Volume - 12 | Issue - 07 | July - 2023 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

# ROLE OF NEAR-INFRARED DEVICE AS A SCREENING TOOL FOR THE DETECTION OF INTRACRANIAL HEMORRHAGE IN STROKE AND TRAUMA

Neurology



| | |
|---|---|
| **Dr. Dhivya Selvaraj*** | DM Neurology Resident *Corresponding Author |
| **Dr. Sivakumar. S** | Professor and Head, Department of Neurology, GMKMC, Salem |
| **Dr. Thiruvarutchelvan. K** | Professor, Department of Neurology, GMKMC, Salem. |
| **Dr. Selvaraj. C** | Assistant Professor, Department of Neurology, GMKMC, Salem |
| **Dr. K. S. Raja** | Assistant Professor, Department of Neurology, GMKMC, Salem |




## ABSTRACT

**Background:** Computed Tomography (CT) is the gold standard test to detect intracranial hemorrhages. Infra-scanner is a portable and easy to use device without any radiation exposure that functions based on Near InfraRed Spectroscopy (NIRS) to identify haemorrhages. It takes minimal time and can be done by any field staff with minimal training. In this prospective study, we assessed the usefulness of NIRS in acute stroke and head trauma patients as compared to CT brain. **Methods:** NIRS were performed on eight anatomical points on the scalp, bilateral frontal, temporal, parietal and occipital regions. The device will show a red mark if it detects a higher haemoglobin concentration and green mark if no hemorrhage is detected. Non-contrast CT of the brain was considered the reference standard. This study included 100 patients of acute stroke and 70 patients of acute head injury admitted in emergency department who were planned for CT brain. Data analysed with SPSS 16 software. **Results:** Sensitivity of infrascanner was 87.2%, specificity was 78.9% with positive predictive value of 83.7% and negative predictive value of 83.3% in stroke patients. Among head injury patients, sensitivity was 93.8%, specificity was 66.7% with positive predictive value of 96.7% and negative predictive value of 50%. **Conclusions:** The diagnostic performance of NIRS is modest in stroke and head injury patients. It cannot replace CT, however NIRS being a non-invasive and quick test, may be useful as a screening tool to identify intracranial hemorrhage in pre-hospital triage like ambulance.



## KEYWORDS

Acute stroke, traumatic head injury, near infrared spectroscopy.


## INTRODUCTION:

The worldwide burden of stroke remains high. Increase in stroke onset time to treatment correlated with worse outcome. Stroke subtype determination between ischemic and hemorrhagic stroke, is not confirmed until the patient reach hospital for CT, resulting in suboptimal pre-hospital triage and delayed treatment. The Computed Tomography (CT) scan is the gold standard for identification and localization of traumatic intracranial hematomas as well as hemorrhagic stroke; however, its high cost, limited availability in primary care centres and radiation exposure restricts its use in many situations. Infrascanner is a portable and easy-to-use device without any radiation exposure that functions based on near infrared spectroscopy and is found to be useful in the detection of brain hematomas in traumatic brain injury patients[1]. Several studies showed that sensitivity and specificity of the NIRS for intracranial hematoma are varied[2-5]. There are no adequate studies regarding the use of NIRS in stroke. In this study, we evaluated the usefulness of this innovative technology in assessing traumatic as well as non-traumatic hemorrhage as compared to the CT imaging of brain.

## AIM:

To evaluate the diagnostic reliability of Infra-scanner in detecting intracranial hemorrhages as compared to CT brain

## OBJECTIVES:

To detect intracranial hemorrhages using NIRS in acute stroke patients and in traumatic brain injury patients and to compare the results of NIRS with CT brain

**Period of study**: `6 months (March 2022 – August 2022)

**Type of study**: Prospective, Analytical study

**Inclusion Criteria:**

All adult patients (age > 12 years) presenting to emergency department with acute stroke and traumatic brain injury and willing to participate in the study.

**Exclusion Criteria:**

Patients who had previous history of cranial surgery, shock or cardiac arrest. Very sick patients like those with unstable vitals, anisocoria, those who need immediate CT and intervention are excluded from the study.

**Methodology:**

After the eligible patients gave an informed consent, the NIRS examination was performed and followed by the computed tomography of the brain. The Infrascanner measurements were performed in eight symmetrical anatomical points (frontal, temporal, parietal, and occipital) over the patient's head. The landmark of each area were as follows: frontal site: above the supra orbital ridge and below the hair line; temporal site: temporal fossa above the pinna of the ear; parietal site: midway between temporal area and vertex; and occipital site: on either side of the occipital protuberance. Since scalp hematomas may cause false positive NIRS results, NIRS probe was kept 1-2 cm away from the scalp injury.

If hemorrhage is present, the monitor will show red spot. If no hemorrhage is found, monitor will show green spot as shown in fig.1. Procedure was done by a trained resident in Neurology. Time taken for NIRS procedure was 4-6 minutes on average. CT brain done by 128 slice scanner. CT reported by a Radiologist. Both NIRS and CT brain results were blind to both the NIRS examiner and the Radiologist.

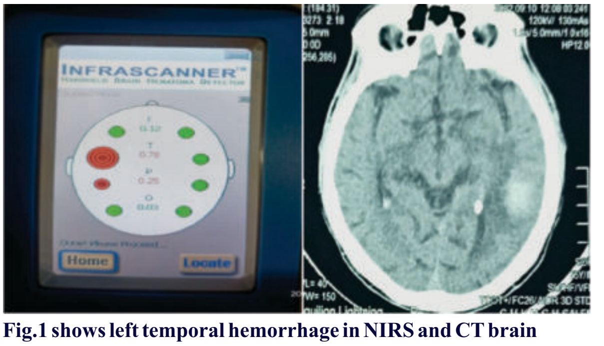



**Fig.1 shows left temporal hemorrhage in NIRS and CT brain**

**Data collection**:

Baseline characteristics of all eligible patients were recorded. The Infrascanner exam data were collected on the results of the presence or absence of hemorrhage, location of the hemorrhage, the difference in optical density (ΔOD). The CT brain results were recorded on presence and the location of hemorrhage (subdural, epidural, intracerebral and subarachnoid hemorrhage).

**Statistical analysis**:

Data were entered in excel sheet and analysed using SPSS 16 software. The primary endpoint of the study was a description of diagnostic properties of the NIRS compared with the CT brain including sensitivity, specificity, positive predictive values(PPV), negative predictive values(NPV), area under the receiver operating curve(ROC).

## RESULTS:

There were 170 patients enrolled in the study after fulfilling inclusion and exclusion criteria and obtaining informed consent. Out of 170 patients, 100 patients had acute stroke and 70 had acute head injury. Among stroke, 70 had ischemic stroke and 30 had hemorrhagic stroke. Age group among stroke was 28-75 years, among head injury patients was between 23-70 years, mean age in both groups was between 58 – 65 years. There is no sex predilection in stroke group whereas males are more among head injury patients. Results of NIRS scan were recorded by trained Neurology residents (table 1). CT reports were collected from the Radiologist. NIRS results were compared with CT brain (table 2).

**Table 1 NIRS performance in trauma and stroke**

| | | | Trauma | Stroke | Total |
|---|---|---|---|---|---|
| NIRS bleed | no | Count | 8 | 64 | 72 |
| | | % | 11.4% | 64% | 42.4% |
| | yes | Count | 62 | 36 | 98 |
| | | % | 88.6% | 36% | 57.6% |
| Total | | Count | 70 | 100 | 170 |
| | | % | 100.0% | 100.0% | 100.0% |

Table 2 Cross-tabulation of NIRS and CT findings

| | | | bleed on CT | | Total |
|---|---|---|---|---|---|
| | | | no | yes | |
| NIRS bleed | | no | 60 | 12 | 72 |
| | | % | 78.9% | 12.8% | 42.4% |
| | | yes | 16 | 82 | 98 |
| | | % | 21.1% | 87.2% | 57.6% |
| Total | | Count | 76 | 94 | 170 |

Among ischemic strokes (70), NIRS detected 14 patients as hemorrhage, out of which 6 were hemorrhagic transformation as confirmed by CT brain. Rest 8 patients had massive cerebral ischemia later detected in CT brain which NIRS detected as bleed. Among hemorrhagic strokes (30), NIRS detected 22 patients. Rest 8 patients were deep seated and tiny hemorrhages which were missed by NIRS.

Among head trauma patients, NIRS detected bleed in 62 patients. Out of remaining 8 patients, CT detected bleed in 4 patients and rest of the 4 patients had no bleed even in CT scan. It can be used as out-patient basis for all alleged head trauma to identify whom to refer for CT imaging especially in minor trauma, pediatric and antenatal patients.

The difference in optical density (ΔOD) in case of the NIRS positive was between 0.21 and 1.95. The sensitivity and specificity of NIRS in stroke and head trauma were shown in table 3. Area under ROC curve were shown in figure 2a,2b.

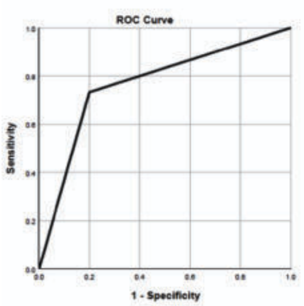
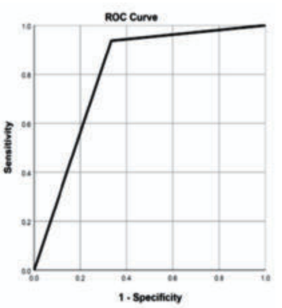



**Fig.2a:** Stroke patients AuROC – 0.767




**2b:** Head Trauma patients AuROC – 0.802

**Table 3 - Diagnostic properties of NIRS as compared with CT brain**

| Diagnostic performance of NIRS | In stroke patients | In trauma patients |
|---|---|---|
| Sensitivity (95% confidence interval [CI]) | 87.2 (74.3-95.2) | 93.8 (79.2-99.2) |
| Specificity (95% CI) | 78.9 (62.7-90.5) | 66.7 (9.4-99.1) |
| Positive predictive value (95% CI) | 83.7 (70.3-92.7) | 96.7 (83.3-99.9) |
| Negative predictive value (95% CI) | 83.3 (67.2-93.6) | 50.0 (6.8-93.2) |

## DISCUSSION:

This study showed that NIRS has modest sensitivity (87.2%) and specificity (78.9%) among stroke patients with 95% confidence interval ranges from 74.3 – 94.5 for sensitivity and 62.7-90.5 for specificity. This implies though NIRS is not accurately diagnosing all haemorrhages, it detects most of the superficial bleeds and massive infarcts as bleeds. Hence it can be used as a screening tool in pre-hospital setting or in triage. Also, it detects even the smaller bleeds like hemorrhagic transformation in ischemic stroke which can be used at bedside in ICU to monitor any hemorrhagic transformation post-thrombolysis or after mechanical thrombectomy from time to time as it is a non-invasive, without any radiation exposure and portable, need not shift patient every time to CT room.

This study implies a good sensitivity (93.8%) and positive predictive value (96.7%) in head trauma patients as compared to other studies [1] although specificity is low. Among head injury, most common etiology observed in this study was road traffic accident followed by assault and self fall. NIFS detects extra-axial bleeds (subdural and epidural hemorrhages) better when compared to intra-axial bleeds. 8 patients where NIRS failed to detect actual bleed were subarachnoid hemorrhage (cisternal and inter-hemispheric) and deep seated bleeds. In some of the previous studies, it is mentioned that the efficacy of NIRS was to detect blood volume >3.5 ml and <2.5cm depth from the brain surface[4,5]. These parameters were not analysed in this study.

There are not much studies available on the use of this portable device in stroke patients unlike in traumatic intracranial hematomas. Hence this study can lead a way for future studies on utility of near infrared spectroscopy device in stroke ICU centres.

## CONCLUSION:

The diagnostic performance of NIRS is modest in stroke and head injury patients. It cannot replace the gold standard CT imaging of brain. However, NIRS being a non-invasive and quick test, may be useful as a screening tool to identify hemorrhage in stroke patients in pre-hospital triage or in places were CT scan is not available. This portable device can be handled by ambulance personnel, emergency technicians and any field staff permitting better triage and earlier treatment of both stroke and head injury patients. Further studies are needed to validate these findings.

**Limitations:**

Size of bleed and exact location of the bleed whether extradural or subdural cannot be identified. Also it is difficult to say whether it is intraparenchymal or subarachnoid, Arterial or venous hemorrhage.

**Author Disclosure Statement:**

No competing financial interests exist.

## REFERENCES

1. Chaiyaporn Yuksena, et al. Diagnostic properties of a portable near-infrared spectroscopy to detect intracranial hematoma in traumatic brain injury patients. European Journal of Radiology Open 7 (2020) 100246
2. Peters, Van Wageningen, Hoogerwerf, et al. Near-Infrared Spectroscopy: A Promising Prehospital Tool for Management of Traumatic Brain Injury. Prehosp Disaster Med. 2017;32(4)
3. L. Xu, X. Tao, W. Liu, Y. Li, J. Ma, T. Lu, B. Han, B. Liu, Y. Zhao, J. Li, J. Zhao, Portable near-infrared rapid detection of intracranial hemorrhage in Chinese population, J. Clin. Neurosci. 40 (2017) 136–146, https://doi.org/10.1016/j.jocn.2017.02.056.
4. Robertson, E.L et al ,Clinical Evaluation of a Portable Near-Infrared Device for Detection of Traumatic Intracranial Hematomas. JOURNAL OF NEUROTRAUMA 27:1597–1604 (September 2010)
5. J. Leon-Carrion, J.M. Dominguez-Roldan, U. Leon-Dominguez, F. Murillo-Cabezas et al, The Infrascanner, a handheld device for screening in situ for the presence of brain haematomas. Brain Injury, September 2010; 24(10): 1193–1201
6. Francis, S.V., Ravindran, G., Visvanathan, K., and Ganapathy, K.(2005). Screening for unilateral intracranial abnormalities using near-infrared spectroscopy: a preliminary report. J. Clin. Neurosci. 12, 291–295.
7. M.A. Correa et al. Implementation of the infrascanner in the detection of post-traumatic intracranial bleeding: A narrative review. Brain Disorders 5 (2022) 100026
8. Gopinath SP, Robertson CS, Contant CF, Narayan RK,Grossman RG, Chance B. Early detection of delayed traumatic intracranial hematomas using near-infrared spectroscopy. Journal of Neurosurgery 1995;83:438–444.

PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

9. Strangman G, Boas DA, Sutton JP. Non-invasive neuroimaging using near-infrared light. Biological Psychiatry 2002; 52:679–693
10. C.Y. Liang, Y. Yang, C.S. Shen, H.J. Wang, N.M. Liu, Z.W. Wang, F.L. Zhu, R.X. Xu, Chinese military evaluation of a portable near-infrared detector of traumatic intracranial hematomas, Mil. Med. 183 (2018) e318–e323, https://doi.org/10.1093/milmed/usx088.