

ORIGIN OF THE RIGHT VERTEBRAL ARTERY EXAMINED WITH CTA

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ABSTRACT

Background: The vertebral artery arises from the first part of the subclavian artery and provides posterior brain circulation. The abnormal origin of the vertebral arteries is an uncommon finding. The aim of this study was to examine the origin of the right vertebral artery and to discuss its clinical implications.

Materials and methods: We examined radiographs of 203 patients who had CT angiography undertaken for a variety of clinical reasons, performed as part of their medical treatment at the University Clinic for Radiology in Skopje, R. N. Macedonia.

Results: The study population included 203 patients, 108 male and 95 female, age range from 19-82, mean age 59.6 years. In 202 patients (99.5%) the right vertebral artery originated from the right subclavian artery. In one patient (0.49%) we found atypical right vertebral artery arising from the right common carotid artery in combination with the origin of the right subclavian artery from the aortic arch.

Conclusions: The knowledge of the potential vertebral artery origin variants is important for clinicians for safe performance of diagnostic and interventional procedures in radiology and for surgeons during planning and accomplishing surgical interventions.

Keywords: right vertebral artery, anomalous origin, common carotid artery, CT angiography

INTRODUCTION

Vertebral artery (VA) is the first branch of the ipsilateral subclavian artery and is divided into four segments: prevertebral, vertebral, suboccipital and intracranial segment [1]. The French surgeon and anatomist Jean Baptiste Bonhomme in the eighteen century described the trajectory and the branches of the VA, including

the fact that the VA was a major blood supplier of the posterior fossa structures [2]. Since that time the importance of the VA has grown considerably and, today, the profound knowledge of the VA is essential in different fields of medicine [1, 3]. The aim of this study was to examine the origin of the right VA (RVA).

MATERIALS AND METHODS

This study included 203 patients who underwent CT angiography undertaken for a variety of clinical reasons, performed as part of their medical treatment at the University Clinic for Radiology in Skopje, R.N. Macedonia. An anatomical analysis of the CTA images performed for medically justified goals, with the approval of the Ethics Committee (of the Faculty of Medicine) was made. The CTA examinations were performed using a CT scanner Somatom Definition AS Siemens Healthcare, Erlangen, Germany. The images were obtained with the scanning protocol as follows: detector rows 16, gantry rotation time 0.4 s, collimation 0.625, pitch 1.375, slice thickness 0.625 mm, tube load 380 mA and tube voltage 120 kV. The contrast material was injected through an 18- or 20-gauge IV catheter inserted into an arm vein, a total volume of 80 to 100 ml at a rate of 4 ml/s with a pressure injector, followed by a flush of 40 ml of saline administered at the same injection rate. After the contrast medium was injected, by use of bolus tracking software, the scanning was carried out automatically. The data were transferred to a workstation for post-processing. The reconstruction included the following: maximum intensity projection - MIP; four-dimensional CTA with volume rendering; reformatted multiplanar reformation - MPR. The SYNGO software was used in the process of post-processing. The CT reports were analyzed by two independent examiners for the origin of the RVA.

RESULTS

We evaluated CT angiographic images of 203 patients for the origin of the RVA. In all patients the image quality was sufficient for evaluation of the origin of the RVA. Our study included 108 male and 95 female patients, age range from 19-82, mean age 59.6 years. The RVA had usual patterns of origin from the right subclavian artery in 202 (99.5%) of patients (Fig. 1). In one (0.49%) patient RVA had origin from the right common carotid artery (RCCA) (Fig. 2). Additionally, in this patient the right subclavian artery had origin from the aortic arch. The subclavian

artery had retroesophageal course and caused slight compression on the esophagus.

DISCUSSION

A large number of anatomical variations of the VA have been reported in the literature, among them variation in the origin of RVA [4, 5, 6, 7, 8, 9, 10]. Variations in the origin of the VA more commonly involve the left VA; aortic arch origin was between 2.4 to 5.8 % [11, 12]. An anomalous origin of RVA is divided into three categories: first, those originating from the aortic arch; second, those originating from the carotid arteries; and third, those with duplicated origin [13]. According to the available literature variable origin of the RVA was described from the ascending [4] and descending aorta [14], from the aortic arch [7, 9, 15, 16, 17], from the thyrocervical trunk [18], from the right occipital artery [19], from the RCCA [5, 10, 20, 21, 22, 23, 24, 25], from the external carotid artery [26], from the internal carotid artery [8, 27, 28] and from the brachiocephalic trunk [6, 12, 29].

Anomalous origin of RVA is extremely rare and so far, most often case reports have been published regarding this issue [8]. In a recent large-scale study conducted by Lin et al., 1218 CT angiographies were analyzed and in 1209 (99.3%) patients RVA had origin from right subclavian artery, in eight (0.7%) from aberrant subclavian artery and in one patient (0.1%) from RCCA [30]. Palmer et al. reported 0.18% of cases with origin of the RVA from the RCCA associated with aberrant right subclavian artery [31]. In our study RVA in one (0.49%) patient had origin from the RCCA, which was similar to previously published data. A significant increase in use of noninvasive diagnostic procedures such as computed tomography and magnetic resonance imaging will certainly lead to an increased number of detected anatomical variations in the origin of RVA.

Normally VA is formed by longitudinal anastomosis between the right six cervical intersegmental arteries [11, 32]. Meanwhile, the horizontal portions of the cervical intersegmental arteries connect to the dorsal aorta and all of them disappear, except the seventh one which forms the proximal portion of the subclavian artery and the origin of the VA [32]. If the obliterated



Figure 1. *Origin of the right vertebral artery from the right subclavian artery*



Figure 2. *Origin of the right vertebral artery from the right common carotid artery*

ation occurs proximally to the seventh cervical intersegmental artery, then the right subclavian artery starts as the last branch from the aortic arch [16]. Persistence of cervical intersegmental arteries will lead to a wide range of variations in the origin of the VA. Failure of involution of the first and second cervical intersegmental artery will lead to a variable origin of the VA from the internal or external carotid artery. If third to sixth cervical intersegmental artery persists, a variable origin of the VA from the RCCA or aortic arch will be noticed [10].

In anatomy, surgery, angiography and in all non-invasive procedures it is very important to know the exact course of the VA and the possible variations [3].

In most of the cases reported in the literature, anomalous origin of the RVA did not result in clinical symptoms [9, 22, 23, 25]. The patient in our study was also asymptomatic, which correspond with previously published data. In the study conducted by Yuan et al., only 5.5% of patients had symptoms that were probably related to the aberrant origin of RVA [33]. But nevertheless the knowledge of a potential VA variant origin results in a greater care for those who teach anatomy and appears to be mandatory in surgery, diagnostic and interventional radiology [3].

Procedures that would necessitate exposure of the RVA include repair of aneurysms, VA endarterectomy, VA bypass and new therapeutic options in intracranial interventions, anterior cervical spine surgery, thyroid surgery, esophageal surgery or other interventions [27].

VA injury is a known complication during anterior cervical spine surgery, which can result in fatal bleeding and permanent neurologic deficits [11]. Furthermore, during thyroidectomy or thyroid aspiration with a needle, there is a possibility of inadvertent injury or puncture of the VA [12, 27]. The risk of complications during aortic arch surgery or esophageal surgery increases in patients with variations in VA origin, especially in those with variable origin of RVA [11, 16, 34].

Detailed knowledge of arterial anatomy and variations is of utmost important for accurate interpretation of CTA, MRA and Doppler sonography images or performing diagnostic or interventional angiography. If VA is not identified in their normal position, this can be misinterpreted as the vessel being congenitally absent. This has become more important in the era of ca-

rotid artery stents, VA stents and new therapeutic options for intracranial interventions [23].

When the RVA originates from carotid artery or its branches, the ligation of the CCA may compromise the posterior fossa blood supply [30].

During aortic arch dissection the orifices of the CCA may often become occluded, drastically decreasing cerebral blood flow [14].

Clinicians performing open surgical procedures in the region of the RVA such as neurosurgeons, vascular and thoracic surgeons, and radiologists must have an indispensable knowledge of the anatomy and variations of the RVA in order to avoid complications [3].

CONCLUSION

In conclusion, we have presented a rare case of variable origin of the RVA from the right CCA with an incidence of 0.49%. Although anatomically interesting, an awareness of the RVA variations in origin is clinically important. A detailed understanding of the RVA variations in origin is essential for the accurate diagnosis and appropriate management of patients in radiology, for the safe and proper performance of surgical procedures and for avoiding iatrogenic complications during various interventions.

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Резиме

АНАЛИЗА НА ПОТЕКЛОТО НА ДЕСНАТА ‘РБЕТНА АРТЕРИЈА СО КТА

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Вовед: ‘Рбетната артерија потекнува од првиот дел на потклучната артерија и учествува во формирање на задната мозочна циркулација. Варијабилно потекло на ‘рбетната артерија е невообичаен наод. Целта на оваа студија беше да се испита потеклото на десната ‘рбетна артерија и да се анализираат нејзините клинички импликации.

Материјали и методи: За реализирање на оваа студија анализирани се слики на 203 пациенти, кои од оправдани медицински причини беа прегледани со компјутеризирана томографска ангиографија, извршена како дел од нивниот медицински третман на Универзитетската клиника за радиологија во Скопје, РС Македонија.

Резултати: Во студијата беа вклучени 203 пациенти, 108 мажи и 95 жени, на возраст од 19 до 82 години, со просечна возраст 59,6 години. Кај 202 пациенти (99,5 %) десната ‘рбетна артерија потекнуваше од десната потклучна артерија. Кај еден пациент (0,49 %) десната ‘рбетна артерија излегува од десната заедничка каротидна артерија, во комбинација со потекло на десната потклучна артерија од аортниот лак.

Заклучоци: Познавањето на потенцијалните варијации во потеклото на ‘рбетната артерија е важно за лекарите за безбедно извршување на дијагностичките и на интервентните процедури во радиологијата и за хирурзите за време на планирањето и на спроведувањето на хируршки интервенции.

Клучни зборови: десна ‘рбетна артерија, заедничка каротидна артерија, варијации, КТ ангиографија