MEDICAL IMAGING—VIEW POINT

Use of computed tomography left atrial appendage as an alternative to trans-oesophageal echocardiography during the COVID-19 pandemic

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Introduction

The COVID-19 pandemic has evolved from the initial outbreak in March 2020 to the 2021 Delta variant and is continuing with the Omicron variant. Healthcare procedures which result in aerosol generation have been disrupted in particular by the requirement for COVID-19 testing to minimise risk to patients and staff. Trans-oesophageal echocardiography (TOE) has long been recognised as the gold standard for imaging of the left atrial appendage in patients with atrial fibrillation prior to direct current cardioversion. TOE however is an invasive, resource intensive investigation requiring procedural sedation and is an aerosol-generating procedure (AGP).[1] Computed tomography left atrial appendage (CTLAA) has been increasingly recognised as a safe, minimally invasive and accurate alternative to TOE. We believe that CTLAA should supplant TOE as the standard of assessment prior to direct current reversion and that as the main proprietors of CT scanners in hospitals, radiologists have a pivotal role in driving this change. The aim of this article is to describe the implementation of CTLAA as an alternative to TOE in an Australian setting during the COVID-19 pandemic.

Computed tomography left atrial appendage can be performed without the same aerosol-generating risks of TOE, requires fewer healthcare workers to interact directly with the patient and has a shorter duration of patient contact time. Internationally, the uptake has been widespread with endorsement by the Society of Cardiac Computed Tomography (SCCT) for the use as an alternative to TOE in the SARS-CoV-2 pandemic.[2] The authors are not aware of any current Australian-based guidelines for the use of CTLAA, with local use primarily being for the exclusion of LAA thrombus and surgical planning in patients prior to pulmonary vein isolation, and in structural heart disease planning for pre- and post-left atrial appendage occlusion.

Computed tomography left atrial appendage has excellent evidence for excluding LAA thrombus with a

negative predictive value of 99% when delayed phase imaging is used.[3] Early studies of CTLAA had heterogenous results for positive predictive value in diagnosing LAA thrombus, likely due to the presence of sluggish contrast mixing on early arterial phase imaging (Fig. 1). The inclusion of delayed phase imaging was shown to improve the positive predictive value in the meta-analysis by Romero *et al*.,[4] from 41% to 92%. This was subsequently shown again in the most recent meta-analysis by Yu *et al*.[3] which had a greater proportion of delayed phase imaging. This highlights the need for appropriate protocolling when using CTLAA, with a delayed phase essential to allow adequate time for contrast mixing in the LAA (Fig. 2).

Discussion

At our institution, CTLAA has been used as an alternative to TOE since September 2020. We use a 384-slice dual-source CT scanner (Siemens SOMATOM FORCE, Siemens Healthineers, Forchheim, Germany) with ultra-fast, low dose high-pitch (FLASH) as our preferred image acquisition type. Our CTLAA is prospectively ECG gated with a single contrast bolus and dual-phase acquisition with an arterial and a delayed phase. Our technique involves using a test timing bolus of 10 mL iodixanol intravenous contrast administered with a 30-mL saline flush at 5 mL/s with measurement of peak enhancement time in the ascending aorta. For the diagnostic scan a single bolus 60 mL iodixanol, 20 mL iodixanol mixed with 20 mL saline and finally 40 mL saline is administered at 5 mL/s. The arterial phase has a start delay of peak enhancement time plus 5 s and delayed phase imaging is acquired 45 s post arterial phase, typically occurring around 60 s post contrast injection.

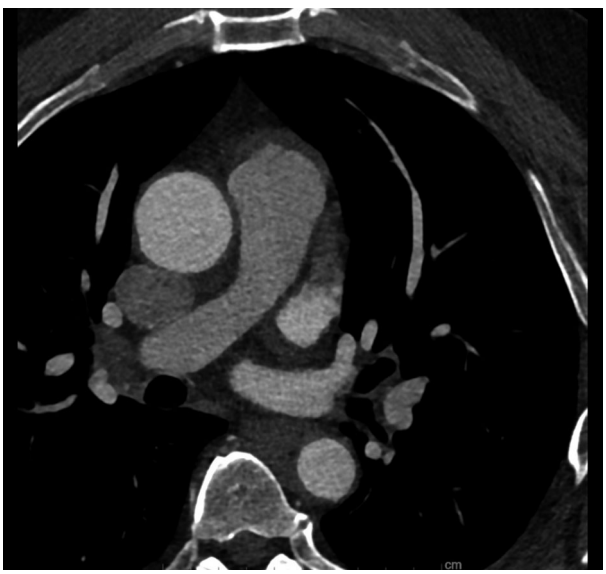

Fig. 1. Arterial phase of CTLAA demonstrating limited early opacification of the left atrial appendage, thrombus unable to be excluded.

Fig. 2. Delayed phase CTLAA demonstrating now complete opacification with no thrombus seen in the left atrial appendage.

We have imaged 12 patients since introducing our protocol. 10 patients were male and 2 were female. Ages ranged from 38 to 79 years. Indications for CTLAA have included exclusion of LAA thrombus prior to elective direct current cardioversion, serial imaging of known LAA thrombus and review LAA occlusion post-surgical ligation. Only one patient had an inconclusive finding on CTLAA and went on to require TOE to exclude the diagnosis of adherent thrombus. Although only utilised in a relatively small number of cases, we have been successful in reducing the number of patients requiring TOE at our institution and hence avoided several unnecessary AGPs during the pandemic.

Potential limitations to CTLAA that may reduce its applicability to certain patient groups are radiation and contrast exposure. The radiation dose of CT is a concern particularly in younger patients. Employing dose reduction techniques of prospectively ECG gating, reducing tube voltage and iterative image reconstruction should result in very low doses.[5] CTLAA requires administration of relatively large boluses of iodine-based contrast agents with some studies giving up to 120 mL of contrast to patients.[6] The risk of contrast induced nephropathy, particularly in patients with known renal impairment is an important consideration when using CTLAA as an alternative imaging modality. The risk of contrast allergy and potential for anaphylaxis is also of note and CTLAA is contraindicated in patients with known iodine-based contrast allergy, and these patients should generally proceed to TOE.

In our experience, patients undergoing dual-phase CTLAA with our preferred FLASH acquisition have had

satisfactorily low radiation doses with an average dose length product of 211 mGy*cm (Range 118–255). Two of our patients underwent helical acquisition, one during the protocol introductory period and one patient who required simultaneous CT chest angiography for a separate indication, these cases had higher doses of 1450 mGy*cm and 2978 mGy*cm respectively. Our local policy is to avoid cardiac CT in patients with eGFR < 30 mL/min/1.73 m^2. In our patient group, our eGFR range was 53-90 mL/min/1.73m^2. We are not aware of any contrast-related adverse events occurring in our patient group.

A limitation of our data is the small cohort size in the audited timeframe. This reduces the external validity of the results. Our findings should be considered in the context of the published international meta-analyses.[3,4] Further longitudinal research within the Australian setting is required.

Recommendations

Computed tomography left atrial appendage has been endorsed internationally by SCCT as a safe, minimally invasive alternative to TOE for imaging of the LAA in the COVID-19 pandemic. Ongoing uncertainty regarding the long-term efficacy of vaccination and emergence of new variants of concern such as the Omicron variant mean that we should be looking to change our model of care with regard to AGPs. Radiologists, as the gatekeepers of medical imaging departments are well positioned to increase CTLAA use in Australia and reduce the need for TOE and the associated risks. We suggest a review of current guidelines from RANZCR and CSANZ with regard to promoting the use of CTLAA as an alternative to TOE in the current pandemic.

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Data availability statement

The data that support the discussion of this article are available on reasonable request from the corresponding author. The data are not publicly available due to privacy restrictions.

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