

Transcranial Doppler Sonography Diagnostic Value for the Cerebral Flow Velocity Changes in Different Types of Headache: A Review Article

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Abstract: *The disproportion of the cerebrovascular response during brain activity is related to the etiology of migraine. Previous research tried to figure out if transcranial Doppler (TCD) might detect variations in brain flow velocity during the interictal phase of typical migraine. The goal of this review was to establish the diagnostic utility of transcranial Doppler (TCD) for variations in cerebral flow velocity during the interictal phase of various headache types. A comprehensive literature search was conducted on PubMed to find research that employed transcranial Doppler for distinct cerebral arteries in the interictal period; 15 articles were assessed, and ictal monitoring studies were discarded. We found increased cerebral flow in migraineurs and most frequent vessel with TCD abnormality was MCA then ACA, and lastly the PCA. As previously documented, higher flow velocity in migraine sufferers is thought to be due to arteriolar vasodilation rather than decreased lumen diameter in the insonated major arteries., increased neuronal excitability and neurovascular coupling in migraine. This altered visual processing in migraine patients and stronger changes in the MCA velocity can be used as prognostic tools, predicting more frequency of attacks with stronger CBFV changes*

Keywords: Migraine, tension headache, cerebrovascular reactivity, Middle cerebral artery

1. Introduction

Migraine affects around 12% of population. About 30% of these individuals, migraine episodes are preceded by temporary cortical malfunction, referred to as aura. (1).

The processes behind migraine pain are still unknown, and the involvement of vascular and neurological pathways has been extensively explored and investigated, although for most of the twentieth century, migraine research was dominated by the vascular theory of vasodilation as a cause of migraine. (2)

Factors behind pathophysiology of migraine still not completely clear, and no physiological indicators have yet been confirmed. When aura symptoms were present, cerebral blood flow was reported as values low as 23 mL/100 g per minute during migraine episodes, this was reported according to artery diameter changes during migraine attacks using MRA. (3) One of the theory for migraine headache is the altered excitability of the brain that lead to trigeminovascular system stimulation in genetically susceptible individuals. (4)

Transcranial Doppler is a noninvasive technique that uses a pulsed ultrasonic beam to assess the cerebral blood flow parameters in the cerebral arteries as well as the cerebrovascular reserve. TCD research in migraine, on the other hand, show mixed outcomes. (5)

Hypersensitivity to multiple internal and extrinsic stimuli is one of the most important pathophysiological changes in migraine. Due to a lack of habituation, migraineurs have a weaker adaptability to environmental stimuli than healthy

controls. Cerebral vasoreactivity may also inherit these traits. (6).

Hemodynamics abnormalities were reported in many migraine patients studies (11) Some of them have showed raising in cerebral blood flow, other studies showed normal flow (7). This changes extended to cerebral flow between patients suffering from migraine with aura and those without aura. (8)

2. Transcranial Color Coded Doppler

Transcranial color - coded duplex ultrasonography (TCCS) provide a very easy and helpful tool for examination of exploring the cerebral vessels through the skull by coloring blood flow. The flow direction of the arteries of the circle of Willis in reference to the midbrain can be utilized to identify them anatomically. (9)

Because of its high time resolution, TCCS is a popular neuroimaging technique. In addition to its diagnostic use for cerebral vascular disease, this approach is beneficial in intensive care and stroke departments. . The use of echo contrast compounds in difficult anatomical situations can increase the diagnostic reliability of the investigation. (10)

Due to its imaging component TCCD is more valuable as investigation tool than TCD. Most typically, variants are detected. These anatomical variances can be demonstrated by Transcranial Color Coded Doppler, especially in the axial plane. (11) Furthermore, while using TCD, we cannot know the angle of the insonated vessels. As a result, the flow velocity of the artery may be underestimated. (12).

The sample volume in the vessel section of interest placed within our scene using TCCS. Despite this, blood flow velocity change in relation to angle of insonation. This is important for assessing blood flow velocities in pathological situations, especially for determining the degree of stenosis in an intracranial artery. (13)

3. TCD in Headache

Many other procedures, such as transcranial Doppler sonography, have been used to assess interictal migraine without conclusive findings. (14)

Depending on type of stimuli, studies evaluating interictal cerebrovascular reactivity in migraine produced variety of results, if not contradicting, results. . Most studies using vasoconstrictor stimuli demonstrated an increased response in migraine subjects although some studies reported decrease only in migraine with aura. (15) These raise the doubts about this findings whether this are the same in migraine with and without aura and whether if these two forms could be the same disorder. (16)

As mentioned before, The main pathophysiological alterations in migraine are neural hypersensitivity to many types of stimuli. These traits may be passed on to cerebral vasoreactivity, however the data is inconsistent. In researches, interictal migraineurs have higher cerebral vasoreactivity to CO stimuli. Also cerebral changes was reported as response to some autonomic tests such as head tilt, cold pressure, or the Valsalva technique. (17)

In migraine patients no habituation or even potentiation of their response to repeated stimuli in electrophysiological trials. This is not limited to cortical regions involved in task processing but also other regions could be involved. The lack of habituation can be consider as type of cortical malfunction in information processing. . (2, 18)

It appears to be more remarked throughout the interictal phase and begins to normalize right before and during the migraine episode. Although tight linkage has been demonstrated during attacks, the relation of these results to cerebral perfusion and their relation to vasomotor response is unknown. (19)

Cerebral blood flow Changes are influenced by systemic variables as well as localized cerebral activity. In migraineurs, these autonomic changes were more apparent. Blood pressure, heart rate, intracranial pressure, and other systemic variables have increased the velocity of both arteries. In migraineurs, however, cerebral activity was greater, but it was not limited to locations fed by the posterior cerebellar artery. (20)

The few studies using Transcranial Doppler addressed to answer the heterogeneous results of response of CBF changes according to different stimulus . this can be due to the different type of stimulus used and the different method to record, in addition the sample size, lack of medication of patient control. Also including of both types of migraine may have contributed to the controversy of the results. Still there is some question marks about the changes in the interictal phase cerebral flow changes and the vasomotor response in

migraine, and why this response change in the ictal phase (21)

Kastrup A et al., reported in 1998 that the increase velocity in MCA of migraine patients can be explained with vasodilatation, especially in arterioles, or can be due to lower lumen diameter of the examined part of the middle cerebral artery (22). Other transcranial Doppler sonography studies showed reduced pulsatility index and an improved response to hypocapnia according to Silvestrini M, supporting the previous explanation (23)

Bolay H et al., in 2002 reported that, There is a link between cortical spreading depression (CSD) and trigeminal nerve stimulation in migraine animal models. As a result, the stimulation of the trigeminal nerve appears to trigger a cascade of meningeal and brainstem events similar to those seen during a migraine episode. This Cortical depression causes increase in blood flow in the middle cerebral artery that lasts for a long time. And this low changes is dependent on the degree of trigeminal and parasympathetic activation. (24)

Behnaz Sedighi et al., in 2011 reported, as they noted increase in peak systolic velocity significantly post photic stimulation , this also match what In 2008, Przegle Lek reported that the values of cerebral blood flow velocities rose by more than 10 cm/s in 6 patients in response to visual stimulation 2, 25

In a study of cerebrovascular reactivity in migraine, Thie et al. (1992) found that migraineurs had significant increase of the mean flow velocity in the MCA during the cognitive task and photic stimulation than controls (9.1 % in migraineurs vs 5.0 % in controls; P = 0.06). . (26)

The cerebrovascular responses to visual stimuli in both PCA and MCA were substantially stronger in migraine sufferers than in controls, according to K Nedelchev et al. in 2004 This remark might be interpreted in one of two ways; the migraine patient have more evident autonomic response, this can give us impression that factors such as blood pressure, rate, and others can affect the a velocity to increase in both arteries. (27)

A second explanation for this is that patients with a diagnosis of migraine with aura exhibit a stronger cerebrovascular response to visual stimuli than headache - free controls this can be as part of higher level of cerebral arousal or autonomic hyper reactivity. (27)

One of the earliest studies in this field is Beker et al., in 2001 who reported an significant increase in the MCA blood flow with steady increase till 10 seconds after the light was off , this finding wasn't present in the normal subjects , with early habituation to light (28, 29)

4. Conclusion

Trans cranial Doppler testing of cerebrovascular changes is a reliable and interesting for the diagnostic evaluation for migraine patients, changes in the cerebral blood vessels have very different results, as resting evaluation and as reactivity to stimulation, the most common finding is the increase

MCA velocity parameter in migraine patient and the increase vessels reactivity in MCA and VA in migraine and tension headache patient respectively.

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