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EDITORIAL

Diagnosing carotid near-occlusion with 1 mm side-to-side asymmetry: a tough task made too easy

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In this issue of Neuroradiology, Koskinen and colleagues present their idea: that carotid near-occlusion (a tight stenosis that causes a collapse of the distal artery) can be separated from conventional ≥50% stenosis by measuring the distal diameter and all cases with ≥1.0 mm side-to-side difference is a near-occlusion [1]. Their goal was "to facilitate the recognition and diagnosis of near-occlusion, and raise the notion that even when a subtle distal ICA LD [Luminal Diameter] reduction is present, a possible near-occlusion should be considered." It is important to raise awareness of near-occlusions without full collapse, when the distal artery otherwise seems normal, albeit smaller than usual. Indeed, this issue is so important that we recently ranked it as one of the two major near-occlusion issues in most need of improvement [2]. Any neuroradiologist who is not well aware of the near-occlusion without full collapse would do well to apply this as a first step towards improved understanding. However, apart from raising initial awareness, we advocate against the use of this proposed 1.0 mm criterion for diagnosing near-occlusion.

Interpretative approach to near-occlusion diagnosis

Carotid near-occlusion is a pattern-recognition diagnosis where interpretation of multiple key features is at the core of diagnosis [3]. These multiple key features have been presented before [4, 5]: for both conventional angiography and CTA, side-to-side ICA difference and similar-sized or smaller ICA than ECA are features; for conventional angiography, delay of contrast and evidence of collaterals are features; and for CTA, absolute ICA size and impressive stenosis are features. "Impressive" stenosis applies to when contrast is hardly (or no longer) seen in the stenosis [4] and remaining features are "positive" when visible to the eye of the observer. Studies with sensitivity and specificity of these features have compared to interpretation [4, 5]. Hence, a previously reported 0.87 side-to-side ratio was an approximation of what was visible [4]. It is also important to interpret what is seen, such as whether side-to-side asymmetry is likely due to uniform collapse or something else such as old dissections or anatomical variance. An example of the interpretive approach using the illustrated case in the new article [1] is that there is a clearly visible side-to-side difference with uniform collapse where the distal artery otherwise seems normal (A + C), small absolute ICA size (B and provided measurement), ICA similar to ECA (A + C), and stenosis hard to assess due to calcifications. The interpretation of these findings is a near-occlusion without full collapse, and the interpretation seems certain from available information (even though the stenosis could not be clearly assessed, but it could be impressive). The interpretative approach is justified as it was used for the pooled NASCET and ECST analyses [5], from which we base our understanding of prognosis and management. While the definition of near-occlusion with interpretation might still be better clarified, a new approach needs to be shown superior by virtue of showing enhanced prognostic ability. Yet, this study defining 1.0 mm difference between ICAs as near-occlusion is compared to itself and is not yet fully compared to the published interpretive approach in diagnostic and prognostic ability.

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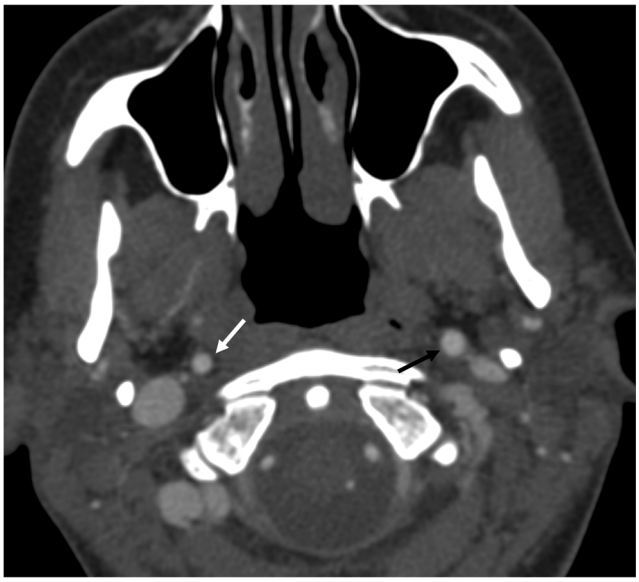

Fig. 1 Anatomical variance of ICA size in a 29-year-old female without stenotic disease. Side-to-side difference in ICA diameter of 1.1 mm (*arrows*), caused by right-sided A1-hypoplasia (not shown)

Why do we think this new method is inferior?

There is low sensitivity. The true border for side-to-side difference between near-occlusion and no near-occlusion may be lower than 1.0 mm. The illustrated case presented by the authors has a very visible side-to-side difference well beyond the borderline, but just at the border of the 1.0 mm cutoff. Hence, other cases of near-occlusion with lesser but still visible differences may be missed. Indeed, the authors compare their finding to the prior 0.87 side-to-side ratio and found that it was present in all their 142 near-occlusion cases, but also in 16 additional cases. We wonder what those 16 cases show with interpretative criteria; that they did not study them may be a lost opportunity. Using their normal ranges of distal ICA size (ca 3.5–6.0 mm, based on the Koskinen et al. Fig. 2), the 0.87 side-to-side ratio leads to 0.46–0.78 mm side-to-side difference. Hence, their 1.0 mm threshold could miss several cases—the threshold seems to be too high.

There is low specificity. The choice of 1.0 mm as a cut point was based on mean + 2 SD of "normal" material—a generally acceptable approach that results in good specificity. However, this is not applicable in instances where there is a confounding from anatomical variation to skew a normal distribution. The authors dismiss the idea of Circle of Willis variations causing ICA asymmetry as a confounding entity yet their opinion does not change the fact that such variations exist. Our experience suggests that they have overlooked such anatomical variations and are in error; previous diagnostic studies [4, 5] were performed utilizing this as an existent entity. Circle of Willis variation is very common and do seldom lead to notable ICA asymmetry except when subtleties are sought. Such variation is noticeable from time to time (Fig. 1), estimated (based on our experience) to be in about 5% of individuals of all ages. When a patient with this side-to-side difference in anatomy happens to have a stenosis on the side of the smaller ICA, it could mimic a non-existent near-occlusion (Fig. 2). Indeed, this is a common enough near-occlusion mimic and the main reason why a near-occlusion diagnosis based on side-to-side ICA difference alone is

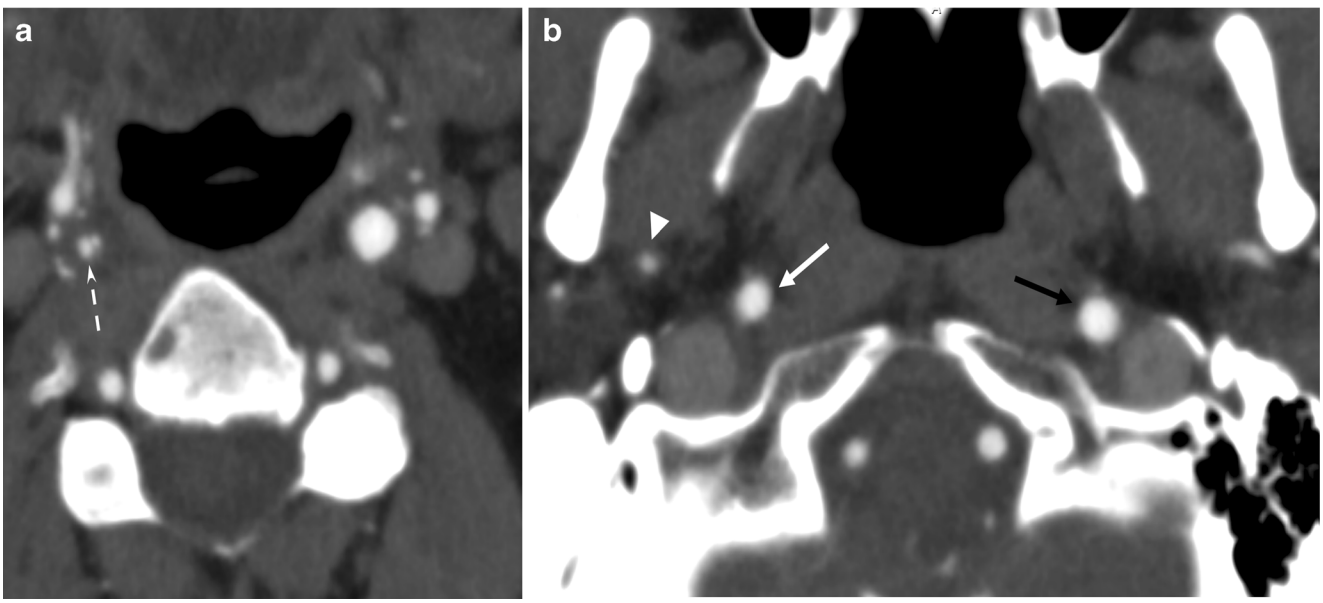

Fig. 2 Anatomical variance of ICA size in a 65-year-old male with a moderate carotid stenosis. **a** A moderate stenosis (*white dashed arrow*) measuring 1.8 mm which is not "impressive" as a severe stenosis in the near-occlusion context. **b** Side-to-side difference in ICA diameter of 1.2 mm (*arrows*), but left ICA still larger than left ECA (*white arrowhead*). Using interpretation of all features, this is not near-occlusion, the more likely cause is the patient's right-sided A1-hypoplasia (not shown)

incomplete without assessing other features. However, in most cases with visible ICA asymmetry caused by Circle of Willis variation, the side-to-side difference is less than 1.0 mm. So with the threshold as high as 1.0 mm, the impact on specificity may not be major, though the impact on sensitivity is likely greater. With a lowered threshold, anatomical variants will be an unaddressed common mimic.

There are other methodological limitations. The authors excluded a lot of cases where their 1.0 mm measurement was not relevant. That was their experimental method. However, it is not applicable clinically as there is a high risk for 1.0 mm difference to be applied blindly. In contrast, the interpretative approach can handle inter-patient variability even with information such as ECA-collapse due to CCA-stenosis or lack of information such as contra-lateral occlusion, by figuring out even when components are skewed or missing and with caution to be certain that other components fit. The use of a single absolute measurement like 1.0 mm difference has many potential error sources; the authors acknowledge this and offer reliability because their readers are expert. However, two radiologists working with the same equipment and same exams do not fully test the reliability over common error sources like machines that do not allow 0.1 or even 0.2 mm caliper steps. Additionally, the authors do not study the variability of windowing, handling of fuzzy edges (fuzzier when magnified), and differences in contrast concentration between exams. Thus, true reliability of using 1.0 mm is not tested.

Summary

We do believe that the authors have achieved the goal to raise awareness of degrees of near-occlusion in the partial collapsed range. They created a convenient tool to seek near-occlusion without full collapse—a tool that may be used by neuroradiologists otherwise unaware of this entity. Awareness of part near-occlusion is crucial step for each individual radiologist and this promotes seeking for modest collapse.

However, this new approach to near-occlusion diagnostics is based on the blind use of a measurement in absence of studying or even promoting other features of part near-occlusion and there is absent validation of the technicalities for measurement. As a tool for those unaware of near-occlusion without full collapse, it is a first step but not on its own. As a stand-alone tool, we recommend against its use.

Compliance with ethical standards

Funding No funding was received for this study.

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent In accordance with Swedish legislation and with specific approval from the local ethics committee, informed consent was not obtained for the patient data in this article since the study was strictly observational.

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