Assessing Concussion with MRI and Machine Learning

Nicholas Simard[1], Dr. Michael D. Noseworthy[1,2]
Electrical & Computer Engineering, McMaster University; Imaging Research Centre, St. Joseph's Healthcare Hamilton

Abstract

The following research investigates an improved diagnostic method for individuals suffering from a concussion. Using advanced neuroimaging techniques and a machine learning framework, a novel technique is proposed that provides objective and comprehensive information on a concussion injury. This method avoids the traditional requirement for baseline testing (which is not always reliable or available) and enables the identification of injury location and severity metrics. This new method aims to equip patients and clinicians with a higher quality injury assessment to make better data driven decisions for treatment and finally help those suffering from concussion.

Objective

1.7 Million People are affected by concussion each year[1]

Concussion victims are left with poor clinical outcomes and ineffective assessments of their injury

Current diagnosis methods are subjective and are based on patient self-evaluations and clinical opinions

A more robust technique is required to more appropriately assess concussion

Background

Magnetic Resonance Imaging (MRI) is a form of neuroimaging which collects brain data with high clinical quality and relevancy. More importantly, since physiological data is measured, MRI provides a completely objective source of data collection. Advanced methods can also be utilized to investigate microstructural and functional integrity of the brain.

Machine Learning approaches are a form of high level computing which allow for the identification of patterns in data. When implementing a large number of neuroimaging datasets into a machine learning pipeline, subtle abnormalities can be detected such as a minor concussion on an MRI.

Methodology

Diffusion Tensor Imaging (DTI) is an MRI technique used to assess the brain's microstructural integrity

DTI and fMRI data for over 10,000 healthy controls are collected to establish the healthy reference point for each age and sex

Functional Magnetic Resonance Imaging (fMRI) is a technique used to assess the brain's functional integrity

A novel machine learning pipeline is used to compare MRI data for a concussed individual to their expected healthy control group

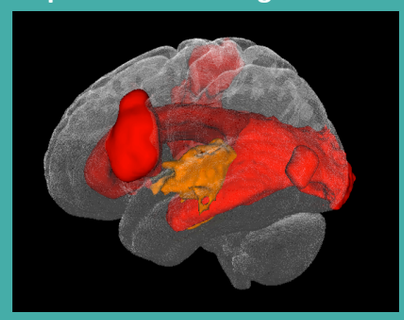
Results

This robust technique does not require any type of patient baseline testing and allows for a unique evaluation for each subject, enabling a more personalized medicine approach

The blend of both MRI and machine learning also provides spatial and injury severity information, finally enabling better rehabilitation timelines and more focused treatment

31 concussion patients have been tested with this technique and working with local healthcare professionals, this method has been validated to have a positive clinical impact

An example of spatial and injury severity information is depicted in the image below



Final Remarks

This technique can finally provide concussion patients with a more appropriate diagnosis, a better understanding of their injury and their expected recovery timeline, and can lead to better treatment and a higher quality of life

The comprehensive injury information can also equip clinicians with higher quality data leading to more improved data-driven decisions for treatment and rehabilitation plans

This method also offers tremendous growth as this approach is not limited to concussion, it can potentially be applied to other neurological diseases such as Alzheimer's (AD), Parkinson's (PD), and Multiple Sclerosis (MS)

References

[1] Faul, Mark, et al. "Traumatic brain injury in the United States; emergency department visits, hospitalizations, and deaths, 2002-2006." (2010).

* All images sourced from thenounproject.com