



# CLINICAL UTILITY OF SPECT NEUROIMAGING IN THE DIAGNOSIS AND TREATMENT OF TRAUMATIC BRAIN INJURY: AN UPDATED SYSTEMATIC REVIEW

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## ABSTRACT

**The purpose of this study is to update findings from a previous systematic review and to assess the clinical utility of single photon emission computed tomography (SPECT) in the diagnosis and treatment of traumatic brain injury (TBI).<sup>1</sup>**

Data analysis included 14 cohort studies not available in the previous systematic review. A narrative synthesis compared sensitivity and specificity of brain SPECT for TBI of all severity.

Preliminary results indicated that cross-sectional and longitudinal cohort studies have reported positive relationships between brain SPECT and TBI. These findings must be replicated in RCTs with large samples.

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## INTRODUCTION

TBI is a major public health issue and an economic strain on healthcare. It is estimated that 69 million people suffer from TBI annually worldwide, and the majority of cases are mild (81%) and moderate (11%) brain injury.<sup>2</sup>

SPECT is a metabolic scan that has evolved since its initial development in 1960's. It is a nuclear imaging modality that uses radioactive tracers to develop 3D images of blood flow.<sup>3</sup>

Abnormalities are typically detected based on visual assessments. Brain SPECT produces lower quality images compared to other imaging modality such as PET scan. Visual inspection alone may lead to false positives without corrections.<sup>4</sup>

Quantitative analysis (e.g., Chang's correction technique) using normal database increases the reliability of findings for brain SPECT.<sup>4</sup>

## METHODS

This review followed the protocols outlined in the PRISMA 2020 guidelines and was submitted to PROSPERO for approval (ID: CRD42021276772).<sup>5</sup>

PubMed, MEDLINE (Ovid), Embase (Ovid), Google Scholar, and citation searching were utilized to identify relevant articles published in English between December 2012 to July 2021.

Search results from electronic databases are uploaded in Mendeley and charted in Excel. Duplicates are automatically removed and examined for accuracy.

RCTs, longitudinal and cross-sectional cohort studies that used brain SPECT to evaluate patients with TBI will be included for analysis.

Measures of diagnostic accuracy were extracted for analysis (sensitivity/specificity).

## RESULTS

Search strategy from the previous systematic review was replicated, and 2235 articles were found from three electronic databases PubMed (n=720), Ovid Medline (n=671), Ovid Embase (n=843), and other sources (n=1).

Search results were uploaded into a reference management software and 211 duplicates were removed. An additional 1915 records were eliminated after title and abstract screening. Investigators reviewed the full text of 109 articles. The analysis included 14 cohort studies (11 cross-sectional and 3 longitudinal studies).

The combined sample size for this study is 21,689 persons with TBI of all severity (20746 participants were included in a single retrospective cohort study conducted by Amen et al. 2015).

All studies reported positive findings between brain SPECT and TBI to an extent. However, there were mixed findings for some conditions such as post concussion syndrome and depression.

No RCT were found and methodology greatly differed between studies. Heterogeneous data precludes performing a meta-analysis.

Study	Sensitivity	Specificity
Jacobs <sup>6</sup> 1996	78% - 100%	53% - 85%
Uruma <sup>7</sup> 2013	73% - 100%	75% - 83%
Raji <sup>8</sup> 2015	80% - 92%	64% - 85%
Amen <sup>9</sup> 2015	67% - 100%	54% - 100%
Amen <sup>10</sup> 2016	86% - 90%	80% - 87%

**TABLE 1. BRAIN SPECT SENSITIVITY AND SPECIFICITY RANGE REPORTED IN COHORT STUDIES**

## DISCUSSION

The bottom line is that clinicians should interpret the SPECT findings in the context of clinical history. This view is consistent with correspondence between Adinoff and Devous (2010)<sup>11</sup> and Amen (2010)<sup>12</sup>, who agreed that the evidence base to support the application of SPECT for diagnosis and treatment without the consideration of other sources of data is insufficient. As a rule of thumb in clinical medicine, imaging, laboratory, and radiological findings need clinical correlation. As noted by Amen (2010)<sup>12</sup>, "Thoughtful clinicians would never use SPECT in isolation. That is not how imaging is or should be practiced."

A widely accepted standardized protocol need to be established for brain SPECT and TBI. Correlation is not causation. Future research on this topic should utilize better study designs to enhance the strength of evidence available in the current literature.

## CONCLUSIONS

In conclusion, there is no consensus among experts about the clinical utility of brain SPECT. SPECT is currently not the gold standard diagnostic imaging to investigate TBI. CT Scan and MRI are widely used and acceptable diagnostic imaging for TBI. Future studies need to include scientifically rigorous methodology in order to reduce significant risk of bias.

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