Venous air embolism: A complication during percutaneous nephrolithotomy

Geeta P. Parikh, Sumedha R. Sonde, Prachi Kadam

Department of Anaesthesia and Critical Care, Smt. K. M. Mehta and Smt. G.R. Doshi Institute of Kidney Diseases and Research Center, Dr. H. L. Trivedi Institute of Transplantation Sciences, Civil Hospital Campus, Asarwa, Ahmedabad, Gujarat, India

ABSTRACT

Venous air embolism during percutaneous nephrolithotomy (PCNL) following air pyelogram or saline irrigation has been occasionally reported. We present a case of suspected venous air embolism during air pyelogram in a patient undergoing PCNL. The clinical diagnosis of air embolism was made by fall in end tidal carbon dioxide blood pressure and Oxygen saturation and was conservatively managed. Early diagnosis with rapid resuscitation is the key to management of a patient with air embolism.

Key words: Air pyelogram, percutaneous nephrolithotomy, venous air embolism

INTRODUCTION

Venous air embolism during percutaneous nephrolithotomy (PCNL) following air pyelogram or saline irrigation has been reported previously. We describe a case of suspected air embolism during air pyelogram in a patient undergoing PCNL.

CASE REPORT

A 32-year-old female patient, weighing 72 kg, with no co-morbidities was posted for PCNL for a 9 mm × 16 mm, middle calyx calculus. After recording baseline vitals (Pulse-99/min, BP-132/88, SpO₂-100), balanced general anaesthesia was administered. Patient was pre-medicated with intravenous glycopyrrolate 0.4 mg and fentanyl 150 µg. Induction was carried out with intravenous thiopentone 350 mg and scoline 70 mg were used for intubation. Controlled ventilation was instituted and anaesthesia was maintained with 50% nitrous oxide in oxygen and isoflurane, with intravenous vecuronium as muscle relaxant. Intraoperatively, patient was monitored with ECG, SpO₂, ETCO₂, heart rate, BP measured at 5 min intervals.

The patient was placed in lithotomy position and a ureteric catheter was inserted in left kidney through a cystoscope under fluoroscopic guidance. The patient was then carefully turned prone. Following identification of the calyx, 18 G needle was directed to the targeted calyx. The tract was dilated and nephroscopy was commenced. After 30 min of the procedure, due to non-visualization of the calculus, another puncture was attempted. Air pyelogram was done by injecting 40 ml of air in increments followed by 10 ml saline for proper identification of the pelvi-calyceal system. Within 1 min of injection of air, there was an abrupt fall in ETCO₂ from 32 mmHg to a sudden 6 mmHg in a span of 10 seconds. Heart rate had elevated from 93/min to 142/min and the BP dropped from 142/90 mmHg to 77/38 mmHg. Simultaneously, SpO₂ started declining to 77%. ECG at this point showed tachycardia with ST-T depression. Chest auscultation revealed bilaterally equal air entry without any bronchospasm. Endotracheal tube obstruction, circuit disconnection, and anaesthesia machine were checked. Since the whole incidence was of transient duration under anaesthesia and there was no bronchospasm, the airway pressures and tidal volumes remained unchanged. Air...
embolism was suspected due to sudden drop in ETCO₂, hypotension, and hypoxemia.

Immediately, nitrous oxide was discontinued and manual ventilation with 100% oxygen was carried out. Temporarily isoflurane was stopped and rapid intravenous fluid supplementation was implemented. Preparations were being made to turn the patient over to left lateral decubitus position. However, within 3 min, SpO₂ began to increase, heart rate and ETCO₂ returned to normal values.

Patient was vitally monitored till hemodynamic parameters stabilized. The surgery was allowed to be continued. Anaesthesia was now maintained with 50% air in O₂, isoflurane, and vecuronium. At the end of procedure, neuromuscular block was reversed, patient was uneventfully extubated and shifted to post-anaesthesia care unit.

**DISCUSSION**

Venous air embolism (VAE) is a potentially life threatening condition that has been reported in several surgical procedures. Cases of VAE in patients undergoing retrograde pylography and PCNL have been reported in literature, albeit rarely.[2-4]

Lopez first described that displacement of air occurs due to pyelovenous backflow from renal pelvicalyceal system into renal veins.[3] Injection of large air volume in the confined renal pelvicalyceal system could be potentially hazardous. Air embolism following injection of substantial amount of air occurred in our case as in a report by Usha.[4]

Air entering the venous system lodges in the pulmonary circulation and causes increased pulmonary vascular resistance, ultimately leading to a fall in the right cardiac output which will cause a decrease in ETCO₂ and SPO₂. If systemic vasoconstriction fails to compensate, then systemic hypotension occurs.[5] The factors that influence the morbidity and mortality of VAE include volume of air entrained, rate of air entrainment, position of the patient during the event, and the cardiac status of the patient.[6] Prone position is detrimental as it produces significant gravitational gradient between right heart and the renal pelvis.[2]

The application of end tidal carbon dioxide monitoring during general anaesthesia is a routine practice and could provide a sensitive and specific method to detect VAE.[7] Nowadays, in surgeries where air embolism is likely, invasive monitoring such as intra-arterial blood pressure monitoring, trans-oesophageal echocardiography, precordial doppler are routinely used. A right atrial catheter is inserted for diagnostic and therapeutic purpose. In short procedures, like PCNL where air embolism is a rare complication, the use of these measures routinely may not be validated. Hence, detection of air embolism under general anaesthesia is difficult and requires a high index of suspicion and prompt treatment.

In our case as soon as the ETCO₂ and SpO₂ dropped and hemodynamic instability ensued, air embolism as a probable cause was considered. We ruled out other possibilities like cardiac arrhythmia, pneumothorax, displacement of the endotracheal tube, ventilatory or mechanical failure can simulate air embolism.

Immediately nitrous oxide was discontinued and 100% oxygen was administered. High concentration of oxygen produces a gradient which could displace nitrous oxide from the air bubble.[2] Rapid intravenous fluid therapy instituted as low central venous pressure and hypotension would favor further air entrainment by increasing the pressure gradient between open veins and the right atrium. After patient was ensured to be hemodynamically stable surgery was allowed to be continued; however, nitrous oxide was not reintroduced to prevent increase in the size of any residual bubbles.

Usha[4] reported a similar case of air embolism during PCNL, however their patient developed asystole and was required to be turned supine and resuscitated. A similar case of intra-operative air embolism during PCNL resulting in paradoxical air embolism was described by Droghetti et al.[2] Their patient presented with blindness and neurological deficit.

To summarize, air embolism should be kept in mind following air pyelogram during PCNL surgery. This may be avoided or minimized by using smaller amounts of air or other alternate gas like CO₂. Vigilant monitoring with available monitors, particularly end tidal CO₂ and prompt treatment could result in favorable outcome following air embolism.

**REFERENCES**

1. Pyron CL, Segal AJ. Air embolism: A potential complication of retrograde pyelography. J Urol 1983;30:125-6.
2. Droghetti L, Giganti M, Memmo A, Zatelli R. Air embolism: Diagnosis with single photon emission tomography and successful hyperbaric therapy. Br J Anaesth 2002;89:775-8.
3. Lopez FA, Dalinka M, Doboy JG. Pyelovenous backflow in human kidney. Facts, fallacies and significance. Urology 1973;2:612-4.
4. Usha N. Air embolism-a complication of percutaneous nephrolithotomy. Br J Anaesth 2003;91:760-1.
5. Archer DP, Pash MP, MacRae ME. Successful management of venous air embolism with inotropic support. Can J Anaesth 2001;48:204-8.
6. Song SH, Hong B, Park HK, Park T. Paradoxical air embolism during percutaneous nephrolithotomy: A case report. J Korean Med Sci 2008;22:1071-3.
7. Albin MS. Air embolism. In: Albin MS, editor. Textbook of Neuroanesthesia with Neurosurgical and Neurosciences perspectives. New York: McGraw Hill; 1997. p. 1017-8.