

Bilateral variation in the course of the internal carotid artery: case report

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SUMMARY

The internal carotid artery arises at the bifurcation of the common carotid artery and continues upwards within the carotid sheath. It has no branches and passes straight up in the carotid sheath and beside the pharynx to the carotid canal in the base of the skull. This division of the internal carotid artery is defined as the cervical part. Variations in the course of the cervical part have been found in the different studies and have been classified as kinking, coiling and tortuosity. It is known that these variations are associated with cerebrovascular failure and transient ischaemic attack. During routine dissections of the cervical region for educational purposes, bilateral course variations with a marked kinking on the right and distinctive tortuosity on the left side were found in the internal carotid artery of a 75-year old male cadaver. The case is of interest since variations in the course of the internal carotid artery have been shown to be related to cerebrovascular failure.

Key words: Course variations – Internal carotid artery – Kinking – Tortuosity

INTRODUCTION

The relationship between the anatomical variability of the internal carotid artery (ICA) and cerebrovascular insufficiency has been clearly acknowledged for many years (Ghilardi et al., 1993). Several studies in the literature addressing the diversity of the course of the ICA have suggested three main types of abnormality: tortuosity, coiling and kinking. Accurate management, identification and classification of these abnormalities of the ICA cannot be disregarded owing to their relatively common incidence (Ghilardi et al., 1993; Weibel and Fields, 1965a,b). Nevertheless, the clinical significance of these elongations and their etiology remain controversial.

The ICA supplies most of the ipsilateral cerebral hemisphere, the eye and its appendages, the forehead, and part of the nose. The ICA and its branches are often referred to as the anterior circulation of the brain (Moore and Dalley, 1999; Williams et al., 1989). The artery begins at the level of the upper border of the thyroid cartilage after the bifurcation of the common carotid artery, where it usually has a carotid sinus. Then, the course of the artery continues with its ascending part to the cranial base, from where it courses vertically upwards in the neck. It then curves horizon-

tally forwards and medially in the petrous carotid canal and enters the cranial cavity via this canal, after which it turns anteriorly through the cavernous sinus in the carotid groove on the side of the sphenoid body. The course of the ICA ends below the anterior perforated substance and its terminal branches are the anterior and middle cerebral arteries (Moore and Dalley, 1999; Williams et al., 1989). Bouthillier et al. (1996) described the following seven anatomical segments of the ICA: C1, cervical; C2, petrous; C3, lacerum; C4, cavernous; C5, clinoid; C6, ophthalmic; and C7, communicating. Nevertheless, the ICA may usually be divided into the cervical, petrous, cavernous and cerebral parts. The cervical part begins at the carotid bifurcation and ascends in front of the upper three cervical transverse processes to the carotid canal (Williams et al., 1989). The anatomical path of the cervical ICA is posterolateral to the lateral pharyngeal wall, and it lies embedded in the carotid sheath with the internal jugular vein and vagus nerve in this region (Wasserman et al., 2006). It courses superficially in the carotid triangle first, and then passes deeper, medial to the posterior belly of the digastric muscle (Williams et al., 1989).

The anatomical variability of the ICA has been studied as regards its relationships to the tissues surrounding its path and pharyngeal surgery or traumatic events (Paulsen et al., 2000). In the cervical region, the pars cervicalis courses following three major abnormal and different routes. These variations in course are called tortuosity, kinking and coiling (Desai and Toole, 1975). «Tortuosity» displays «S» or «C» letter shapes at the curling of the vessel. «Coiling» is an anomaly in which the vessel traces a circular course. In addition, when the vessel folds over itself with a sharp angle, the anomaly classified as «Kinking» (Weibel and Fields, 1965a,b).

Anatomical variations of the course of the ICA have been reported in 4-66% of adults and in 16-43% of fetal autopsies (Desai and Toole, 1975; Ghilardi et al., 1993; Huemer et al., 1998; Koskas et al., 1993). Kinking is the most widespread course anomaly of the ICA and its incidence ranges between 5% and 27% (Ghilardi et al., 1993; Macchi et al., 1997; Paulsen et al., 2000; Pellegrino et al., 1998; Weibel and Fields, 1965a,b). Paulsen et al. (2000) reported that out of 282 specimens 74 (26.2%) showed a curved course to the base of skull, and 17 (6%) showed kinking and coil-

ing. Paulsen et al. (2000) also found 4.26% of kinking only and 1.77% of coiling only variations in the course of the ICA. Within the kinking anomaly, this is designated «degree one», if the angle is between 60° and 90°. Between 30° and 60°, it is known as «degree two», and if it is under 30°, the term «degree three» is used (Pancera et al., 2000).

In this respect, the aim of this paper is to report the course anomalies of the internal carotid artery found bilaterally with a rare combination of kinking and tortuosity in a 75-year old male cadaver.

CASE REPORT

During routine dissections of the cervical region for educational purposes, bilateral course anomalies of the internal carotid artery were found in a 75-year old male cadaver who had died of cardiac arrest. In this study, a stainless calliper and a goniometer were used for measurements.

On the left side, the internal carotid artery coursed approximately 5.8 cm upward from the carotid bifurcation, and then coursed horizontally 0.6 cm in the medial direction and perpendicularly to the previous route with a 1 cm interval before entering the carotid canal (Fig. 1A). On the right side, the internal carotid artery arose vertically in the neck region from the carotid bifurcation and coursed approximately 6.3 cm, after which it changed its direction medially and coursed 0.9 cm perpendicular to the previous trajectory. Later, the artery coursed downward 1.4 cm and formed a curled 41° angle. After this curve, it rose upwards vertically 2.6 cm before entering the carotid canal (Fig. 1B).

In this report, the course anomalies of internal carotid artery were evaluated as «tortuosity anomaly» and «kinking anomaly» on the left side and right side, respectively. The angle of the kinking anomaly was found to be 41° on the right side and this anomaly was designated as «degree two». There were no aneurysms observed associated with the kinking or tortuosity anomalies in the extracranial parts of the right and left ICA.

DISCUSSION

The ICA is responsible for supplying blood to the intracranial structures and has been the subject of many investigations. The cervical

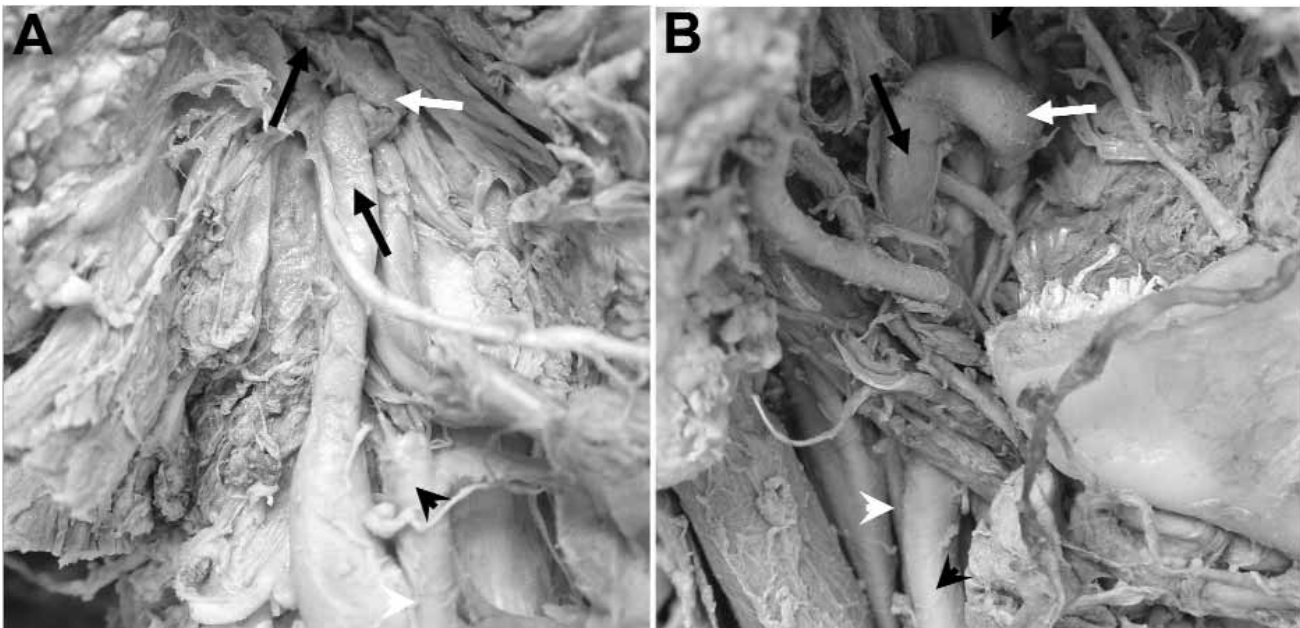


Figure 1. **A:** Left side anomaly of the internal carotid artery. Black arrow: internal carotid artery (ICA); white arrow: tortuosity anomaly of the ICA; black arrow head: external carotid artery (dissected); white arrow head: carotid bifurcation. **B:** Right side anomaly of internal carotid artery. Black arrow: internal carotid artery (ICA); white arrow: kinking anomaly of ICA; black arrow head: common carotid artery; white arrow head: carotid bifurcation.

part of the internal carotid artery has drawn the attention of many authors, especially as regards the issue of course variations, with a location suitable for investigation and also for having risks during several surgical procedures. Commonly, clinical events related with course anomalies are not rare. In different studies it has been shown that course anomalies of the ICA are involved in several clinical events such as atherosclerosis, stroke, cerebrovascular injury, sudden child death, transient ischemic failure and also persistent abnormal sensations of the throat (Ballotta et al., 2005; Huemer et al., 1998; Witz and Lehmann, 2001). Extracranial ICA anomalies are also at risk of injury in surgical procedures such as tonsillectomy, drainage of peritonsillar abscess as well as adenoidectomy, and may be the cause of some complications, such as fatal hemorrhage. Therefore, variations in the ICA's should be checked preoperatively by physical examination and noninvasive diagnostic imaging such as USG (Ballotta et al., 2005; Galletti et al., 2002; Okami et al., 2001; Paulsen et al., 2000; Wasserman et al., 2006). Course anomalies of the ICA are relatively common angiographic findings and are more frequently located in the lower than in the upper half of the ICA (Weibel and Fields, 1965a,b). However, we found the right side kinking and left side tortuosity anomalies

located bilaterally on the upper half of the ICA. Weibel and Fields also reported the site of the course anomalies at about 2-4 cm beyond the carotid bifurcation in 75% of patients with kinking and 3-4 cm beyond with tortuosity (Weibel and Fields, 1965a,b). These findings are also shorter than the course anomalies observed by us: 6.3 cm on the right side with kinking, and 5.8 cm on the left side with tortuosity.

The first report explaining the relationship between the kinking anomaly of the internal carotid artery and cerebrovascular insufficiency was published five decades ago (Weibel and Fields, 1965a,b). Later, it was suggested that the variations of the ICA plays a pathological role in brain ischaemia (Desai and Toole, 1975; Huemer et al., 1998; Pancera et al., 2000). Kinking anomalies related to atherosclerosis also cause transient ischemic attacks (TIA). Pancera et al. (2000) reported a certain relationship between kinking and transient ischaemic attacks, and Metz et al. (1961) found a significant prevalence of recurrent episodes of TIA in subjects with high-grade kinkings. Weibel and Fields pointed out that the kinking of the ICA is an acquired abnormal condition that occurs mostly in older individuals, whereas coiling is a congenital rather than an acquired anomaly (Weibel and Fields, 1965a,b). Many authors have also

reported that the kinking anomaly is related to old age. However, it is unclear whether the etiologies of the tortuosity and coiling anomalies are related to congenital or acquired pathologies (Okami et al., 2001; Paulsen et al., 2000; Weibel and Fields, 1965a,b).

Kinking is frequently associated with degenerative changes of the vessel wall in advanced age and predisposes patients to atherosclerotic stenosis (Pancera et al., 2000; Paulsen et al., 2000; Weibel and Fields, 1965a,b). The altered fluid dynamics produced by kinking may lead most frequently to degenerative changes in the vessel wall, and the flow turbulence linked to kinking may also play a role in atheromatous lesions (Pancera et al., 1998; Pancera et al., 2000; Paulsen et al., 2000). Because the kinking variation is the most seen anomaly of the ICA, our case of the kinking variation together with contralateral tortuosity should be helpful for further related works addressing this issue.

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