans had both EH and SDH and were of sufficient quality to undergo manual segmentation

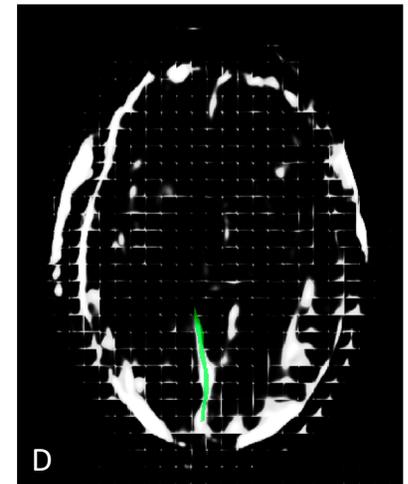
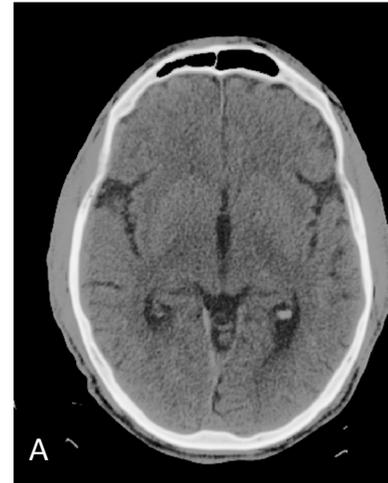
# Results

A: Depicted is a right sided hyperdensity along the tentorial leaflet, consistent with acute subdural hematoma in the setting of trauma.

B: The human trained segmentation is shown overlying the hemorrhage.

C: The automated probabilistic image is shown with intensities ranging from 0 to 1. A linear right sided brightness is shown which correlates to the location of the tentorial bleed. Also noted is background false positive signal.

D: The human trained segmentation overlies the probabilistic image.



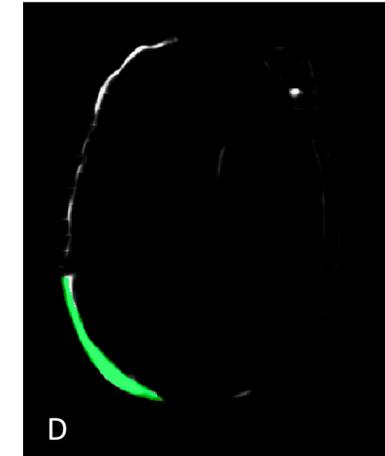
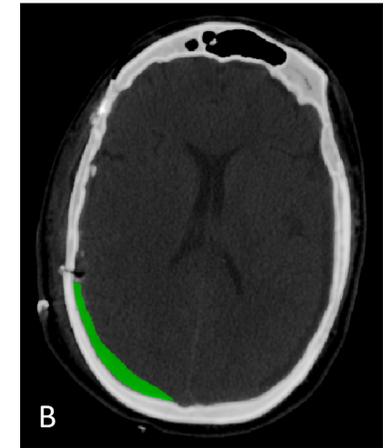
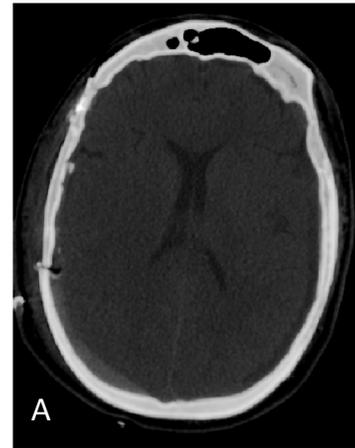
# Results

A: Depicted is a crescentic right sided hyperdensity along the parietooccipital lobe, consistent with acute subdural hematoma in the setting of trauma.

B: The human trained segmentation is shown overlying the hemorrhage.

C: The automated probabilistic image is shown with intensities ranging from 0 to 1. A right sided brightness is shown which correlates to the location of the extra-axial bleed.

D: The human trained segmentation overlies the probabilistic image.



# Conclusions

- Human trained automated detection of significant medical imaging findings is a promising method for the rapid identification of intracranial mass lesions in TBI.
- In a clinical workflow, this approach could reduce time between scan acquisition and management.
- These methods rely upon the identification of features predictive of the pathology of interest.
- Thus far, the framework has produced intensities which are consistent with known bleeds under the human trained segmentation data.
- Also seen are false positive intensities on the probabilistic images, which is expected to correct itself with more training data.
- This study targets identification of predictive features of epidural and SDH with the goal of making these data available to the medical imaging community for incorporation into platforms that may be used in the patient care setting.