DOI: 10.4149/BLL_2013_127

Bratisl Lek Listy 2013; 114 (10)
590 – 594

CASE REPORT

Transient ischemic attack in the vertebro-basilar circulation due to a hemodynamically significant variation – kinking of the extracranial section of the left vertebral artery

Wagnerova H, Goldenberg Z

1st Department of Neurology, Medical Faculty of the Comenius University and University Hospital Bratislava-Stare Mesto, Bratislava, Slovakia. **wagnerova.helena@gmail.com**

Abstract: We present a case report of a 74-year old female patient with the clinical diagnosis of transient ischemic attack (TIA) in the vertebro-basilar (VB) circulation, in whom we found bilateral variation of the extracranial section of vertebral arteries on ultrasound, on the left side to the extent of kinking. This finding was later confirmed by magnetic resonance angiography (MRA). We discuss the presumed hemodynamic significance of this variation and its etiological relation to the patient's clinical picture. Ultrasound examination of the carotid and vertebro-basilar circulations is an important examination technique contributing to an early detection of possible aetiology of the cerebral circulation disorders *(Fig. 7, Ref. 18)*. Full Text in PDF *www.elis.sk.*
Key words: transient ischemic attack, vertigo, vertebral artery, ultrasound, kinking.

A transient ischemic attack (TIA) is an acute episode of neurological dysfunction resulting from focal cerebral ischemia not associated with permanent cerebral infarction. A group of cerebrovascular experts proposed a shift from the arbitrary time-based definition of TIA to a tissue-based definition in 2002 with a new definition for TIA as "a brief episode of neurological dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting less than one hour, and without evidence of an acute infarction". (1) This proposed new definition was well received and endorsed by many clinicians. The American Heart Association and American Stroke Association (AHA/ASA) 2009 Guidelines endorsed this new definition, modifying it with the omission of the phrase "typically less than one hour," as there is no time cut-off that reliably distinguishes whether a symptomatic ischemic event will result in tissue infarction. The AHA/ASA-endorsed definition of TIA is following: Transient ischemic attack (TIA) is a transient episode of neurological dysfunction caused by focal brain, spinal cord, or retinal ischemia, without an acute infarction (2).

TIA in the vertebro-basilar (VB) circulation is characterized by vertigo, nausea, vomiting, double vision, ataxia, dysarthria, dysphagia and bilateral or alternating disturbances of movement or sensory functions. An isolated vertigo may be the initial symptom; however, a combination of symptoms is more typical (3). Atherosclerosis of the major vessels has been the cause of TIA in the VB circulation in 31 % of patients, followed by embolism from the heart (27 %), intra-arterial embolism (17 %), affection of the smaller vessels (16 %), and a number of more uncommon causes (9 %). Stenotic changes in the VB circulation may cause the symptom onset by a hemodynamic mechanism; frequently there are short, stereotypic, and predominantly orthostatic TIAs. Compression or stretching of the vertebral arteries due to the degenerative changes in the cervical spine, depending on position of the head, may also result in perfusion disturbances; retroflection, rotation, and their combination in particular, are of the highest risk (4). The ischemia often manifests itself at rest and early in the morning, when there usually is a physiological lowering of the blood pressure resulting in the systemic hypoperfusion (5). Notably, the elderly patients with signs of atherosclerosis are at risk. The differential diagnosis of TIA in VB circulation should involve other causes of vertiginous states (e.g. positional vertigo, vestibular neuronitis) and

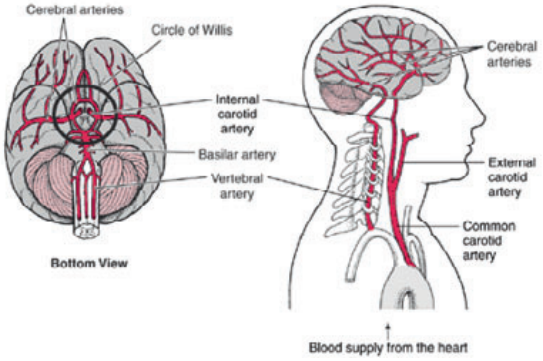

Fig. 1. Vascular supply of the brain. Source: http://www.merck.com/media/mmhe2/figures/fg086_1.gif.

1st Department of Neurology, Medical Faculty of the Comenius University and University Hospital Bratislava – Stare Mesto, Bratislava, Slovakia

Address for correspondence: H. Wagnerova, MD, 1st Department of Neurology, Medical Faculty of the Comenius University and University Hospital Bratislava – Stare Mesto, Mickiewiczova 13, SK-813 69 Bratislava, Slovakia.
Phone: +421.2.57290101

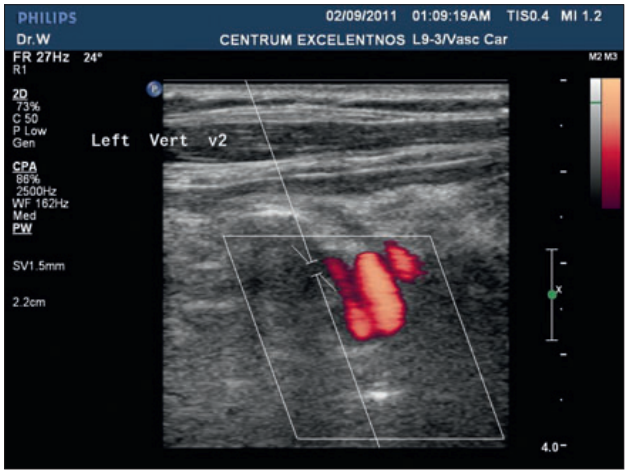

Fig. 2. Left vertebral artery – V2 section, Power mode (PW mode).

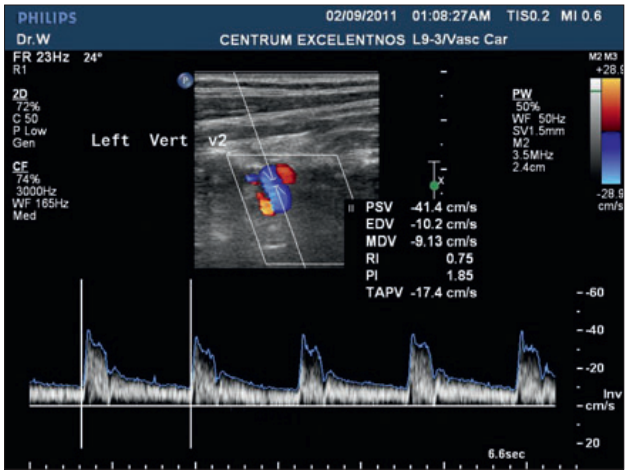

Fig. 3. Left vertebral artery – V2 section, Colour coded doppler mode (CCDM).

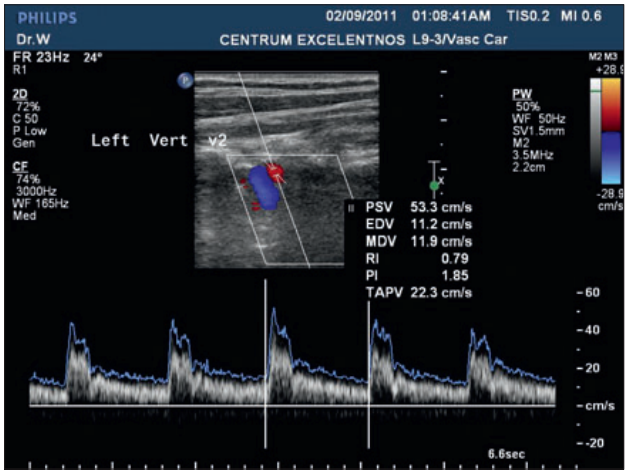

Fig. 4. Increase of the flow velocity in the region of the kinking of the left vertebral artery.

distinguishing vertigo from other disturbances of the balance or non-specific sings, such as pre-collapsing states, hypoglycaemia, anaemia, adverse effects of medication in use and so on.

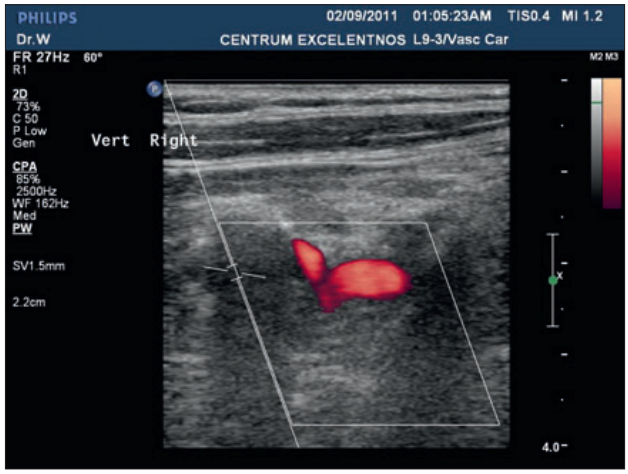

Fig. 5. Right vertebral artery – V2 section, PW mode.

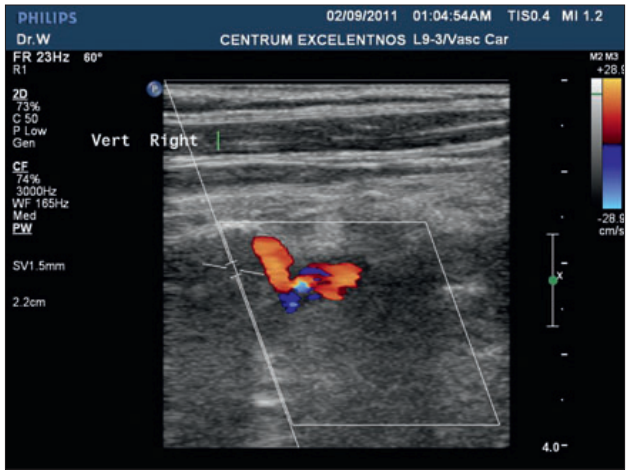

Fig. 6. Right vertebral artery – V2 section, CCDM.

Anatomical considerations

The vascular supply of the brain consists of the carotid (approx. 85 %) and vertebro-basilar circulation. Blood from the VB region supplies the brainstem, cerebellum and occipital lobes. Pair of vertebral arteries, arising from the subclavian arteries, run through the costo-transversal foramina of the cervical vertebrae C6–C2 and enter the skull through the foramen occipitale magnum. There in the pontomedullar region they merge into an unpaired basilar artery (Fig. 1).

Variations of the course of vertebral arteries have often been reported in relation to the vertiginous states or to combined symptoms of TIAs in their vascular supply regions. Their discovery is, however, more frequently accidental during surgical procedures in the cervical spine and cranio-cervical junction, where they increase the risk of peri-operative complications (6). They are purposefully investigated when a hemodynamic significance is presumed. In the atlas (C1) region, a less frequent Kimmerle anomaly – stenosis of the vertebral artery caused by a compression mechanism – may be found (7). Variations of the V2 section are usually detected in a form of greater loops or coiling, or less frequently kinking.

The term "coiling" has been used for describing a looping variation of the course of an artery. The term "kinking" defines an angular bending variation of the course of an artery, which can be also multiple.

Diagnosis

History of the patient and analysis of the symptoms (including differentiation of vertigo from other possible unspecific symptoms) is essential for a proper diagnosis, followed by use of the imaging techniques, namely the computerized tomography (CT) or more frequently the magnetic resonance imaging (MRI), that is able to identify smaller brainstem and cerebellar lesion with a higher sensitivity. Examination of the vascular system starts with an ultrasound; suspicion of pathological finding may by confirmed by CT angiography (CTA) or MR angiography (MRA), or eventually by digital subtraction angiography (DSA). Furthermore, as in all TIAs, examinations focused on stratification of the risk factors of atherosclerosis are performed.

Treatment

TIA has been considered a risk factor for a completed ischemic stroke within the next year in 10–30 % patients (especially in the first few days or weeks after the TIA). Therefore, it is imperative to start with the secondary preventive measures in all TIA patients (8, 9, 10). Except for antithrombotics and statins, the management includes control of the risk factors, such as arterial hypertension, coronary heart disease and diabetes mellitus. The acute therapy of vertiginous states includes a symptomatic treatment with antiemetics (thiethylperazine) and antihistamines (betahistidine, which has also a vasodilating effect in the inner ear). In certain cases, when a tortuosity in the extracranial section of the vertebral artery is detected, vascular surgery is considered. Nishijima et al. showed good results in more than 60 % of patients having undergone a surgical procedure (11). Chronic vertiginous states require a multidisciplinary approach due to often multifactorial aetiology.

Case report

A 74-year old female patient with a history of arterial hypertension, hypothyroidism and mastectomy with radiotherapy due to a mammal carcinoma in 2002 was admitted to the 1st Department of neurology in Bratislava on February 2, 2011 due to an acute onset of a rotational vertigo associated with thrusting of the body to the right side, nausea, recurrent vomiting and dysarthria. She had similar problems ten years ago, but not of such intensity, and a history of recurrent inflammation of the right ear. Clinical presentation included mild dysarthria, horizontal 1° nystagmus at lateral gaze to both sides, ataxia of the stance and gate, positive Romberg sign to the right side and elevated blood pressure (170/100 mmHg). CT scan did not show any acute focal lesion; there were signs of leucoaraiosis and old, minute and scarce post-ischemic lesions in the external and internal capsules bilaterally and in the left caudate nucleus. Likewise, MRI of the brain did not show any acute focal lesions in the region of posterior fossa; there were sings of a chronic microvascular leucoencephalopathy, mild-to-moderate diffuse brain atrophy, as well as the signs of chronic post-inflammatory changes in both pyramids. The ENT specialist clinically evaluated the patient as having a chronic residuum after right-sided middle ear inflammation. The videonystagmographic examination showed affection of the right posterior semicircular canal. Cardiological examination excluded the possibility of cardiac aetiology. Our diagnostic conclusion was a vertebro-basilar artery syndrome. Examination of the carotid and vertebro-basilar circulation with a colour-coded duplex sonography (CCDS) device Philips iU22 identified variations of the course of both vertebral arteries in the extracranial V2 section, with more prominent finding on the left side, where we detected a hemodynamically significant kinking (Figs 2–6). MR angiography confirmed the finding of irregularities in the course of both vertebral arteries including kinking on the left vertebral artery, and besides, coiling of the distal section of the right vertebral artery (Fig. 7).

The patient's condition resolved after the vasodilatatory, antithrombotic and antiemetic treatment within 1 hour. There remained only symptoms of dizziness and mild ataxia during rotational movement at walking, that she had experienced for several years.

As her symptoms at presentation had started at night, we presumed adopting an improper position of the head and cervical spine during sleep and, as a consequence, accentuation of the hemodynamic significance of the course of left vertebral artery.

Due to the co-morbidities and patient's age, we did not propose the surgical procedure. In the secondary prevention of ischemic strokes and TIAs we recommended clopidogrel 75 mg daily and atorvastatin 80mg daily. The patient was educated about a range of movements and hazardous positions of the cervical spine (retroflection, retroflection + rotation). The patient's condition has

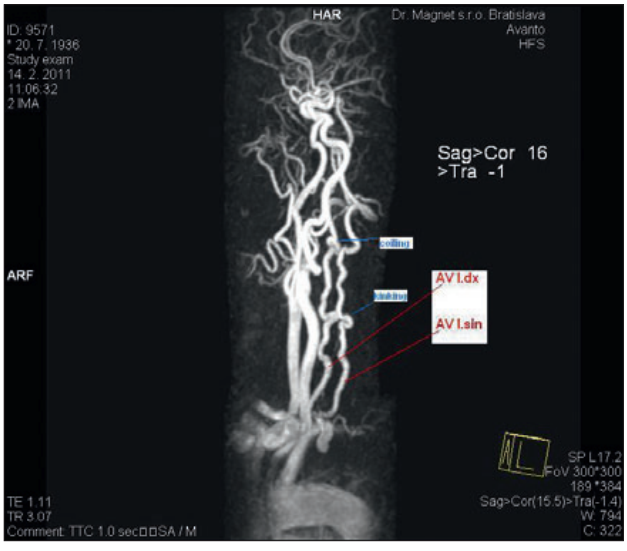

Fig. 7. MRA: bilateral irregularities in the course of the vertebral arteries - kinking of the left AV, distal coiling of the right AV (Courtesy of Dr. Magnet, s.r.o., Bratislava).

been stable over the next 6 month, without problems that lead to the previous hospitalization.

Discussion

The transient ischemic attack is usually in 10–30 % of cases followed by a completed ischemic stroke (most frequently in the first few weeks after the TIA). Therefore, it is crucial to be alert when dealing with patients presenting with symptoms and signs of TIA. The most appropriate measure is hospitalization of the patient immediately after the onset, performing all the necessary diagnostic techniques and monitoring of the patient over the first several hours. Distinguishing the symptoms and signs of TIA from other disorders of balance and vertiginous states is significant towards an early implementation of the secondary preventive measures of the imminent ischemic stroke. After the clinical examination, imaging techniques for investigation of the brain tissue and its vascular supply should follow the diagnostic work-up of TIA. As the first imaging technique, the most frequently used examination of the brain, for an exclusion of a tumour or cerebral haemorrhage, has been the computerized tomography (CT), usually due to its wide accessibility. The special method of magnetic resonance imaging – diffusion-weighted imaging (DWI) – seem to be more appropriate, since it is able to reveal early signs of ischemia, namely in the posterior fossa, where the capabilities of CT are limited. Using the ultrasound of the carotid and VB vessels for the evaluation of the vascular supply of the brain, it is possible to detect the hemodynamically significant stenoses quite quickly. Their aetiology has been predominantly atherosclerotic; less frequently arterial dissections and variations of the course of the vessels may be found. These findings indicate the necessity of further investigation, namely CT angiography or MR angiography, followed by potential endovascular or surgical consultations.

The above mentioned 74 year old female patient presented with the symptoms of rotational vertigo associated with thrusting of the body to the right side, nausea and recurrent vomiting and the signs of mild dysarthria, horizontal nystagmus at lateral gaze to both sides, ataxia of the stance and gate and positive Romberg sign to the right side. She mentioned having similar, but less severe, symptoms approximately 10 years ago and suffered from chronic otitis media. Both CT and MRI examinations of the brain did not show signs of an acute focal brain lesion, however there were chronic post-inflammation changes in both pyramidal bones. A peripheral vertigo has been excluded due to dysarthria, central type of the nystagmus and disharmonic vestibular symptoms, moreover the symptoms resolved within 1 hour. Our diagnostic conclusion was the vertebro-basilar artery syndrome. Examination of the carotid and vertebro-basilar circulation with a colour-coded duplex ultrasound (CCDS) device Philips iU22 identified variations of the course of both vertebral arteries in the extracranial V2 section, with more prominent finding on the left side, where we detected a hemodynamically significant kinking. This finding was later confirmed by MRA.

The onset of patient's symptoms at presentation was during the night hours; therefore we presume adopting an improper position of the head and cervical spine during sleep and, as a consequence, accentuation of the hemodynamic significance of the course of left vertebral artery.

Association of the kinking type variations in the V2 section of vertebral arteries with symptoms and signs of TIA in the VB circulation have been a rare finding in the literature; in total 10 % in V1–V3 sections according to some reports (13). Kinking is more frequent in the atlas loop region. Koskas et al. (10) found various tortuosities of the carotid and vertebral arteries in symptomatic patients on 10–43 % of angiograms.

We consider the examination with ultrasound as a method of choice for the primary identification of conditions in the carotid and vertebro-basilar circulation in symptomatic patients due to its broad availability and low invasiveness.

Conclusion

Early identification of the patients presenting with the symptoms of a possible acute brain ischemia, early detection of their aetiology and, consequently, implementation of therapeutic measures has a significant impact on the quality of their lives in the future. The so called "uncompleted" transient ischemic attacks enable and, moreover, force us to make every effort to find the cause of these conditions. Imaging techniques able to visualize focal lesion of the brain and its vascular supply help in establishing the proper diagnosis when clinical suspicion points to a possible cerebral ischemia. Magnetic resonance imaging, more specifically the DWI method, seems to be the most suitable as it is able to detect the earliest stages of the focal cerebral ischemia. Due to its availability, CT of the brain has been the first imaging technique in our region, in combination with ultrasound of the extracranial and intracranial sections of the carotid and vertebro-basilar cerebral circulations. In the case of a hemodynamically significant finding on the arteries, we complete the imaging of the vessels with CTA of MRA.

Association of the kinking type variations in the V2 section of vertebral arteries with symptoms and signs of TIA in the VB circulation have been a rare finding in literature; in total 10 % in V1–V3 sections according to some reports (11). Koskas et al found various tortuosities of the carotid and vertebral arteries in symptomatic patients on 10–43 % of angiograms (12). When performed by a skilled investigator in good conditions (depending also in the patient's habitus and cooperation) the colour-coded duplex ultrasound is a reliable initial method for detection of stenotic processes in the carotid and vertebro-basilar circulation. Its accessibility and low invasiveness may help to direct the diagnostic work-up for determination of aetiology of the disorders of cerebral circulation quite quickly.

References

1. Albers GW, Caplan LR, Easton JD, Fayad PB, Mohr JP, Saver JL et al. Transient ischemic attack – proposal for a new definition. N Engl J Med 2002; 347 (21): 1713–1716.

2. Easton JD, Saver JL, Albers GW et al. Definition and evaluation of transient ischemic attack: a scientific statement for healthcare professionals from the American Heart Association/American Stroke Association Stroke Council; Council on Cardiovascular Surgery and Anesthesia; Council on Cardiovascular Radiology and Intervention; Council on Cardiovascular Nursing; and the Interdisciplinary Council on Peripheral Vascular Disease. The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists. Stroke 2009; 40 (6): 2276–2293.

3. Ambler Z. Vertebrobazilární insuficience. Interní medicína pro praxi 2003; (9): 453.

4. Bednařík J, Ambler Z, Růžička E. Klinická neurologie, část speciální I. Praha: Triton, 2010: 23–24. ISBN 978-80-7387-389-9.

5. Bednařík J, Ambler Z, Růžička E. Klinická neurologie, část speciální I. Praha: Triton, 2010: 54. ISBN 978-80-7387-389-9.

6. Ulm AJ, Quiroga M, Russo A, Russo VM, Graziano F, Velasquez A, Albanese E. Normal anatomical variations of the V 3 segment of the vertebral artery: surgical implications. J Neurosurg Spine 2010; 13 (4): 451–460.

7. Koutsouraki E, Avdelidi E, Michmizos D, Kapsali SE, Costa V, Baloyannis S. Kimmerle´s anomaly as a possible causative factor of chronic tension-type headaches and neurosensory hearing loss: case report and literature review. Int J Neurosci 2010; 120 (3): 236–239.

8. Feinberg WM. Guidelines for the managemetn of transient ischemic attacks. From the Ad Hoc Committee on Guidelines for the Management of Transient Ischemic Attacks of the Stroke Council of the American Heart Association. Circulation 1994: 86 (6): 2950–2965.

9. Hacke W. Acute treatment of ischemic stroke. Cerebrovasc Dis 2000; 10 (Suppl 3): 22–23.

10. Kalvach P et al. Mozgové ischemie a hemoragie. Praha: Avicenum, 1997, 408.

11. Nishijima M, Harada J, Nogami K, Endo S, Takaku A. Operative correction of kinking and coiling at the origin of vertebral artery and stellate ganglionectomy in patients with severe vertigo and dizziness. No Shinkei Geka 1989; 17 (3): 255–261.

12. Koskas F, Kieffer E, Kieffer A, Bahnini A. Loops and folds of the carotid and vertebral arteries: indications for surgery. J Mal Vasc 1994; 19 (Suppl A): 51–54.

13. Trattnig S, Schwaighofer B. Color-coded Doppler sonography of the vertebral arteries. Radiologe 1990; 30 (11): 520–524.

14. Rossiti S, Volkmann R. Changes of blood flow velocity indicating mechanical compression of the vertebral arteries during rotation of the head in the normal human measured with transcranial Doppler sonography. Arq Neuropsiquiatr 1995; 53 (1): 26–33.

15. Wakayama K, Murakami M, Suzuki M, Ono S, Shimizu N. Ischemic symptoms induced by occlusion of the unilateral vertebral artery with head rotation together with contralateral vertebral artery dissection – case report. J Neurol Sci 2005; 236 (1–2): 87–90.

16. Beliavskij NN, Likhachev SA, Varenik TN, Demarin V. Vertebrobasilar transient ischemic attacks in young and middle aged patients. Zh Nevrol Psikhiatr Im S S Korsakova 2008; Suppl 22: 3–9.

17. Uchino A, Saito N, Watadani T, Okada Y, Kozawa E, Nishi N, Mizukoshi W, Inoue K, Nakajima R, Takahashi M. Vertebral artery variations at the C1–2 level diagnosed by magnetic resonance angiography. Neuroradiology 2011; 22.

18. Slaba S, Mallak N, Abdelmassih T, Nassar J, Haddad F. Complex anomaly of the origin of supraaortic vessels. J Mal Vasc 2010; 35 (4): 270–273.

Received November 10, 2011.
Accepted July 20, 2013.