ECHOCOLOR DOPPLER LESSONS

CASE REPORT:
PARADOXICAL PERIPHERAL EMBOLISM

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TRANSCRANIAL DOPPLER AND PARADOXICAL EMBOLISM

INTRODUCTION.
TRANSCRANIAL DOPPLER AND PARADOXICAL EMBOLISM.
PATENT FORAMEN OVALE

- A PFO is present in approximately 25% of the general population, and can be found in up to 40% of younger pts with otherwise cryptogenic stroke.

- There is a higher risk of stroke with PFO, especially when combined with atrial septal aneurysm.

- In a meta-analysis of case control studies that examined the relative frequency of PFO, atrial septal aneurysm, or both, in all pts with ischaemic stroke, cryptogenic stroke and known stroke cause, PFO and atrial septal aneurysm were significantly associated with ischaemic stroke in pts <55 years.

TRANSCRANIAL DOPPLER (TCD) AND PARADOXICAL EMBOLISM

- TCD is a first-line non-invasive diagnosis of right-to-left shunt caused by a PFO by detecting bubble signs in the middle cerebral artery after the injection of agitated saline in the antecubital vein.
TCD AND PFO

- TEE remains the gold standard for detection of a PFO or an atrial septum defect.
- However, TCD with a contrast agent has been turned out as a potential method to diagnose a RLS in several studies which have been published during the last years, and a RLS other than at the atrial level may be detected only by this method.
- Furthermore, the VM can be applied more comfortably and more reliably during Doppler examination than during TEE.

TCD AND PFO

RECOMMENDATIONS TO STANDARDIZE THE EXAMINATION PROCEDURE

1. The patient should be prepared with an 18-gauge needle inserted into the cubital vein and should be in the supine position.

2. Insonation of at least one middle cerebral artery (MCA) using TCD is performed.

3. The contrast agent is prepared using 9 ml isotonic saline solution and 1 ml air mixed with a three-way stopcock by exchange of saline/air mixture between the syringes and injected as a bolus.

4. In case of little or no detection of microbubbles (MB) in the MCA under basal conditions, the examination will be repeated using the Valsalva maneuver (VM).

5. Contrast agent will be injected 5 s before the start of the VM; the overall VM duration should be 10 s.

1. Injection of a mixture of saline solution (9mL) and air (1mL) agitated between two 10 mL syringes connected by a 3-way stopcock

2. ACM rt. US registration: procedure during:
   a) normal breathing and
   b) during a Valsalva maneuver
TRANSCRANIAL DOPPLER AND PARADOXICAL EMBOLISM

TCD AND PFO

RESULTS

A four-level categorization according to the microbubbles (MB) count should be applied:

1. 0 MB (negative result)
2. 1-10 MB
3. >10 MB and no curtain
4. Curtain ('curtain' refers to a shower of MB, where a single bubble cannot be identified)

The results should be documented for basal condition and Valsalva maneuver testing separately.

A four-level categorization according to the microbubbles (MB) count should be applied:
(1) 0 MB (negative result); 2) 1-10 MB; 3) >10 MB and no curtain; 4) curtain.
It is essential to quantify the magnitude of RLSH by contrast TCD during the Valsalva maneuver, given that only those with shower and curtain patterns are associated with a higher risk of ischemic stroke in a non selected population.

*Serena J. Stroke 1998*
PERIPHERAL EMBOLISM AND PARADOXICAL EMBOLISM

- symptoms of pulmonary thromboembolism and associated DVT and systemic arterial embolism, suggest a diagnosis of paradoxical embolism.

- however, the frequency of peripheral embolism among all cases of paradoxical embolism is very low.
PARADOXICAL PERIPHERAL EMBOLISM
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- the frequency of peripheral embolism among all cases of paradoxical embolism is very low.
- this case report describes a patient with paradoxical peripheral embolism associated with patent foramen ovale
PARADOXICAL PERIPHERAL EMBOLISM
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IN EMERGENCY ROOM

- a 61-year-old man
- exertional dyspnea for two weeks
- subsequent appearance of pain in the right lower limb and left calf swelling
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CASE REPORT

IN EMERGENCY ROOM
- a 61-year-old man, exertional dyspnea, pain in the right lower limb and small left calf swelling

which investigations?
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IN EMERGENCY ROOM
- a 61-year-old man, exertional dyspnea, pain in the right lower limb and small left calf swelling

which investigations?

IN EMERGENCY ROOM
1. ECG
2. chest Rx
3. angio CT of the lung
4. transthoracic echocardiogram
IN EMERGENCY ROOM

1. ECG; 2. chest Rx results: no pathological findings
IN EMERGENCY ROOM

3. angio CT of the lung result: bilateral pulmonary embolism (bilateral occlusion of the pulmonary arteries).
IN EMERGENCY ROOM

4. transthoracic echocardiogram result: dilatation of the right ventricle and pulmonary hypertension.
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IN EMERGENCY ROOM

- a 61-year-old man, exertional dyspnea, pain in the right lower limb and small left calf swelling

1. which treatment?
2. which further investigation?
**PARADOXICAL PERIPHERAL EMBOLISM**

**CASE REPORT**

**IN EMERGENCY ROOM**

- a 61-year-old man, exertional dyspnea, pain in the right lower limb and small left calf swelling

1. which treatment? -> heparin

2. which further investigation? -> echocolor Doppler of the lower limbs
ONE DAY LATER

- a 61-year-old man, exertional dyspnea, pain in the right lower limb and small left calf swelling

**echocolor Doppler of the lower limbs result:**

**right side:**

a) occlusion of the popliteal artery and low flow in the dorsalis pedis artery
b) echogenic material in the popliteal vein due to the outcome of previous popliteal DVT (not previously known)

c) DVT of the popliteal vein

**left side:**
FIVE DAYS LATER

- a 61-year-old man continues anticoagulant therapy with clinical improvement: disappearance of the pain in the right lower limb.

Echocolor Doppler of the lower limbs, control. Result:

a) complete recanalization of the right popliteal artery
b) unchanged the lt. popliteal DVT and the outcome of previous rt. popl. DVT

a) rt. popliteal artery: spectral waveform

b) lt. popliteal vein: transverse scan
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FIVE DAYS LATER
- a 61-year-old man continues anticoagulant therapy with clinical improvement: disappearance of the pain in the right lower limb.

1. which diagnosis?
2. which investigation?
FIVE DAYS LATER

- a 61-year-old man continues anticoagulant therapy with clinical improvement: disappearance of the pain in the right lower limb.

1. which diagnosis? -> paradoxical embolism?

2. which investigation? -> TCD bubble test!
15 DAYS LATER

- a 61-year-old man continues anticoagulant therapy with clinical improvement

**TCD bubble test (microbubble test to investigate the shunt rt-> lt.). Result:**
- “curtain” pattern (uncountable microbubbles in middle cerebral artery, during normal breathing --> presence of a large PFO (right-to-left shunt).
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15 DAYS LATER

- A 61-year-old man continues anticoagulant therapy with clinical improvement

**Echocolor Doppler of the lower limbs, control. Result:**

- a) Complete recanalization of the right popliteal artery

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**rt. popliteal artery: color**

**rt. popliteal artery: spectral waveform**

**rt. post. tibial artery: spectral waveform**
15 DAYS LATER

- a 61-year-old man continues anticoagulant therapy with clinical improvement

Echocolor Doppler of the lower limbs, control. Result:

a) initial patency of the left popliteal DVT.
b) unchanged the outcome of previous right DVT (echogenic material in the popliteal vein)

a) Lt. popliteal vein: transverse scan
b) Rt. popliteal vein: longitudinal scan
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DURING HOSPITALIZATION

a 61-year-old man continues oral anticoagulant therapy

Further investigations. Results:

1. transesophageal echocardiogram: presence of a large PFO
2. brain CT scan: nn
the patient was discharged 16 days after admission, and no recurrent emboli have been observed.
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AFTER DISCHARGE
a 61-year-old man continues oral anticoagulant therapy

which further investigations?
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AFTER DISCHARGE

a 61-year-old man continues oral anticoagulant therapy

which further investigations?  
1. brain MR
2. thrombophilia study
3. TCD control
PARADOXICAL PERIPHERAL EMBOLISM
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AFTER DISCHARGE
a 61-year-old man continues oral anticoagulant therapy

which further investigations? ->
1. brain MR
2. thrombophilia study
3. TCD control

Further investigation after discharge. Results:
1. brain MR: negative for ischemic lesions
2. thrombophilia study: negative
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AFTER DISCHARGE

a 61-year-old man continues oral anticoagulant therapy

3. TCD bubble test, control. Result:
a) no more the “curtain” pattern during normal breathing (confirming the improvement of pulmonary hypertension)
b) “curtain” pattern only after the Valsalva manoeuvre

TCD bubble test in basal condition (during normal breathing):
four microbubbles in middle cerebral artery

TCD bubble test after the Valsalva manoeuvre:
“curtain” pattern \(\rightarrow\) large shunt
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TCD BUBBLE TEST COMPARISON (FOLLOW UP).

a) acute phase and b) control twenty-two days later (basal condition)

a) acute phase: TCD bubble test in basal condition (during normal breathing). Result:
- “curtain” pattern (uncountable microbubbles in middle cerebral artery)

b) twenty-two days later: TCD bubble test in basal condition (during normal breathing). Result:
- no more the “curtain” pattern (four microbubbles in middle cerebral artery) confirming the improve of pulmonary hypertension
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61-year-old patient: recurrent "primary" DVT in PFO (one DVT complicated by a pulmonary and peripheral embolism)

which therapy?
PARADOXICAL PERIPHERAL EMBOLISM

CASE REPORT

61-year-old patient: recurrent "primary" DVT in PFO (one DVT complicated by a pulmonary and peripheral embolism)

which therapy? the patient continues oral anticoagulant therapy
This complex clinic case highlights:

1) the need of an exhaustive study of patients with peripheral arterial embolism of doubtful origin

2) the importance of the echocolor Doppler study (in particular TCD with contrast agent) which allowed: a) to know the pathophysiology of the embolism; b) to make a non-invasive diagnosis of the paradoxical embolism (DVT, pulmonary and peripheral arterial embolism, and PFO)

3) the sensitivity of TCD in demonstrating the regression of the pulmonary hypertension: the transition from a spontaneous "curtain effect" (in the course of pulmonary hypertension), to a "curtain effect" just after the Valsalva maneuver (once the pulmonary hypertension was resolved)
short videos and playlists on echocolor Doppler of the intracranial vessels and of the lower limbs are available on my youtube channel:
http://www.youtube.com/channel/UCij561sX0bQoEjXlWKuPnKg