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*Assessment of respiratory system efficiency during
experimental thoracotomy with lung tissue resection
in sheep based on arterial gas blood analysis*

Ocena wydolności układu oddechowego w czasie doświadczalnej torakotomii
z resekcją tkanki płucnej na podstawie badań gazometrycznych krwi tętniczej

Proper gas exchange in patient's respiratory system is a major factor providing safety during surgical operation. Blood oxygenation disturbances and hypercapnia may increase intraoperative and postoperative complication risk, which affects final treatment results.

Among many parameters monitored during operation measurement of gas exchange plays a major role.

The aim of this study was the examination of circulatory and respiratory systems by arterial blood gas analysis during open chest surgery with lung tissue resection in sheep. Available medical and veterinary literature does not contain such publications.

Anaesthesia as well as the disease and surgical technique contribute to beneficial final results of treatment. In veterinary practice open chest surgery is rare. It requires intratracheal intubation, controlled ventilation and is connected with a higher operative risk.

In human open chest surgery gas exchange disturbances are frequent. Scanty publications on animal experimental models of chest diseases usually do not contain anaesthesia course depiction and gas exchange analysis.

MATERIAL AND METHODS

For the experiments we used 20 individuals of cross-breed sheep of both sexes, 2 to 3 years old, weighing 35 to 68 kg (mean 51.5 kg). The animals were kept in the same conditions and were equally fed. After disinfestation with Savermin (Polfa) in a dose of 1 g/kg of body weight, two-week quarantine and veterinary examination the animals were qualified for surgery.

All animals underwent the same surgical procedure in identical operating room conditions, under the same anaesthesia. The operation and anaesthesia was performed by the same staff. The experiment consisted in performing the right thoracotomy and resecting the middle lobe of the right lung under general endotracheal anaesthesia. The animals were prepared for the surgery by shaving the right part of the chest and disinfecting the skin with hibitan alcoholic solution.

Premedication was carried out 30 minutes before the beginning of the operation by intramuscular injection of Relanium Polfa in a dose of 1 mg/kg of body weight. After the animal was placed on the left flank, the region of the right forearm was locally anaesthetised with 2% Lignocaine hydrochloride solution and after dissecting the median artery, a catheter (Venflon) was introduced into it, for drugs administration and infusions. It was also used to obtain arterial blood samples for laboratory examinations.

The animals were anaesthetised by intramuscular injection of Rometar (0.15 ml/kg b.w.) and intravenous injection of Thiopental (Biochemie GmbH, 10-20 mg/kg b.w.) until cilio-spinal reflex disappeared. Next an intubational tube was introduced into the trachea and inhalation anaesthesia with halothan (Narcotan – Leciva) in concentration 1.5 – 2.5% in mixture with oxygen was commenced.

For precise assessment of each anaesthesia phase, arterial blood was collected at the following time: 0/ 30 min. after premedication, 1/ 5 min. after intubation, 2/ 5 min. after opening of the chest and lobectomy, 3/ 5 min. after chest closure, 4/ 30 min. after extubation.

Corning blood gas device was used for measurements. Results were printed and analysed statistically.

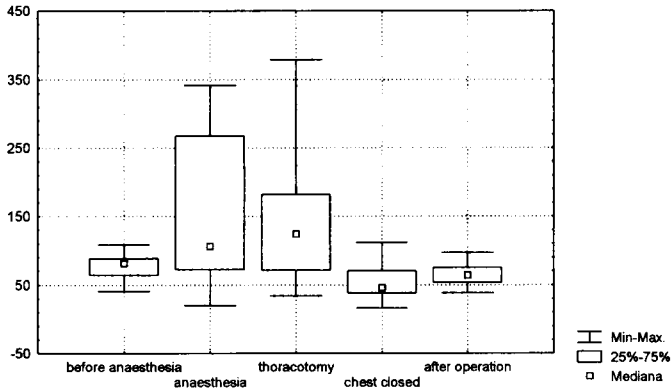


Fig. 1. Mean values of pO₂ in consecutive phases of anaesthesia

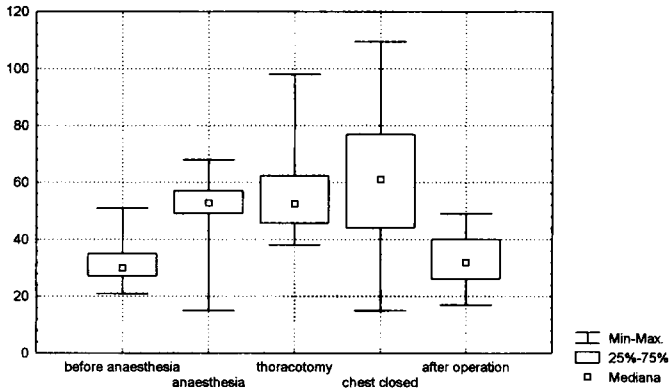


Fig. 2. Mean values of pCO₂ in consecutive phases of anaesthesia

RESULTS AND DISCUSSION

Results of blood gas measurement were analysed with the use of computer program STATISTICA by means of Wilcoxon and Mann-Whitney tests. Values of O₂ and CO₂ were averaged and presented graphically.

Results were referred to preoperative values /0/ acknowledged as normal. The analysis revealed that:

1. Decrease of pH in test 1 (after intubation) differs statistically significantly ($p < 0.005$) from normal (test 0). It revealed most significant scattering of values. Also statistically significant differences were noted in the next tests, major – after extubation ($p < 0.01$) when pH was higher than normal and values were most stable.

2. The greatest differences in oxygen partial pressure (pO_2) occurred in test 1 ($p < 0.05$), 2 ($p < 0.05$). In test 1 and 2 it was higher than normal, and in test 3 higher than in test 0 (Fig. 1).

3. Increase in arterial carbon dioxide partial pressure was statistically significant in tests 1-3 ($p < 0.005$) (Fig. 2).

4. Base excess (BE) was shifted towards basic during the whole experiment (statistical significance in the following tests 1 – $p < 0.01$; 2 – $p < 0.001$; 3 – $p < 0.005$; 4 – 0.01).

5. Noted concentration of bicarbonates (HCO_3^- – $p < 0.05$; 0.005; 0.01) and total carbon dioxide (TCO_2 – $p < 0.005$; 0.0001; 0.005; 0.05) – statistically significant differences in all phases of anaesthesia.

6. Arterial blood oxygen saturation appeared to be the most stable parameter. Significant decrease was observed in the final phase of the operation ($p < 0.05$).

Shortness of this period allowed to normalise this ventilatory disturbance after extubation.

The other parameters also returned to preoperative values.

Gas exchange disturbances during open chest surgery – hypoxia or hypercapnia – are the major cause of intraoperative death. Results obtained in this experiment may be useful in another big animals' surgery. The analysis of gasometric results shows that gas exchange significantly fluctuates depending on the phase of operation. These fluctuations may reach critical values which may cause circulatory arrest and death.

The first phase of anaesthesia, between drug-induced muscle relaxation and intubation, is the most difficult period. The threat of circulatory arrest increases with an increased time of intubation, during which the patient remains in apnoea. An additional obstacle is the necessity to intubate the animal lying in the lateral position. Intubation and variable gas concentration general anaesthesia provide that open chest surgery is usually safe. It is confirmed by the analysis of gasometric measurements /Fig. 1,2/.

The analysis of variables obtained from arterial blood gas analysis during open chest surgery in general anaesthesia in sheep entitles to draw the following conclusions:

1. Anaesthesia in elective thoracotomy should be performed with the use of equipment ensuring patient's safety and treatment success.

2. Time of intubation is the most dangerous period of anaesthesia, and gas exchange disturbances during open chest surgery depend mostly on the technique of anaesthesia.

3. Gas exchange disturbances are not life-threatening, if there is a possibility to perform gasometry for intraoperative assessment of patient's condition.

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STRESZCZENIE

Autorzy wykonali badania gazometryczne krwi tętniczej podczas operacji doświadczalnej w zakresie klatki piersiowej u owcy. Założeniem pracy było wykazanie znaczenia tego badania w ocenie zaburzeń wentylacji i związanego z tym ryzyka w poszczególnych fazach operacji i znieczulenia. Na podstawie analizy wyników opracowanych statystycznie i przedstawionych graficznie oceniono stopień zaburzeń oraz możliwości ich korekty w czasie operacji resekcji tkanki płucnej przez prowadzącego znieczulenie. Wykazano bardzo znaczne odchylenia od normy w poszczególnych etapach znieczulenia i zabiegu w zakresie wszystkich parametrów badania gazometrycznego z wysoką istotnością statystyczną. Najbardziej stabilnym wskaźnikiem był poziom saturacji tlenu. Otwarcie klatki piersiowej jak i wycięcie płata płuca nie miało dostrzegalnego wpływu na zmianę składu gazów krwi tętniczej podczas operacji, nie było więc istotnym czynnikiem, który zwiększył ryzyko powstania powikłań wynikających z obserwowanych zaburzeń wentylacyjnych. Należy więc przypuszczać, że obserwowane znaczne zaburzenia wentylacyjne były następstwem niedoskonałości technicznych znieczulenia, szczególnie zależnym od czasu pomiędzy wyłączeniem oddechu własnego a intubacją i włączeniem oddychania zastępczego o kontrolowanym składzie gazów.

