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Original Investigation

Prevalence of Anomalously Originating Occipital Artery in a Group of Turkish Individuals: A Retrospective Study using Angiography

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ABSTRACT

AIM: Although it is well known that the occipital artery (OA) originates from the external carotid artery (ECA), the incidence of variations remains unknown. In our study, we investigated the prevalence of anomalously originating OA using angiography in a group of Turkish individuals.

MATERIAL and METHODS: The images recorded in the picture archiving and communication system for a total of 114 patients, in which the whole vertebral artery, as well as the ECA and its branches, were visualized, were retrospectively reviewed. Images were obtained using a Toshiba INFNX-i 8000V (Canon Medical Systems, Otawara, Tochigi, Japan) angiography device.

RESULTS: We diagnosed 11 cases (12 arteries) with anomalously originating OA, representing a prevalence of 9.64%. In 7 cases, the ascending pharyngeal artery and OA originated with a common root from the ECA (8 arteries); and in 4 patients, OA originated from the distal part of the ECA (C1 vertebral level).

CONCLUSION: As for many vascular structures, the prevalence of OA variations may vary according to the population under question and the examination method used. Our study has shown that in a sample from the Turkish population, the prevalence of anomalously originating OA was much higher than that stated in the literature, which used magnetic resonance angiography. To avoid complications, the high prevalence of this anomaly must be taken into account during surgeries that require the use of OA, endarterectomies, and endovascular interventions.

KEYWORDS: Anatomy, Angiography, Arterial variations, External carotid artery, Occipital artery

INTRODUCTION

The occipital artery (OA) usually originates from the posterior aspect of the proximal external carotid artery (ECA) (42,45) and, can be divided into three distinct segments: digastric, horizontal (suboccipital), and terminal (occipital) (Figure 1) (3). Based on anatomical, surgical, and radiological studies, various variations of OA have been described in the literature (1,3,6,7,9-11,14,15,20-23,27-30,37,38,41-43). It has also been reported in several publications that the incidence of some cerebrovascular diseases, Willis polygon, and superior thyroid artery variations differ among populations (12,13,17-19,25,31,32,40,44,46).

To the best of our knowledge, no studies, published in English, have investigated the prevalence of OA origin variations using angiography. We investigated and reported the rate and types of OA origin variations using catheter angiography in a group of Turkish individuals.

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MATERIAL and METHODS

All the images recorded in the picture archiving and communication system of the 440 cerebral angiography procedures performed in the Interventional Neuroradiology Unit of Fatih Sultan Mehmet Education and Research Hospital Radiology Department between July 2016 and December 2017 were retrospectively reviewed. A total of 114 patients had the entire vertebral and external carotid arteries, and their branches, visualized. Most of the examined patients had suspected or proven ischemic cerebrovascular disease. Of the 114 patients, 79 were men and 35 were women, and the mean age was 64.3 years (range 41-86 years). The need for informed consent was waived by the internal institutional review board because of the retrospective nature of the study.

Toshiba INFNX-i 8000V (Canon Medical Systems, Otawara, Tochigi, Japan) was used as the angiography device. A total of 12 cc of non-ionic contrast medium (OMNIPAQUE 300 mg iodine/ml, GE Healthcare, Cork, Ireland) was injected at a rate of 4 cc/sec into the corresponding common carotid artery (CCA) to visualize the ECA, OA, and their branches. A total of 5 cc of contrast medium, injected at a rate of 3 cc/sec was used to visualize VA origin and its proximal part, and a total of 9 cc injected through the proximal part of VA at a rate of 3 cc/sec was used to visualize the distal part of vertebral artery (VA) and the posterior circulation. Two experienced neuroradiologists, Murat Velioglu and Osman Kula, reviewed all angiographic images to observe the abnormal origin of OA.

RESULTS

Eleven cases with anomalously originating OA were detected among the 114 cases (9.64 %) using catheter angiography. The ascending pharyngeal artery (APA) and OA originated from the ECA with a common root in 7 of the 11 cases with OA variation. In two of them, the pharyngo-occipital trunk (POT) originated from a proximal part of the ECA (Figure 2), and one had bilateral POT (Figure 3A, B). In 4 patients, OA originated from the distal part of the ECA (C1 vertebral level) and was directed posteriorly (Figure 4).

DISCUSSION

We found anomalously originating OA in 11 out of 114 cases (10.52 %), which was well above the previously reported incidence in studies of OA variation using non-contrast magnetic resonance angiography (MRA)(42). To the best of our knowledge, this is the first report about the incidence of anomalously originating OA using catheter angiography.

Many variations of OA were described in postmortem dissections before 1841 (14,22). Recent reports describing OA origin variations are limited to case reports of incidental angiographic or intraoperative findings (1-3,6,10,11,15,20-22,27-30,33,38,41,43,45). We found only one incidence study using non-contrast MRA in the literature published in English, in which the incidence of OA origin variation was reported as 0.21 % (42).

Currently, catheter-based digital subtraction angiography (DSA) is considered the gold standard for the diagnosis of occlusive extra- and intracranial carotid artery diseases (39). Slow, turbulent, and non-turbulent flow cannot be detected in unenhanced MRA (39), so anomalously originating blood vessels may be missed during MRA studies. OAs originating from CCA have also been reported in the literature (15,45) and the true prevalence of this variant may have been underestimated with MRA. Another reason for the lower rate of variations in the study by Uchino et al. is that MRA was performed up to the carotid bifurcation only (42).

CCA usually divides into the ECA and internal carotid artery (ICA) at the C3-4 level (16). The OA classically originates from the posterior part of the ECA at 20 mm distal to the carotid bifurcation, then turns medial to the posterior bundle of the digastric muscle, and after passing through the medial part of the mastoid advances posteriorly between the occipital bone and C1 (Figure 1) (26,45). The exact origin of the OA is over the origin of the facial artery in 57% of individuals (Figure 1), between the facial and lingual arteries in 32%, and below the lingual artery in 11% (16). In one of our cases, OA originated at the C1 level (Figure 4), and we could not find similar reports in our search of the literature published in English.

The embryology of OA and other variant origins of ECA branches were not fully understood until Lasjaunias et al. hypothesized that OA is formed from the proatlantal intersegmental artery (26). The ascending pharyngeal artery (APA) often shares a common origin with OA, and the

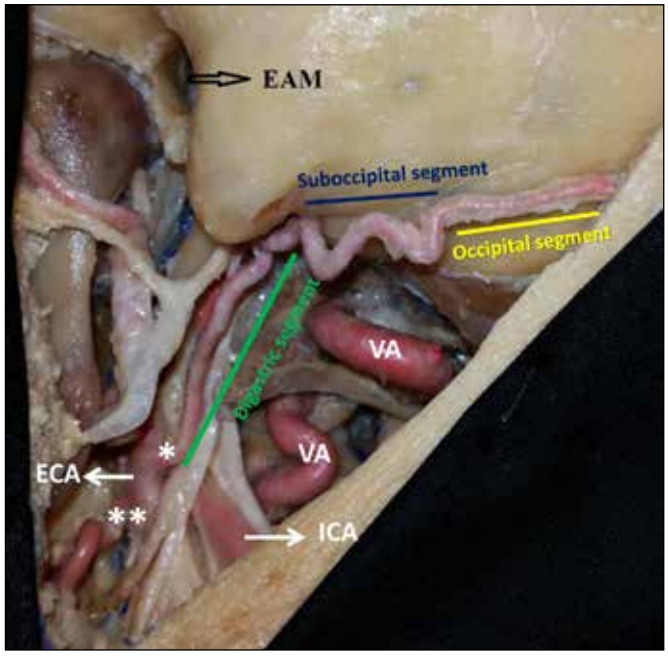

Figure 1: Photograph showing the classic origin of the occipital artery from the left external carotid artery and the digastric, suboccipital and proximal occipital segments of the occipital artery. ***:** origin of the occipital artery; ****:** facial artery; **EAM:** external auditory meatus; **ECA:** external carotid artery**; ICA:** internal carotid artery; **VA:** vertebral artery.

phylogenetic and embryological details of this common origin of APA and OA has been previously described (1,26). While Hayashi et al. found the prevalence of APA to be 19% in Japanese cadaveric dissections (16), Cavalcanti et al. reported it at 7.9% in their cadaveric dissections (8). In our study using DSA, we detected 7 cases (6.1%) in whom the OA and APA originated by a common root from ECA. While the two POTs were localized proximal to the left ECA (Figure 2), the bilateral output of the POT was noted in 1 case (0.87%) (Figure 3A, B). To the best of our knowledge, no other cases with bilateral POT have been reported in the literature published in English.

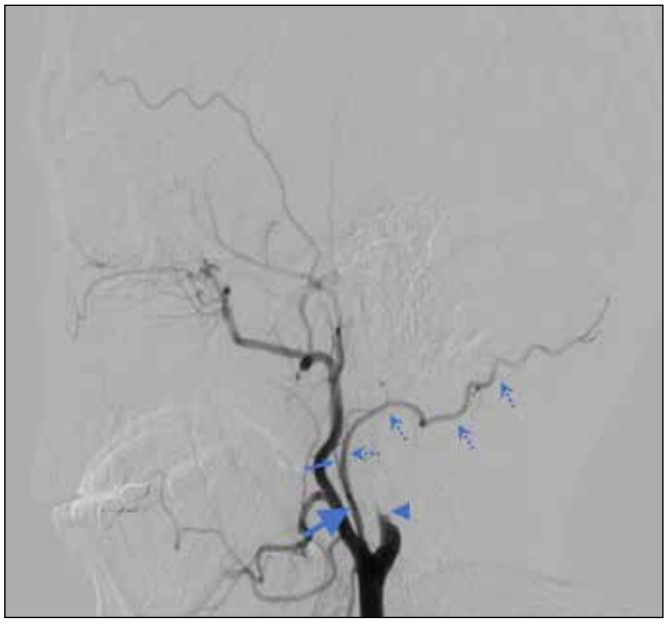

Figure 2: Left lateral angiogram is showing the apparently proximal origin of the pharyngeal occipital trunk in relation to the external carotid artery **(large arrow)**, followed by the ascending pharyngeal **(arrow)** and occipital arteries **(interrupted arrow)**. Also, internal carotid artery dissection is observed **(arrowhead)**.

Anomalies of the carotid vessels are usually asymptomatic, but they are increasingly becoming recognized with the increasing number of surgical procedures and endovascular interventions of the carotid arteries and their branches (20). However, these variations recognized by chance may sometimes be clinically important (11,15,30). In the literature, it was reported that a case was mistakenly diagnosed with carotid stenosis using ultrasonography and was planned for stenting, but after DSA, it was found that OA and APA were both originating from an occluded ICA stump, and the intervention was abandoned (43). Also, OA is a commonly used vessel in the revascularization surgery of the posterior cranial fossa as an intracranial bypass graft (4,5,24,34-36). Taking the OA variations into consideration and evaluating it with DSA before bypass surgery is important for surgical planning. Atherosclerotic stenosis of the extracranial carotid artery typically occurs at the junction of the CCA, ECA, and ICA arteries (11,14). Hence extracranial ICA anomalies affect the plan of surgical endarterectomies. In their study, Hayashi et al. emphasized the importance of awareness of the variations in the origin of vessels during carotid endarterectomy to avoid injuries or problematic back bleeds during atherosclerotic plaque extraction (16).

The limitations of our study include the retrospective nature and the small sample size. Moreover, almost all our cases have been diagnosed with or were suspected to have, atherosclerotic vascular disease (Figure 2).

Uchino et al. (42) suggest that since atheromatous plaques are most frequently observed at the posterior aspect of the proximal ICA, OA arising from the posterior aspect of the ICA may be occluded in some of these patients. Therefore,

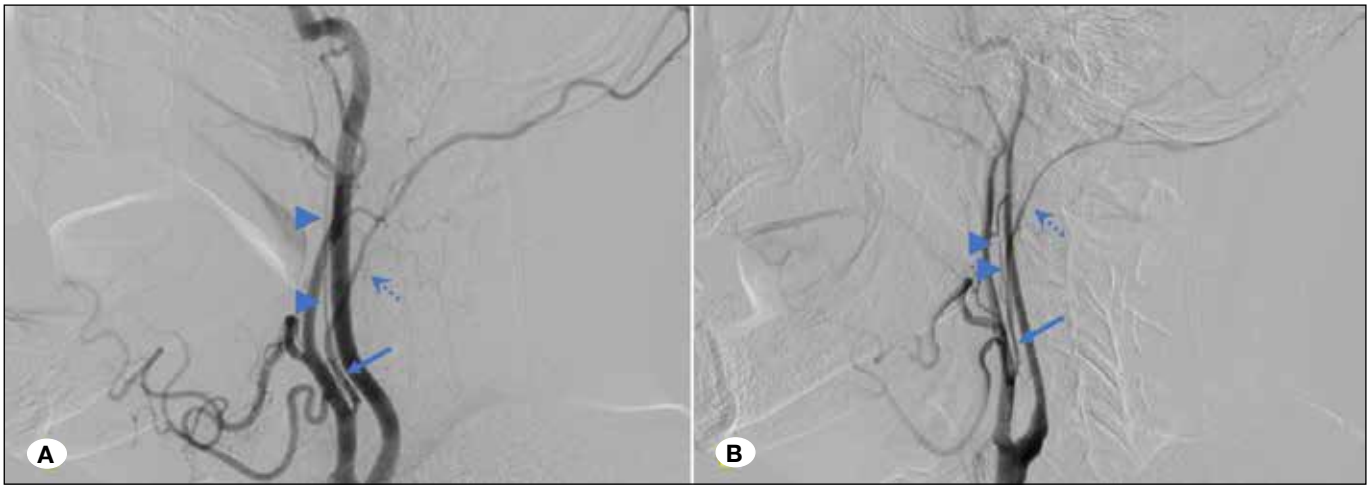

Figure 3: Case with the bilateral pharyngo-occipital trunk. **A)** A lateral angiogram performed from the right main carotid artery better delineates the pharyngo-occipital trunk **(arrow)** originating from the posterior wall of the external carotid artery. The ascending pharyngeal artery **(arrowheads)** and the occipital artery **(interrupted arrow)** is followed along its course. **B)** The pharyngo-occipital trunk **(arrow)** originating from the posterior wall of the external carotid artery in a lateral angiogram performed from the left main carotid artery of the same case. The ascending pharyngeal **(arrowheads)** and the occipital arteries **(interrupted arrow)** are followed along with its course.

Figure 4: A DSA image from the lateral projection of left common carotid artery injection. Note the occipital artery **(arrow)** is arising from the external carotid artery at C1 vertebral level.

occlusion of the orifice of the OAs may have caused some of our cases to be overlooked, and the rate of variations may have been less than the rate found in anatomic studies. While some of the OA variations are often detected on angiographic images (20-22,30), others require gross anatomic dissections to reveal the relationship between OA and adjacent soft tissues (1,3,10,27,41). However, angiography is more easily performed and is more widespread than anatomical dissections in almost all populations and can be used to evaluate most of the cases.

CONCLUSION

In our study of Turkish individuals using angiography, we found that the prevalence of anomalously originating OA was much higher than that reported in the literature using MRA. Before surgeries that require the use of OA, endarterectomies and endovascular procedures, a detailed examination is necessary to avoid complications resulting from the high rate of variations.

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