Service evaluation of a new contrast protocol for cardiac CT's in patients with Glenn and Fontan circulation.

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INTRODUCTION

Glenn and Fontan procedures involve the diversion of systemic venous return from the heart to the pulmonary arterial system in patients with univentricular cardiac anatomy. During cardiac CT's the lack of cardiac pulsation removes the contrast-mixing effect of atrial and ventricular contraction resulting in poorly mixed dense contrast and unopacified blood which can mimic the appearance of thrombus.

Different contrast injection protocols have been used to try and avoid this. It is traditionally thought that it is not possible to enhance both the aorta and Fontan conduit in the same acquisition. Therefore, an early aortic phase scan is followed by a delayed phase. This effectively doubles the radiation compared to typical cardiac CT.

METHODS

We modified the 'Bastion wheel' contrast protocol from trauma imaging for use in univentricular circulation. A long slow injection for systemic venous enhancement with a short faster injection timed for arterial enhancement ensures that venous contrast has passed through the visceral capillary bed, returning to the SVC and IVC at the time of acquisition ensuring good mixing and reducing the potential for artefacts.

OBJECTIVE

To compare the diagnostic image quality and the need for a delayed phase acquisition in cardiac CT's performed with the modified Bastion wheel and the standard protocol.

RESULTS

57 cardiac CTs performed on patients with Fontan and Glenn circulation within the past five years were assessed. 25 used the modified Bastion wheel and 33 used the standard protocol.

Of the Bastion wheel CTs 18 (72%) had diagnostic image quality good enough to not require a second delayed acquisition and 7 (28%) required a delayed acquisition. In the Standard CT's 5 (15%) did not require a delayed acquisition and 28 (85%) required a delayed acquisition (significant via Fisher's exact p=0.0001).

CONCLUSIONS

The use of the modified Bastion wheel contrast protocol in patients with Fontan and Glenn circulations significantly reduces the need for repeat delayed phased imaging, halving the ionising radiation exposure in a significant number of cases compared to other contrast administration methods.

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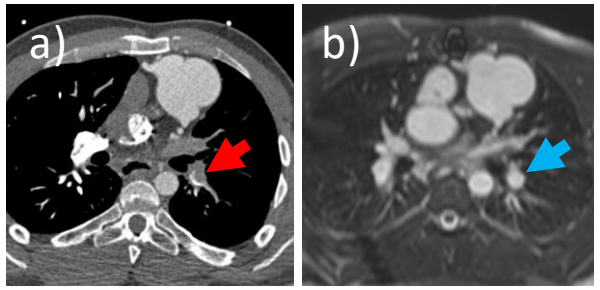

Figure 1 – a) CT demonstrates a filling defect within the left pulmonary artery resembling a large PE (red arrow) in a 27-year-old with Fontan circulation. b) Contemporaneous MRI (3d trueFISP) demonstrates no filling defect within the LPA (blue arrow) confirming the CT appearance as a 'pseudo-PE' resulting from poor mixing of contrast opacified blood from the SVC with non-opacified blood from the IVC preferentially filling the left pulmonary artery.

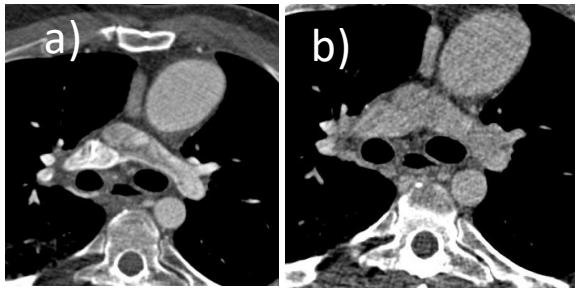

Figure 2 – Two scan protocol a) Early post-contrast acquisition results in good systemic arterial enhancement, but with mixing artifact in the pulmonary arterial circulation. b) Late-phase imaging (60 seconds later) confirms the lack of convincing pulmonary arterial thrombus but with sub-optimal pulmonary arterial enhancement.

Figure 3 – Bastion wheel protocol applied to a 4-year-old with Fontan circulation. There is a significant reduction in pulmonary arterial mixing artifact, meaning a late phase acquisition is no longer required, the imaging is easier to interpret, and the examination radiation dose is halved compared to a two-scan protocol (this scan was performed at 80 kV with a DLP of 17mGy cm and an acquisition CTDIvol of 0.52mGy).

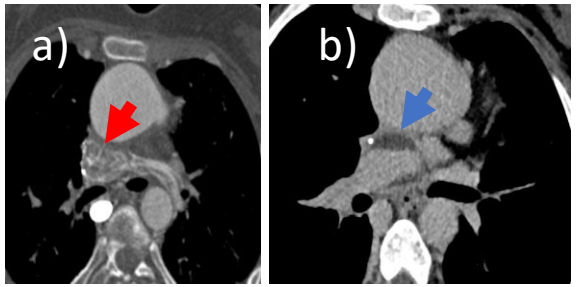

Figure 4 – 17-year-old with Fontan circulation. a) 1st pass imaging demonstrates extensive mixing artefact at the pulmonary arterial bifurcation (red arrow). b) Delayed imaging (60s later) demonstrates lamellar thrombus within the anterior portion of the pulmonary bifurcation, hidden by the mixing artefact on the earlier acquisition.