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# *Vascular rings-pitfalls in initial diagnosis and its verification with multi-slice computed tomography*

Vascular rings are defined as abnormal configuration of aortic arch or its branches resulting in encircling the trachea and esophagus. Three major types of this anomaly are: arteria lusoria, right-sided aortic arch and double aortic arch. Arteria lusoria is referred to aberrant course of the right subclavian artery which originates from the aortic arch as the last vessel and passes to the right side behind the trachea and esophagus. This is the most frequent type of vascular ring occurring in 0.5–0.2% of general population (1). Right-sided aortic arch is found in about 0.1% of population (2) with high probability of vascular ring formation resulting from retroesophageal course of the left subclavian artery. The least common, but the most symptomatic is double aortic arch (3).

The possible symptoms related to compression of esophagus and trachea are: dyspnea, recurrent pneumonia, stridor, and dysphagia (4). The initial diagnosis based on chest x-rays or contrast examination of the esophagus usually leads to incorrect conclusions and vascular reasons of the ailments are hardly ever taken into account. Correct diagnosis is usually based on angiographic examinations, magnetic resonance or computed tomography (5–7).

The aim of the study was to evaluate the possibilities of multi-slice computed tomography (MSCT) in diagnostics and imaging of vascular rings and its usefulness in verification of initial diagnosis.

## MATERIAL AND METHODS

Electronic and clinical documentation of 17 patients (mean age 48.1 ± 16.4; 12 females and 5 males) with vascular ring detected during MSCT examination of the chest or the heart was processed. The examinations were performed with 8 or 64 row tomograph after administering 80–120 ml of non-ionic contrast medium in standard chest (2.5 mm collimation), or cardiac protocol (1.2 or 0.6 mm collimation). Either axial scans or multiplanar and three dimensional reconstructions were used to evaluate the anomaly. Remaining structures of the chest and the heart were assessed in respect to find associated congenital or acquired pathologies. The clinical reasons of performing the CT examination were analyzed.

## RESULTS

In ten patients of the selected group vascular ring in the form of arteria lusoria was diagnosed (Fig. 1), six patients had right-sided aortic arch (Fig. 2) and in one case double aortic arch which formed complete vascular ring encircling trachea and esophagus was revealed (Fig. 3, Fig. 4). Thirteen patients complained about difficulties in swallowing caused by compression of the esophagus by vascular structures (Fig. 5), three of them had dyspnea related to narrowing of the trachea by aberrant vessel, additionally (Fig. 6). In four cases MSCT examination was performed due to the causes unrelated to typical vascular rings' ailments, such as: suspicion of tumor of the left atrium – based on echocardiography performed previously, sarcoidosis and tuberculoma – initially diagnosed with plain x-rays of the chest and tetralogy of Fallot. MSCT confirmed initial diagnoses in these cases, revealing vascular rings additionally.

The suspicion of right-sided aortic arch was the reason of performing MSCT examination in one case only. In the rest of the cases the causes of performing MSCT were: suspicion of mediastinal tumor or mediastinal lymph nodes' pathology, suspicion of pulmonary embolism, cough, recurring bronchitis and bronchectasis. MSCT examination did not confirm the initial diagnoses in these cases and revealed the vascular reasons of ailments.


Fig. 1. Axial projection of aberrant right subclavian artery *arteria lusoria* (AL) arising as the last vessel of aortic arch (AA). Compression of the esophagus indicated with the arrow


Fig. 2. Axial projection of aberrant left subclavian artery (ALSA) originating from right-sided aortic arch (AA)


Fig. 3. Oblique, MIP reconstruction of double aortic arch forming complete vascular ring. Trachea (Tr) and esophagus (white arrow) encircled and compressed by vascular structures

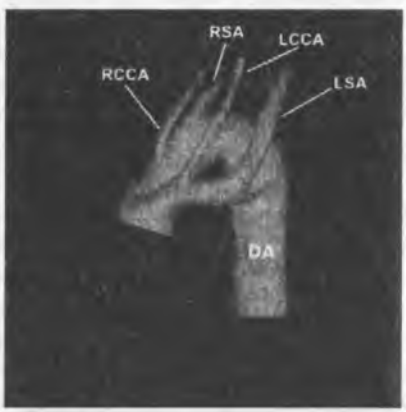


Fig. 4. Volume rendering of double aortic arch with its branches – right common carotid artery (RCCA), right subclavian artery (RSA), left common carotid artery (LCCA), left subclavian artery (LSA) [DA – descending aorta]

Fig. 5. Sagittal reconstruction. Compression of the esophagus (white arrow) caused by arteria lusoria (black arrow)

Fig. 6. Virtual bronchoscopy. Impression and modelling of the trachea caused by vascular ring

## DISCUSSION

Vascular rings are congenital malformations resulting from disturbances in aortic arch's embryogenesis (2, 8). Aberrant vessels, by encircling the mediastinal structures, impress the esophagus and trachea causing dysphagia and dyspnea, typically. The majority of patients are asymptomatic, nevertheless, symptoms may occur in elder age due to increasing tortuosity of incorrect vessels and atheromatous process related to age (4, 9).

The knowledge about the vascular rings, their variants and possible implications is not common among the majority of the clinicians. Usually, symptoms which may be caused by vascular rings do not make clinicians suspecting the real cause of the complaints. In the majority of cases the radiologists also make initial diagnosis incorrect and the most common suspicion based on plain x-rays are mediastinal tumors.

On the other hand, precise diagnostic techniques, such as MSCT enable accurate diagnosis and verification of initial opinion. For that reason, in all unclear cases, if the symptoms, such as dysphagia or dyspnea occur, the clinicians should extend the diagnostics bearing in mind the vascular reasons of ailments.

## CONCLUSIONS

MSCT seems to be an excellent method of evaluation of mediastinal arteries which enables certain detection of vascular rings. Application of 3D and MPR reconstructions allows to visualize the anatomical relations of mediastinum, compression of trachea or esophagus, as well as to confirm or exclude other pathologies of lungs and mediastinum.

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SUMMARY

Vascular rings are defined as abnormal configuration of aortic arch or its branches resulting in encircling the trachea and esophagus. Three major types of this anomaly are: *arteria lusoria*, right sided aortic arch and double aortic arch. The possible symptoms related to compression of esophagus and trachea include: dyspnea, recurrent pneumonia, stridor and dysphagia. Diagnosis based on chest x-rays or contrast examination of esophagus usually leads to incorrect conclusions and vascular reasons of the ailments are hardly ever taken into account. The aim of the study was to evaluate the possibilities of multi-slice computed tomography (MSCT) in imaging of vascular rings and its usefulness in verification of initial diagnosis. Electronic and clinical documentation of 17 patients with vascular ring detected during MSCT examination of the chest was investigated. MPR and 3D reconstructions were used to evaluate the anomaly. Clinical reasons of performing MSCT were analyzed. Ten patients of the selected group had vascular ring in the form of *arteria lusoria*, six patients had right-sided aortic arch and in one case double aortic arch was revealed. The initial diagnosis was related to vascular anomalies in one case only. MSCT allowed precise verification in the rest of the patients of the investigated group. MSCT is a highly sensitive method of evaluation of mediastinal arteries which enables certain detection of vascular rings. Application of 3D and MPR reconstructions allows to visualize anatomical relations of mediastinum, compression of trachea or esophagus, as well as to confirm or exclude other pathologies of mediastinum.

Pierścienie naczyniowe – pułapki we wstępnej diagnostyce i weryfikacja rozpoznania przy użyciu wielorzędowej tomografii komputerowej

Pierścienie naczyniowe są wynikiem nieprawidłowego rozwoju łuku aorty lub jego gałęzi, czego skutkiem jest otoczenie przez struktury naczyniowe tchawicy i przełyku. Trzy główne typy tej anomalii to *arteria lusoria*, prawostronny łuk aorty i podwójny łuk aorty. Możliwe objawy wynikające z ucisku przełyku i tchawicy to: duszność, nawracające infekcje układu oddechowego, stridor i dysfagia. Zazwyczaj wstępna diagnostyka oparta na zdjęciach przeglądowych klatki piersiowej lub badaniach kontrastowych przełyku prowadzi do błędnych rozpoznań, a przyczyny naczyniowe dolegliwości rzadko są brane pod uwagę. Celem pracy było przedstawienie możliwości wielorzędowej tomografii komputerowej (WTK) w diagnostyce i obrazowaniu pierścieni naczyniowych oraz jej użyteczności w weryfikacji wstępnego rozpoznania. Przeanalizowano dokumentację elektroniczną i kliniczną 17 pacjentów z wykrytą podczas badania WTK klatki piersiowej anomalią pod postacią pierścienia naczyniowego. Celem oceny anomalii użyto rekonstrukcji wielopłaszczyznowych

i trójwymiarowych. Analizie poddano przyczyny skierowań na badanie WTK. U dziesięciu pacjentów stwierdzono pierścienie naczyniowe pod postacią *arteria lusoria*, u sześciu prawostronny łuk aorty, a u jednego pacjenta podwójny łuk aorty. Tylko w jednym przypadku wstępne rozpoznanie zakładało anomalię naczyniową. WTK umożliwiła precyzyjną weryfikację rozpoznań u pozostałych pacjentów z badanej grupy. Podsumowując, WTK jest wysoce czułą metodą oceny tętnic śródpiersia umożliwiającą pewne wykrycie pierścieni naczyniowych. Zastosowanie rekonstrukcji wieloplaszczyznowych i trójwymiarowych umożliwia wizualizację warunków anatomicznych śródpiersia, ucisku na tchawicę lub przełyk jak również potwierdzenie lub wykluczenie innych patologii śródpiersia.