Transcutaneous $P_O_2$ Monitoring in Anaesthesia

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Abstract. In 23 patients 18 to 73 years old transcutaneous $P_O_2$, relative local perfusion and cardiorespirogram during induction and end stage of anaesthesia were monitored. This method allows continuous sufficiently exact estimation of $P_aO_2$.

The comparison between tc$P_O_2$ and corresponding blood gas analysis from arterial samples showed a good correlation of $r = 0.94$. Thus continuous tc$P_O_2$ registration enables quick diagnosis of hypoxia and its therapy.

Key words: Transcutaneous $P_O_2$, Monitoring of anaesthesia, Induction phase, End stage of anaesthesia.

Oxygen supply during induction and end stages of intubation anaesthesia must be considered to be very critical. During some parts of these periods the body depends exclusively on its oxygen reserves, therefore on chemically bound, physically dissolved oxygen, and on the gas in the alveolar space. Until now it has not been possible to study the dynamics of oxygen pressure values as a measure of oxygen supply because all previous methods only allowed a single analysis of arterial oxygen pressure to be made, or were time limited (4) and not free of risks (4, 8).

Having shown that the transcutaneous technique of measuring oxygen enables reliable, quantitative and continuous recordings of oxygen pressure in newborn infants (6) and adults (5, 10), the changes in oxygen tension during different stages of anaesthesia were determined in a series of routine anaesthesia cases.

Material and Method

Arterial $P_O_2$ was monitored continuously over the intact skin of the patient. Direct heating of the modified Clark $P_O_2$-electrode produces hyperaemia thus “arterializing” capillary blood below the electrode. This makes it possible to consider blood gas values in this region as arterial. The heating energy required for keeping the present temperature at a constant level against the cooling effect of the flowing blood can be registered and used as a relative dimension of local perfusion. The in vitro response time (95%) of the electrode covered with 12 $\mu$m cuprophane and 12 $\mu$m teflon membranes was about 6–8 sec. After a two point in-vitro calibration with water vapour saturated air and nitrogen, a procedure which takes only a few minutes, the tc$P_O_2$-electrode was fixed to the sternum of the patient by means of a self-adhesive ECG ring. Complete hyperaemia was obtained approx. 10 min. after application of heat and the $P_O_2$ registration then showed a steady state under normal breathing conditions. Heart rate, transthoracic impedance and respiratory rate — a so-called cardiorespirogram — were registered using ECG electrodes and corresponding apparatus (Hellige, Freiburg, and Hewlett-Packard, Böblingen). Heart rate was recorded beat to beat. All parameters were recorded on a 6 channel multipen recorder (Rikadenki, Hellige, Freiburg) with a chart speed of 3 cm/min. Blood sampling for comparative $P_O_2$ measurements and for $P_{CO_2}$ and pH determination was performed from the radial artery using the method of Huch and Huch (7). Blood values of $P_O_2$, $P_{CO_2}$ and pH were determined in a Gas-check from AVL (Bad Homburg).

The measurements were performed on 23 non-selected patients whose age ranged between 18 and 73 years. In 11 of the 23 all stages of anaesthesia were recorded. In 13 cases operations were performed abdominally, in 7 on the extremities and in the remaining 3 subtotal thyroidectomy was undertaken. Premedication was made 30–45 min. before induction of anaesthesia with Atropine and Thalamonal® (Janssen). Patients received thiopental-halothane-
Results

Fig. 1 shows the graph of correlation between the transcutaneous $\text{PO}_2$ values and those obtained from the Gas-check measurement on arterial samples. The regression curve is represented by: $y = 6.15 + 0.86 \cdot x$, with a coefficient of correlation of $r = 0.94$. This regression line deviates from the optimal 45°-line by 10%, which means that transcutaneous values in adults in this series are approximately 10% lower than the corresponding arterial samples.

Fig. 2 shows the behaviour of the following variables during the induction phase: heart rate, transcutaneous $\text{PO}_2$ (tc$\text{PO}_2$), local perfusion, transthoracic impedance and respiratory rate. After reaching a steady state of transcutaneous $\text{PO}_2$, 20 mg Gallamin and 250 mg Thio-\text{pental were administered.}

It can be seen that heart rate and local perfusion increased. Whereas heart rate continued to increase, local perfusion and respiratory parameters decreased markedly. After about 30 sec tc$\text{PO}_2$ dropped about 17 mmHg. It increased immediately after administration of a mixture of $\text{N}_2\text{O} - \text{O}_2$ (6:1 + 21). Anaesthesia was then continued with addition of halothane.

Thereafter the patient was relaxed with succinyl-bisc-bicholine (70 mg), ventilated manually and intubated with a cuffed tube. Note that tc$\text{PO}_2$ continued to increase and did not fall even during the apnoeic phase of the intubation. This was true in all of our measurements. Fig. 3 shows the behaviour of heart rate, arterial pressure, tc$\text{PO}_2$ and local perfusion during the terminal phase of a NLA.