Video Article

Automated Midline Shift and Intracranial Pressure Estimation based on Brain CT Images

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Abstract

It is estimated that every year, 1.4 million people in the United States sustain traumatic brain injuries (TBI)1. Over 50,000 of these patients will not survive and many others will be left permanently disabled. Severe TBI is known to be accompanied by an increase in intracranial pressure (ICP) as the presence of hematomas and swelling compresses brain tissue. This reduces cerebral perfusion pressure and thus cerebral blood flow, placing the injured brain and additional risk. Severe ICP can be fatal, and as such it must be closely monitored for patients with brain injuries. This typically requires placement of indwelling catheters directly into the brain for monitoring of pressure, a risky procedure for patients that may can only be performed at specialized medical centers. The procedure also involves risk such as infection. However, some signs of elevated ICP may be noticeable in medical imaging. In particular, midline shift is often associated with an increase in the ICP and can be captured from the brain Computed Tomography (CT) images. As such, these images provide an opportunity for non-invasive detection of elevated ICP which can be used as a pre-screening step before cranial trepanation. Among all these imaging modalities, since the speed and cost of diagnosis are vital, CT imaging is still the gold standard for initial TBI assessment2. More specifically, a CT examination is quick and relatively inexpensive, does not require strict patient immobility, and can reveal severe abnormalities such as bone fractures or hematomas. While CT is commonly used for detection of injuries in the brain, based on the current technology, midline shift is not automatically measured and therefore physicians must assess this important factor by visual inspection. Inaccurate or inconsistent CT interpretation is often associated with the nature of the human visual system and the complex structure of the brain. While small midline shifts are elusive, they are often invaluable for assessment of brain injury, in particular at early stages of injury before a patient s condition becomes more severe. On the other side of the spectrum, large midline shift suggests highly elevated ICP and more severe TBI. However, it is a very challenging task for humans to visually inspect CT images and predict the level of ICP quantitatively. Due to advances in automated computational techniques, features extracted from CT images, such as midline shift, hematoma volume, and texture of brain CT images, can be measured accurately and automatically using advanced image processing methods. However, the relationship between ICP and midline shift as well as other features such as degree of bleeding, the texture from CT images has not been explored. In this paper, we propose a computational framework to measure the midline shift measurement as well as other physiological / anatomical features on brain CT images and predict the degree of ICP non-intrusively based on features extracted from CT images which can be used as a pre-screening step to recommend for or against invasive ICP monitoring.

Disclosures

No conflicts of interest declared.