


A case in which contrast-enhanced transoral carotid ultrasonography was useful for pre- and post-procedural evaluation in carotid artery stenting

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Abstract Contrast-enhanced transoral carotid ultrasonography (CETOCU) is a novel examination modality that is superior to other modalities in the cases of pseudo-occlusion with severe arteriosclerotic stenosis of the distal internal carotid artery (ICA), and is also useful for noninvasively evaluating changes over time in the vessel distal to the stent following carotid artery stenting (CAS). We report a case of a patient who we evaluated with CETOCU for a pseudo-occlusive ICA before and after CAS.

Keywords Contrast-enhanced transoral carotid ultrasonography · Carotid artery stenting · ICA pseudo-occlusion

Introduction

Transoral carotid ultrasonography (TOCU) is a modality proposed by Yasaka et al. for imaging the extracranial internal carotid artery (ICA), which is not possible with the conventional carotid ultrasonography [1]. In TOCU, a probe intended for transrectal or transvaginal use is inserted into the mouth and pressed against the wall of the left

or right pharynx to image the distal ICA. As imaging to the second cervical vertebra is possible, TOCU is useful for evaluating ICA dissection and other extensive lesions of the ICAs [2, 3]. We herein report our use of contrast-enhanced TOCU (CETOCU) with the contrast agent Sonazoid[®] for the assessment of the extracranial ICA before and after carotid artery stenting (CAS). CETOCU was found to be useful for diagnosing pseudo-occlusion and for evaluation distal to the stent, which is difficult with other modalities.

Case report

Patient

A 72-year-old man.

Medical history

Hypertension, diabetes mellitus, dyslipidemia.

Course

The patient presented cerebral infarcts caused by complete occlusion of the right ICA. In the absence of sequelae, the patient was sent home and followed up on an outpatient basis. However, magnetic resonance angiography performed 2 months later revealed recanalization of the right ICA. The patient was admitted for CAS of the affected area.

Carotid ultrasonography showed severe stenosis of the right ICA (85 % according to North American Symptomatic Carotid Endarterectomy Trials method) with flow of 450 cm/s in the most constricted area. Cerebral

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angiography showed severe stenosis at the origin of the right ICA, with distal imaging showing a flow delay suggestive of pseudo-occlusion (Fig. 1a). We performed TOCU, because cerebral angiography was unable to clarify whether the distal end of the stenosis represented an elongated arteriosclerotic lesion or vascular collapse. However, we were unable to evaluate either the inside of the vessel lumen in detail on B-mode TOCU (Fig. 2a, b), or the flow of ICA on color Doppler TOCU because of the extremely slow flow through the narrowed, collapsed vessel. Subsequent intravenous injection of Sonazoid® contrast agent allowed clear imaging of the ICA. This contrast-enhanced TOCU showed, in addition to ICA collapse due to vessel narrowing, that plaque stenosis extended further than indicated on cerebral angiography (Fig. 3a).

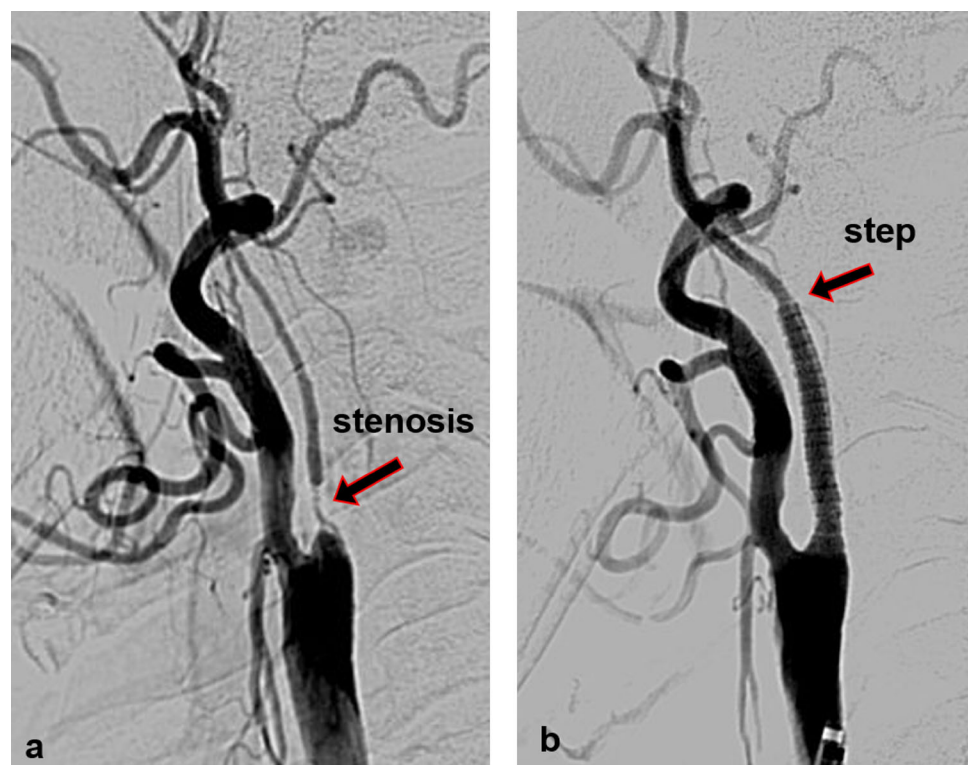
We performed CAS using the Parodi anti-embolic system, placing a stent (Precise 7 × 30 mm; Johnson & Johnson, Cordis, Miami, FL) after balloon predilation. We did not perform postdilation. As pre-stenting CETOCU showed the diameter of the distal ICA to be much narrower than that of the common carotid artery, we deployed and placed the stent so as to cover only the ICA. The procedure was uneventful and resulted in a small amount of debris, but post-procedural angiography showed the step between the distal end of the stent and the de-collapsed vessel (Fig. 1b). No further procedures were performed, because distal flow was considered to have improved sufficiently after stenting.

CETOCU was again performed post-procedurally to closely evaluate the vessel distal to the stent. As a result of de-collapsing, the diameter of the ICA distal to the stented region was increased compared to preoperatively, and no flow problems were apparent. Although no protrusions were present within the stent, a step at the stent-vessel border indicated the presence of remnant plaque around the vessel (Fig. 3b). Pre-stenting CETOCU (Fig. 3a) had shown plaque in this area. The selected stent was clearly too short to cover the entire lesion, but we decided against further intervention, because the stenosis of less than 50 % and satisfactory intraluminal flow indicated a low risk of obstruction.

Discussion

The ability of TOCU to image the extracranial ICA to a degree not possible with the conventional carotid ultrasonography makes this modality useful for diagnosing and following extracranial ICA dissection [2, 3] and for peri-operative evaluation of carotid endarterectomy (CEA) [4–6]. TOCU allows the evaluation of the extracranial ICA, which is not possible on the conventional carotid artery ultrasonography. CETOCU, which is essentially TOCU performed with the ultrasonography contrast agent Sonazoid®, produces clearer intraluminal imaging, as the contrast agent flows through the lumen. CETOCU is also

Fig. 1 **a** Right carotid angiography before carotid stenting. Severe stenosis is present at the origin of the right ICA. The distal vessel is collapsed and shows delayed blood flow, representing pseudo-occlusion. **b** Right carotid angiography after carotid stenting. Stenting has expanded the stenosis at the origin of the right ICA, but a step is evident between the collapsed distal ICA and stent. The diameter of the previously collapsed distal ICA is relatively large, but remains too small for the collapse to be completely corrected at this stage



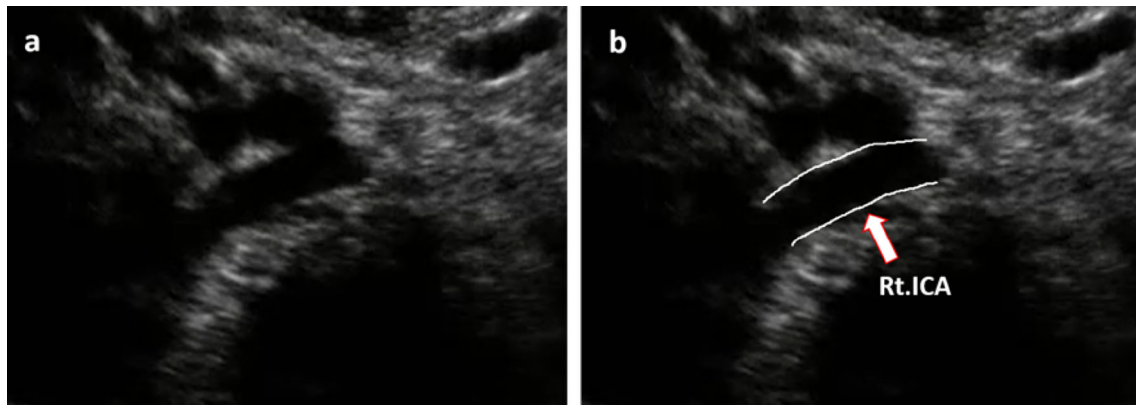


Fig. 2 **a** Conventional transoral carotid ultrasonography (TOCU) before carotid stenting. TOCU shows a collapsed ICA, but the plaque in the vascular lumen is not evident. **b** The schematic image of **a**

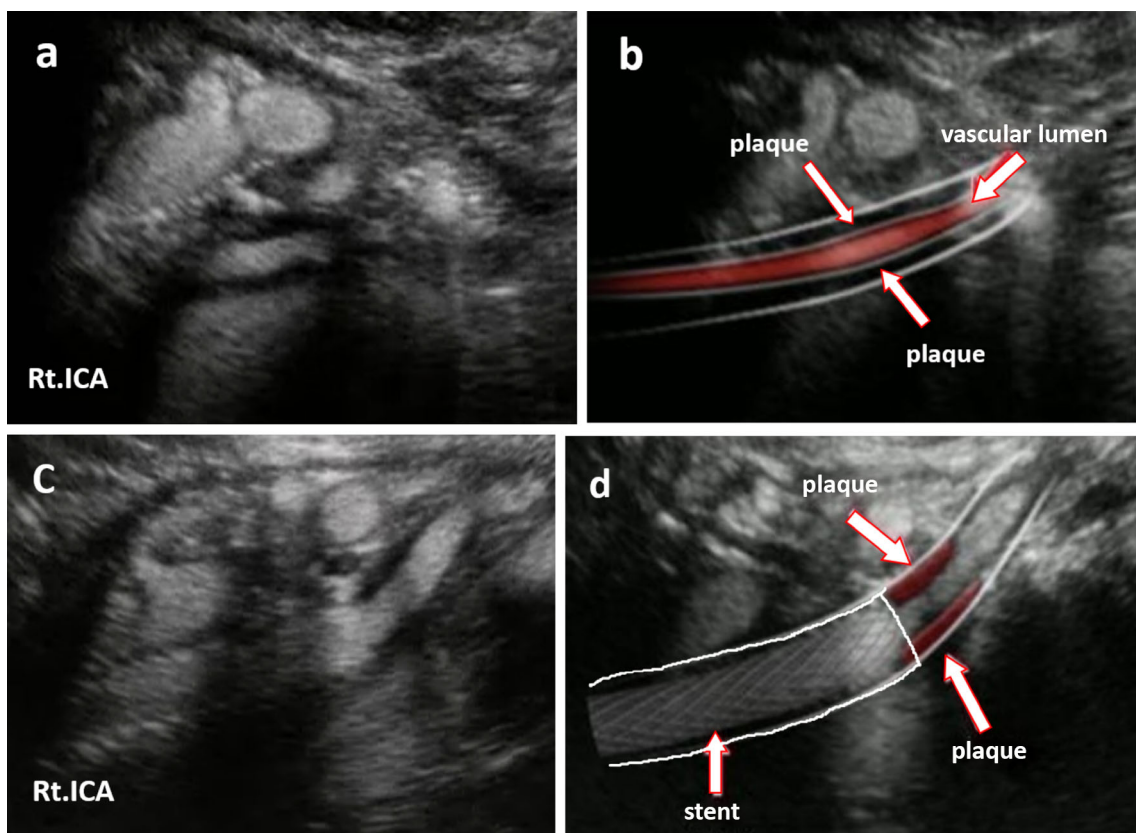


Fig. 3 Contrast-enhanced transoral carotid ultrasonography (CETOCU) was performed using a Xario system (Toshiba Medical Systems, Tokyo, Japan) equipped with a PVT-661VT 3–9 MHz endovaginal probe (Toshiba Medical Systems). The mechanical index was set at 0.9. **a** CETOCU before carotid stenting. **b** Right figure is a schematic representation of **a**. Sonazoid reveals the distal end of the

collapsed ICA. Imaging shows a narrowed ICA with surrounding the plaque. Although the vascular lumen is collapsed, the extent of the plaque is apparent. **c** CETOCU after carotid stenting. **d** Right figure is a schematic representation of **c**. Stenosis caused by remnant plaque is evident at the distal end of the stent. The step observed on angiography between the stent and vessel is attributable to the plaque

suited to evaluating peripheral tissues and plaque status. Unlike CT angiography and cerebral angiography, CETOCU enables imaging for 5–10 min after contrast agent injection, and thus allows focused evaluation of the region of interest. Since Sonazoid is not nephrotoxic, this

agent can be used safely and repeatedly in patients with renal impairment [7, 8]. The most important advantage of CETOCU over TOCU is availability to evaluate the vessel in the cases of ICA pseudo-occlusion. Differentiation of pseudo-occlusion from stenosis caused by elongated

arteriosclerotic lesions is difficult with angiography, and TOCU, which provides information on the periphery of the vascular lumen at the site of stenosis, is useful. However, identifying the ICA is extremely difficult when flow is extremely slow in a collapsed vessel, even using color Doppler TOCU. As long as some blood flow is present, CETOCU reveals collapsed vessels when Sonazoid passes through. This modality can thus better depict the extent of ICA stenosis in patients with pseudo-occlusion, enabling selection of the appropriate stent length for CAS. Confirmation of the lesion extent also allows medical personnel to judge how difficult CEA will be. Although the use of cerebral angiography alone in patients with pseudo-occlusion does not enable identification of the extent of stenosis and is not conducive to preoperative determination of the appropriate stent length, angiography paired with CETOCU provides relevant information for stent length and procedure selection. Evidence is building that plaques apparent on contrast-enhanced ultrasonography may be unstable [7, 8]. If this hypothesis is borne out, CETOCU is also expected to allow the evaluation of plaque status.

Angiography of the present patient just after stenting revealed a step between the distal edge of the stent and the vessel, suggesting the possibility of plaque protrusion or dissection. CETOCU suggested that the step represented remnant plaque not covered by the stent, because pre-stenting CETOCU had shown plaque in the same region. The stent selected for the procedure was too short to cover the entire lesion. TOCU without an ultrasonography contrast agent does not show echolucent plaques, such as in the present patient. Such plaques within a stent and before and after stenting are generally difficult to visualize on color Doppler ultrasonography, making CETOCU useful for post-stenting evaluation. Providing detailed information about the extracranial ICA, noninvasive CETOCU can be repeatedly performed at the bedside for perioperative CAS evaluation. Our hope is that CETOCU, which is not yet supported in the literature, will become more widely used.

Compliance with ethical standards

Ethical statements All procedures followed were approved by the St. Marianna University Bioethics Committee and performed in accordance with the Helsinki Declaration of 1964 and later versions.

Informed consent Informed consent was obtained from the patient for inclusion in this study.

Conflict of interest The authors have no conflicts of interest to declare.

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