Right-Left-Shunt (RLS) detection

Background:

Patent foramen ovale is frequently associated with embolic cerebrovascular accidents. The diagnosis of patent foramen ovale (PFO) is easier since the advent of transesophageal echocardiography but is invasive and does not allow to detect extracardiac RLS. Contrast transcranial Doppler ultrasound enables the detection of the passage of a contrast material injected into a peripheral vein to the cerebral circulation across an orifice which is most often a patent foramen ovale.
It is subject to recent research to investigate the value of TCD in RLS diagnosis in contrast to other techniques.
There is controversity about the optimal patient position for the detection of right-to-left shunt (RLS).

Literature:

Right to left shunt in cryptogenic stroke: TCD vs. TEE

Author	*M. S. Park, J.-M. Kim, D.-E. Kim, B. C. Kim* Department of Neurology, Chonnam National Unversity Hospital, South Korea
Content/Summary	Identification of Right to left shunt (RLS), especially patent foramen ovale (PFO), is essential for secondary preventionin patients with cryptogenic stroke. Transesophageal echocardiography (TEE) has been known to be the gold standard method in detecting of PFO but Transcranial Doppler (TCD) is recently spotlighted to a safe, easy to perform and non-invasive method. We tried to standardize TEE and TCD technique as a screening method for PFO and compare the results of TEE with modified Spencer TCD grading system. **Methods:** 220 patients who had been hospitalized in Chonnam National University Hospital from January, 2008 to December, 2011 for ischemic stroke/TIA with undetermined etiology (UD) or a suspicion of cardiogenic etiology were enrolled. TCD procedure followed as standardized protocol of TCD agreed on in the consensus conference on Venice. TEE procedure was similar to TCD using microbubble test during Valsalva maneuver. Comparative analysis was performed between positive result and negative result groups of TCD & TEE.
Comment	TCD and TEE is a complementary inspection tool rather than competitive tool for diagnosis of RLS.Furthermore, if more than modified Spencer grade IV bubble is detected on TCD, intracardiac PFO was confirmed without invasive technique of TEE

Doppler-device	Not known
Quantification	

Cerebral microemboli during carotid artery endarterectomy and angioplasty with stenting Right to left shunt in cryptogenic stroke: TCD vs. TEE

Author	*N. V. Rybalko , O. I. Vinogradov, A. N. Kuznetsov* National Pirogov Centre of Therapy and Surgery, Neurological Department, Moscow, Russia
Content/Summary	Cerebral microembolism is the common reason of neurological complications with carotid artery endarterectomy (CEA) and angioplasty with stenting (CAS). Intraoperative solid and gaseous microemboli are associate with post-procedural ipsilateral ischemic stroke. However the real clinical significance of microembolic signals (MES) is still controversial. **The aim** of our research to correlate the frequency and type of per-procedural MES and cerebrovascular ischemic events in early postoperative period.
Comment	Carotid surgery is strongly associate with the high microemdolic loading on the cerebral vessels and can be the reason of post procedural vascular complications. The most harmful to the brain during CEA and CAS are solid microemboli.
Doppler-device	Not known
Quantification	

Comparison of two contrast agents for right-to-left shunt diagnosis with contrast-enhanced transcranial Doppler.

Author	Hao N1, Liu K1, Guo ZN1, Wu X1, Yang Y2, Xing Y3.
Content/Summary Abstract	We compared two contrast agents, agitated saline and agitated saline with blood, with respect to their efficacy in the diagnosis of right-to-left shunt with contrast-enhanced transcranial Doppler. Three hundred thirty Chinese patients underwent examinations with one of four different methods in random order: (i) 9 mL agitated saline solution with 1 mL air without the Valsalva maneuver (ASwoVM); (ii) 9 mL agitated saline solution with 1 mL air with the Valsalva maneuver (ASwVM); (iii) 9 mL agitated saline solution, 1 mL air and a drop of the patient's blood without the Valsalva maneuver (ASbwoVM); and (iv) 9 mL agitated saline solution, 1 mL air and a drop of the patient's blood, with the Valsalva maneuver (ASbwVM). Rates of detection were 11.5%, 17.9%, 16.7% and 23.6% for the ASwoVM, ASwVM, ASbwoVM, and ASbwVM examinations, respectively. The embolus track numbers for these examinations were 4.0 ± 1.83, 11.5 ± 6.2, 10.5 ± 4.9 and 33.7 ± 14.9, respectively. There were significant differences between the four groups (all comparisons, $p < 0.001$). For contrast-enhanced transcranial Doppler examinations, the agitated saline/blood agent yielded better rates of diagnosis of right to-left shunt than did the agitated saline alone.
Comment	Big study with over 300 patients
Doppler-device	Multi-Dop X TCD detector, DWL
Quantification	This elegant study provides confirmation that a drop of patients blood in the mixture of air and agitated saline solution increases rate of diagnosis of right-to-left shunts.

Provoked right-to-left shunt in patent foramen ovale associates with ischemic stroke in posterior circulation.

Author	Kim BJ[1], Kim NY[1], Kang DW[1], Kim JS[1], Kwon SU[2].
Content/Summary Abstract	**BACKGROUND AND PURPOSE:** Right-to-left shunt (RLS) via the patent foramen ovale is an important cause of cryptogenic stroke. The Valsalva maneuver provokes or enhances RLS, but RLS can also occur during normal respiration. This study examined whether the ischemic lesion pattern differs depending on the character of RLS. **METHODS:** All consecutive patients with a patent foramen ovale (diagnosed by transesophageal echocardiography) who had a cryptogenic stroke and underwent transcranial Doppler-patent foramen ovale test (monitoring of microbubbles in the right middle cerebral artery by transcranial Doppler after hand-agitated saline injection) were divided according to whether RLS was constant (microbubbles detected both at baseline and after the Valsalva maneuver) or provoked (microbubbles detected only after the Valsalva maneuver). The groups were compared in terms of clinical and imaging characteristics. **RESULTS:** Seventy-six patients met the eligibility criteria: 50 had constant RLS and 26 had provoked RLS. Provoked RLS patients were significantly younger. The ischemic lesions in provoked RLS patients were located predominantly in the vertebro-basilar circulation (73.1% versus 28.0%; P=0.002), whereas constant RLS patients were more likely to have multicirculatory lesions (16.0% versus 0.0%; P=0.045). After adjusting for confounders, provoked RLS associated independently with a vertebro-basilar lesion location (OR=3.306; P=0.03).
Comment	If right-to-left shunt is detected with normal breathing, there is higher chance to have the anterior circulation stroke, while for the shunts detected after Valsalva's maneuver there is a tendency for posterior circulation stroke.
Doppler-device	ST3 TCD; Spencer Technologies, WA
Quantification	The predominance of posterior-circulatory infarction in provoked RLS patients suggests that the Valsalva maneuver may promote RLS and paradoxical embolization to the posterior circulation.

Sensitivity of brachial versus femoral vein injection of agitated saline to detect right-to-left shunts with Transcranial Doppler.

Author	Gevorgyan R[1], Perlowski A, Shenoda M, Mojadidi MK, Agrawal H, Tobis JM.
Content/Summary Abstract	BACKGROUND: Transcranial Doppler (TCD) can detect a right-to-left shunt (RLS) with high sensitivity but has a 5% chance of a false negative study. TCD is usually performed with injection of agitated saline into an arm vein. We compared the sensitivity of TCD performed from the brachial versus femoral veins. METHODS: Patients presenting to the cardiac catheterization laboratory for percutaneous closure of a patent foramen ovale (PFO) were enrolled. Power M-mode Transcranial Doppler (Terumo 150 PMD) was conducted. After injection of a mixture of 8 cc of agitated saline, 0.5 cc of air, and 1 cc of blood into the brachial vein, embolic tracks were counted over the middle cerebral arteries. The degree of RLS was evaluated by TCD at rest, and with Valsalva at 40 mmHg aided by visual feedback with a manometer device. The test was repeated using femoral venous injections.
Comment	Sixty five patients were enrolled, mean age 52, 43% male. TCD grades were significantly higher with femoral injections compared to brachial injections at rest ($p<0.0001$), and with the Valsalva maneuver ($p<0.0001$). The presence of a RLS was confirmed by intracardiac echocardiography (ICE) during cardiac catheterization in 62 (95.4%) patients.
Doppler-device	Not known
Quantification	The sensitivity of TCD for detection of RLS is increased when agitated saline injections are performed through the femoral vein. In patients with a high clinical suspicion for RLS, low TCD grades obtained with traditional brachial venous access should be interpreted with caution. When possible, a repeat study using femoral venous access may be considered.

Transcranial Doppler ultrasonography should it be the first choice for persistent foramen ovale screening?

Author	Komar M[1], Olszowska M, Przewłocki T, Podolec J, Stępniewski J, Sobień B, Badacz R, Kabłak-Ziembicka A, Tomkiewicz-Pająk L, Podolec P.
Content/Summary Abstract	**BACKGROUND:** Persistent foramen ovale (PFO) is considered a cause of cryptogenic stroke and a risk factor for neurological events in young patients. The reference standard for identifying a PFO is contrast-enhanced transesophageal echocardiography (TEE).The goal of this study was to evaluate the feasibility of transcranial color Doppler (TCD) and its diagnostic sensitivity compared with TEE. **METHODS:** We investigated 420 patients admitted to our department with cryptogenic stroke, transient ischemic attacks or other neurological symptoms. All patients underwent TCD and TEE evaluation. TCD and TEE examinations were performed according to a standardized procedure: air-mixed saline was injected into the right antecubital vein three times, while the Doppler signal was recorded during the Valsalva maneuver. During TCD the passage of contrast into the right-middle cerebral artery was recorded 25 seconds following the Valsalva maneuver.
Comment	We detected a right-to-left shunt in 220 patients (52.3%) and no-shunts in 159 patients (37.9%) with both TCD and TEE. In 20 (4.8%) patients TEE did not reveal contrast passage which was then detected by TCD. In 21 (5.0%) patients only TEE revealed a PFO. The feasibility of both methods was 100%. TCD had a sensitivity of 95% and a specificity of 92% in the diagnosis of PFO.
Doppler-device	Not known
Quantification	TCD has a relatively good sensitivity and specificity. TCD and TEE are complementary diagnostic tests for PFO, but TCD should be recommended as the first choice for screening because of its simplicity, non-invasive character, low cost and high feasibility.

Safety of transcranial Doppler 'bubble study' (TCD-BS) for identification of right to left shunts: an international multicentre study.

Author	(Georgios Tsivgoulis u. a., 2011)
Content/Summary	The rate of ischaemic cerebrovascular complications during or after TCD-BS was 0% (95% CI)
Comment	
Doppler-device	Not known
Quantification	TCD-BS is a safe screening test for identification of RLS, independent of the presence of cardiac structural abnormalities.

Comparison of Agitated Saline Mixed with Blood to Agitated Saline Alone in Detecting Right-to-Left Shunt during Contrast- Transcranial Doppler Sonography Examination.

Author	(Shariat u. a., 2011)
Content/Summary	The sensitivity of the bilateral middle cerebral artery monitoring in diagnosis of right-to-left shunt was 94.2%, 71.2%, 96.2% and 76.9% for agitated saline with Valsalva manoeuvre, agitated saline without Valsalva manoeuvre, agitated saline and blood with Valsalva manoeuvre, and agitated saline and blood without Valsalva manoeuvre methods, respectively. Application of Valsalva manoeuvre resulted in detection of more right-to-left shunt ($P = 0.002$).
Comment	Fifty-two patients with stroke who had Transesophageal echocardiography proven right-to-left shunt underwent contrast-transcranial Doppler sonography with injection of agitated (i) 9 ml saline with 1 ml air with Valsalva manoeuvre, (ii) 9 ml saline with 1 ml air without Valsalva manoeuvre, (iii) 8 ml saline, 1 ml of the patient's fresh blood and 1 ml air with Valsalva manoeuvre, and (iv) 8 ml saline, 1 ml of the patient's fresh blood and 1 ml air without Valsalva manoeuvre
Doppler-device	FD-T98II (Guangzhou Doppler Electronic Technologies, China)
Quantification	Agitated saline mixed with blood with Valsalva manoeuvre is a sensitive method to detect right-to-left shunt, especially in the case of severe shunt. Mixing agitated saline with blood may increase the sensitivity of the test.

Low sensitivity of the echocardiograph compared with contrast transcranial Doppler in right-to-left shunt.

Author	(Martínez-Sánchez u. a., 2011)
Content/Summary	TTE and TEE show a considerable number of false negatives for RLS detection. Clinical studies should consider the c-TCD as the best technique to diagnose RLS when a paradoxical embolism is suspected.
Comment	The accuracy of TTE and TEE for detecting RLS was calculated by comparing them with c-TCD.
Doppler-device	Not known
Quantification	TCD is superior to TTE and TEE

Patent foramen ovale in children with migraine headaches.

Author	(McCandless u. a., 2011)
Content/Summary	These data suggest that PFO may contribute to the pathogenesis of migraine with aura in children and have implications for clinical decision making.
Comment	Children aged 6.0 to 18.0 years with migraine headache were evaluated for PFO and right-to-left shunting with color-flow Doppler scanning.
Doppler-device	Not known
Quantification	Evaluation of PFO might be indicated in patients with migraine.

Effects of posture on right-to-left shunt detection by contrast transcranial Doppler.

Author	(Agustin u. a., 2011)
Content/Summary	With Valsalva manoeuvre, this was highest in upright sitting (20.4% versus 8.3%; P<0.0002)
Comment	Each patient was examined at rest and after Valsalva manoeuvre in 4 positions: supine, right lateral decubitus, right lateral leaning, and upright sitting, in random order.
Doppler-device	Nicolet EME Companion III
Quantification	RLS is best detected in the upright sitting position with Valsalva manoeuvre.

Contrast transthoracic echocardiography versus transcranial Doppler for patent foramen ovale detection.

Author	(Corrado u. a., 2011)
Content/Summary	
Comment	Probably a very useful article. Unfortunately no abstract available.
Doppler-device	Not known
Quantification	

Transcranial Doppler detection of cerebral fat emboli and relation to paradoxical embolism: a pilot study.

Author	(Forteza u. a., 2011)
Content/Summary	In patients with long bone fractures, the presence of an RLS is associated with larger and more frequent microembolic signals to the brain detected by transcranial Doppler study and can predict the development of neurological symptoms.
Comment	We prospectively studied patients with femur shaft fracture with RLS evaluation, daily transcranial Doppler with embolus detection studies, and neurological examinations to evaluate the relation of RLS and microembolic signals to the development of fat embolism syndrome. Forty-two patients were included; 14 had an RLS detected.
Doppler-device	Nicolet Pioneer TC 4040
Quantification	RLS should be diagnosed even in surgical patients.

Paradoxical emboli--clinical importance of transcranial Doppler for detection of patent foramen ovale.

Author	(Zivanović u. a., 2010)
Content/Summary	Transcranial Doppler sonography showed 100% sensitivity and 100% specificity for the prediction of right-to-left shunts proven by transesophageal contrast echocardiography. Both positive and negative predictive values in our group of patients were 1.
Comment	Seventeen patients with acute ischemic stroke and transient ischemic attacks hospitalized at the Department of Neurology.
Doppler-device	Not known
Quantification	Transcranial Doppler with bubble test is a reliable method for the detection of a patent foramen ovale, with a high level of sensitivity and specificity which is comparable with transesophageal echocardiography. Moreover, it is cheaper and more comfortable than transesophageal echocardiography, and should be used routinely in neurological practice.

Valsalva manoeuvre procedures in the diagnosis of right-to-left shunt by contrast-enhanced transcranial Doppler using agitated saline solution with blood as a contrast agent.

Author	(Lange u. a., 2010)
Content/Summary	Positive MCA tests were observed in 47 (56%) CAduringVM tests and in 50 (59.5%) CApreVM tests, p=0.64.
Comment	42 patients. cTCD technique was done with two different moments of the VM: [1] the CA injection during the VM (CAduringVM test); [2] the CA injection before the VM (CApreVM test).
Doppler-device	Doppler-Box DWL, Singen, Germany
Quantification	There is no significant difference in the results of RLS screening by cTCD when two different moments of VM were done.

Sensitivity of transcranial Doppler versus intracardiac echocardiography in the detection of right-to-left shunt.

Author	(Van u. a., 2010)
Content/Summary	Intracardiac echocardiography underestimated shunting in 34% of patients with Valsalva manoeuvre or manometer after closure compared with TCD.
Comment	Thirty-eight consecutive patients who were undergoing PFO closure had simultaneous transcranial Doppler and intracardiac echocardiography performed.
Doppler-device	PMD 150 Digital System (Spencer Technologies, Seattle, Washington)
Quantification	Transcranial Doppler with immediate feedback provided by forced expiration against a manometer to 40 mm Hg is more sensitive than echocardiographic imaging for the detection of RLS.

Transcranial Doppler and transesophageal echocardiography: comparison of both techniques and prospective clinical relevance of transcranial Doppler in patent foramen ovale detection.

Author	(Caputi u. a., 2009)
Content/Summary	In diagnosing PFO, cTCD has a good accuracy compared with cTEE. To detect a RLS at rest, cTCD appears to be more sensitive than cTEE.
Comment	A total of 100 consecutive patients (59 women and 41 men, age 46 +/- 12 years) were evaluated after stabilized ischemic stroke/transient ischemic attack, migraine, and lacunae, and before neurosurgery in sitting position. All patients undertook cTEE and cTCD, at rest and under Valsalva manoeuvre (VM).
Doppler-device	Not known
Quantification	The combination of cTEE and cTCD could be considered the real gold standard for PFO in the near future.

Unilateral versus bilateral middle cerebral artery detection of right-to-left shunt by power M-mode transcranial Doppler.

Author	(Jesurum, Fuller, Moehring, u. a., 2009)
Content/Summary	Unilateral and bilateral detection were equally able to detect large RLS (grades IV or V) following Valsalva (P= 1.00).
Comment	Doppler data from 87 patients with confirmed RLS
Doppler-device	PMD100 TCD platform (Spencer Technologies, Seattle, WA)
Quantification	Unilateral detection of ET by power M-mode transcranial Doppler is equivalent to bilateral detection to assess RLS.

Transcranial Doppler detection of venous-to-arterial circulation shunts: criteria for patent foramen ovale.

Author	(Sastry u. a., 2009)
Content/Summary	All 16 of the 39 patients with PFO on TEE had more than 15 micro-emboli on standardized TCD; in 14 of these 16, paradoxical embolization required no provocation. Three of 9 patients with 'major' v-aCS (>50 microbubble emboli at rest or >10 at rest with >80 on provocation) on standardized TCD were not identified by TEE as having large shunts.
Comment	Standardized TCD was performed 2 weeks before simultaneous TEE and TCD in 39 patients aged 15-39 following ischemic stroke (n = 33) or myocardial infarction (n = 6).
Doppler-device	Neuroguard TCD
Quantification	The standardized TCD protocol is sensitive in the diagnosis of PFO and with the use of provocation manoeuvres measures the functional importance of v-aCS more accurately than TEE.

Diagnosis of secondary source of right-to-left shunt with balloon occlusion of patent foramen ovale and power M-mode transcranial Doppler.

Author	(Jesurum, Fuller, Renz, u. a., 2009)
Content/Summary	Seventeen patients (20%; 95% CI: 11.7 to 28.8) had secondary RLS during balloon occlusion At late follow-up (n = 66), 13 of 14 (93%) patients with secondary RLS and 23 of 52 (44%) patients without secondary RLS had residual RLS (p = 0.002). This is the first report to systematically assess the prevalence of secondary RLS in patients undergoing PFO closure.
Comment	Eighty-eight patients who underwent transcatheter PFO closure to prevent recurrent paradoxical cerebral embolism between June 2005 and December 2006 were evaluated for a secondary source of RLS
Doppler-device	PMD100
Quantification	Residual RLS detected by TCD may be due to secondary RLS, which may have implications for clinical outcomes.

Transesophageal echocardiography and transcranial color Doppler: independent or complementary diagnostic tests for cardiologists in the detection of patent foramen ovale?

Author	(Mangiafico u. a., 2009)
Content/Summary	for c-TCD, we defined a sensitivity of 94% (95% confidence limits 90-98) and a specificity of 97% (94-100). The positive predictive value for the detection of the shunt was 98% (95% confidence limit 96-100) and the negative predictive value was 92% (95% confidence limit 87-97).
Comment	Two hundred and eighty-six consecutive patients with a presumed paradoxical cerebrovascular event were investigated by both c-TEE and c-TCD for the detection of patent foramen ovale.
Doppler-device	Not known
Quantification	c-TDC results in an effective, safe and low cost examination, with excellent sensitivity and specificity as compared with c-TEE.

Effect of body positioning during transcranial Doppler detection of right-to-left shunts.

Author	(Lao u. a., 2007)
Content/Summary	If the initial supine testing was negative, all subsequent positions/injections were also negative for RLS.
Comment	We report the safety and feasibility of this expanded contrast TCD protocol. Patients with ischemic stroke were evaluated.
Doppler-device	Not known
Quantification	Our findings support the safety and feasibility of the expanded TCD protocol. If the initial supine Valsalva-aided contrast TCD test is negative, there may be no need to study the patient in additional positions. However, if microB are detected in the supine position, additional testing for RLS in alternative positions may be found to be worthwhile.

Diagnosis of right-to-left shunt with transcranial Doppler and vertebrobasilar recording.

Author	(Del Sette u. a., 2007)
Content/Summary	Vertebrobasilar recording reached high specificity (100%) and good sensitivity (83.72%) for the diagnosis of RLS after the Valsalva manoeuvre. For only medium and large shunts, both sensitivity and specificity reached 100%. Time to bubble appearance after injection was higher in the vertebrobasilar circulation (4.36+/-1.7 vs 6.77+/-2.5 seconds; P<0.001).
Comment	183 subjects with a standard protocol for RLS diagnosis by simultaneously monitoring the right middle cerebral and vertebrobasilar circulations.
Doppler-device	MultiDop X4 DWL
Quantification	Transcranial Doppler with vertebrobasilar monitoring is highly sensitive and specific in detecting RLS, particularly when medium or large. It can be proposed for subjects with an insufficient temporal bone window.

Is transcranial Doppler for the detection of venous-to-arterial circulation shunts reproducible?

Author	(Sastry u. a., 2007)
Content/Summary	On average, 18 agitations produced 1.86 (95% CI 1.62-2.13) times more bubbles than 6 agitations. Mixtures with blood produced on average 3.8 times more bubbles (3.08-4.69).
Comment	TCD investigation for v-aCS was repeated in 42 patients using a standardised protocol (i) by the same investigator and (ii) by a different investigator. Agitated saline was produced by mixing saline and 1 ml of air between two 10-ml syringes.
Doppler-device	Not known
Quantification	Contrast TCD is reproducible and reliable for the detection of v-aCS. The addition of blood and 18 mixes rather than 6 significantly increased the number of microbubbles produced and may increase the effectiveness of microbubble contrast.

Neurosurgical operations with the patient in sitting position: analysis of risk factors using transcranial Doppler sonography.

Author	(Engelhardt u. a., 2006)
Content/Summary	The intraoperative positioning in these patients was adapted to the risk for a paradoxical air embolism, although, after surgical recommendations, three patients with a persistent PFO underwent surgery in sitting position.
Comment	Ninety patients with a mean age of 56.5 yr (range 14-81 yr) undergoing surgery in sitting position were investigated by TCD with contrast agent to detect functional PFO, that is PFO that can be provoked with a Valsalva manoeuvre.
Doppler-device	MultiDop_X4 (DWL, Sipplingen, Germany)
Quantification	To address the risk of a paradoxical air embolism, especially in patients undergoing surgery in sitting position, preoperative detection of PFO is advisable. If surgery is performed in seated PFO patients, additional monitoring and special care are warranted.

Contrast-enhanced transcranial Doppler ultrasound for diagnosis of patent foramen ovale.

Author	(Nedeltchev und Mattle, 2006)
Content/Summary	As below
Comment	Review
Doppler-device	none
Quantification	Compared to TEE, c-TCD is more comfortable for the patient, enables an easier assessment of the size and functional relevance of the RLS, and allows also the detection of extracardiac RLS. However, c-TCD cannot localize the site of the RLS. TEE and TCD are complementary methods and should be applied jointly in order to increase the diagnostic accuracy for detecting PFO and other types of RLS.

Summary:

c-TCD is a safe method for RLS detection.

c-TCD results in an effective, safe and low cost examination, with excellent sensitivity and specificity as compared with c-TEE. Specifity of RLS detection by TCD is nearly 100%, sensitivity seems to be between 85% and 95%.Application of Valsalva manoeuvre resulted in detection of more right-to-left shunts. Point of time of Valsalva manoeuvre plays only a minor role.

Unilateral detection of ET by power M-mode transcranial Doppler is equivalent to bilateral detection to assess RLS.

TCD allows also the detection of extracardiac RLS, but cannot localize the site of the RLS.
In case of insufficient temporal bone window, it is possible to detect RLS due to insonating vetebro-basilar system.

Experts:

McCollum C
Tsivgoulis G

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