Airway Occlusion Pressure (P_{0.1}) — A Useful Predictor for the Weaning Outcome in Patients with Acute Respiratory Failure

Kazufumi OKAMOTO, Toshihide SATO and Tohru MORIOKA

Twenty-five patients who required mechanical ventilatory support (MVS) after major surgery or severe burns were studied to determine whether airway occlusion pressure (P_{0.1}) is a clinically useful indicator to predict the success or failure of the weaning trial. A total of 33 weaning trials were attempted on these patients. Of the 33 trials, 24 were followed by successful weaning and 9 by failure. Although the success group, when compared with the failure group, had a lower respiratory rate (P < 0.001), a lower minute ventilation (P < 0.001), a higher maximal voluntary ventilation to minute ventilation ratio (P < 0.01) and a higher forced vital capacity (P < 0.05), no threshold values separated the success from the failure group. The alveolar-arterial P{subscript O2} gradient, with an F{subscript O2} of 1.0, in weaning success and failure showed no statistical difference. In contrast, all patients in the success group had a P_{0.1} of less than 3.5 cmH{subscript 2}O and those in the failure group had a P_{0.1} of greater than 3.5 cmH{subscript 2}O (P < 0.001). We conclude that P_{0.1} is a clinically superior indicator for discontinuing MVS in patients with acute respiratory failure. (Key words: airway occlusion pressure, acute respiratory failure, mechanical ventilation, weaning)

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For successful weaning from mechanical ventilatory support (MVS), some indicators as to arterial oxygenation, alveolar ventilation, and the mechanical properties of the respiratory system and respiratory muscles are commonly used\(^1\),\(^2\). However, these are not always valid to predict a successful weaning outcome\(^3\),\(^4\).

Airway occlusion pressure (P_{0.1}) is the pressure developed at the trachea during the first 0.1 seconds of inspiratory effort against an occluded airway\(^5\). P_{0.1} has been found to reflect an increase or a decrease in respiratory neuromuscular activity\(^6\),\(^8\) and has been suggested to be a useful predictor for successful ventilator weaning in patients with chronic obstructive lung disease (COPD)\(^7\),\(^8\). However, there are few observations in patients with acute respiratory failure (ARF)\(^9\). The purpose of this study was to examine whether P_{0.1} was a clinically useful indicator to predict the success or failure of the weaning trial in patients with ARF.

Methods

During about a 2-month period, a weaning trial was performed on 27 adult patients who required MVS after major surgery or severe burns. Of these patients, 25 consented to participate in the present study. They were conscious and understood the nature of the study. Ten were females and 15 males...
with a mean age of 58 years (range, 18 to 82 years).

Six of the patients received esophagogastrectomy (one complicated with postoperative pneumonia and sepsis); 5 received coronary artery bypass graft (one complicated with perioperative infarction); 4 received mitral and/or aortic valve replacement; 2 received repair of thoracic aortic aneurysm and 6 received other thoracoabdominal surgical procedures (one complicated with postoperative pneumonia). The remaining 2 patients had severe burns and were complicated with inhalation injury. All were hemodynamically stable and recovering from the critical condition which had necessitated MVS. No patients had COPD or impaired function of the respiratory muscles due to neuromuscular disease.

Each patient was evaluated at our routine morning conference with regard to undergoing a weaning trial. The decision whether to try weaning or not was primarily based on clinical assessment and the patient's ability to generate a forced vital capacity (FVC) of at least 10 ml-kg\(^{-1}\) body weight or greater. In some of the patients, FVC was a little bit lower than 10 ml-kg\(^{-1}\) body weight, but a weaning trial was still judged clinically appropriate if a patient's general physical condition was good.

The study was conducted in a semirecumbent position. The lead II of ECG and systemic arterial pressure were monitored continuously. A radial or dorsalis pedis arterial line was used to obtain arterial blood samples. All blood gas tensions and pH were measured with a Corning 168 pH/blood gas analyzer. Just prior to each weaning trial, arterial blood gases, with an ordinary Fi\(_{2}\) over 0.2, were measured to calculate the ratio of the arterial oxygen pressure to the fraction of inspired oxygen (P\(\text{aO}_2/\text{FiO}_2\)). Then, the patients were ventilated with pure oxygen for 15 min, for calculating the alveolar-arterial oxygen tension difference (A-a\(\text{Do}_2\)) with an Fi\(_{2}\) of 1.0.

FVC, minute ventilation (MV) and maximal voluntary ventilation (MVV) were measured during a brief period off the ventilator by using a Wright respirometer (Medishield, U.K.). Spontaneous respiratory rate (RR) was measured at the time of the measurement of MV. Tidal volume (V\(_T\)) was calculated from MV and RR. The maximal voluntary ventilation to minute ventilation ratio (MVV/MV) was calculated by dividing MVV by MV.

Airway pressure was monitored through a small catheter (2.0 mm ID and 2.7 mm OD) inserted into the endotracheal tube through the side port of a tube connector. The tip of the airway pressure catheter was placed 10 cm distal from the top of the endotracheal tube. The proximal side of the airway pressure catheter was connected to a pressure transducer (P23ID, Statham Instruments, U.S.A.) and airway pressure was continuously recorded on a polygraph (Nihon Koden, Japan) at a speed of 50 mm-sec\(^{-1}\).

Prior to the measurement of P\(_{0.1}\), MVS was discontinued and the patients were placed on the T-piece breathing circuit to allow spontaneous respiration. One minute later, the breathing circuit was disconnected from the connector of the endotracheal tube. Then, the orifice of this connector was tightly occluded with the tip of the finger. The occlusion was started at the end-expiratory phase and was maintained during the first 0.4 – 0.6 seconds of the inspiratory phase. Because of its shortness, it did not disturb the patients and was not noticed by most of them.

Careful attention was paid to the following points: (1) the patients could neither see nor hear the occlusion; (2) the timing of the occlusions was varied enough so that patients could not predict when the occlusions would occur. At least 5 measurements of P\(_{0.1}\) were obtained, and the mean value was used for analysis.

After all the measurements were made, it was attempted to wean the patients from MVS. Most patients were directly placed on the T-piece breathing circuit with a large balloon reservoir\(^{10}\). Three to 5 cmH\(_2\)O of continuous positive airway pressure (CPAP) were applied if clinically needed. For some patients, intermittent mandatory ventilation (IMV) or pressure support ventilation (PSV)