Posterior transverse plication of the internal carotid artery to correct for kinking

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Background: **The occasional need for shortening of the internal carotid artery (ICA) following carotid endarterectomy (CEA) to correct for kinking is still controversial. Although several technical options have been suggested, the impact on perioperative outcome remains unclear, and long-term clinical follow-up is lacking. Shortening by resection has a theoretical risk for a twisted anastomosis and subsequent ICA thrombosis. Posterior transverse plication (PTP) offers an alternative shortening technique without the need for a new anastomosis. We aimed to assess the safety and patency of CEA with concomitant PTP. Secondly, we aimed to provide an overview of different technical modalities for shortening of the carotid artery in current literature.**

Methods: **Within the time frame of 2000 through 2011, 29 patients (mean age, 73.4 years) undergoing CEA with additional PTP of the ICA and standardized patchplasty were retrospectively identified. Patient characteristics, surgical procedural details, and both short- (<30 days) and long- (>30 days) term clinical and duplex ultrasound follow-up were retrieved. Restenosis was defined as ≥50% stenosis on duplex ultrasound. In addition, a literature search was performed on different techniques for ICA shortening.**

Results: **Thirty-day outcome revealed no deaths or strokes. No postprocedural thrombosis or narrowing of the ipsilateral ICA was observed. During follow-up (mean, 34.3 months; range, 3-125 months), one patient (4%) died of a non-cardiovascular cause. Three patients (11%) developed ipsilateral neurological symptoms (1 stroke, 2 transient ischemic attacks) after 5, 19, and 66 months follow-up, respectively. Of these, two patients (7%) had restenosis at the site of PTP. Asymptomatic restenosis occurred in one other patient (4%) after 16 months.**

Conclusions: **Although the indications for additional shortening procedures following CEA need to be defined, in this small series, PTP as an additional shortening procedure of the ICA following CEA seems feasible and safe with no additional periprocedural risk for narrowing at the plicature or thrombosis of the endarterectomy plane. However, restenosis at the plicature may hamper the long term benefit of carotid reconstruction. (J Vasc Surg 2014;59:968-77.)**

Kinking of the extracranial internal carotid artery (ICA) is most often defined as an angulation of one or more cervical segments of the carotid artery due to elongation, which may cause disturbances in the blood flow to the brain.[1] The incidence of coiling and kinking in the general population ranges between 10% and 16%.[2,3] In patients undergoing carotid surgery, a 5% incidence of kinking has been reported.[4,5]

The need for additional shortening procedures to correct for ICA kinking following carotid endarterectomy (CEA) remains controversial. Although classifications have been proposed, a clinically proven grading scale of elongation severity is lacking.[3,6] In other words, at present, no objective guidelines if and how to correct for kinking following CEA exist. The decision for an additional shortening procedure following CEA therefore is still based on the intraoperative judgement of the operating surgeon. In our series, in general, the carotid lesion was considered to be related to ipsilateral neurological symptoms, while the distal kinking was considered to be asymptomatic itself.

A theoretical advantage of shortening of the ICA is an undistorted blood flow to the brain to prevent cerebrovascular insufficiency. However, a causal correlation of a kinked ICA with cerebrovascular symptoms remains unproven, while it is still unclear whether kinking solely, or as a contributing factor, can cause neurological deficit. Head-turning movements in patients with a kinked ICA may cause neurological symptoms.[7-11] Secondly, as the endarterectomized part of the ICA is thrombogenic, shortening the desobstructed part of the ICA may reduce the risk of thrombosis.[12] Shortening procedures applying a resection with complete reanastomosis imply a theoretical risk for narrowing or twisting and thus subsequent thrombosis of the endarterectomy plane. In 1967, Imparato et al described a technique to shorten the origin of the vertebral artery.[13] Adapted to the ICA, this technique was referred to as posterior transverse plication (PTP).[14,15] PTP theoretically guarantees shortening without the risk of a twisted anastomosis. Most of these studies focused on technical aspects of the procedure, including perioperative outcome. However, long-term clinical follow-up in terms of stroke prevention and restenosis is lacking. Although the theoretical principle for a shortening procedure of a floppy desobstructed proximal ICA segment may be clear, from an educational point of view, knowledge among vascular

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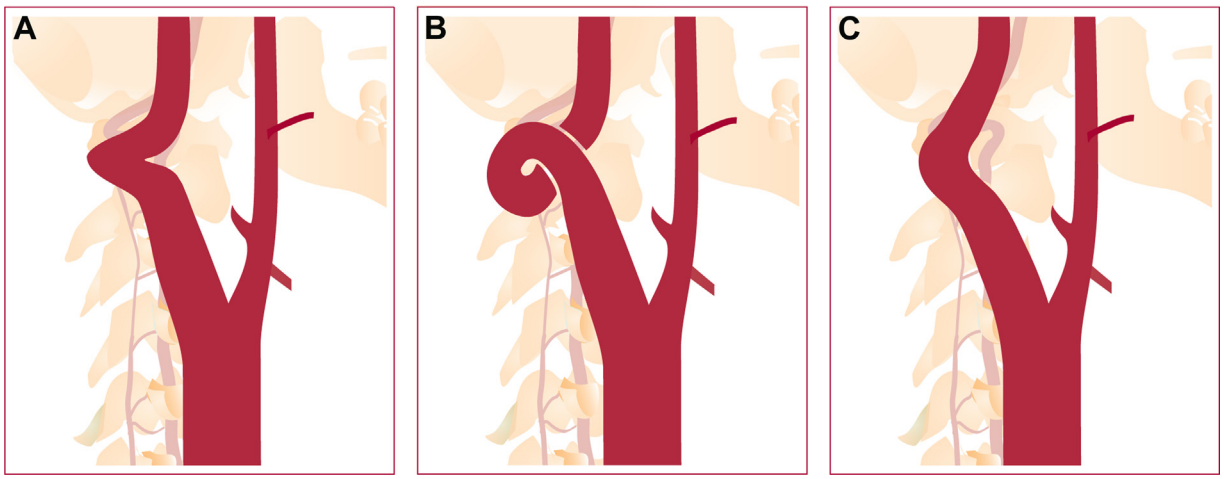

Fig 1. Different types of elongation. **A,** Kinking; **B,** coiling; **C,** tortuosity.

surgeons treating carotid stenotic disease on shortening techniques is supposedly scarce.

Therefore, the aim of our present study was twofold: (1) to review our single center experience with PTP to treat severe kinking of the ICA following CEA; and (2) to provide an overview of different technical modalities for shortening of the carotid artery in current literature.

METHODS

Definitions

Terms such as kinking, coiling, and tortuosity have been proposed to describe the nonstraightened course of the ICA due to elongation from carotid bifurcation towards the carotid siphon at the base of the skull (Fig 1). Based on angiographic findings, the course of the ICA was described by Weibel and Fields to improve the comparability between studies on different types of elongation. Kinking was defined as an angulation of one or more segments of the ICA, being associated with a (functional) stenosis in the affected segment,[16-18] (Fig 1, *A*) and may be associated with symptoms.[6] Coiling is an elongation or redundancy of the ICA resulting in an exaggerated S-shaped curve or in a circular configuration (Fig 1, *B*), and seems not be associated with symptoms.[6] Tortuosity is any S- or C-shaped elongation or undulation of the course of the ICA (Fig 1, *C*).[16] In order to improve readability, for the remainder of this article, we utilized the term "kinking" to indicate any type of elongation, unless otherwise specified.

Patient selection

Our prospectively registered database on patients undergoing carotid surgery in a single Dutch tertiary vascular referral center (University Medical Center Utrecht, the Netherlands) was retrospectively searched within the time frame of January 2000 through December 2011. This study was conducted under approval granted by the Medical Ethics Committee of the St Antonius Hospital.

Fig 2. Angiogram reveals severe elongation of the stenotic internal carotid artery (ICA).

All patients provided written informed consent. They were included for the present analysis, if an additional PTP was performed following actual endarterectomy of the stenotic ICA lesion. There were no patients in our cohort that received a shortening procedure exclusively. Patients with alternative shortening procedures other than PTP were excluded, because the surgical records of these alternative shortening techniques did not give sufficient information on the specific modality of shortening being performed,