TITLE : VARIATIONS OF VENTILATORY PATTERN DURING KETAMINE ANESTHESIA

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INTRODUCTION : External measurement of chest wall movements have been claimed to be an ideal method to evaluate relative contribution of rib cage (RC) and abdomen (AB) to tidal breathing (1). Anesthetics drugs have been shown to induce a preferential suppression of intercostal muscular activity and consequently may alter geometry of the respiratory system and volume-motion relationship. This point has not been clearly investigated during anesthesia. The aim of the present study was to investigate respiratory pattern during Ketamine anesthesia, with a particular interest on functionnal residual capacity (FRC), RC contribution, and volume-motion relationship.

METHODS : 13 male patients, ASA I, mean age 27±7years (X±SD), mean weight 67±8kg, unpremedicated were studied in supine position prior to surgery. Informed consent and institutional approval for the study were obtained. Changes in RC and AB circumferences were simultaneously measured with two belts equiped with differential linear transducers (DLT) positioned at mamillary and umbilical levels. DLT are characterized by high sensitivity ($360mv.mm^{-1}$) and stability. Direct lung volume variations were measured with a water filled 9 liters spirometer. The calibration procedure in awake patient was performed as follow : during voluntarily alternate thoracic and abdominal predominant breathing, RC and AB circumferences variations were matched to simultaneously measured spirometric volume. Studied volumes ranged from 300 to 2000ml. The least square regression was used to calculate a first set of volume-motion coefficients for RC (K_{RC}) and AB (K_{AB}). Then patients were disconnected from the spirometer and left in a quiet environment. Anesthesia was induced by Ketamine ($3mg.kg^{-1}$), Succinylcholine ($1mg.kg^{-1}$) was injected to facilitate orotracheal intubation after Lidocaine 5% was sprayed into the larynx and trachea. Anesthesia was maintained by Ketamine infusion ($20mcg.kg^{-1}.min^{-1}$). Patients breathed spontaneously a 40% O_2 air gas mixture. In order to change the contributions of RC and AB compartments, endotracheal tube was briefly occluded. Then a new calibration was performed using spontaneous breathing cycles and post-occlusion tidal-volumes. Each subject was studied awake and during Ketamine anesthesia 10 and 20minutes after induction. Variations of RC and AB circumferences were continuously recorded during the study. With corresponding set of volume-motion coefficients, they allow to calculate : tidal-volume (VT), respiratory rate (RR), minute-volume (V_E), mean inspiratory flow (VT/Ttot), RC contribution to tidal-volume (RC/VT) and change in end-expiratory levels of RC and AB (ΔEEL). VT measured by DLT during the two calibrations procedures were within ± 5% of values simultaneously obtained by spirometry. In 7 patients, FRC was measured by Helium dilution technique and values were corrected for BTPS conditions. Analysis of variance and modified Student's t-test were used.

RESULTS : Between awake and anesthetized measurements (Table I) : there was a significant decrease in K_{AB}/K_{RC} ratio (Figure 1). V_E, Ti/Ttot, RC/VT were significantly increased, whereas VT, RR, VT/Ti were not significantly modified. The important increase in Ti/Ttot gave a breathing pattern typically apneustic. Although FRC remained stable, there was a significant increase in end-expiratory levels of RC and AB. K_{AB}/K_{RC} ratio remained stable throughout anesthesia. RC/VT increased significantly between 10 and 20minutes anesthesia.

DISCUSSION : Change in calibration at the induction of Ketamine anesthesia suggests an alteration in chest wall geometry and/or relative compliance of RC and AB. This change impedes interpretation of end-expiratory levels and RC/VT variations. Thus, increase in RC and AB circumferences cannot be expressed in terms of volume. Compared to other anesthetic drugs, Ketamine has original respiratory effects : FRC stability, and increased RC/VT during anesthesia suggesting an increased intercostal activity.

TABLE I : Values are mean ± SEM

	AWAKE	KETAMINE 10min	KETAMINE 20min
K_{AB}/K_{RC}	1.46±0.11	1.03±0.18*	
VT (ml)	375±40	420±48	470±48
F ($c.min^{-1}$)	16±1.17	17.4±1.4	18.4±1.4
V_E ($ml.min^{-1}$)	5.8±0.4	7.4±1.2	8.8±1.4
RC/VT (%)	0.34±0.05	0.48±0.05*	0.62±0.03**+
Ti/Ttot ($ml.sec^{-1}$)	0.45±0.01	0.61±0.02**	0.62±0.02**
VT/Ti ($ml.sec^{-1}$)	254±17	228±42	232±46
FRC (ml)	2880±180	2360±160	
ΔEEL (mm)			
RC		+ 7±1.3	
AB		+ 5.3±1.9	

* p < 0.01 anesthetized vs awake
** p < 0.001 anesthetized vs awake
\+ p < 0.001 10min vs 20min

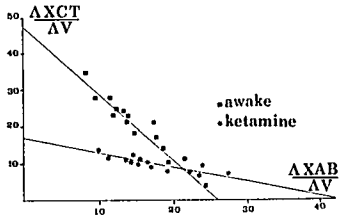

FIGURE 1 : Change in calibration (patient N°2)

REFERENCE

1 - KONNO K., MEAD J. : Measurement of the separate volume changes of rib cage and abdomen during BREATHING. J. Appl. Physiol. 22 : 407-422, 1967.