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Piero Mognoni, Franco Saibene, Giuseppe Sant'Ambrogio

Effect of anaesthesia on the contribution of the diaphragm to ventilation in the rabbit

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Fisiologia. — *Effect of anaesthesia on the contribution of the diaphragm to ventilation in the rabbit*(*). Nota di PIERO MOGNONI, FRANCO SAIBENE e GIUSEPPE SANT'AMBROGIO, presentata dal Socio R. MARGARIA.

RIASSUNTO. — Il contributo meccanico del diaframma alla ventilazione, nel coniglio, dipende dal livello di anestesia: a livelli di anestesia profonda esso aumenta di circa il 50% rispetto al valore di controllo. Ciò dimostra che l'anestesia deprime selettivamente l'attività dei muscoli inspiratori extradiaframmatici.

It has been shown that the contribution of the diaphragm to ventilation increases with anaesthesia probably because the anaesthetic selectively depreses the extradiaphragmatic inspiratory muscles (Guedel [1] and Gillepsie [2]). The aim of this study is to give quantitative data on the effect of an intravenous anaesthesia on the respiratory muscles.

The experiments were carried out on 7 rabbits prepared under Thiopentone anaesthesia. A tracheal cannula, connected to a Fleisch pneumotacograph, was inserted, and a couple of silver electrodes was placed on the sternal portion of the diaphragm. The surgical wounds were then sutured and infiltrated with novocaine. The effect of the Thiopentone anaesthesia almost disappeared after 60-90 min, as judged from 1) the reactivity of the animal to pain stimuli, 2) the degree of spontaneous motility and 3) the respiratory frequency. At this stage the respiratory volume, obtained by electrical integration of the pneumotacographic signal, and the integrated electrical activity (IEMG) of the diaphragm were recorded as a control. A general anaesthesia was then progressively re-induced by injection of a mixture of urethane and penthobarbitone sodium (218 mg urethane and 7.5 mg penthobarbitone sodium per ml) given through the marginal vein of the ear: 1 ml of anaesthetics was injected every 5 min until the animal died.

Assuming that the integrated electrical activity of the diaphragm is proportional to the mechanical effect of its contraction and that the tidal volume (V_T) is an index of the overall activity of the inspiratory muscles, the ratio between the IEMG of the diaphragm and V_T may be considered an index of the mechanical contribution of the diaphragm.

Fig. 1 shows that the relative contribution of the diaphragm increases significantly only when the level of the anaesthesia is very deep: in fact the value of the pulmonary ventilation is reduced to 50 % of the control and the corneal reflex is absent.

(*) Dall'Istituto di Fisiologia Umana dell'Università di Milano. Ricerca eseguita col contributo del C.N.R.

(**) Nella seduta dell'11 gennaio 1968.

The decrease of the relative mechanical output of the extradiaphragmatic muscles could be ascribed to the suppression of the facilitatory proprioceptive reflex, which is present in the intercostal muscles but not in the diaphragm.

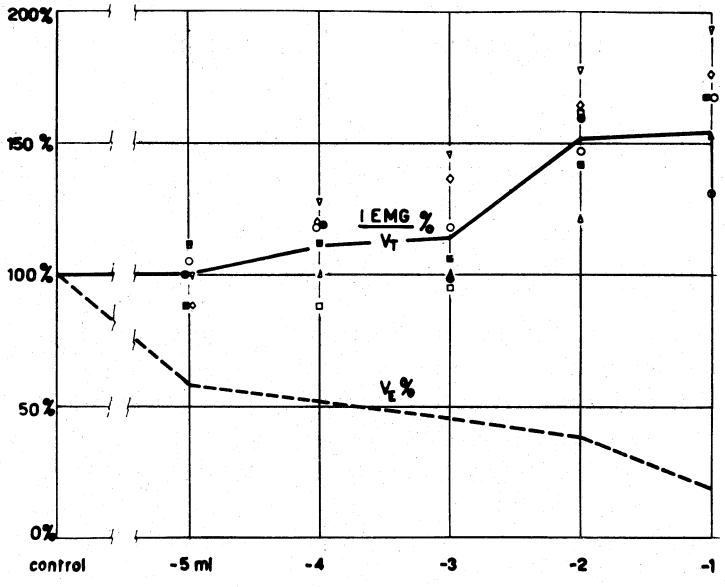

Fig. 1. – Effect of the depth of the anaesthesia on the mechanical contribution of the diaphragm to the ventilation and on the pulmonary ventilation.

Ordinate: ratio between integrated electrical activity of the diaphragm and tidal volume as percent of the control value, IEMG/V_T% (continuous line and experimental data); pulmonary ventilation as percent of the control value, V_E% (broken line). Abscissa: depth of anaesthesia expressed as volume of anaesthetic necessary to reach the lethal dose.

In a previous work [3] the contribution of the diaphragm to the ventilation has been found to be ab 84 % during quiet breathing in rabbits with anaesthesia of medium level. The present data indicate that the validity of such a conclusion is not affected by a possible error due to the anaesthetics used in those experiments.

References.

[1] Guedel A., *Inhalation Anaesthesia,* 2nd. edit. The Macmillan Co., New York 1951.

[2] Gillespie N., *The signs of anaesthesia,* «Current Research in Anaesth. and Analg.», *22,* 275–282 (1943).

[3] Mognoni P., F. Saibene and G. Sant'Ambrogio, *Contribution of the diaphragm and the other inspiratory muscles to different levels of tidal volume and static effort in the rabbits* J. Physiol., in press.