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PNEUMOTHORAX AND PNEUMOPERITONEUM DURING THE APNEA TEST

HOW SAFE IS THIS PROCEDURE?

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ABSTRACT - Apnea test is a crucial requirement for determining the diagnosis of brain death (BD). There are few reports considering clinical complications during this procedure. We describe a major complication during performing the apnea test. We also analyse their practical and legal implications, and review the complications of this procedure in the literature. A 54 year-old man was admitted for impaired consciousness due to a massive intracerebral hemorrhage. Six hours later, he had no motor response, and all brainstem reflexes were negative. The patient fulfilled American Academy of Neurology (AAN) criteria for determining BD. During the apnea test, the patient developed pneumothorax, pneumoperitoneum, and finally cardiac arrest. Apnea test is a necessary requirement for the diagnosis of brain death. However, it is not innocuous and caution must be take in particular clinical situations. Complications during the apnea test could be more frequent than reported and may have practical and legal implications. Further prospective studies are necessary to evaluate the frequency and nature of complications during this practice.

KEY WORDS: apnea test, brain death, pneumoperitoneum, pneumothorax, complications.

Pneumotorax y pneumoperitoneo durante el test de apnea: cuán seguro es este procedimiento?

RESUMEN - El test de apnea (AT) es un requerimiento esencial para el diagnóstico de muerte encefálica. Hay pocos estudios que consideren complicaciones clínicas relacionadas con este procedimiento. Describimos un paciente que desarrolló una complicación mayor mientras se efectuaba el test de apnea. Realizamos una revisión de las complicaciones relacionadas con este procedimiento en la literatura. *Caso clínico:* Un hombre de 54 años fue admitido por deterioro del sensorio debido a una hemorragia intracerebral. Seis horas posteriores, el paciente no tenía respuesta motora, y todos los reflejos del tronco cerebral estaban abolidos. El paciente cumplía con los criterios diagnósticos de Muerte Encefálica de acuerdo a lo establecido por la Academia Americana de Neurología. Durante el test de apnea, el paciente desarrolla súbitamente pneumotorax, pneumoperitoneo, y finalmente paro cardíaco. *Conclusión:* El test de apnea es un requerimiento necesario para determinar el diagnóstico de muerte encefálica. No obstante, no es un procedimiento inocuo. Complicaciones durante este procedimiento pueden ser mas frecuentes que lo reportado en la literatura y tiene implicancias prácticas y legales.

PALABRAS CLAVE: test de apnea, muerte cerebral, pneumoperitoneo, pneumotorax, complicaciones.

During decades, death has been defined as asystole and cessation of respiration. Brain death (BD) is the irreversible cessation of all functions of the entire brain, including the brainstem. Several

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criteria have been used to define this condition, differing in the ancillary method requirements and the time necessary to confirm the BD diagnosis. The most widely accepted criteria are the guidelines of the American Academy of Neurology (AAN) for determining brain death, which include: unresponsiveness or coma, absence of brainstem reflexes, and apnea.[1] The apnea test (AT) is a necessary requirement to establish the diagnosis of BD. There are few reports describing complications during this procedure[2-4].

We report a patient who developed pneumoperitoneum and pneumothorax during the apnea test and review the complications of this procedure in the literature.

CASE

A 54-year-old man with a prior history of arterial hypertension was admitted to the hospital due to impaired consciousness. He was eating when he had sudden neck pain and fell down to the floor. The same day, when admitted to the ICU he was comatose. A CT scan of the head showed a large right fronto-parietal and temporal hematoma, measuring approximately 300 ml in size. His past medical history included tobacco smoking but no chronic obstructive pulmonary disease, and a subtotal gastrectomy following gastrointestinal bleeding two years before.

One day after admission, the patient was still unresponsive. No brain or brain stem reflexes could be elicited. He met the AAN criteria for brain death. Core temperature was 36.6°C and blood pressure was 120/70. He received dopamine at a dose of 6 ug/kg/min. Pulmonary examination revealed bilateral rhonchi, although the chest X-ray was normal. Cardiovascular functions were stable before the apnea test. After preoxigenation with 100% oxygen, arterial oxygen tension was 400mmHg. In addition, the patient fulfilled the AT prerequisites. According to the AAN guidelines for performing the apnea test, a 12-french catheter was inserted 10 cm down into the y-endotracheal tube to provide an oxygen flow of 8 L/min. Two minutes later, oxygen saturation decreased to 60% and blood pressure to 80/40. At this moment, bradycardia ensued. Lung auscultation revealed bilateral absence of breath sounds. Abdominal distension and signs of cyanosis were observed. The oxygen catheter was removed and the patient was immediately connected again to the ventilator, although he continued to deteriorate. A chest X-ray showed massive bilateral pneumothorax and pneumoperitoneum. He did not respond to an IV epinephrine bolus and cardiac arrest occurred before the pneumothorax was treated. “Cardiac” death was declared after cardiopulmonary resuscitation maneuvers failed.

DISCUSSION

BD patients may be suitable organ donors. For that reason, the apnea test is an essential procedure to establish this diagnosis. Any complication during this procedure may impair organ perfusion.

The established AAN prerequisites for performing the apnea test are: core temperature > 36.5C, systolic blood pressure > 90 mmHg, corrected diabetes insipidus, pCO2 > 40 mmHg, and PO2 >200 mmHg after preoxigenation[1].

The conventional technique consists in connecting a pulse oxymeter and disconnecting the ventilator. Subsequently, a cannula is placed at the level of the carina and 100% O_2 is delivered at a rate of 8 liters per minute while looking closely for respiratory movements. PO_2, CO_2, and pH are measured at baseline and 8-10 minutes after. Subsequently, the ventilator is connected again. If respiratory movements remain absent and arterial PCO_2 is >60 mmHg (or there is a 20 mmHg increase over a normal baseline PCO_2), the apnea test is positive (supporting the diagnosis of BD)[1]. Artificial CO_2 augmentation showed that the required time to perform the apnea test is markedly reduced when compared with the conventional technique[5]. Apnea denotes loss of brainstem function. Central chemoreceptors sense arterial PO2 and the pH of the CSF changes. Thus, they control the stimulus for neurons in the reticular and dorsal vagal nerve nuclei. There also are other mechanical and chemical influences on the respiratory neurons in the brainstem[6,7].

Pitfalls in performing the apnea test could be encountered in clinical practice[1,9]. A few studies using small numbers of individuals have been performed in order to standardize this method[10]. There are anecdotal reports of medical complications during or after performing the apnea test[2,3,10,11]. However, prospective studies are lacking in the literature.

Gad Bar et al. reported two patients with tension pneumothorax during the apnea test[2]. One of them was a 55-year-old man who had intracerebral hemorrhage and developed pneumothorax when the catheter was at the level of the carina. The second case was a 14-year-old girl who had a severe head injury. One minute after starting the apnea test, "the chest looked insufflated". Both patients had arterial hypotension, bradycardia, and finally cardiac arrest. Marks and Zisfein mentioned a case with subcutaneous emphysema and thoracic insufflation[3].

Wijdicks warned about the hypercarbia, acidosis, hypoxemia, and pulmonary edema that may appear during the apnea test. He questioned the safety of this procedure specially when the cited prerequisites were not considered[4,7].

Cardiovascular adverse effects related to the apnea test have been reported in small series of patients, such as 30% decrease of the systemic vascular resistance, increment of the cardiac index, hypoxemia, arterial hypotension, and pulmonary hypertension[7,9,10]. Appropriate perfusion is a cardinal condition to preserve the organ function. Thus, prophylactic treatment with epinephrine or dopamine has been suggested to prevent hemodynamic complications, even though there is no evidence favoring this management.

We studied complications related to the AT in 129 BD individuals[11]. We found major and minor complications during the AT in more than two thirds of patients, including: arterial hypotension (12%), acidosis (68%), and hypoxemia (23%). Baseline hypotension (systolic blood pressure < 100 mmHg or median arterial blood pressure < 60 mmHg) and pH <7.30 were the most common predicting risk conditions.

We report a 55-year-old man with intracranial hemorrhage with no previous lung abnormalities, who developed thoracic and abdominal insufflation during the apnea test. This complication occurred even when following the recommendations for performing this test. The difference between our patient and other cases was the presence of abdominal insufflation. To our knowledge, this is the first documented-report of pneumoperitoneum associated with pneumothorax during this procedure. The pathophysiological bases are difficult to explain. Although no increase in peak airway pressure was detected, this may be the underlying clue. Several conditions may predispose to this complication, such as, a) mechanical factors e.g.: external diameter of the cannula, and length of the endotracheal tube, b) time between BD diagnosis and apnea test, and c) patient condition, e.g.: age, COPD, arterial hypotension, hypothermia, or acidosis. Thus, risk factors such as COPD, pneumonia, arterial hypotension, or acidosis should be taken into account and considered before performing this test. We also suggest delaying the apnea test in high-risk patients, especially in those with severe acidosis (pH <7.20) due to the risk of subsequent arterial hypotension and organ hypoperfusion.

In our country, as well as in others, an isoelectric EEG is a legal requirement for the diagnosis of BD. The apnea test is usually performed at the end of the clinical exam and before the EEG. Thus, a cardiac arrest due to a complication of this procedure may have legal implications because the BD diagnosis has not been definitely established in the individual yet.

Because of the documented complications during the apnea test, we do not consider this procedure as innocuous[11]. On the other hand, it is a cardinal requisite that should not be avoided to complete the diagnosis of BD. For this reason, we believe this test should be done at a more adequate time. Thus, we suggest the apnea test should be performed after the neurological evaluation and the EEG.

In summary, medical complications may occur during the apnea test. Prospective studies are necessary in order to establish high-risk conditions and to define the frequency of complications during this procedure.

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