Low-dose, High-resolution Neuro CT Imaging for Rapid Patient Evaluation

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Introduction

For a diagnostic neuro CT examination, we require excellent differentiation between gray and white matter to detect for subtle changes that represent a disease state. We also need to visualize the different brain structures without the presence of excessive noise and artifacts, such as beam hardening. In addition, we need neuro imaging to be of consistent high image quality and low dose regardless of the challenges the patient may present.

FMIG is a privately owned network of radiology centers in Melbourne, Australia, with a commitment to high-quality imaging services where the health and safety of our patients is paramount. Approximately 10% of our CT imaging cases are neuro, although we have experienced an increase in referrals for neuro combined with CTA imaging since the implementation of our Revolution™ CT scanner at our Hawthorn practice. Due to the system's speed, image quality, and low-dose capabilities, referrals are coming from both general practice physicians and specialists for symptomatic patients with a history of headache or as a follow up after injury, as well as for non-symptomatic patients that have a family history of ruptured aneurysms and other similar conditions. We are often looking for diseases such as brain mass, bony lesions of the skull, signs of hemorrhage or infarct, vessel narrowing, aneurysms, and vascular diseases.

Today, CT is our preferred examination over ultrasound because the latter can have its limitations in assessing the vasculature of the neck. These include difficulty in ascertaining the tortuosity of the vessels, shadowing caused by calcium deposits, and in cases of uncooperative patients an ultrasound can become laborious and time consuming. While there are limitations in CT such as radiation dose and iodine contrast load, Revolution CT has helped us overcome these with the use of ASiR-V™ combined with low kVp protocols.

Patient history

A 59-year-old female patient with symptoms of headache and severe neck pain was referred by her cardiologist for a pre- and post-contrast brain with CTA of the head and neck to detect or rule out a sub-arachnoid hemorrhage and/or carotid artery disease. We performed a low-dose, non-contrast CT brain followed by a CTA of the head and neck and a post-contrast CT brain.

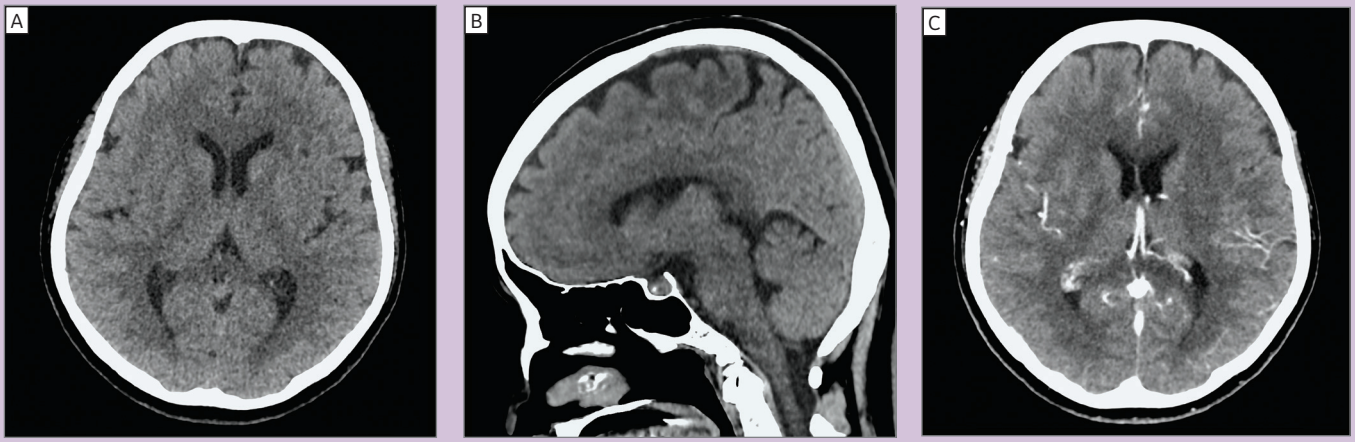

Figure 1. EC2 images of the brain; (A) non-contrast axial, (B) non-contrast sagittal, and (C) post-contrast axial.

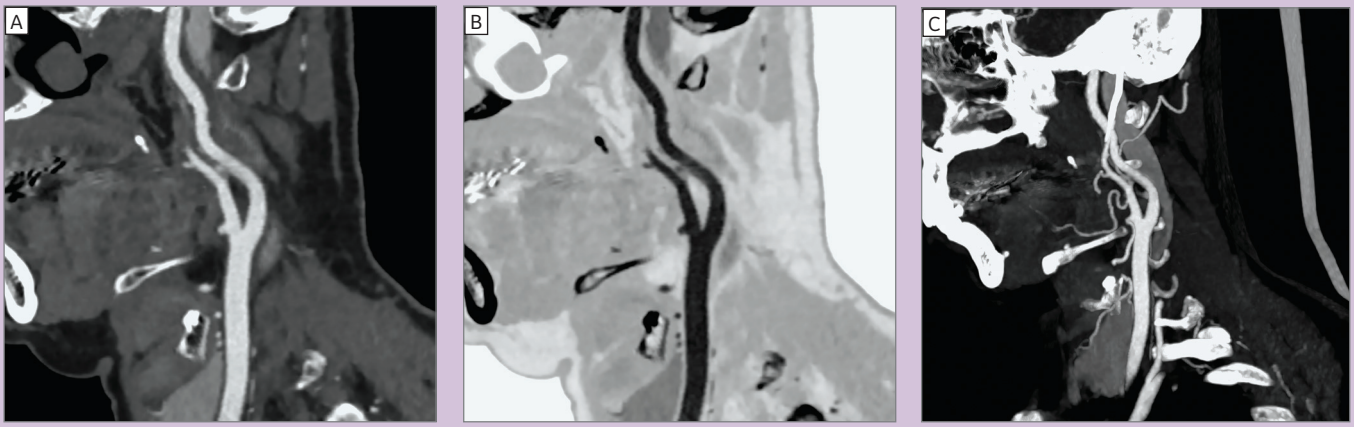

Figure 2. (A) Curved CTA of the left carotid; (B) inverse gray; and (C) MIP.

Acquisition

Brain - pre and post contrast:
Scan type: Axial
kV: 120
mA: 160-186
Rotation speed: 1 sec
Slice thickness: 0.625 mm/0.625 mm
Scan range: 184.3 mm
Recon parameters: STND algorithm, EC2
Dose: 1.19 mSv* per scan

Carotid CTA:
Scan type: Helical, 0.984:1 pitch
kV: 100
mA: 164-406
Rotation speed: 0.35 sec
Slice thickness: 0.625 mm/0.625 mm
Scan range: 330 mm
Recon parameters: STND algorithm
Dose: 0.7 mSv^

Findings

There was no focal intracranial lesion detected. In particular, no abnormal enhancing intra or extra axial mass or recent infarct or hemorrhage was identified with normal gray/white matter differentiation. No significant abnormalities were identified in the major cerebral arteries or major branches. In particular, no cerebral aneurysm was identified. The common carotid, internal carotid arteries, and vertebral arteries appeared within normal limits with no significant plaque or stenosis. No evidence of dissection was detected.

Discussion

With Revolution CT, we are able to provide low-dose neuro imaging at approximately 1 mSv for a brain and well below 1 mSv for a carotid CTA. This gives us a dose outcome closer to what we would have achieved for a single brain examination on prior generation technology. In addition, we are able to utilize low iodine volume injections through the use of low kVp techniques at around 50 ml of iodinated contrast for carotid CTA imaging; for this examination we have used only 30 ml. The combination of low-dose, low-iodinated contrast and speed through coverage and temporal resolution enables us to provide high diagnostic image quality with multiphasic neuro imaging accessible to all patients.

The coverage and temporal resolution of Revolution CT has been especially beneficial for patients who are restless and where time to scan and time on the table needs to be as short as possible. Through flexible protocolling, we can scan the brain in less than 1 second and the carotids in less than 2 seconds. Regardless of these short scan times, the resulting high spatial resolution images deliver exquisite soft and bony anatomic detail that often enables us to answer the clinical questions without engaging the patient in any further follow up or additional imaging. This goes a long way in reducing the overall anxiety for the patients and their families.

New to Revolution CT is the enhanced contrast (EC) reconstruction algorithms that boost the differentiation between gray and white matter. As we know, reducing dose decreases the low contrast that is needed in CT brain imaging, therefore, being able to drop our dose to 1 mSv and still have excellent gray/white matter differentiation, with the combination of EC and 50% ASiR-V, is very important to the overall service our practice provides. With three levels to choose from (EC1, EC2, and EC3) we routinely reconstruct on EC2 and we have the ability to retrospectively reconstruct on EC3 if we want to confirm a subtlety. We invested in Revolution CT because we believe the technology provides outcomes aligned with FMIG's mission statement of personalized service and we have seen the technology continue to advance, which enables us to continue offering our patients the very best care. ■

* Obtained using a head factor of 0.0023 x DLP.
^ Obtained using a head and neck factor of 0.0049 x DLP.