# TRANSCRANIAL ECOCOLOR DOPPLER
## from methodology to clinical applications

Transcranial Ecocolor Doppler is currently the elective Imaging method for noninvasive study of intracranial arteries and their hemodynamics. Feasible in adults and children, it is indicated for the early diagnosis of acute brain disease and in the follow-up of chronic cerebrovascular states.

## TCD: EXAMINATION TECHNIQUE

With the patient in the supine position and with the operator behind the patient's head, it is possible to visualize the intracranial vessels through the 3 *acoustic windows*, areas of the skull, made up of the bones that allow the penetration of the US:

### Ultrasound windows: Temporal, Occipital, Frontotemporal

Among them, the most interesting for diagnostic use is the temporal window (Fig. 1,2).


Fig. 1

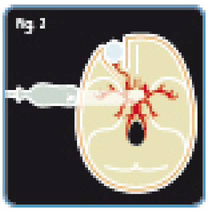


Fig. 2

Rectangular area on the squamous part of the temporal bone subdivided in 3 zones: front, middle and rear.

**Middle cerebral artery (MCA)**
It collects about 60-70% of the blood coming from the *internal carotid arteries (ICA)*, allowing, therefore, the estimate of blood flow to the hemisphere ipsilateral (Fig. 3).
It allows to explore (Fig. 4):

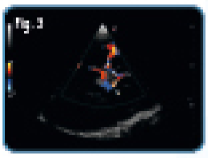


Fig. 3

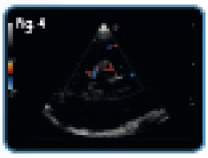


Fig. 4

*Middle cerebral arteries (MCA)*;
in the M1 and M2 *Anterior cerebral arteries (ACA)* sections;
in A1 and A2, *Posterior cerebral arteries (PCA)*, P1 and P2.

In most patients, identification is possible through the 'butterfly wings sign' (Fig. 5).
In intracranial vessels, the Doppler signal highlights a flow with a predominant diastolic component (Fig. 6).


Fig. 5

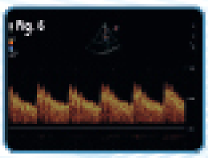


Fig. 6

## TCD: INDICATIONS

From the spectral analysis of the Doppler signal it is possible to calculate the cerebral flow rate. Cerebral (Mean CBFV) (Table 1, 2)

**Table 1 - Factors influencing cerebral blood flow velocity**

| Factor | Change in CBFV |
|---|---|
| Age | Increase up 6-10 yr then decrease |
| Sex | Woman > men |
| Pregnancy | Decrement in the III trimester |
| Hematocrit | Increase with decreasing Hct |
| $PCO_2$ | Increase with increasing $PCO_2$ |
| Main | Arterial pressure increase with increasing MAP |

CBFV: Cerebral blood flow velocity; MAP: Mean arterial pressure.

**Table 2 - Mean cerebral blood flow (cm/s) related to age**

| Artery | Age 20-40 yr | Age 40-60 yr | Age > 60 yr |
|---|---|---|---|
| Anterior cerebral artery | 56-60 | 53-61 | 44-51 |
| Middle cerebral artery | 74-81 | 72-73 | 58-59 |
| Posterior cerebral artery P1 | 48-57 | 41-56 | 37-47 |
| Posterior cerebral artery P2 | 43-51 | 40-57 | 37-47 |
| Vertebral artery | 37-51 | 29-50 | 30-37 |
| Basilar artery | 39-58 | 27-56 | 29-47 |

$$\text{Mean CBFV} = (\text{PSV} + [\text{EDV} \times 2])/3$$

PSV = peak systolic velocity
EDV = end-diastolic blood flow velocity
Change of CBFV mean, may suggest vasospams

**Lindegaard Ratio (LR):** (Table 3)

**Table 3 - Intracranial arteries: severity of vasospasm**

| | MFV | LR modified |
|---|---|---|
| MCA or ICA vasospasm (%) | | |
| Mild (< 25) | 120-149 | 3-6 |
| Moderate (25-50) | 15-199 | 3-6 |
| Severe (> 50) | > 200 | > 6 |
| BA vasospasm (%) | | |
| Possible vasospasm | 70-85 | 2-2.49 |
| Moderate (25-50) | > 35 | 2.5-2.99 |
| Severe (> 50) | > 85 | > 3 |

MCA: Middle cerebral artery; ICA: Internal carotid artery; LR: Lindegaard ratio; BA: Basilar artery; MFV: Mean flow velocity. MCA: Middle cerebral artery; ICA: Internal carotid artery; LR: Lindegaard ratio; BA: Basilar artery; MFV: Mean flow velocity.

**MCA mean CBFV/extracranial ICA mean CBFV** (v.n. <3)

**BA mean CBFV/left or right extracranial VA mean CBFV** (v.n. <2)


Fig. 7

## TCD: CRYPTOGENIC STROKE AND t-RLS

In subjects aged < 55 years, in 40% of cases stroke is of cryptogenic origin. In these pts, the prevalence of Patent Foramen Ovale (PFO), responsible for paradoxical embolism due to *transient Right to Left shunt (t-RLS)*, is about 40%.

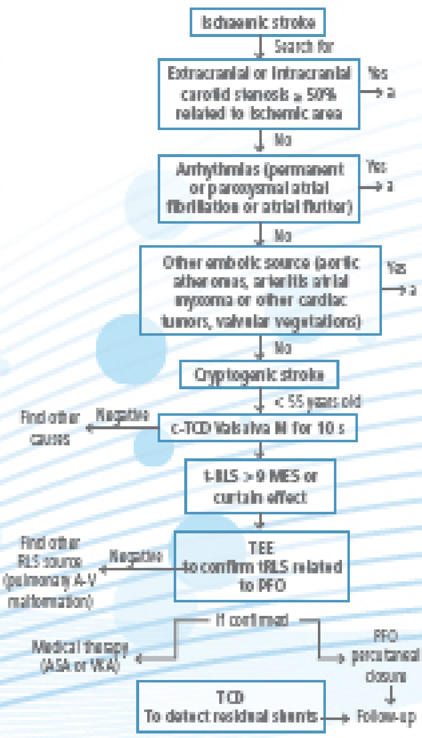
**Examination technique** (Fig. 7)
*t-RLS* is highlighted through shaken saline solution that behaves as a contrast.
Contrast agent: 9 mL of normal saline solution with 1 mL of air or blood, shaken up about 10 times through a system constituted by two 10 mL syringes linked by a 3-way stopcock. The agitated solution is administrated into the antecubital vein by an 18-gauge. The patient is then invited to perform a forced expiration against the closed glottis for a minimum of 10 seconds.

**Table 4 - Grade of transient right to left shunting based on microembolic signals grading score**

| Grade transient shunt | MES |
|---|---|
| No shunt | 0 |
| Low grade shunt | 1-10 |
| Moderate grade shunt | 11-25 |
| High grade shunt | > 25 (shower) or uncountable (curtain effect) |

MES: Microembolic signals

C-TCD, placing the PW Doppler slider on the MCA, show the passage of 'Microembolic Signals-MES', indirect manifestations of t-RLS.




a = Specific management

esaote

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