Assessing Residual Hematoma Volume During Endoscopic ICH Evacuation: Intraoperative Ultrasound and DynaCT Appear Unreliable

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Disclosures

— None related to this topic.
Introduction

- Conventional CT offers rapid, reliable measurement of the extent and volume of ICH.
- However, there are limited options for monitoring the extent of hematoma resection intraoperatively.
- Burr-hole ultrasound and intraoperative CT have been explored as potential imaging methods.
- There is currently no guideline or evidence for how intraoperative imaging might guide minimally invasive ICH evacuation. Quantitative assessment of these intraoperative modalities for ICH volume measurement accuracy is necessary.
Methods

- 20 patients underwent endoscopic minimally invasive ICH evacuation at our institution between July 2016 - May 2017.
- Pre- and postoperative CT imaging was performed. In the operating room, burr-hole ultrasound images were acquired pre- and post-evacuation, and DynaCT images were acquired post-evacuation.
- The ABC/2 method was used to estimate hematoma volumes from ultrasound images. Analyze Pro semi-automated threshold-guided volume analysis was used to estimate hematoma volumes from DynaCT and CT images.
- Statistical Analysis: To assess the differences in volume estimates, one-sample t-tests and Bland-Altman analysis were performed.
Results

- With CT as standard, pre-procedure ultrasound significantly underestimated hematoma volume, with mean volume difference (mL) of 
\(-9.42 \pm 18.54\) (\(p = 0.04\)).

- Hematoma volumes estimated from post-evacuation ultrasound did not significantly differ from postoperative CT (\(-1.82 \pm 10.98\), \(p = 0.47\)). However, Bland-Altman analysis showed a very wide limits of agreement (95% LOA, -45.74 to 26.90).

- Post-evacuation DynaCT significantly underestimated hematoma volume, with mean volume difference of \(-4.31\text{mL} \pm 6.62\text{mL}\) (\(p = 0.01\)).
Results

Figure 1. Example of Preoperative Ultrasound vs. CT

Left) The ABC method was applied to estimate hematoma volume from axial and sagittal preoperative ultrasound images. Hematoma in preoperative CT is shown for reference.

Right) Bland-Altman plot shows significant underestimation (p=0.04) and wide limits of agreement.
Results

Figure 2. Example of Postoperative Ultrasound vs. CT
Left) The ABC method was applied to estimate residual hematoma volume from axial and sagittal post-evacuation ultrasound images. Postoperative CT images are shown for reference.
Right) Bland-Altman plot shows nonsignificant difference (p=0.47), but wide limits of agreement.
Figure 3. Example of Post-evacuation DynaCT vs. Postoperative conventional CT

Left) Compared to CT, there is noticeably lower contrast level in soft tissue in DynaCT (acquired post-evacuation in the OR), making accurate estimation of hematoma volume difficult.

Right) Bland-Altman plot shows significant underestimation (p=0.01) and wide limits of agreement.
Discussion

- There is currently no guideline for intraoperative imaging in minimally invasive ICH evacuation.
- Accurate intraoperative hematoma volume measurement may be important to assess for hematoma re-expansion.
- Our results suggest that intraoperative ultrasound may be unreliable, as it gives inconsistent measurements of pre- and post-evacuation hematoma volume.
- Intraoperative DynaCT may also be unreliable as it gives inconsistent measurements of residual hematoma.
Summary Points

- The intraoperative imaging modalities Burr-hole ultrasound and DynaCT failed to consistently provide reliable measurements when compared to conventional CT.

- Effort should be directed to developing improved intraoperative imaging that can accurately monitor minimally invasive ICH evacuations.