peer reviewed **CASE REPORT**

Case report: Transient interruption of contrast

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Abstract

Transient interruption of bolus contrast is a physiologic artefact due to a poor mixture of blood and contrast material. It is encountered when performing computed tomography pulmonary angiograms (CTPA). A working knowledge of this phenomenon is crucial to avoid a misdiagnosis of pulmonary embolism. A relatively high percentage (5-6%) of CTPA has been deemed inconclusive or technically insufficient due to poor contrast enhancement of the pulmonary arteries, which affects 40% of CTPAs. This case report describes this phenomenon and the setting in which it occurs. The patient's clinical history, radiological findings, appearance, and possible countermeasures, are described.

Keywords

Bolus contrast, artefact, computed tomography, pulmonary angiograms, pulmonary embolism.

Case report

A female inpatient geriatric was referred to the CT department. She complained of chest pains, shortness of breath and had reduced saturations of 83% (normal above 90%). A CT pulmonary angiogram was requested to rule out pulmonary embolism. The examination was treated as an emergency since pulmonary embolism is one of the leading causes of acute cardiovascular disease, after myocardial infarction and stroke, which may be fatal.[1] Urea and creatinine levels were within the normal range. Informed consent was obtained from the patient. It was ascertained that the patient had no known allergies to iodine. A pre-contrast scan was not performed. The contrast enhanced sequence was obtained after administration of 80ml of Jopamiron (Iopamidol) 370mgI/ml injected at a rate of 4ml/s followed by 20ml of normal saline. The contrast was injected using a Medrad Stellant injector pump. The scan and view scan was positioned a centimetre below the carina. The contrast was automatically tracked using Surestart until 160 Hounsfield units (HU) had been reached, after which it automatically triggered scanning. Before the start of the scan the patient was instructed to take a deep breath and hold her breath. An immediate review of the CT scan was done on the console monitor. It demonstrated contrast within the superior vena cava, ascending thoracic aorta and descending aorta, but with an unenhanced pulmonary trunk (see Figures 1 and 2). A radiologist reviewed the scan and informed the patient that further scans were needed. For the repeat scan, the patient was instructed not to take a deep breath prior to the scan but to just hold her breath following normal breathing. The scan showed that the pulmonary arteries were opacified (Figure 3). In this instance there were no obvious filling defects typically found on CTPA (see Figure 4).

Discussion

Transient interruption of contrast (TIC) is a flow artefact that consists of relatively poor contrast opacification in the pulmonary arteries while there is optimum contrast enhancement in the aorta and superior vena cava.[2] This phenomenon is unwelcome for many reasons, mostly because it may result in emboli being obscured within the insufficiently opacified pulmonary artery leading to a misdiagnosis. This then means that it is a phenomenon, which all CT radiographers should be aware of, as it has potentially devastating consequences.

Further imaging may be needed to exclude thrombus hidden in the poorly enhanced vessels.[2] A repeat CT scan means increased ionising dose to patients, and adds to the costs of the examination. Another disadvantage is that patients may become anxious. So how does this artefact come about? Instructing patients to take a deep breath and hold their breath immediately prior to scanning, as what occurred during this CTPA examination, has been reported to result in transient interruption to the flow of contrast into the pulmonary trunk.[3]

It is believed that when a patient inspires deeply, just before scanning begins, it results in either increased venous return of unopacified blood from the inferior vena cava or reduced delivery of iodinated contrast from the superior vena cava.[4] Unopacified blood entering the right atrium dilutes the contrast column coming from the superior vena cava; the result is seen as a transient decrease in attenuation.[4] After inspiring deeply patients tend to perform the Valsalva manoeuvre involuntarily when asked to hold their breath prior to scanning. This can cause an increase in intrathoracic pressure leading to decreased blood filling of both ventricles, resulting in reduced cardiac output and delaying peak contrast enhancement of the pulmonary arteries.[5] In other cases the presence of a patent foramen ovale causes a transient intra-cardiac right-to-left shunt with deep inspiration.[4] Patients with large areas of active lung disease, like atelectasis, also tend to have lower contrast enhancement in pulmonary arteries. A reason for this could be regional vasoconstriction, which leads to increased pulmonary vascular resistance and therefore decreased blood flow in the pulmonary arteries.[5]

Literature suggests that TIC is more prevalent in pregnant patients than the general population, ranging from 5.6% to 35.7%.[6] This is because of the haemodynamics effects of pregnancy which include an increase in cardiac output, total vascular

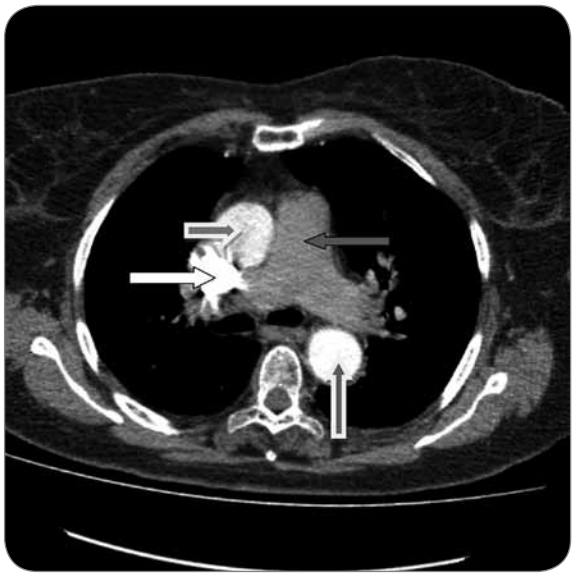

Figure 1. A contrast-enhanced axial CT image of the thorax showing the superior vena cava (bottom right arrow, white outline), ascending aorta (top right arrow, white outline) and descending aorta (bottom left arrow, white outline) opacified with contrast while the pulmonary trunk is relatively unenhanced (top left grey arrow, black outline).

Figure 2. A contrast enhanced coronal CT image of the same patient as above shows the superior vena cava (short grey arrow, on the right) and ascending aorta (top left arrow) opacified with contrast while the pulmonary trunk (bottom left white arrow) is not opacified.

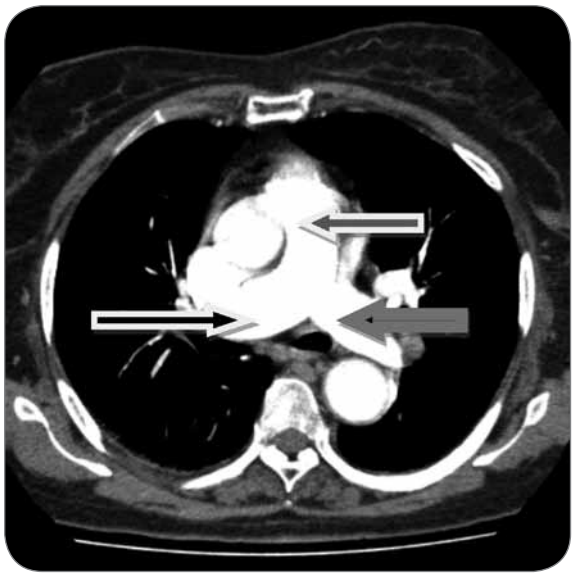

Figure 3. A CT axial scan of the thorax in the same patient showing opacification of the main pulmonary trunk (top left arrow, white outline) and pulmonary arteries (right black arrow showing the right pulmonary artery and the bottom left arrow, thick grey outline, showing the left pulmonary artery) after breathing normally during the scan.

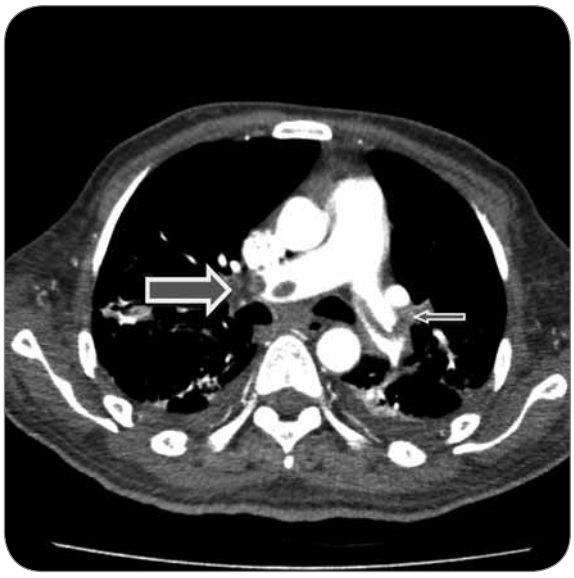

Figure 4. A CT axial scan of the thorax in a different patient showing positive saddleback pulmonary emboli. The pulmonary trunk is opacified which allows easy identification of the emboli against the white background of contrast (both arrows, left and right).

resistance, heart rate and plasma volume. These hemodynamics effects lead to dilution of the contrast bolus and an increase in inferior vena cava pressure, which can give rise to TIC.[6]

Scanning with the patient breath-holding at ease was shown to have a beneficial effect of improving contrast density in pulmonary arteries therefore improving diagnostic image quality.[5] This could explain why the second examination, in this case report, had a better outcome. The breathing instructions should be easy to understand as much as possible. Instructions such as 'stop breathing' or 'hold your breath' appear most appropriate while the automatically generated 'take a deep breath in and hold it' should be avoided.[1] To reduce inspiration and breath-holding associated artefacts some authors have promoted expiratory CTPA. They concluded that that expiratory scanning could be used as the optimal protocol for pulmonary artery imaging. The drawback to this protocol is that it suffers inferior parenchymal enhancement and should be reserved for failed inspiratory breath-hold CTPA.[1] In pregnant patients, with suspected pulmonary embolism, a pulmonary protocol optimised for use in pregnancy include a high flow rate of contrast (in the region between 5 and 7ml/s), a high volume of contrast and shallow held inspiration

Conclusion

Computerised tomography pulmonary angiography remains the gold standard for diagnosing pulmonary emboli.[6] One of the major artefacts, which hinder diagnostic accuracy of CTPA, is the flow-related one called transient interruption of contrast (TIC). Having a working knowledge of this artefact should enable CT radiographers to reduce indeterminate CTPAs. This would lead to increased confidence in reporting by radiologists and ultimately better patient management.[5]

Acknowledgement

Ethics permission to write this case study was obtained from the head of the radiology department and the chief radiographer.

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