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Pneumopericardium Associated With Face-Mask Continuous Positive Airway Pressure*

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This is an uncommon case of a patient who developed pneumopericardium while being treated with face-mask continuous positive airway pressure (CPAP) for hypoxic respiratory failure following a coronary artery bypass graft surgery. A pneumopericardium detected by chest radiograph resolved completely after discontinuation of face-mask CPAP. Possible mechanisms that may have been involved in this unusual complication are reviewed.

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Key words: barotrauma; continuous positive airway pressure; coronary artery bypass graft; pneumopericardium

Abbreviations: CABG=coronary artery bypass graft; CPAP=continuous positive airway pressure

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Noninvasive spontaneous continuous positive airway pressure (CPAP) is an effective and simple method to increase arterial oxygenation in patients with hypoxic respiratory failure. This prevents the need or delay for endotracheal intubation and assisted mechanical ventilation. A common and simple means of providing spontaneous CPAP consists of a continuous, high flow of gas with an expiratory resistance valve attached to a tight-fitting face mask. Like positive end-expiratory pressure through an endotracheal tube, spontaneous CPAP improves arterial oxygenation. Unfortunately, CPAP also suffers from the same disadvantage as positive end-expiratory pressure—a heightened risk of pulmonary barotrauma in the presence of acute lung injury or ARDS.1 However, only two cases are reported in the literature as having an association of spontaneous CPAP with barotrauma such as pneumomediastinum and pneumothorax. In one patient with hypoxic respiratory failure, pneumomediastinum was observed following transtracheal aspiration for sputum culture but resolved spontaneously despite continued use of CPAP therapy.2 In a case series, 1 out of 18 patients with Pneumocystis carinii pneumonia and hypoxic respiratory failure was noted to develop a pneumothorax during CPAP therapy.3 Pneumopericardium from various causes has been reported in the literature;4,5 however, as best as can be determined, the occurrence of pneumopericardium with the use of spontaneous noninvasive CPAP during hypoxic respiratory failure has never been reported.

A case is presented of a patient who developed hypoxic respiratory failure a few days after a coronary artery bypass graft (CABG) surgery. While being treated with face-mask CPAP, a pneumopericardium was detected by a chest radiograph, which completely resolved after discontinuation of face-mask CPAP. Possible mechanisms that could be involved in this unusual complication are reviewed.

CASE REPORT

A 65-year-old male veteran underwent a five-vessel CABG at the University Medical Center in Jackson, Miss. His postoperative course was complicated by prolonged mechanical ventilation. On the 7th postoperative day, he was extubated and placed on conventional face mask with 40% FiO2 and intermittent CPAP of 5 cm H2O. On the 9th postoperative day, he was transferred back to the coronary care unit at the VA Medical Center in Jackson, Miss., for further postoperative management and observation. Upon arrival, the patient was alert but mildly dyspneic; his respiratory rate was 33 breaths per minute while using a conventional face mask with an FiO2 of 40%. A physical examination disclosed bilateral coarse breath sounds on auscultation. His chest radiograph revealed mild reticular nodular type infiltrates diffusely. The arterial blood gas values, with 40% FiO2, revealed a PaO2 of 44 mm Hg, a PaCO2 of 34 mm Hg, and a pH value of 7.52. The FiO2 was increased to 60% and the tight-fitting face-mask CPAP was increased to 10 cm H2O to maintain arterial oxygen saturation greater than 90%. He continued to tolerate the face-mask CPAP and became less dyspneic. Twenty-four hours later, a routine chest radiograph revealed worsening bilateral infiltrates with two obvious radiolucent areas along both heart borders, suggesting pneumopericardium (Fig 1). The chest radiograph also showed a thin radiolucent area outlining the right mediastinum, suggesting possible pneumomediastinum. The ex-
tent of the barotrauma was evaluated with a CT scan of the chest which revealed extensive bilateral airspace consolidation and the presence of a pneumopericardium but no pneumomediastinum or pneumothorax (Fig 2).

The patient appeared more dyspneic but remained hemodynamically stable, and results of a physical examination at that time were normal. The face-mask CPAP was promptly discontinued and the patient was then treated with 100% nonrebreathing conventional face mask. A bedside echocardiogram and catheterization of the right side of the heart revealed no obvious cardiac tamponade. We elected to closely monitor the patient during that time period with the intention of performing emergency pericardiocentesis in the event of hemodynamic instability. Serial chest radiographs over the following 72-h period showed complete resolution of the pneumopericardium while bilateral infiltrates persisted (Fig 3). He developed respiratory distress, and intermittent CPAP was reinstituted after the patient declined endotracheal intubation and mechanical ventilation. He deteriorated, as manifested by worsening radiographs and hypoxemia, despite advancement to continuous face-mask CPAP and died the following day.

**FIGURE 1.** Chest radiograph reveals bilateral parenchymal infiltrates with two radiolucent areas along the lateral borders of the heart suggesting pneumopericardium. Also evident is a thin radiolucent line along the right mediastinal border suggesting pneumomediastinum.

**FIGURE 3.** Chest radiograph taken 72 h after discontinuation of spontaneous CPAP shows resolution of the pneumopericardium while bilateral infiltrates persist.

**DISCUSSION**

Pneumopericardium, a form of barotrauma, refers to the presence of air within the pericardial sac, a condition that is much less common than either pneumothorax or pneumomediastinum. Pneumopericardium results from mediastinal air dissecting at the reflection of the parietal to visceral pericardium near the ostia of the pulmonary veins. This occurs more frequently in infants than in adults. This is probably due to the stronger adhesions between the pericardial layers in the adult, precluding communication between the pericardial space and the mediastinum.

In mechanically ventilated patients, there is an increased incidence of pulmonary barotrauma especially when there is an associated underlying pulmonary parenchymal process and high airway pressure. It is possible that our patient developed alveolar disruption from severe acute lung injury, and spontaneous CPAP contributed to increasing the pressure gradient between alveoli and the bronchovascular sheath leading to pneumomediastinum and pneumopericardium. Furthermore, pneumopericardium resolved completely once the CPAP was discontinued. Shawl and Chun reported a case of pneumopericardium due to sternal dehiscence following CABG surgery leading to entry of air into the pericardial sac during inspiration. The reported patient did not have sternal dehiscence, but the alteration of the normal mediastinal and pericardial structures during CABG surgery may have allowed air to enter directly into the pericardium from the mediastinum.

Radiographically, pneumomediastinum and pneumopericardium frequently are confused since they can occur concomitantly. However, three signs on a chest radiograph can help in differentiating pneumopericardium from pneumomediastinum. These include a radiolucent halo of air partially or completely surrounding the heart but not extending superiorly to the attachments of the pericardium, a shift in pericardial air on a decubitus radiograph, and the absence of a continuous diaphragmatic sign. In this case, the initial chest radiograph showed a thin radiolucent area outlining the right mediastinum, suggesting pneumomediastinum, and two obvious radiolucent areas along the lateral borders of the heart, suggesting...
pneumopericardium (Fig 1). Pneumothorax was not evident on this chest radiograph. However, a CT scan of the chest to evaluate the extent of pulmonary barotrauma revealed only pneumopericardium (Fig 2).

Management of pneumopericardium is similar to that of pneumomediastinum. Surgical intervention, catheter drainage procedures, or both would be appropriate in patients with concomitant hemodynamic compromise. Also, these patients need to be observed closely since they are at high risk for other barotrauma complications. In this case, the pneumopericardium resolved soon after the discontinuation of CPAP and initiation of treatment with high inspired oxygen.

This complication associated with face-mask CPAP during hypoxic respiratory failure is uncommon since no similar case was found in the medical literature. In patients with severe lung injury, a greater awareness of the possible pulmonary barotrauma from spontaneous CPAP should be considered. Because of the possible asymptomatic presentation, a serial chest radiograph and hemodynamic monitoring should enable the physician to make an early diagnosis and to begin treatment as soon as possible.

REFERENCES