A Survey on Detecting Mild Traumatic Brain Injury

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ABSTRACT

Traumatic brain injury (TBI) is the brain injury caused by trauma to the head. There are three types of traumatic brain injury mild, moderate and severe traumatic brain injury based on the range of Glasgow Coma Scale (GCS) and the level of consciousness. By using automated detection approaches like computed tomography (CT) technique and magnetic resonance imaging (MRI) technique one private can adept to detect moderate and severe traumatic brain injury lesions. But mild traumatic brain injury (mTBI) lesions are cannot be able to detect because from the results of CT and MRI images these injury lesions are appeared as a very low contrast nature.

Keywords— Brain injury, Glasgow Coma Scale (GCS), lesion, TBI, Trauma.

I. INTRODUCTION

Awareness of traumatic brain injury has been increased traumatically in recent years [15]. TRAUMATIC BRAIN INJURY (TBI) is one of the major cause of death and disability. Sports injuries, automobile casualty smash injuries in the army, and falls in workplace are the major causes of traumatic brain injury [2, 11]. A traumatic brain injury basically affects young people in industrialized countries [4]. Relatively 25% of these injuries results in a long term impairment, social and economical concern. When elementary injury cannot be prevented, secondary brain damage can be reduced [30].

The clinical progress achieved over the last 30 years in the management of traumatic brain injury (TBI) which is based on the understanding of rapid intervention to treat the immediate sequelae of TBI, like shock and hypoxia, which correlate with brain edema, mortality and misery [26]. The misery of TBI results in a long-term impairment and family burden [6]. In recent years, studies have been focused attention on psychiatric disorders occurring after TBI, revealing their important role in the morbidity of the disease [19]. The most common psychiatric syndromes following TBI are depression and personality changes. Studies of consecutive samples says that prevalence rates of depression ranges from 9–36%, and personality changes affects more than one-third of severe TBI survivors [31].

Unconsciousness, Numbness in arms and legs, Severe headache, Repeated vomiting, Seizures, Weakness, Dilated pupils of the eye are the physical symptoms of traumatic brain injury [5]. Slurred speech, Confusion, Agitation, Memory or concentration problem, Amnesia about events prior to injury are the psychological symptoms [25].

From the information of Centers for Disease control, 85 cases per 100,000 populations are affected by traumatic brain injury, which means that in United States 1.4 million people are TBI patients per year [1]. 235,000 people are hospitalized in each year with a diagnosis of TBI and 50,000 do not survive [4]. If the Abbreviated Injury Score (AIS) for the head region was equal to or more than 4 then those patients were known as have traumatic brain injury [17]. If the patient had a 90 mm Hg or lesser systolic blood pressure then it was described as hypotensive [29]. The American College of Surgeons defines a criterion which says when blood pressure was not recorded; presence of a pulse was used for the estimation of blood pressure [7, 14].

The Glasgow Coma Scale (GCS) is a valuable first observation to measure the severity of traumatic brain injury immediately following brain trauma [9, 33, 20]. The duration of loss of consciousness (LOC) is also a significant diviner of the severity and long-term prognosis of injury [36]. The duration of posttraumatic amnesia (PTA) is also another clinical predictor of the severity of traumatic brain injury [10, 21].

This paper is organized as follows; section 2 discussed classification of traumatic brain injury. Section 3
describes the detection methods for traumatic brain injury. Section 4 presents the conclusion.

II. CLASSIFICATION OF TRAUMATIC BRAIN INJURY

From the level of consciousness or Glasgow coma scale (GCS) score traumatic brain injury is classified as mild, moderate or severe [4, 18, 3].

A. MILD TRAUMATIC BRAIN INJURY

Mild traumatic brain injury is a complex condition. Among 1.5 million Traumatic Brain Injury (TBI) persons 75% of those are confidential as mild Traumatic Brain Injury (mTBI) by the criteria of the Centers for Disease Control and Prevention (CDC) [23]. The cerebral concussion is another name of mild traumatic brain injury which results from a blow to the head. Mild traumatic brain injury results in a transient loss of consciousness or a brief period of amnesia or peri-injury confusion [32]. When loss of consciousness is shorter than 30 minutes and GCS score ranges from 13-15 then it is known as mild Traumatic Brain Injury (mTBI)[12, 22]. In most of the cases mild traumatic brain injury is a concussion, many of these person have short-term memory and absorption difficulties [16, 24, 34, 38, 28]. Significant disability and unemployment exists from an effect of cognitive, physical, psychological, and social dysfunctions after mild TBI [35, 43, 52, 47].

B. MODERATE TRAUMATIC BRAIN INJURY

When loss of consciousness is 30 minutes to 6 hours and GCS score ranges from 9-13 then it is known as moderate traumatic brain injury [53]. Nausea and worsening headache are the primary cause of moderate traumatic brain injury [38]. Physical, cognitive, and/or behavioral destruction last for months or are pertinent. Moderate injuries usually result from a non-penetrating whop to the head, and/or an uncontrollable agitation of the head. As lucky break would have it many individuals assist such head injuries without any possible consequences. After all, for many others, such injuries result in persistent exhausting impairments [41].

C. SEVERE TRAUMATIC BRAIN INJURY

When loss of consciousness is more than 24 hours and GCS score ranges 8 or less then it is established as severe traumatic brain injury. Intracranial contusion, hematoma, or brain laceration is falls under severe traumatic brain injury [39, 50]. Severe head injuries generally result from crushing blows or permeating lesion to the head. Such injuries crush, rip and prune subtle brain tissue. This is the most life, and the most incurable category of brain injury. TBI can stimulate a broad range of functional short- or long-term changes affecting thinking, sensation, language, or emotions [54].

III. METHODS FOR THE DETECTION OF MILD TRAUMATIC BRAIN INJURY

Traumatic Brain Injury can be detected by using six methods. The methods are Pressure Monitor, Diffusion tensor imaging, Biomarker, Neuropathology, Portable medical system, Electrophysiological.

A. PRESSURE MONITOR

A Bianchi et al. [40] proposed computational methods for the mild Traumatic Brain Injury (mTBI) evaluated from Magnetic Resonance Imaging (MRI). This method detects mild Traumatic Brain Injury lesions by high-level context and low-level visual information combination. The contextual model estimates the progression of the disease using subject information and visual model utilizes texture features in MRI together probabilistic support vector machine to maximize the discrimination in unimodel MR images.

A Bianchi et al. [55] proposed a Textural features and contextual model. In which contextual model is developed to imitate the progression of the disease using number of inputs, such as the time post-injury and the location of injury. Feature selection for a single MR modality used by texture feature.

W Wake land et al. [57] proposed a computer model of intracranial pressure (ICP) dynamics that measure clinical treatment options for high ICP during Traumatic Brain Injury (TBI). This model uses fluid volumes are primary state variables and explicitly models fluid flows associated with each intra- and extra cranial compartment and it evaluates clinical events and therapies are intra and extra-parenchyma lose blood and mild hyperventilation.

B. DIFFUSION TENSOR IMAGING

Min Jing et al. [42] proposed a spatial group independent component analysis (GICA), in which an individual mild Traumatic Brain Injury (mTBI) to analysis the diffusion scalar maps and the average of a set of controls are arranged according to their lot of data collection time points. In addition to GICA model a constrained GICA (CGICA) model is also proposed by the prior information into the GICA decomposition process it taking available knowledge of mild Traumatic Brain Injury into account.

Jaswal et al. [58] proposed an analysis of Diffusion Tensor Imaging (DTI), which is performed result of mild traumatic brain injury by the subject of display visual dysfunction. And then a comparison is made between the subject’s data before and afterwards undergoing vision training in order to evaluate any comparison between the fractional anisotropy (FA) and white matter fiber regions. A signal increase is identify the regions of interest (ROI) term in fractional anisotropy values as well as ROIs represented by the number of fibers.
E.A. Wilde et al. [60] proposed the Diffusion tensor imaging of the corpus callosum. In brain injury patients and can support as certain if thalamic injury is associated with cognitive impairment. TC WG et al. [63] proposed an integrity of cingulum bundles (white matter) using Diffusion Tensor Imaging (DTI), and the relationship between white matter and memory functioning. The result of this system indicate that cingulate injury and cognitive sequela during the early phase post-mild traumatic brain injury.

M L Lipton et al. [49] proposed an identification method for white matter abnormalities in patients suffering persistent cognitive destruction by cause of mild traumatic brain injury (TBI). And this method Fractional anisotropy (FA) and mean diffusivity (MD) images derived from DTI were compared using whole brain histogram and voxel-wise analyses.

C. BIOMARKER

VM Vergara et al. [61] proposed a biomarker. From the functional magnetic resonance (fMRI) imaging to derived resting state functional network connectivity (rsfNC). The fMRI is emerging as a possible biomarker. The main concerns with this technique is the suitableness of methods and this method used to correct for subject movement.

ED Bigler et al. [44] proposed a contemporary neuroimaging methods that detect anomallity in mild traumatic brain injury (mTBI). Magnetic resonance imaging (MRI) provides several measures that could serve as mild traumatic brain injury biomarkers. Biomarkers including the hemosiderin and white matter abnormalities detections, from diffusion tensor imaging to evaluate white matter integrity and directly assess neuroanatomy to quantitative measures.

Poellabauer et al. [65] proposed an assessment tool. The acoustic metrics extracted from speech have the inherent to serve as novel biomarkers for a mixture for the condition of neurological and neurodevelopmental. And this biomarker is considered as an assessment tool, this tool used for detection of mild traumatic brain injury.

H Zetterberg et al. [46] proposed reliable diagnostic methods that can establish whether a blow to the head has affected the brain. In which potential biomarkers of injury to different structures and cell types in the CNS that can be detected in body fluids.

D. NEUROPATHOLOGY

F Schwinger et al. [59] proposed a wireless pressure sensor system. This system embrace a piezoresistive flexible substrate mated among a microcontroller and radio. The radio is designed and constructed to provide information of mild Traumatic Brain Injury detection.

Michael Falcone et al. [64] Proposed speech analysis method that detect mild Traumatic Brain Injury. Vowel sounds are isolated by the recordings and acoustic features. These features are extracted and used to one-class machine learning algorithms.

M Pacula et al. [60] proposed online crisis hotline chats. This method extract fine-grained distress indicators based on chat and Diagnostic and Statistical Manual of Mental Disorders (DSM) based on graph. In addition to perform triage classification based on the severity of distress.

Nathan D.E et al. [48] proposed standard clinical imaging modalities. In this the intrinsic functional networks of the left and right thalamus in mTBI range (N=15) and neurologically intact healthy controls (N=12) is evaluated based on graph theory analysis method.

E. PORTABLE MEDICAL SYSTEM

Mobashsher, A.T et al. [62] proposed portable microwave system. Here the injuries are detected based on virtual arrayed monostatic radar approach. In which data sets recorded at 32 antenna positions around the head, and to generate images of the scanned head based on back projection algorithm.

H Sjaaheim et al. [51] proposed a portable system for emergency TBI analysis and observe personalized treatment based on quantitative electro encephalo graphy (qEEG) and High interpretation transcranial Electrical Stimulation (HD-tES).

F. ELECTROPHYSIOLOGICAL

M Gaetz et al.[66], Proposed visual event-related method of potentials and post-concussion syndrome (PCS) self-reports. The cumulative damages are indicated by event-related potentials that damages can occur successive lot of concussions. These measures correlate much with cognitive self-reports of PCS symptoms.

G Ordek et al.[56], Proposed histochemical techniques, using particular protein staining. Here electrophysiological recording and multi-contact array electrodes is used to detect the fluid percussion injury (FPI).

IV. CONCLUSION

This paper describes different automated methods for the detection of mild traumatic brain injury. These methods are more useful and provide much better result about the detection of mild traumatic brain injury correlated to magnetic resonance images (MRI) and computerized tomography (CT) images. These detection methods help to mild traumatic brain injury detection by accurate segmentation which is very crucial otherwise the wrong identification of disease can lead to several consequences.

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