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Review article

Motor cortex excitability in attention-deficit hyperactivity disorder (ADHD): A systematic review and meta-analysis



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ABSTRACT

Background: The core characteristic of attention deficit hyperactivity disorder (ADHD) is a persistent pattern of inattention and/or hyperactivity-impulsivity that causes developmental or functional impairment. Observational studies have investigated neurophysiological features in individuals with ADHD using transcranial magnetic stimulation (TMS) to identify which intracortical mechanisms are associated with the symptoms. This systematic review aimed to assess the quality of these studies and present meta-analyses of the available neurophysiological measures.

Methods: This systematic review searched the PubMed, Scopus, Web of Science, with no date restrictions. The methodological quality of observational studies was assessed utilizing the Agency for Healthcare Research and Quality (AHRQ) criteria for observational studies. The analysis of the mean and standard deviation of the neurophysiological measurements was performed using the RevMan software version 5.0 for the meta-analyses of studies.

Results: Nine publications that met the inclusion criteria were evaluated. Most of the AHRQ criteria were satisfied, indicating the good quality of the studies. On comparing subjects with ADHD and controls, the forest plot profiles were similar in respect to the resting motor threshold (RMT), and silent period (SP) but a significant difference was found for short intracortical inhibition (SICI).

Conclusion: This meta-analysis found reduced SICI in individuals with ADHD, when compared with controls. Given the small number of studies, it is important that further studies be conducted for a more robust conclusion to be formed.

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What this paper adds?

This systematic review shows that individuals with ADHD had lower cortical inhibition than healthy subjects. This finding is an important aspect that should be highlighted in the neurophysiological understanding of ADHD

1. Introduction

Attention-deficit hyperactivity disorder (ADHD) can be considered one of the most prevalent psychiatric disorder of childhood with a prevalence estimated between 5 and 10% (American Psychiatric Association, 1980; Biederman, 2005; Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007). The main symptoms of ADHD are impulsivity, hyperactivity and inattention. These symptoms seem to persist into adulthood in about 50–60% of cases, with a prevalence of 2.5% in the general population (American Psychiatric Association, 1980; Barkley, Fischer, Smallish, & Fletcher, 2002; Mick, Faraone, & Biederman, 2004). The disorder is associated with a host of other difficulties such as cognitive, developmental and academic difficulties, and even physical health-related problems (Barkley, 2008).

The diagnosis of ADHD is established clinically based on the criteria listed in the Diagnostic and Statistical Manual of Mental Disorders (DSM) and in the International Classification of Diseases (ICD), in combination with a physician's clinical impression (Rubio et al., 2015). Similar to other psychiatric disorders, there is still no biomarker with sufficient predictive power to diagnose ADHD in children and adults (Dias et al., 2013). The lack of reliable diagnosis may result in inadequate clinical management of ADHD. Transcranial magnetic stimulation (TMS) may be useful to help to address this limitation.

TMS is an established neurophysiological tool used to examine neural circuitry in respect to neurological and psychiatric disorders (Groppa et al., 2012; Kobayashi & Pascual-Leone, 2003) including ADHD (Bunse et al., 2014). Indeed, some studies have suggested that some TMS measurements, in particular intracortical inhibition, may be a neurophysiological marker of ADHD (Gilbert, Isaacs, Augusta, Macneil, & Mostofsky, 2011; Wu, Gilbert, Shahana, Huddleston, & Mostofsky, 2012). However, to apply TMS measurements in the clinical practice for the diagnosis of ADHD, it is important to evaluate critically existing literature to ascertain the current level of evidence on this issue. Therefore, this systematic review aims to provide an up-to-date view of publications related to the use of TMS as a diagnostic tool in ADHD, regarding the measurement of the main neurophysiological parameters used by this noninvasive technique.

2. Methods

2.1. Literature search

A literature search of the following databases was performed with no date restriction: PubMed, Scopus, Web of Science. The key search terms used were “cortical excitability”, “transcranial magnetic stimulation”, “attention deficit disorder with hyperactivity”, and “motor excitability”. These terms were used in various combinations to find relevant studies. Furthermore, the references of all papers found were checked to find publications not identified in the initial search. The investigation was carried out between October 2014 and April 2015 with no language restriction.

The search was performed by two authors independently (A.B. and T.D.) who screened the title and abstract of papers found by the initial search strategy against the inclusion criteria (Table 1) of this study. Differences of opinion between the authors were resolved by consensus.

2.2. Outcome measures

The following measures were considered: motor evoked potential (MEP), motor threshold (MT), intracortical inhibition and facilitation (SICI and ICF), and silent period (SP).

2.3. Quality assessment

The quality and validity of each article comprising this analysis were assessed using the Agency for Healthcare Review and Quality—AHRQ (West et al., 2002) criteria for observational studies. The items “study groups comparable to non-participants with regard to confounding factors”, “length of follow-up adequate for question”, “modeling and multivariate techniques appropriate” and “dose-response assessment if appropriate” of the AHRQ were not applied to this analysis because these

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