Apneic oxygenation for elimination of respiratory motion artefact in an intubated patient undergoing helical computed tomography pulmonary angiography

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Radiology Case. 2008 Oct; 2(4):5-7 :: DOI: 10.3941/jrcr.v2i4.54

Journal of Radiology Case Reports

ABSTRACT

Respiratory motion artifact in intubated and mechanically ventilated patients often reduces the quality of helical computed tomography pulmonary angiography (CTPA). Apneic oxygenation is a well established intra-operative technique that allows adequate oxygenation for short periods (up to 10 min) in sedated and paralyzed patients. We describe the use of the apneic oxygenation for elimination of respiratory motion artefact in an intubated patient undergoing CTPA.

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CASE REPORT

Computed tomography (CT) pulmonary angiography is a first-line diagnostic test for the evaluation of the patients with suspected pulmonary embolism. CT pulmonary angiography is performed in a single breath-hold ranging from 5 to 30 sec, depending on the collimation used and the scanner type; time for CT pulmonary angiography decreses with increasing rows in multidetector systems and could be as long as long as 30 sec when a single row helical CT scanner is employed. In intubated and mechanically ventilated patients, however, the acquisition of a good quality CT pulmonary angiography is often challenging because they are not able to perform the required breath-hold maneuver, resulting in poor quality CT images due to respiratory motion artifact (1, 2).

Apneic oxygenation is a technique with established intra-operative use (e.g. as a short term alternative to one lung ventilation during thoracic surgery) where with tracheal insufflation of 100% oxygen in sedated and paralyzed patients (under these conditions the patients are not able to perform chest wall movements) their oxygenation status remains more or less stable with a rate of rise in partial tension of CO2 in arterial blood (PaCO2) 2-4 mm Hg per min. The increase in PaCO2 with the subsequent respiratory acidosis and hypoxia limits the safe duration of apneic oxygenation only for short periods -up to 10-20 min.(3,4).

We report a case of a 72 year old intubated man who underwent CT pulmonary angiography for evaluation of suspected pulmonary embolism under 40 sec of apneic oxygenation. To our knowledge this is the first report of application of apneic oxygenation in intubated patient undergoing spiral CT pulmonary angiography in order to avoid respiratory motion artefact.

Following initial resuscitation and endotracheal intubation the patient was transported to the Radiology department under sedation with continuous propofol infusion and paralysis with cis- atracurium. He was under mechanical ventilation with 100% O2 and close monitoring of vital signs to perform emergency CT pulmonary angiography for evaluation of suspected pulmonary embolism. The patient was placed on the CT scan table under continuous monitoring of electrocardiography (ECG), invasive arterial blood pressure, pulse oxymetry, and respiratory rate. The patient's hands were secured in overhead position and ECG electrodes were placed

in extrathoracic positions to minimize artifacts. With the injection of the contrast material the ventilator was disconnected from the patient and a suctioning catheter connected to wall oxygen outlet at a flow of 9 L/min was inserted into the patent's trachea through the endotracheal tube (Fig. 1). Patient's mechanical ventilation was restored after a 40 sec of apnoea on the whole. During this short period of apneic oxygenation the heart rate and blood pressure did not change and although monitor's apnoea alarm was activated the pulse oxymetry value remained unchanged at 99% haemoglobin O2 saturation. Furthermore, arterial blood gases before and after the period of apneic oxygenation did not show significant changes (partial tension of O2 was 325 mmHg in the first sample and 320 mmHg in the second sample with an increase in PaCO2 from 33 to 35 mmHg and a decrease in pH from 7. 34 to 7.33). CT images did not suffer from motion artefacts and revealed a massive pulmonary embolism extending to third and fourth generation pulmonary artery branches that were clearly visualized (Fig. 2).

DISCUSSION

To avoid respiratory motion artifact of CT pulmonary angiography in mechanically ventilated patients Kaplan and coworkers developed a strategy using continuous positive airway pressure (CPAP) with 10–15 cm H2O and additional sedation without paralysis (5). The possible advantages of apneic oxygenation over CPAP during CT pulmonary angiography are:

1) The avoidance of positive intrathoracic pressure applied by CPAP that may result in circulatory collapse by reducing venous return particularly in hemodynamically unstable patients such as those with pulmonary embolism. In addition, positive intrathoracic pressure, especially at the level of 10- 15 cm H2O CPAP can compress the compliant small caliber pulmonary vessels impairing their visualization.

2) There's no need for additional sedation to depress respiratory motions, whereas the use of neuromuscular blockers assures the absolute absence of respiratory motions. Moreover, the additional sedation can compromise further the patient's hemodynamics and cannot guarantee the absolute suppression of the respiration.

TEACHING POINT

Apneic oxygenation during CT pulmonary angiography can be a useful technique to eliminate respiratory motion artifact in mechanically ventilated critically ill patients.

ABBREVIATIONS

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CPAP = continuous positive airway pressure
CT = computed tomography
CTPA = computed tomography pulmonary angiography
ECG = electrocardiography

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FIGURES

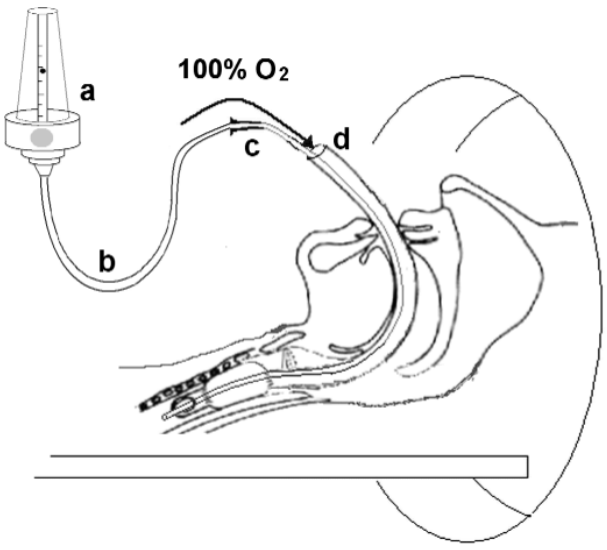

Figure 1: Apneic oxygenation during CT pulmonary angiography. a: wall oxygen supply, b: connection tube, c: suction catheter, d: endotracheal tube.

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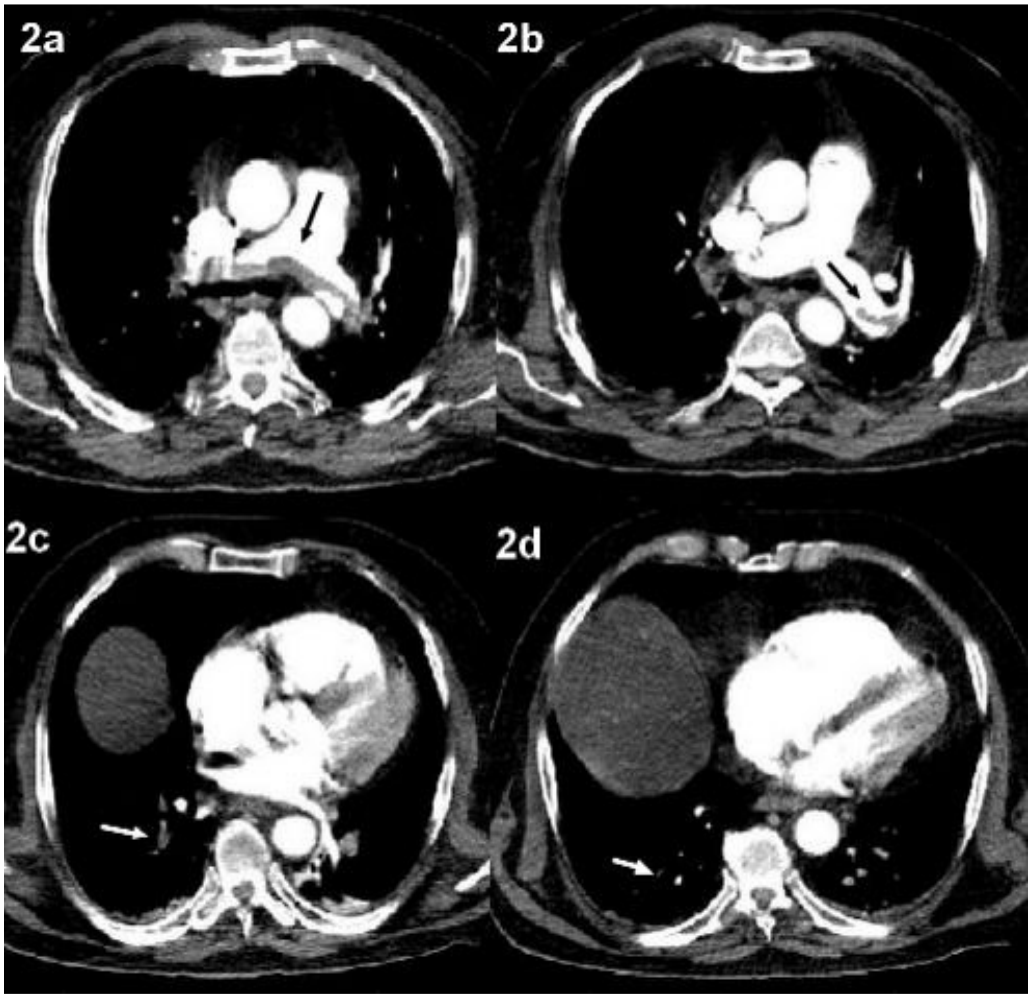

Figure 2: CT pulmonary angiography with apneic oxygenation on a single row helical CT scanner disclosing filling defects in the trunk and central branches of pulmonary artery (2a and 2b- black arrows) and in the branches of third (2c) and fourth generation (2d)- (white arrows).

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