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Original Article

Evaluation of near infrared spectroscopy as screening tool for detecting intracranial hematomas in patients with traumatic brain injury

Wg Cdr V. Trehan [a], *Gp Capt Vikas Maheshwari* [b,*], *Wg Cdr S.V. Kulkarni* [c], *Gp Capt Sanjeev Kapoor* [d], *Gp Capt Anurakshat Gupta* [e]

[a] *Classified Specialist (Surgery) & GI Surgeon, Base Hospital, Delhi Cantt 110010, India*
[b] *Senior Adviser (Surgery) & Neurosurgeon, Command Hospital (Southern Command), Pune 411040, India*
[c] *Classified Specialist (Surgery) & GI Surgeon, Command Hospital (Southern Command), Pune 411040, India*
[d] *Senior Adviser (Surgery & Orthopaedics), 5 Air Force Hospital, Assam, India*
[e] *Associate Professor, Department of Surgery, Armed Forces Medical College, Pune 411040, India*

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ABSTRACT

Background: Traumatic Brain Injury (TBI) is one of the most common surgical emergencies in service hospitals of India. Computed tomography (CT) has been a consistent and reliable technique for detecting intracranial hemorrhages but is limited by its non-availability in most service hospitals. Therefore the need for a cheaper, portable and easily available option required to be explored. The aim of this study was to determine the sensitivity, specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) of Near Infra Red Spectroscopy (NIRS) against the gold standard of NCCT head.

Methods: An observational, prospective study was conducted in 100 patients of closed head injury, attending the emergency department or surgical OPD of a service zonal hospital with NIRS. All these patients were subsequently subjected to NCCT head. Sensitivity, specificity, and positive and negative predictive values of NIRS were calculated. The study was conducted from Oct 2010 to Jul 2012.

Results: All the 100 patients were evaluated with NIRS and subsequently subjected to NCCT head. The results were compiled and statistical analysis of the same was conducted. The data revealed a sensitivity of 58.46%, a specificity of 42.86%, a positive predictive value of 65.52% and a negative predictive value of 35.71%.

Conclusion: Near Infra Red Spectroscopy (NIRS) is a good screening tool for prediction of intra cerebral haemorrhage in the field and even intensive care units. This was the first study of its kind in the Indian subcontinent and the results suggest that NIRS is a good device to predict intracranial subdural and epidural haematomas. It is however not superior to computer tomography and magnetic resonance imaging.

* *Corresponding author.*
E-mail address: drvikas08@rediffmail.com (V. Maheshwari).
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Introduction

Traumatic Brain Injury (TBI) is one of the most common neurosurgical emergency in both civil and military parlance. Patients with TBI may develop Intracranial Haemorrhage (ICH), brain parenchymal injuries in the form of contusion, oedema or diffuse axonal injury (DAI). It is of utmost importance to diagnose these lesions early, initiate prompt treatment to prevent secondary brain injuries resulting from hypoxia, hypothermia and other metabolic abnormalities.[1] Amongst the various available imaging modalities computed tomography (CT) is the most consistent and reliable technique for detecting ICH.[2–4] However some of its limitations are non-availability in field locations, exposure to ionizing radiation, and difficulty in shifting a haemodynamically unstable patient.

Taking this into consideration, there is certainly a requirement of an imaging technique which is simple to use, is non-invasive, less expensive, portable and which can be used in the field by both doctors and paramedical staff. Near Infra Red Spectroscopy (NIRS) is one such device fulfilling the above criteria.[5] In this study the sensitivity, specificity, positive predictive value of NIRS was measured.

Material and methods

An observational, prospective study was conducted from October 2010 to July 2012 on100 patients of closed head injury. All these 100 patients were evaluated with NIRS first and subsequently subjected to NCCT head.

Inclusion criteria

All patients brought to the hospital with history suggestive of head injury.

Exclusion criteria

1. Patients having scalp laceration or any active bleeding
2. Large local scalp haematoma (extra cranial haematoma)

Diagnostic study

A prospective observational study was conducted from October 2010 to July 2012. The patients were evaluated initially with NIRS and then followed by NCCT head. The radiologist and the surgeon were mutually excluded from their respective observations.

Principle of Near Infra Red Spectroscopy (NIRS)

Near Infra Red Spectroscopy (NIRS) is a portable bedside, non-invasive and battery powered device for detecting ICH. It is a handy device to diagnose ICH in field locations, intensive care units (ICU) and emergency rooms for quick triage. Near infra-red light is capable of penetrating scalp, the bony skull, dura and the brain parenchyma. The principle used to identify ICH with NIRS is that the extra vascular blood absorbs NIR light more than the intra-vascular blood. Acute intracerebral bleed therefore has a attenuated signal in comparison to normal brain on the contralateral side. Thus, ICH can be detected by difference in optical density (ΔOD).

Fig. 1 – Crain scan.

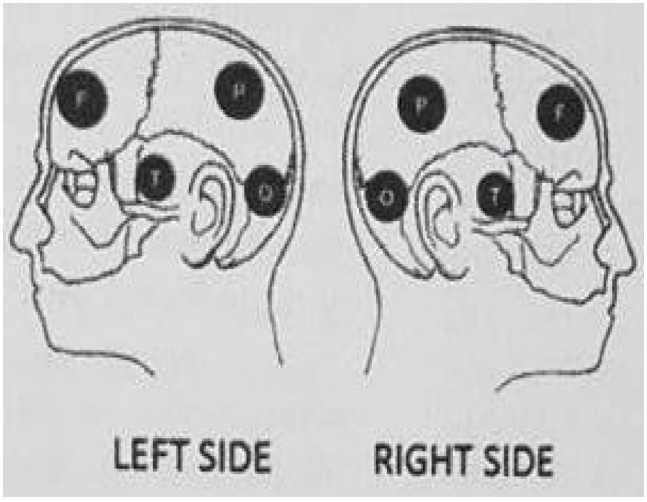

Fig. 2 – Sites of NIRS probe placement.

The NIRS device used for the study (Crain Scan) is shown in Fig. 1. The device has a laser source and photo receiver, which are applied over the scalp of the patient. The reflected activity of near Infra Red light (IR) gets reduced in the presence of haemorrhage. Usually a 4 cm distance between the source and the detector suffices to measure a tissue volume of 2×2.5 cm. The NIRS probe is placed successively on frontal, temporoparietal and occipital region on either side of the scalp Fig. 2. The device measures the difference in absorption of near IR light (at 785 nm wavelength) between the normal and the affected site i.e. ΔOD.[6,7,3] As per the instrument specification, the difference in $\Delta OD > 0.45$ was considered clinically significant.[8]

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