

## Concurrence of bilateral kinking of the extracranial part of the internal carotid artery with coiling and tortuosity of the external carotid artery – a case report

ERIKA CVETKO

*Institute of Anatomy, Medical Faculty, Ljubljana, Slovenia*

### Abstract

Anatomical variations of the carotid arterial system have a great impact on surgical approaches to the neck and radiological imaging interpretation. Although reports on internal carotid artery dolichoarteriopathy (kinking, tortuosity, coiling) have been reported, no report on dolichoarteriopathy of the external carotid artery has been described. Herein, we report a case with concurrent bilateral kinking of the extracranial part of the internal carotid artery associated with extensive calcifications in the relatively high-located carotid bifurcation and coiling with tortuosity of the external carotid artery in a male cadaver – an entity that has not yet been reported. The variation presented should be kept in mind during various surgical procedures in order to decrease possible iatrogenic or surgical complications.

**Keywords:** internal carotid artery, kinking, external carotid artery, tortuosity, coiling.

### Introduction

Anatomical variations of the arteries in the carotid triangle of the neck are important, especially during surgical and radiological intervention in the region. Variations in the course of the extracranial part of the internal carotid artery (ICA) were reported [1–3], classified as tortuosity, kinking, and coiling [4]. The term “dolichoarteriopathies” has been applied to the coiling, kinking, and the tortuosity of the carotid arteries [5]. Coiling and kinking of the ICA was detected with a frequency of 6% [1] and 5% [2] of anatomical preparations. The large number of routine procedures performed in patients in the cervical lateral region makes the variations of the extracranial part of the ICA clinically relevant. They may be either the source of cerebral emboli or intermittent stenoses or occlusion by head rotation, triggering cerebral ischemia symptoms, or may represent a risk factor for massive bleeding during surgical procedures [4, 6–9].

The mode of classification of the variations of the ICA can also be applied to classify the variations of the external carotid artery (ECA) [4]. Variations in the course of the ECA such as coiling, kinking and tortuosity in the available literature have not yet been described. We report on a male cadaver found to have concurrent variations in the course of both the ICA and ECA bilaterally: kinking of the extracranial part of the ICA and coiling with tortuosity of the ECA – an entity that has not yet been reported.

### Materials, Methods and Results

During the course of applied clinical anatomy for dental students on the dissection of the neck of an approximately 70-year-old Caucasian male cadaver, the kinking of the extracranial part of the ICA and coiling

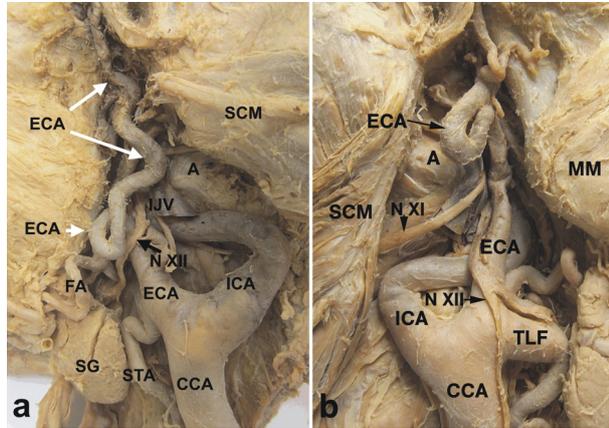
with tortuosity of the ECA were observed bilaterally (Figure 1, a and b). The bifurcation of the common carotid artery (CCA) was relatively high at the level of the hyoid bone on both sides. Extensive calcifications of the arterial wall were present in the bifurcation (Figure 1, a and b) on both sides. The inferior kinked segment of the ICA started at the level of the carotid bifurcation and ran obliquely posterosuperiorly, turning at an angle of 40° anteromedially. The superior kinked segment ran horizontally and was situated in the parapharyngeal space with a close relation to the pharyngeal wall in the region of transition between the mesopharynx and hypopharynx. The terminal part of the aberrant ICA was situated medially to the ECA, just posterior to the mandibular angle. The ICA continued on a straight course up to the entry into the temporal bone.

The initial segment of the ECA was straight, then coiled 1 cm under the mandibular angle on the left and 2 cm above the mandibular angle on the right side, and continued tortuously behind the mandibular ramus on both sides. The branching pattern of the external carotid artery was normal on the left side but, on the right side, the anterior branches of the ECA arose in a common thyrolinguofacial trunk.

The wall of the kinked segment of the ICA was extremely thin: 0.08 mm (left) and 0.11 mm (right), while the thickness of the straight segment of the ICA (0.38–0.44 mm) was similar to the thickness of the ECA wall (0.39–0.49 mm), which did not differ significantly in the straight, coiled and tortuous segments. For comparison purposes, the wall thickness of the internal jugular vein was measured (0.11 mm both sides) and that of the CCA (0.94 mm left and 0.81 mm right).

The kinked part had a larger lumen diameter (5.5–7.5 mm on the right and 5.3–7.6 mm on the left) than the straight part of the ICA (4.0–4.4 mm). The lumen of

the CCA (1 cm inferiorly to the carotid bifurcation) was 7.7 mm (left) and 7.2 mm (right). The lumen diameter of the straight, coiled and tortuous segments of the ECA ranged from 4.1 to 4.5 mm (left) and 3.9 to 4.4 mm (right). No macroscopic pathologies in the neck region were observed. The medical history of the cadaver was not available.



**Figure 1** – Left (a) and right (b) side of the head and neck preparation. The internal carotid artery (ICA) shows lateral kinking, the external carotid artery (ECA) shows coiling and tortuosity (arrows). Atherosclerotic plaque accumulation in the region of the carotid bifurcation and a thin wall of ICA kinking can be observed. CCA – Common carotid artery, TLF – Thyrolinguofacial trunk, SCM – Sternocleidomastoid muscle, reflected, A – Transverse process of atlas, FA – Facial artery, STA – Superior thyroid artery, SG – Submandibular salivary gland, IJV – Internal jugular vein (cut), N XII – Hypoglossal nerve, N XI – Accessory nerve.

## Discussion

The complex embryology underlying the development of the carotid arteries, hypertension, aging and the occurrence of atherosclerotic lesions give rise to a number of anomalous courses of the carotid arteries [10–14]. We present a case of bilateral kinking of the extracranial part of the ICA with bilateral coiling and tortuosity of the ECA. The concurrent dolichoarteriopathy of all four carotid arteries is a unique anatomic variation, which has not yet been reported.

### Development

The genesis of carotid anomalies can be explained in terms of the embryological development of the branchial arch arteries. The ICA develops out of the third aortic arch (the third branchial arch artery) and the cranial part of the dorsal aorta, while the ECA derives from the first arch with some contributions from the second aortic arch [15].

The development begins through a combination of outgrowths from some vessels, the involution of others and the assimilation of preexisting channels that arise from undifferentiated precursor vessels [1]. Normally, the dorsal aortic root descends into the chest by the eighth week of development, thereby straightening the course of the carotid arteries [16]. A loop is formed at the junction between the two blood vessels, reaching its

maximal extension in the fifth and sixth embryonic weeks. Normally, the descent of the large blood vessels and the heart into the mediastinal space during continuous development leads to elongation and straightening of the artery. A failure of this process, incomplete development, or accelerated linear growth of the arteries can result in a persistence of the loop, coils or kinks [1].

### Histological changes

The kinking of the ICA in the case presented was associated with extensive calcifications of the carotid bifurcation wall and thin wall (comparable to the thickness of the internal jugular vein) with the enlarged lumen diameter of the ICA kinked segment. Hemodynamic forces are a potent modulator of arterial wall structure [17]. In kinks, blood flow is impeded by vortex formation with an increase in the wall shear stress, conditioning a critical blood flow area, determining turbulence, fibrin dislodgement, and platelet emboli [17]. To the best of our knowledge, there is no data in the available literature on the wall thickness of the kinked part of the ICA. The finding of a thin wall of kinked ICA segment matches the reported arterial wall abnormalities found by a histological examination of the kinked part of the ICA [2, 3]. Metaplasia of the tunica media, with significant reduction of elastic fibers and muscular cells along with a compensative increase of loose connective tissue [3] and dissections and integrity losses in the layers of tunica intima and tunica adventitia [2] were reported. The structural media remodeling lifts the endoluminal layer, tearing the intimal surface that can be responsible for thromboembolism, dissection, or intramural hematoma or aneurysms [2]. The histological structure and wall thickness changes result in decreased elasticity and increased fragility of the arterial wall that can be easily harmed or torn.

In contrast to the kinked segment of the ICA, there were no differences in the lumen diameter and wall thickness of the straight, tortuous and coiled segments of the ECA. It is assumed that in the case of tortuosity and coiling, any alteration in fluid dynamics and changes to the arterial wall thickness are minimal. No data on the histology of the coiled or tortuous segments of the arteries are available in the literature.

### Anatomy

In the case presented, the pronounced dorsolateral kinking of the ICA was observed with the superior kinked segment situated in the parapharyngeal space with a close relation to the pharyngeal wall in the region of transition between the mesopharynx and hypopharynx. The terminal part of the aberrant ICA was situated medially to the ECA, just posterior to the mandibular angle. A relatively high carotid bifurcation was found on both sides, located at the level of the hyoid bone. The ECA looped 1 cm under the mandibular angle on the left and 2 cm above the mandibular angle on the right side and ascended tortuously behind the mandibular ramus on both sides.

### Surgical anatomy

The thin arterial wall of the kinked part of the ICA without any muscular consistency needs appropriate

handling during surgical procedures. The risk of disastrous bleeding during pharyngeal surgery is increased in cases of an ICA that is medially displaced due to its anomalous course [1–3].

Knowledge of the carotid bifurcation site is important for vascular surgical procedures in the region, such as arterial catheterization, treatment of aneurysms, carotid endarterectomy or radical neck dissection. The presence of high carotid bifurcation should alert surgeons that the hypoglossal nerve lies in closer proximity and is more vulnerable than in more common presentations.

Tortuosity and coiling of the ECA constitute a risk factor for hemorrhage in surgical procedures carried out in the region, and are expected to cause difficulties for catheter insertion when administering intra-arterial chemotherapy for cancer treatment [18].

Although anatomical variations of the ICA are usually asymptomatic, they may present dysphagia, throat pain, hoarseness or increased sensations of a foreign body in the pharyngeal area [19]. They may be either the source of cerebral emboli or intermittent stenoses [5, 7, 8] or represent a risk factor for massive bleeding [1]. Atherosclerosis, hypertension, and aging may play an important role in producing carotid abnormalities, with aging appearing to be more important than atherosclerosis [19]. Head and neck surgeons should recognize kinking of the ICA, as an abnormal ICA is a risk factor during both major (e.g., oropharyngeal tumor resection) and less extensive surgical procedures (e.g., tonsillectomy, adenotomy, and drainage of peritonsillar abscesses).

## ☒ Conclusions

Kinking of the ICA and tortuosity of the ECA can constitute a risk factor for acute hemorrhage in routine surgical procedures. The noninvasive techniques, such as magnetic resonance angiography and digital subtraction radiography are extremely important for avoiding complications.

## Acknowledgments

The dissecting work of Ivan Blažinovič and Friderik Štendler and the figure labeling of Marko Slak is highly acknowledged.

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## Corresponding author

Erika Cvetko, DMD, PD, Professor of Anatomy, Institute of Anatomy, Medical Faculty, Korytkova 2, 1000 Ljubljana, Slovenia; Phone +386–1–5437303, Fax +386–1–5437301, e-mail: erika.cvetko@mf.uni-lj.si