CPAP with Air and Oxygen to Non-Ventilated Lung Improves Oxygenation During One Lung Anaesthesia

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Abstract

Ten adult patients undergoing one lung ventilation for elective thoracotomy were selected. All these patients failed to maintain oxygen saturation (SaO2) >90% despite administration of 100% oxygen to the non-ventilated lung (NVL). These patients were studied for the efficacy of continuous positive airway pressure (CPAP) of the NVL using air and oxygen combination (FiO2 0.5) employing a variable FiO2 CPAP system. It was observed that application of CPAP (5-10 cm H2O) with a mixture of air and oxygen to the NVL increased the Sa02 >90% in all these patients. This could be attributed to nitrogen in air which prevented absorption atelectasis in the NVL. This produced a better ventilation/perfusion ratio and hence the increased oxygen saturation (JPMA 45:43, 1995).

Introduction

Thoracic anaesthesia has been greatly facilitated by causing selective atelectasis of the lung being operated upon. The normal response of the pulmonary vasculature to atelectasis is an increase in pulmonary vascular resistance thereby diverting blood partly to the ventilated lung[1-3]. This response may be inhibited in the presence of general anaesthetics especially inhalational agents[3-6] leading to hypoxaemia. In majority of the patients application of 100% oxygen in the anaesthetic mixture and/or application of continuous positive airway pressure ventilation with 5 - 10 cm H20 pressure (CPAP) to the non-ventilated lung (NVL) improves oxygenation. However, in some patients these measures may not improve oxygenation. This may be due to possibility of absorption atelectasis. Also 100% oxygenation may not be feasible in all cases[7]. This study evaluated the efficacy of applying 5 - 10 cm CPAP to the NVL employing oxygen-air combination (FiO2 0.5) and to assess its effect on intra-operative oxygen saturation (Sa02) following failure to maintain >90% Sa02 with 100% oxygen to the NVL.

Patients and Methods

Following King Fahad Hospital Ethical Committee approval 10 ASA physical status II and III patients who failed to keep intraoperative Sa02 more than 90% during one lung ventilation despite CPAP with 100% oxygen to the NVL were selected for this study. All were scheduled for one lung ventilation for upper lobe lobectomy. The other lung was healthy. The mean age and weight of the patients were 37.2±8.65 years and 63.9±6.35 kg respectively. All patients had undergone pulmonary function tests preoperatively. All patients had been premedicated with midazolam 0.05 mg/kg 30 minutes before the operation. lntraoperative monitoring included direct arterial pressure. central venous pressure. pulse oximetry, EKG, nasopharyngeal temperature, end tidal CO2 (ETCO2), oxvgenanalyzerand neuro-muscular response to train-of-four. Anaesthesia had been induced with fentanyl 1 meg/kg and 4 - 6 mg/kg of thiopental administered over 45 - 60 seconds. Paralysis was achieved with atracurium 0.6 mg/kg. Following the absence of train-of-four response, a double lumen tube was positioned and confirmed by fiberscope. Initially, both lungs were ventilated with oxygen and nitrous oxide (FiO2 0.5,

tidal volume 12 mI/kg, respiratory rate adjusted so that ETCO2 remained between 34 -4-mm Hg and SaO2 over 90%). During one lung anaesthesia. ventilation was established with 100% oxygen. tidal volume 10 ml/kg, respiratory rate adjusted so as to have ETCO2 ranging between 34 - 40 mm Hg. During this period, anaesthesia was maintained with isoflurane 1 - 2% and small doses offentanvi intermittently if needed. SaO2 was continuously observed intra-operatively, It was recorded every 5 minutes. The minimum and maximum saturation during the entire intra-operative period was also recorded in each case. In cases showing Sa02 below 90%. arterial blood gas analysis was done and CPAP of 5 - 10 cm H2O with 100% oxygen was applied to the NVL. Despite the above measures, in 10 patients SaO2 remained <90%. At this stage. nearly 30 minutes after initiating one lung ventilation, instead of 100% oxygen a combination of air and oxygen (Fi02 0.5) with 5- 10 cm H2O CPAP was applied to the NVL using a "variable FiO2 CPAP system" (Figure).

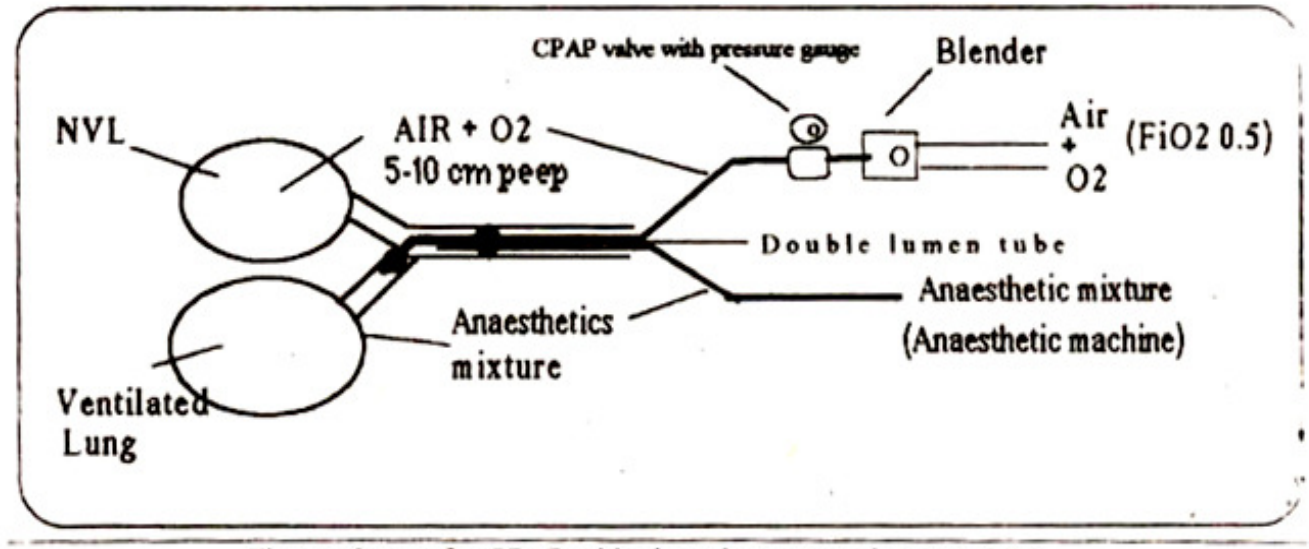

Figure. Set up for CPAP with air and oxygen mixture to NVL.

Ventilation to the other lung was continued as before. On completion of surgeiy, residual neuro-muscular blockade was reversed using a combination of neostigmine and glycopyrrolate. Patients were nursed post-operatively in the semi-propped up position and received oxygen enriched CPAP apparatus comprised of two separate tanks containing 100% oxygen and (medical) Air. The two cylinders were connected to gas blender. The oxygen and air mixture delivered by this device were connected to CPAP device with pop off valve set between 5 - 10 cm of water. With this system not only could FiO2 be varied from 0.21 to 1.0 but also any desired level of CPAP could be applied (Figure). Data (Table) have been expressed as mean±standard deviation. Paired "t" test was used for statistical analysis of data. P< 0.05 was taken as significant.

Results

Table. Effects of CPAP to the NVL using air and oxygen combination.

Age (Years)	Weight (kg)	Parameter	At 30 minutes with CPAP to NVL 100% O2	O_2-air
37.2	63.9	SaO_2 (%)	87.6	92.95*
±8.65	±6.35		±2.91	±1.54
		O_2 tension	44.82	69.64*
		(mm Hg)	±4.04	±7.87

*P<0.05

Table shows that both arterial oxygen saturation and tension significantly improved following application of CPAP with a combination of air and oxygen (FiO2=0.5) to the NVL. The average rise in SaO2 and oxygen tension was 5.3% and 13.8mm Hg respectively.

Discussion

During upper lobectomy in the lateral decubitus position marked right-to-left transpulmonary shunt can result when the non- dependent lung is not ventilated. This can be reduced by applying CPAP to the non-dependent lung[8,9] using 100% oxygen. However, our experience demonstrated that the intra-operative oxygen saturation could be further improved if oxygen and air combination was used for CPAP of the NVL instead of 100% oxygen. We believe that CPAP with 100% oxygen leads to absorption atelectasis in the NVL because of the substantial affinity of haemoglobin for oxygen and the continuous metabolic utilization of the oxygen. This in turn leads to lowered ventilation/perfusion ratio hence reduced Correction
saturation. This phenomenon has been observed in dependent lung when both lungs are exposed to high inspired oxygen concentrations[10,11]. Results of this study show that better intra-operative oxygen saturation can be achieved by using air-oxygen combination (FiO2=0. 5) for CPAP of NVL. In such a situation nitrogen of air prevents absorption atelectasis. However, further studies with variable oxygen and air mixture will be needed to find out the optimal combination. Levels of NVL CPAP(5 - 10 cm H2O) were low as it has been observed to be as efficacious as high levels of NVL CPAP (15 cm H2O). Furthermore, low levels of CPAP offers less interference with surgery and haemodynamic complications[3]. In this small series the operating surgeon observed no difficulty during lung resection in any patient due to the CPAP effect on the NVL. It is concluded from this study that intra-operative oxygen saturation canbe improved by using CPAP to the NVL with a combination of air and oxygen (FiO2=0.5) when conventional methods fail to keep the SaO2 >90%. This fact may be invaluable in routine one lung ventilation and in patients who are susceptible to oxygen toxicity of the lungs at higher oxygen concentrations.

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