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Case Report

Clinically significant anatomical variation of the retropharyngeal internal carotid arteries

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ABSTRACT

Although interpatient variations in the course and anatomy of extracranial internal carotid arteries (EICAs) have been described previously, inpatient variability is rarely cited in the literature. Distance between EICAs and the pharyngeal wall is an important determinant of vascular injury risk. A retropharyngeal EICA has crucial implications in patients undergoing pharyngeal procedures, and important in otorhinolaryngology and emergency medicine. Surgical exploration without identification of anatomical landmarks, or emergent intubation in the emergency room poses high risk for EICA injury. Other critical clinical considerations include intra-arterial involvement of tonsillitis, peritonsillar abscesses, or parapharyngeal neoplasms due to close proximity to the EICA.

We present 2 cases with short-term change in retropharyngeal course of EICA to highlight this further. Although no clear etiology for these changes has been identified, we hypothesize that embryology, weight alterations, atherosclerotic disease, and postradiation changes are contributory. Thus, one radiologic study does not exclude variation in vascular anatomy.

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Introduction

The lethality associated with aberrancy in physical form and position of the extracranial internal carotid artery (EICA) has been well documented in the literature. Despite advances in imaging, digital exploration of the retropharynx for a pulsatile mass as proposed by Skillern in 1913 [1] remains the most optimal technique for avoidance of the EICA. Two major categories of variability have been proposed, the first being the distance between the EICA and the pharyngeal wall, and the second being the characteristic morphology of the EICA itself.

Previously published literature on the distances between the EICA and the tonsillar fossa in the pediatric population has demonstrated a pattern where the abovementioned distance increases with the patient's weight and age [2]. Such mobility has clinical implications when one considers the large number of routine surgeries that involve the neck in children and adults. Besides hemorrhage, the close proximity of structures in the retropharynx poses a risk for the spread of infection via seeding from an adjacent abscess. Through the presentation of these 2 cases, we offer hypotheses that would explain changes in the location of the retropharyngeal EICA over a

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short time interval, and predict the inadequacy of a single study to ascertain vascular anatomy.

Case reports

Case #1

A 56-year-old male patient with obesity and hypertension was evaluated for neck pain after trauma in 2012, at which time an unenhanced computed tomography (CT) head was negative for hemorrhage. In 2013, an unenhanced CT neck was obtained for evaluation of continued neck pain that demonstrated severe cervical spondylosis. The course of the cervical internal carotid arteries was anatomically appropriate during this study (Figs. 1A and B). In 2016, after failure of conservative management, a C5-7 anterior cervical discectomy and fusion was planned. A repeat unenhanced CT cervical spine was obtained for preprocedural evaluation and demonstrated retropharyngeal internal carotid arteries (Figs. 2A and B). There was no history of intubation or neck radiation during this period from 2013-2016. His weight had increased from 224 lbs in 2013 to 247 lbs in 2016.

Case #2

A 73-year-old female patient with metastatic adenocarcinoma of the lung and atherosclerosis presented in 2013 for a work up of aphasia. A CT angiogram of the neck was performed which showed normal anatomical course of the internal carotid arteries (Figs. 3A and B). After a fall in 2016, a CT cervical spine was negative for fractures. However, this study demonstrated a retropharyngeal course of bilateral internal carotids (Figs. 4A and B). In this interim period, the patient had no intubations or neck radiation. The earliest weight available was 198 lbs in 2014 with an interval decrease to 180 lbs in 2016.

Discussion

The above-mentioned cases highlight the changes that can occur in the distance between the EICAs and the retropharyngeal wall over a short-term interval. Deutsch et al [2] stated that in children, the distance between the tonsillar fossa and the EICA has a positive correlation with increasing age and weight until the distance reaches a value of 25 mm in adulthood. Routine procedures, such as tonsillectomies and peritonsillar abscess drainage, which are more common in children, have the potential to cause injury to the EICA [3]. The initial artery to pharyngeal mucosal wall distance in our first patient was 13 mm on the right and 12 mm on the left. In 3 years, this distance decreased to 5 mm on the right, and 6.2 mm on the left. Similarly, in our second patient, the initial distance was 4.6 mm on the right and 10 mm on the left. Three years later, the new distances were 2.6 mm on the right and 4.2 mm on the left. Unlike Deutsch et al's study, in our first case, the patient's weight increased from 224 lbs to 247 lbs with the EICA-mucosal wall distance decreasing to 8 mm on the right and 6 mm on the left. In our second case, the patient lost 18 lbs in 2 years and the EICA-mucosal wall distance decreased by 2 mm on the right, and 6 mm on the left. Based on the findings in the second case, loss of neck adipose tissue could potentially be a factor that could explain the variation in the EICAs course leading to their close proximity.

Pfeiffer et al [4] suggested that the embryological development of the EICAs plays a role in its migration as well. In the embryo, a tortuous EICA emerges from the third aortic arch and begins to uncoil as the heart descends into the mediastinum. Pfeiffer et al suggest that the degree of straightening can affect whether or not the EICA remains kinked or looped. As the most common site of coiling is at the level of the tonsillar fossa, this increases both the likelihood of injury and the presence of a retropharyngeal EICA. To evaluate this further, we measured the vertical distance between the

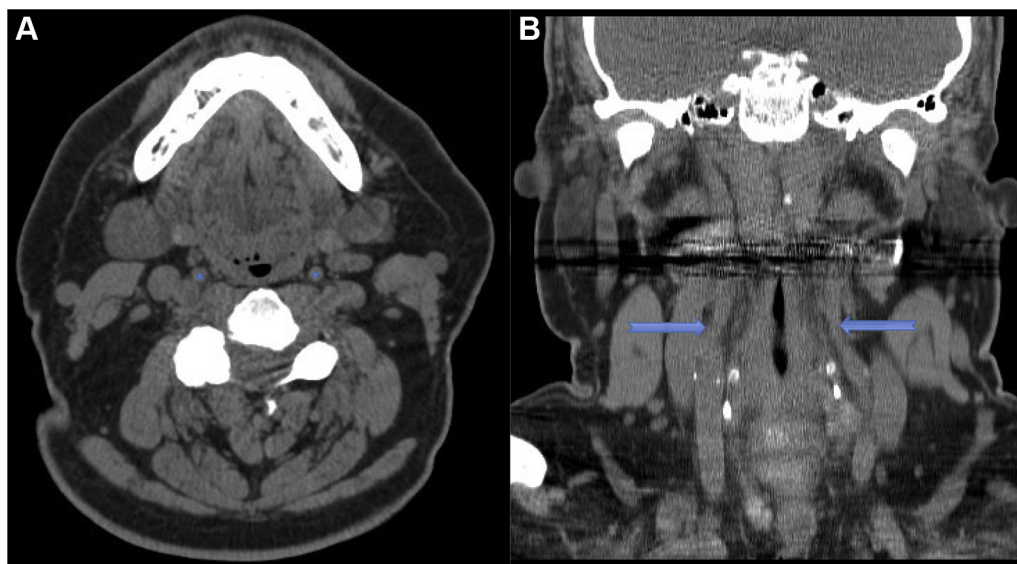


Fig. 1 – Patient 1: CT images of the cervical spine of the initial scan in 2013 demonstrates normal anatomic course of the retropharyngeal internal carotid arteries at C2-C3 level on axial (A) with blue asterisk and on coronal (B) with blue arrows.



Fig. 2 – Patient 1: CT images of the cervical spine on the follow-up scan in 2016 demonstrates close proximity of the retropharyngeal internal carotid arteries at C2-C3 level on axial (A) with orange asterisk and on coronal (B) with orange arrows.

tonsillar fossa and the level of the bifurcation of the common carotid arteries. In the first case, this distance was 4.1 cm on the left and 5.7 cm on the right, whereas in the second case, the distance was 2.2 cm on the left and 3.9 cm on the right. If we factor in the caudal displacement of the heart during embryological development, which varies with each patient, one can hypothesize that the further the migration the more “straightened” the EICA should be. Therefore, a shorter length of the EICA from the bifurcation to the tonsillar fossa would indicate the EICA being less straight, more coiled, and closer to the mucosal wall. Furthermore, with regards to the first case, the horizontal distance between the EICAs on the initial CT in 2013 measured 32 mm, which decreased to 7.55 mm on the follow-up study in 2016. Similarly, with regards to the second case, the horizontal distance between the EICAs on the initial

CT in 2013 measured 25.8 mm, which decreased to 1.2 mm on the follow-up study in 2016.

Pfeiffer et al build on Weibel and Fields's anatomical classification system for the EICA, by developing a grading system based on the distance between the pharyngeal wall and the EICA for risk stratification [5–7]. In this system, a grade of I-IV is used to assess the risk of injury during pharyngeal procedures. Based on initial imaging, our first case had grade I aberrations bilaterally, which indicates low risk. However, follow-up imaging performed 3 years later demonstrated grade II aberrations indicating moderate risk. In the second case, over the course of 2 years, the patient's right EICA remained a grade III, indicating high risk, whereas her left EICA demonstrated an interval increase from grade I to grade III.

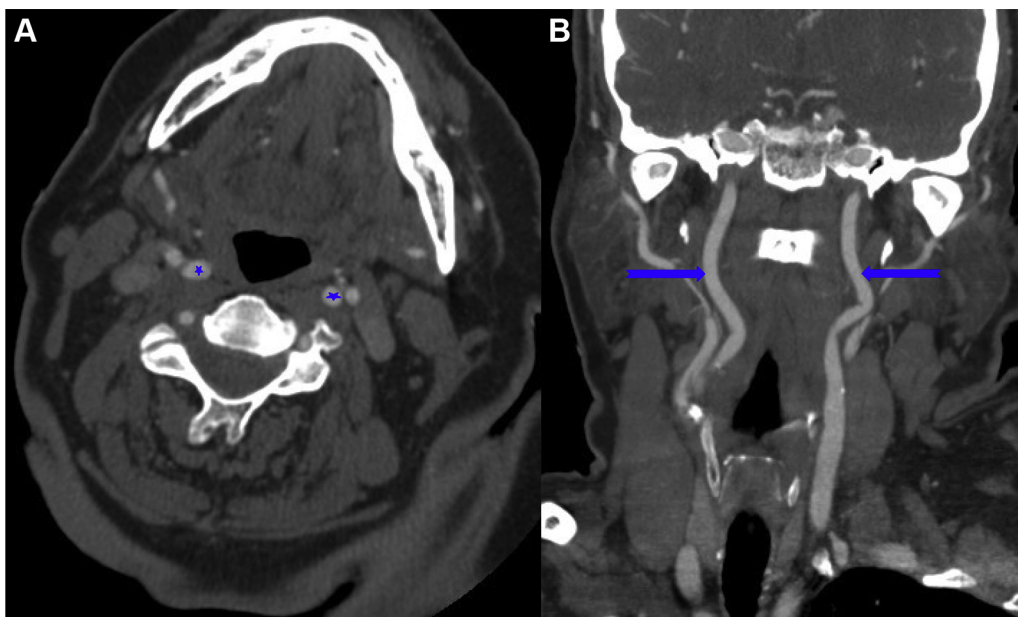


Fig. 3 – Patient 2: CTA images of the neck of the initial scan in 2013 demonstrates normal anatomic course of the retropharyngeal internal carotid arteries at C3 level on axial (A) with blue asterisk and on coronal (B) with blue arrows.

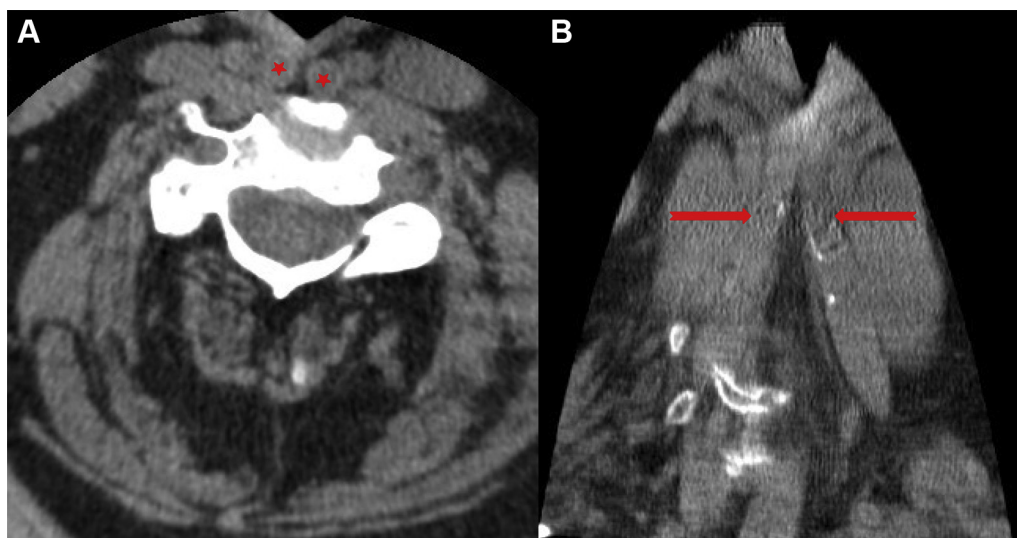


Fig. 4 – Patient 2: CT images of the cervical spine on the follow-up scan in 2016 demonstrates close proximity of the retropharyngeal internal carotid arteries at C3 level on axial (A) with red asterisk and on coronal (B) with red arrows.

Over time degenerative changes of the vessel walls can occur in relation to atherosclerosis, loss of elasticity, hypertension, and fibromuscular dysplasia. These associations can lead to an aberrant vessel course of the EICA. Both our patients are above the age of 50 years, with a history of atherosclerotic disease [5]. Paulsen et al [4] determined the frequency with which structural changes in the EICA occur in both sexes and found that a curved course is seen at a frequency of 25%-28%, and 5%-7% for kinking or coiling. Coiling was linked to embryological changes, curving to aging, and kinking to the development of atherosclerosis. Any alterations from the normally straight course of the EICA is likely to affect the distance between the pharyngeal wall and the vessel. Significantly, the cohort Pfeiffer used to calculate distances to the pharyngeal wall had kinking as the most common EICA aberration. It stands to reason then, that older patients who are more likely to have kinked vessels have a higher chance of demonstrating a short distance between their EICAs and the adjacent pharyngeal wall.

Although the incidence of variations in the course of EICAs and clinical significance of retropharyngeal ICAs have been documented, a methodical approach to identifying the course of these vessels remains unclear [8,9]. In the case of the latter, headway has been made by Galetti et al [10] in identifying that the best imaging modality to identify aberrant EICAs and their course through the mucosa is to use 3-dimensional time-of-flight MR angiograms alongside Doppler ultrasonography. Although the use of MR angiograms before neck surgery could prove vital in avoiding damage to the EICA, CT angiogram of the neck is often the scan of choice considering its reduced scan times and cost effectiveness.

Conclusion

Although there is more than one hypothesis for aberrancies found in the location and physical form of the EICA,

recognition of this phenomenon is of paramount clinical importance. Repeat/follow-up imaging can accurately represent interval changes in location of EICA. These changes are made more likely in patients who undergo neck radiation, significant weight changes, or have atherosclerotic disease. In the absence of up-to-date imaging, digital exploration of the retropharynx remains the best way to avoid a pulsatile mass. Further vascular imaging of the neck may be necessary to detect significant alterations in the course of the EICA. However, the fact still remains that a single prior imaging study is inadequate to ascertain vascular anatomy, especially with respect to the EICA.

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