Electrocardiographic Disturbances in Head Trauma Patients

Thesis

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بسم الله الرحمن الرحيم

قالوا
سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

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List of Abbreviations

AF	: Atrial fibrillation
CAD	: Coronary artery disease
CBF	: Cerebral blood flow
CNS	: Center nervous system
CO	: Carbon monoxide
CSF	: Cerebrospinal fluid
ECG	: Electroencephalogrphic
LQTS	: Long QT Syndrome
MAP	: Mean arterial blood pressure
NSM	: Neurogenic stunned myocardium
SAH	: Subarachnoid haemorrhage
SAH	: Subarachnoid hemorrhage
SCD	: Sudden cardiac death
TBI	: Traumatic brain injury
TCAs	: Tricyclic antidepressants
VF	: Ventricular fibrillation
VT	: Ventricular tachycardia

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Introduction

Traumatic brain injury (TBI) is a major public health concern **(Vijay et al., 2014)**. Complications after TBI known as second insults can worsen neurologic and patient outcomes **(Jeremitsky et al., 2003).**

Acute myocardial damage and heart failure can happen during brain injury in patients without a history of basic cardiovascular pathology **(Polderman et al., 2000).**

Cardiovascular complications are common after brain injury and are associated with increased mortality and morbidity **(Tamsin and Martin, 2012).**

Patients with head trauma may have a variety of electrocardiographic changes **(Macmillan et al., 2002).**

The neurogenic stunned myocardium (NSM) syndrome is characterized by ECG changes, cardiac arrhythmias, release of biomarkers of cardiac injury, and left ventricular dysfunction **(Tamsin and Martin, 2012).**

These changes may be disturbance of rate , rhythm , P wave, QRS complex which may be in the form of prolonged Q-T interval, ST segment elevation or depression, inversion or peaking of T wave and large positive U wave **(Collier et al., 2004).**

The association of specific ECG changes with intracranial disease has been recognized for 5 decades. ECG abnormalities occur most often in patients with subarachnoid hemorrhage, but also have been described in cases of ischemic stroke, intracranial hemorrhage, head trauma, neurosurgical procedures, acute meningitis, intracranial space-occupying tumors, and epilepsy **(Surawicz, 1995).**

Brain injury-related ECG abnormalities are particularly common after SAH where they are reported in 49–100% of cases. The most common findings are ST segment changes, flat or inverted T waves, prominent U waves, and prolongation of the QTc interval (QTc is the QT interval corrected for heart rate) **(Grunsfeld et al., 2005).**

Cardiac rhythm disturbances, including sinus tachycardia, atrial fibrillation, premature atrial and ventricular contractions, and AV dissociation, are also common after brain injury and usually occur within the first 7 days **(Baguley et al., 2006).**

The majority of studies suggest that these electrocardiographic abnormalities result from disturbances in the autonomic nervous system promoting a local excess of catecholamines associated with enhanced adrenal production and activation of the calcium channels leads to an increase in cytosolic and mitochondrial calcium as well as release of free radicals causing contraction band necrosis and reflected as electrocardiogram alterations **(Baguley et al., 2006).**

Traumatic brain injury (TBI) and subarachnoid haemorrhage (SAH) induce a systemic catecholamine ‘storm’ driven by the central neuroendocrine axis which massively increases sympathetic outflow and activates the adrenal glands. Damage to the insular and hypothalamus also initiates a complex cascade of events, including activation followed by dysfunction of the autonomic nervous systems and an intense inflammatory response, which have major adverse effects on the heart **(Tamsin and Martin, 2012).**

Early ECG may serve as an inexpensive test to screen for cardiac dysfunction prior to ordering more expensive and potentially more invasive testing. So, ECG should be amandatory investigation for all patients with isolated traumatic brain injury **(Jeremitsky et al., 2003).**

Aim of the Work

If there are ECG changes in head trauma and certain type of brain injuries, a 12-lead ECG may be an important and inexpensive screening tool to evaluate TBI patients for cardiac dysfunction prior to further diagnostic studies or interventions, which will be useful in managing these cases and in selection and adjusting medication for TBI patients.

Chapter (1)

Head Trauma

Head injuries are among the most common types of trauma seen in North American emergency departments, with an estimated 1 million cases annually. Many patients with severe brain injuries die before reaching a hospital, and almost 90% of prehospital trauma-related deaths involve brain injury. About 70% of patients with brain injuries who receive medical attention can be categorized as having minor injuries, 15% as moderate, and 15% as severe. In 2003 there were an estimated 1,565,000 traumatic brain injuries (TBIs) in the United States, including 1,224,000 visits, 290,000 hospitalizations, and 51,000 deaths. Survivors of TBI are often left with neuropsychologic impairments that result in disabilities affecting work and social activity.

Every year up to 90,000 people in the United States suffer long-term disability from brain injury. In an average European country (Denmark), 363 per million inhabitants suffer moderate to severe TBI yearly, with more than one-third of these requiring brain injury rehabilitation. Therefore, even a small reduction in the mortality and morbidity resulting from brain injury should have a major impact on public health **(Faul and Wald et al., 2010)**

One study searching for the leading causes of TBI in Egypt in 2010, found Male sex was predominantly affected, 79% of cases. Moderate and severe injuries account for 17.2% of all TBI presented cases **(Montaser and Hassan, 2010)**

In another one in Egypt found that road traffic accident was the commonest cause of trauma in 73.7% of the patients. 62.1% of the patients had mild head injury, 17.5% of the patients had moderate head injury, while the remaining 20.3% had severe head injury. Brain contusions, Brain edema, and epidural hematoma were the commonest traumatic pathology in 39.1%, 36.5%, 17.6% respectively. 63.6% of the patients had associated injuries rather than head injury. Good recovery was reported in 62.7% of the patients, moderate disability in 12.1% of the patients, while the mortality rate was 14.3% of the patients **(Taha and Barakat, 2016).**

Anatomy:

A review of cranial anatomy includes the scalp, skull, meninges, brain, ventricular system, cerebrospinal fluid, and tentorium (figure 1).

Scalp:

The scalp is made up of five layers of tissue that cover the skull: skin, connective tissue, aponeurosis, loose areolar tissue, and pericranium. Loose areolar tissue separates the aponeurosis from the pericranium and is the site of subgaleal hematomas. Because of the scalp's generous blood supply, scalp lacerations may result in major blood loss, especially in infants and children **(Oishi and Luce, 1995).**

Skull:

The skull is composed of the cranial vault (calvaria and the base). The calvaria is especially thin in the temporal regions but is cushioned here by the temporalis muscle. The base of the skull is irregular, which may contribute to injury as the brain moves within the skull during acceleration and deceleration.

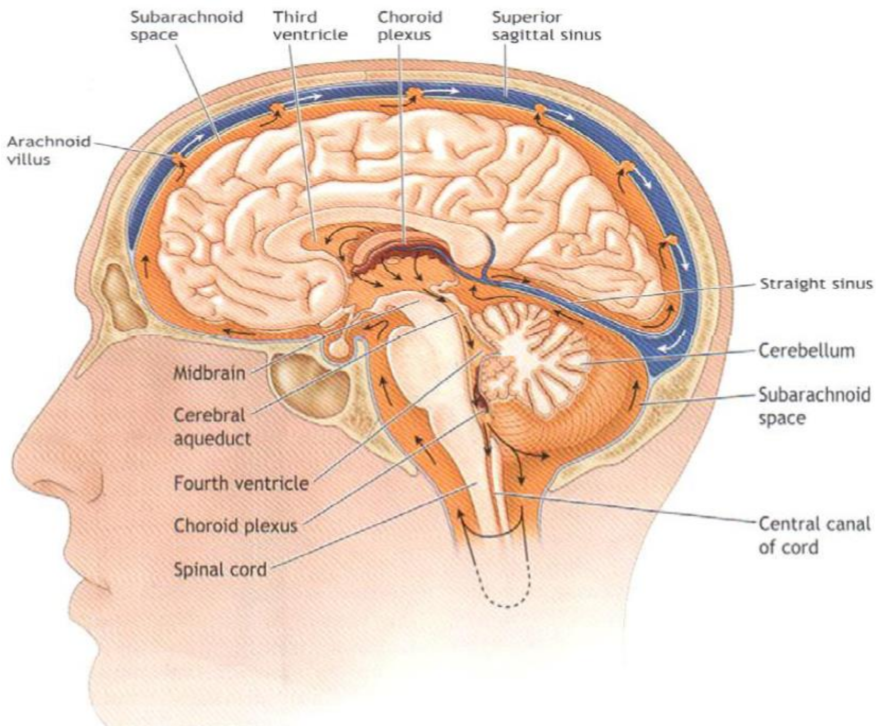

Fig. (1): Overview of cranial anatomy.

The floor of the cranial cavity is divided into three distinct regions: the anterior, middle, and posterior cranial fossae. Simply put, the anterior fossa houses the frontal lobes, the middle fossa the temporal lobes, and the posterior fossa the lower brainstem and the cerebellum **(Parent and Carpenter, 1995).**

Meninges:

The meninges cover the brain, and consist of three layers: the dura mater, arachnoid, and pia mater (figure 2). The dura mater is a tough, fibrous membrane that adheres