SHORT REPORT

Eur J Anat, 12 (3): 175-178 (2008)

Anatomical variations associated with the carotid arterial system in the neck

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SUMMARY

During routine dissection of the neck region of a middle aged female cadaver, the brachiocephalic trunk was found to arise from the arch of the aorta along the left margin of the trachea. The right common carotid arose anterior to the upper trachea and crossed it. The crossing of the upper part of the trachea by the right common carotid artery is a rare occurrence. A more distal branching of the aortic sac during fetal life could explain the anomalous origin of the brachiocephalic trunk. This may lead to an unusual origin and course of the right common carotid artery. Knowledge of this rare variation is clinically important for making midline neck incisions, as well as for revealing the diagnoses of pulsatile neck swellings. The other variations of the carotid arterial system described in this case include bilateral tortuosity of the common carotid arteries and external carotid arteries; an anterolateral relationship of the right external carotid artery to the right internal carotid artery at their origins; high bifurcation of the left common carotid artery, and a bilateral origin of the superior thyroid arteries from the common carotid artery. These more common variations need to be kept in mind when making clinical diagnoses, conducting neck surgeries and carrying out carotid angiography. The isthmus of the thyroid gland was found to be absent. This finding is important because it may be associated with other thyroid abnormalities.

Key words: Common carotid artery – Anomalous origin – Trachea – External carotid artery – Tortuosity

INTRODUCTION

The carotid arterial system constitutes the principal blood supply to the head, neck and brain. Numerous variations of the carotid arterial system in the neck have been described in the literature. Knowledge of variations of this arterial system is important for diagnostic imaging as well as for surgeons operating on this region. The crossing of the trachea by the right common carotid artery has been described earlier (Bergman et al., 1988). However, the crossing of the upper part of the trachea by the right common carotid artery occurs very infrequently (Choi et al., 1998). Here, this finding, combined with the presence of multiple variations in the carotid arterial system, and the absence of the isthmus of the thyroid gland is documented.

Submitted: April 25, 2008
Accepted: November 18, 2008

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Case Report

During routine dissection of the neck region of a female cadaver aged 50 years at the Department of Anatomy of St. John's Medical College, Bangalore, India, the authors found a large artery passing towards the right, crossing the upper part of the trachea. On tracing the artery proximally and distally, it was identified as the right common carotid artery (CCA). The brachiocephalic trunk (BT) was found to arise from the arch of the aorta along the left margin of the trachea, and coursed superiorly and towards the right over the trachea in the suprasternal region. It then terminated by giving off the right subclavian artery (SA) and right CCA over the fourth to sixth tracheal rings. The right CCA crossed the right half of the trachea over the fourth tracheal ring (Fig. 1a). The right SA also crossed the right half of the trachea inferior to the right CCA, before passing towards the medial border of the right scalenus anterior muscle. The isthmus of the thyroid gland was found to be absent.

After reaching the right margin of the trachea, the right CCA coursed superiorly in the carotid sheath with a moderately tortuous course and bifurcated at the superior border of the thyroid cartilage into the right internal carotid artery (ICA) and right external carotid artery (ECA). At its origin, the right ICA was found to lie posteromedial to the right ECA. The right superior thyroid artery (STA) was given off at the level of the bifurcation of the right CCA. The right ECA was found to be highly tortuous, showing five abrupt changes in direction before its termination (Fig. 1b). No variations were found in the branches of the right ECA or its mode of termination. The course of the right ICA in the neck did not reveal any unusual features.

The left CCA was also traced from origin to termination. It arose from the arch of the aorta distal to the BT, followed a gently sinuous course cranially within the carotid sheath, and terminated just above the level of the hyoid bone by dividing into the left ICA and left ECA. The left STA arose around 1.25 cm proximal to the termination of the left CCA. The left ECA showed extreme tortuosity throughout its course in the submandibular and parotid regions. The relationship to the left ICA, its branches, and the mode of termination of the left ECA did not show any variations. The left ICA coursed superiorly from its origin and showed no variations in the neck. The external diameters of the CCA, ICA and ECA were similar on the right and left sides.

Discussion

The carotid arterial system supplies the head, neck and brain through the ECA and ICA. On either side, the CCA is derived from the third aortic arch artery, while the ICA is partly derived from the third aortic arch artery and partly from the cranial continuation of the dorsal aorta. The ECA arises as a branch from the third aortic arch artery (Sadler, 2004). Many variations in these arteries can be explained on the basis of derangements of their embryological origins. These variations are of great significance in making clinical diagnoses, carrying out carotid angiography and conducting neck surgery.

The crossing of the trachea by the right common carotid artery has been described in the literature (Adachi, 1928; Bergman et al., 1988; Lippert and Pabst, 1985). However, the crossing of the upper part of the trachea by the right CCA is a very rare occurrence (Choi et al., 1998). The brachiocephalic trunk is a derivative of the right horn of the aortic sac, which is a continuation of the truncus arteriosus. A more distal branching of the aortic sac could account for the anomalous origin of the brachiocephalic trunk. This variation has evident clinical relevance. Midline vertical neck incisions are commonly used in emergency tracheostomy operations. The crossing of the trachea by vessels such as the BT, the right CCA and the right SA could predispose patients to injury, resulting in catastrophic bleeding during such surgical procedures. Suprasternal pulsations may be seen in cases of an aneurysm of the arch of the aorta. These pulsations could also be caused by the anomalous origin and course of the BT and its terminal branches, as described in this case.

Tortuosity of the common carotid arteries has been described frequently. However, the etiology, clinical significance and prognosis have yet to be adequately elucidated (Pellegrino and Prencipe, 1998). Tortuosity of the common carotid artery is most commonly seen in patients who are elderly, hypertensive, and in those with atherosclerotic lesions (Sandler et al., 1979; Thomas et al., 2005). However, its occurrence in young healthy individuals

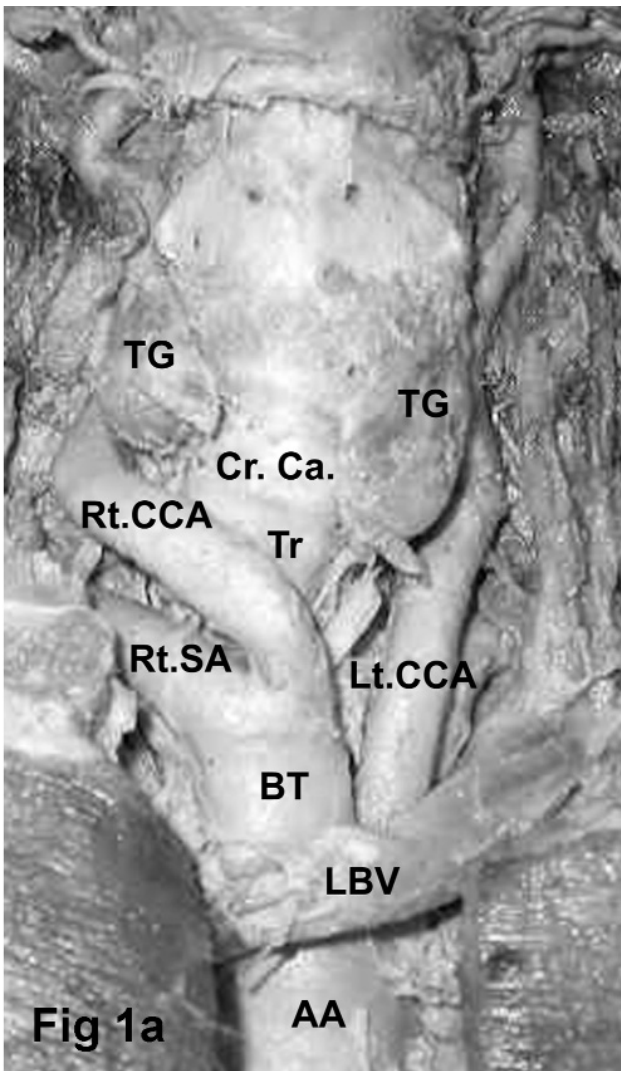

Figure 1a. An anomalous origin of the right CCA in the midline, anterior to the upper part of the trachea.

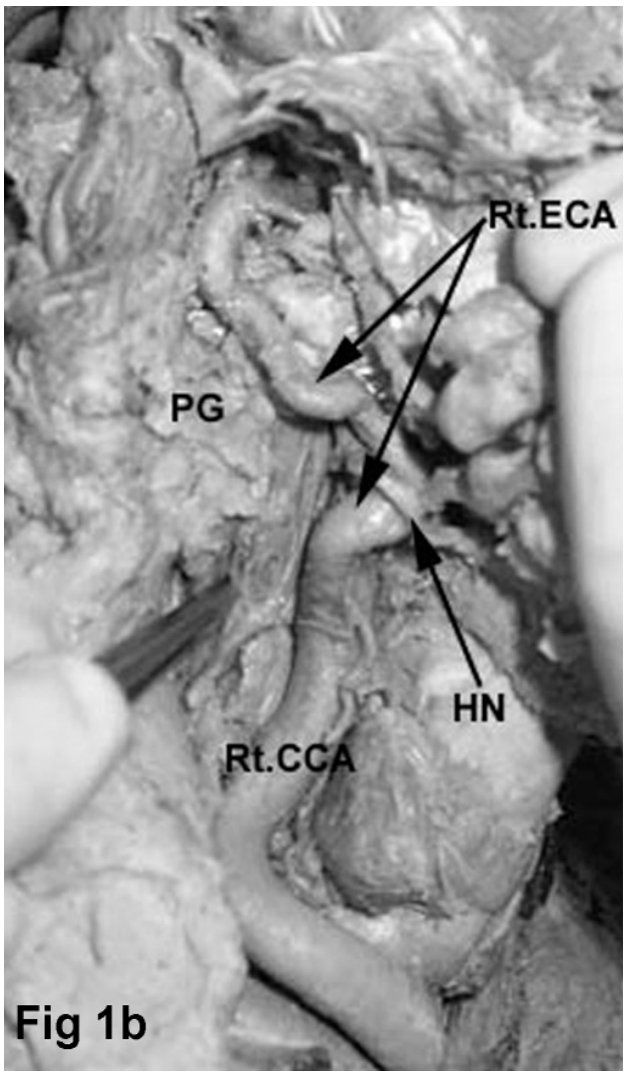

Figure 1b. Extreme tortuosity of the right ECA.

Abbreviations used in the figures:
AA – aortic arch; BT – brachiocephalic trunk; Cr.Ca. – cricoid cartilage; HN – hypoglossal nerve; LBV – left brachiocephalic vein; Lt.CCA – left common carotid artery; PG – parotid gland ; Rt. CCA - right common carotid artery; Rt. ECA – right external carotid artery; Rt.SA – right subclavian artery; TG – Thyroid gland; Tr – trachea.

may point to a developmental basis for the tortuosity. A tortuous common carotid artery, usually the right one, can cause a pulsatile neck mass that may mimic an aneurysm. Performing an arteriography in these cases bears the risk of arterial injury. It is therefore preferable that non invasive techniques like ultrasonography and computerized tomography precede angiography (Godin et al., 1988).

Textbooks describe the STA as occasionally arising from the common carotid artery (Standring, 2005). The origin of the STA from the CCA has been reported with varying frequency by different investigators. The reported incidence varies from 6.41% to 47.5% (Lucev et al., 2000). A meta-analysis of the variations of the STA revealed racial differences in the origin of the STA. A higher frequency of the origin of the STA from the CCA was noted in East Asians as compared to Caucasians (Toni et al., 2004). During thyroidectomy operations the STA must be ligated, and this somewhat frequent variation must be kept in mind by the surgeon.

The bifurcation of the CCA usually occurs at the upper border of the thyroid cartilage (Standring, 2005). However, variability in the termination of the CCA is well documented. This could be due to differences in the level of embryological origin of the external carotid artery. In some recent studies (Lucev et al., 2000; Lo et al., 2006) it was found that the CCA artery bifurcated at the level of the hyoid bone in an almost equal proportion of cases as compared to the usually described level of bifurcation. The hypoglossal nerve lies in clos-

er proximity to the CCA bifurcation when it occurs more superiorly. This makes it more vulnerable to damage during surgical interventions in this region. Thus, preoperative identification of the level of CCA bifurcation may be helpful in preventing iatrogenic injuries to the hypoglossal nerve (Lo et al., 2006).

The ECA has commonly been described to be anteromedial to the ICA at its origin. An anterolateral relationship between the ECA and the ICA in this location is a rare occurrence. Angiographic studies have revealed that the ECA bears an anterolateral relationship to the ICA at its origin in around 12% of cases. This relationship is more common on the right side (Smith and Larsen, 1979; Trigaux et al., 1990). Although the ECA is generally described as having a mildly tortuous course, extreme tortuosity is uncommon. To our knowledge, the incidence of extreme tortuosity of the ECA has not been reported in the literature. The tortuous course in the submandibular and parotid regions could place the ECA at risk during surgery conducted in these regions, in addition to causing difficulties in the interpretation of carotid angiograms.

An absent isthmus of the thyroid gland has been reported, the incidence varying between 5% and 10%. A high division of the thyroglossal duct can result in two separate thyroid lobes with an absent isthmus. Other types of dysorganogenesis such as the absence of a lobe or the presence of ectopic thyroid tissue may be associated with the absence of the isthmus (Pastor Vazquez et al., 2006).

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