Empirical timing protocol versus bolus tracking for optimal CT pulmonary angiography

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As per RCR guidelines “CTPA should detect pulmonary emboli in between 15.4 and 37.4% of patients”. High quality images are required with good contrast opacification of the pulmonary arterial tree in a wide variety of patients. The RCR also identifies a level 210 Hounsfield Units (HU) as acceptable enhancement of the main pulmonary artery in order to identify emboli in peripheral arteries.

Multiple protocols exist for contrast material timing in CT pulmonary angiography (CTPA) acquisition however there is no clear consensus as to which is optimal.

In order to identify the optimal contrast timing method for our busy district general hospital we developed a study to compare a new empirical timing (ET) protocol versus the current bolus tracking (BT) method in optimising image quality and radiation dose.

Patients and Methods

All CTPAs performed on three different scanners over a 5 month period were retrospectively reviewed on PACS by a cardiothoracic radiology consultant and four radiology registrars. The sample included a 3 month period of the ET protocol. Reviewers were blinded to the scanning methodology.

Empirical timing protocol:

- 30 ml IV contrast at 2 ml per second
- 40 ml IV contrast at 4 ml per second
- Trigger scan at 30 seconds

Bolus tracking protocol:

- Interval tracking of region of interest over main pulmonary artery, for 120 HU threshold
- 80 ml IV contrast at 4 ml per second.
- Injection bolus can stopped once scan starts

In both the ET and BT groups, opacification density (OD) of the main pulmonary artery (MPA), segmental pulmonary arteries (SPA), and ascending aorta (AA) were assessed. Image quality, contrast dose and radiation dose-length-product (DLP) were recorded. Scans were acquired on a 128 slice Siemens Definition AS+ and two 128 slice Philips Ingenuity CT scanners.

Figure 1: above: example of excellent contrast opacification in the MPA and AA (each >650 HU).
Right: single slice tracking bolus images.

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<th>MPA</th>
<th>SPA</th>
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<td>p value</td>
<td>0.61</td>
<td>0.71</td>
<td>0.00002*</td>
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Table 1: mean opacification in the main pulmonary artery (MPA), segmental pulmonary artery (SPA) and ascending aorta (AA) for each of the two methods. * denotes statistical significance.

Conclusions

A total of 145 scans were evaluated: 74 in the BT group: 71 in the ET group. Mean patient age was 63 years in both groups. Pulmonary embolism positivity rates were 20% and 17% for BT and ET (p<0.42). 30% of BT studies and 37% of ET studies had an alternative diagnosis for symptoms identified.

Similar contrast opacification can be obtained in the MPA and SPA using either the ET or BT method, but aortic opacification is superior using the ET method. Improved aortic assessment has implications on possible alternative diagnoses in patients presenting with acute chest pain.

Radiation doses conferred by the ET method were 23% lower than in the BT group, a feature which may be relevant, particularly in young female patients.

These results are similar to those seen in a recently published study that demonstrates significantly higher aortic and main pulmonary arterial opacification (p<0.01 and p<0.001 respectively) compared to a timing bolus protocol.

The retrospective nature of our study resulted in a lack of data including height and weight for the patients. We did not assess the third common contrast enhancement method – timing bolus.

Further recommendations include evaluation of dose between scanner models and patient BMI, and comparison of timing bolus for triggering scans.

References