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Head Computed Tomography (CT) Volumetrics to Quantify Cerebral Edema using 3D SLICER

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Keywords

Traumatic Brain Injury (TBI), Cerebral Edema (CE), Brain Volume (BV), Head Computed Tomography(CT), 3D Slicer

Abstract

Introduction

Following traumatic brain injury (TBI), fluid can accumulate in damaged brain tissue (e.g. "cerebral edema" or CE), and cause irreversible injury. Currently, there is no single accepted method to quantify CE. The purpose of this study was to measure the accuracy of a protocol using an open source software platform for medical image informatics(3D SLICER) to evaluate changes in brain volume (BV) on Head CT in order to quantify CE.

Methods

A subset of patients with TBI were identified from a prospectively enrolled cohort of critically ill

trauma patients. Using 3D SLICER, three independent novice readers were trained on a standardized protocol measured BV on head CTs using a semiautomated tool to segment brain regions based on a threshold (20-50) of Hounsfield units. Total BV was calculated with

adjustment for the presence of lesions where applicable. We assessed intra-rater reliability with a two-way random-effects model, reporting an intraclass correlation coefficient. Descriptive statistics were calculated to quantify change in BV between scans; significance was set at $p < 0.05$.

Results

A total of 70 patients with 124 scans were measured for BV, while 16 scans (11%) were excluded(missing (n=5), poor quality(n=11)). The ICC=0.97 (95% CI: 0.96 to 0.98, $p < 0.001$)

indicating excellent agreement between the 3 raters. The mean standard deviation between scan reads was 30mL, which represents 2.7% of the mean BV (1140mL). Fifty-four patients had paired scans that were assessed for BV change between initial and follow up scans. Follow up scans were obtained a median of 7 [6-41] hours after the initial, and on average, BV increased by 2.0% (SD \pm 5.6%), but ranged from -14% to 19% in the cohort.

Conclusions

Novice readers can produce highly reliable brain volume measurements on CT after TBI. Future work will examine the correlation between measured % BV change and clinical measures of CE.