

Transcranial Doppler

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< Doppler Sonography

Transcranial Doppler Ultrasound^[1] ^[2]

Introduction

The Transcranial Doppler Ultrasound (TCD) is a method to dynamically monitor the cerebral blood flow velocity (CBF-V) in the major intracranial arteries. Therefore you are able to diagnose and analyze different symptoms and use the results to compare them with other factors.

It is a noninvasive method which relies on the physical properties of the Doppler sonography. Low-frequency ultrasound waves (< 2MHz) are sent inside the head of the patient to insonate the basal cerebral arteries at thinner walls of the head bone, the so called "insonation windows". It's essential to do it at these points because the waves bounce off different structures and for getting any signals from an artery, you have to measure it at either foramina or thin bones, so the US-waves are able to pass through.

Doppler-Effect in connection with the method

The main statement of the Doppler sonography/physical principle in connection with his method is that if the soundwave strikes a moving object, in this case the erythrocytes, the ultrasoundwave gets reflected but the echo has a different frequency.

The equation for calculating CBF-V with TCD is: $v = (c \times f_d) \div (2 \times f_0 \times \cos\theta)$

where c is the speed of the incident wave, f_0 is the incident pulse frequency, f_d is the received frequency and θ is the angle of the reflector relative to the US probe

In the US Probe electrical impulses get generated by the received echos and therefore the equation gets filled by the measured information for calculating the needed data, in this case the cerebral blood flow.

The relevance in medicine

In medicine it is used for diagnosing different phenomenons that effect the blood-flow, e.g. emboli, stenosis, vasospasm. By diagnosing these symptoms a clinician gets informations which can help him finding out under which diseases the patient suffers or prevent some. Some of these diseases are e.g. sickle cell disease, subarachnoid haemorrhage, acute ischaemic stroke, brain stem death etc. This means that the Transcranial Doppler Ultrasound is able to show up symptoms but is not able to diagnose diseases.

Several positive and negative aspects^[3]

One of the Benefits of the Transcranial Doppler is the easy portability of this device so the clinician is able to carry this machine to different places. Because of the fact that this measurement is noninvasive and there's so danger of any harm to the patient, the clinician is also able to use this machine whenever and as often he wants to. Furthermore it has high temporal resolution and it is very inexpensive compared to CT-scan or other methods. Another positive aspect is that you can use it either for bedside monitoring in the intensive care or with a fixed headset for a quick check-up of the patient which makes its usage really uncomplicated. You can even use this method for prognostication and initiation of preventive measurements (for example sickle cell diseases).

But there are also some negative aspects. For the operator of this method its obligatory that he is highly trained in using this machine and to have a good knowledge about three-dimensional understanding of the cerebral vascular anatomy to obtain good and expressive results. Another Problem is the fact that 10-20% of the patients do not have adequate transtemporal acoustic windows.

Conclusion

At the end we can sum up that there are several positive aspects about this method but you have to be clear about the fact that the measurements of the cerebral blood-flow are not highly expressive concerning a full diagnosis. They just give the physician hints for different possible diseases which are related to the abnormal cerebral blood flow velocity.

Reference list

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