Should Modeling Methodology Suppress Anatomic Excellence?

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See related article, pages 3511–3517.

Wardlaw and colleagues¹ use modeling to validate non-invasive imaging instead of intra-arterial angiography (IAA) for carotid stenosis. They conclude that duplex ultrasonography (DUS) is best. There are not sufficient data with CT angiography (CTA) and MR angiography. Yet carotid CTA gives excellent anatomic depiction, has no stroke risk, and takes a few seconds more than simple CT.²–⁴ It adds to CT for emergency cases in acute stroke protocols and is done 24 hours a day as a regular CT service.

CTA already replaced much of diagnostic IAA. Contrast CT is a common CT technique and CTA is merely scanning during contrast infusion. Its anatomic exactness for stenosis quantification is accepted as anatomically correct,²–¹² yet published data are insufficient for modeling needed for Wardlaw and colleagues.¹ IAA had no scientific verification of arterial anatomic depiction; instead, there was excitement and acceptance that arteries look like arteries. CTA now gives anatomic correction images without stroke risk. Sites expert in CTA face ethical dilemmas against continuing stroke-risk angiography (IAA) to quantify stenosis for clinical or research purposes. CTA includes inherent millimeter measurements, not part of standard IAA digital subtraction angiography measured in pixels.¹³ Because CTA studies were not adequate to plug into Wardlaw and colleagues’ models, CTA was only considered in a limited way for Wardlaw and colleagues’ model.

In the 1990s, some stopped doing IAA for carotid stenosis before surgery, using DUS alone.¹⁴–¹⁷ Inferior anatomic depiction was deemed acceptable by removing IAA stroke risks, thereby enhancing surgical results. DUS is not anatomic, but physiological, measuring velocity within carotid lumen.¹⁷–¹⁹ There is operator variability of DUS probe position. External carotid artery can be misidentified as internal carotid artery (ICA) with common anatomic transposition of ICA medial to external carotid artery if pulsation patterns are distorted by stenoses of both external carotid artery and ICA. The latter is well known to angiographers but not always to those who perform DUS, because external carotid artery and ICA are only truly indentified by images showing where they go, beyond the limited DUS neck view.

Although DUS reports give ranges of percent stenosis, anatomic diameters are not measured for percent calculation. In fact, distal ICA with parallel walls as the denominator for percent stenosis calculation¹⁰ is beyond the DUS neck window view. DUS machines have built-in tables for percent stenosis ranges. In-house calibrations were recommended for DUS against one’s own local angiography.¹⁵,¹⁷,¹¹¹ Published percent stenosis tables for DUS are available, originally measured from IAA for local reference, yet not always derived from IAA using the North American Surgical Carotid Endarterectomy Trial (NASCET) percent stenosis method.¹⁰ There is the pitfall of decreased distal ICA lumen (near occlusion),¹⁰,¹²,¹² fallacious to calculate as percent stenosis with NASCET methods. There is also wide variability of measuring the distal normal ICA for percent stenosis calculation, not always with compliance as “well beyond the bulb where walls are parallel.”¹²⁰ It is difficult to know how some did percent stenosis to match with DUS. Self-calibrated IAA to DUS dissipated over time, because many dropped digital subtraction angiography in favor of DUS. Today most DUS laboratories have percent stenosis correlations from someone else with variations of expressed percent.

There are multiple DUS publications that fit modeling criteria. Anatomic inferiority of DUS meant that percent stenosis ranges are needed to show consistency. DUS differs from anatomic stenosis quantified for IAA, and DUS saw many studies to show stenosis degree ranges. These studies form the bulk of Wardlaw and colleagues’ model¹ with the conclusion to dismiss IAAs (and CTAs) anatomic exactness in favor of DUSs less accurate stenosis quantification with no stroke risk. This result would have been perfect for the mid-1990s when many abandoned IAA for DUS.

Yet currently, with CTA’s exacting anatomy, no stroke risk, and taking seconds more than simple CT, it is passé to accept inferior anatomic depiction. The conclusion to omit anatomic exactness for no stroke risk is obsolete with CTA substituting for IAA.²³ Conclusions from the modeling results¹ omit that CTA has already replaced much IAA in many locales. Once CTA’s capability is understood, ethical problems intercede against continued stroke-risk IAA for pure research purposes. The “Catch 22” is that, for Wardlaw and colleagues, there are not studies of CTA good enough for their modeling method, because CTA’s anatomic exactness substitutes for IAA. Anatomic exactness is not a problem for
DUS, because it was precisely its lack of anatomic exactness that led to numerous comparative publications. 

Evidenced-based outcome studies are normal for treatment. Anatomic imaging has often been accepted as anatomic exactness. Yet there is a wish that imaging studies be assessed by the same rigorous methods as treatments. Anatomic accuracy of IAA, and now CTA, make IAA ethically impossible to now compare CTA matched to IAA or for randomized assignment to CTA or IAA. Such studies are required for scientific models by Wardlaw and colleagues, yet CTA’s anatomic accuracy is difficult to put into perspective if methodology ignores fast, safe, accurate anatomic advancements. Those promoting outcome science for anatomic correction images may not understand CTA. CTA’s anatomic correctness is like the adage that “if it looks like a duck, and quacks like a duck, then it is a duck.” It is not an outcome but an anatomic building block.

Modeling limits CTA’s consideration despite being anatomic correction, without stroke risk, done in seconds,2–12 more timely than IAA or DUS. There is no need to drop accurate stenosis assessment for DUS14–16 to satisfy Wardlaw and colleagues’ goal of safe carotid imaging with dispatch.1 CTA quantifies carotid stenosis as anatomic imaging without stroke risk and in seconds. Somehow Wardlaw and colleagues wrote that CTA is not quickly available.1 Yet it can be available immediately, anywhere and any time with simple CT, 4-slice or more. It is part of state-of-the-art acute stroke protocols.24 CTA examinations should be requested to ensure CTA’s efficient deployment facility by facility. Instead, Wardlaw and colleagues encourage neurologists and other physicians to substitute less anatomic detailed DUS. As scientists, Wardlaw and colleagues seem obliged by methodology to put aside CTA’s anatomic exactness to declare that less accurate percent stenosis from ultrasound is enough.1 Accuracy of IAA is abandoned for risk, yet anatomic CTA without stroke risk is put aside for lack of proper modeling. Anatomic quantification is rejected, just when CTA does it without stroke risk.

Support to abandon anatomic exactness for carotid stenosis with DUS, chosen by some in the 1990s, would have had a better reception in 1995, because now it means putting aside high-quality anatomic CTA imaging. CTA’s anatomic excellence for accurate carotid stenosis should be maintained for patient management. For those who respect IAA’s anatomic accuracy, a move to DUS for quantification lowers imaging standards when CTA has no stroke risk, is timely, and shows accurate anatomy. There seems to be competition between methodology and anatomy. Methodology should not suppress CTA, a revolutionary imaging advance, analogous to CT in the 1970s, digital subtraction angiography in the 1980s, and MR in the 1990s.

Disclosures

None.

References


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