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Body postures and breathing frequency in newborn puppies

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Fisiologia. — *Body postures and breathing frequency in newborn puppies* (*). Nota di JACOPO P. MORTOLA (**), presentata (***) dal Socio R. MARGARIA.

RIASSUNTO. — Abbiamo misurato l'effetto delle variazioni posturali sulla frequenza respiratoria di sette cani neonati in anestesia barbiturica. La frequenza respiratoria rimane pressoché costante in tutte le posizioni eccetto che a testa in su', dove si verifica un calo di circa il 50%. In questa posizione si può calcolare che il volume polmonare di fine espirazione (FRC) aumenta di circa 2.8 ml (15% FRC). Dopo vagotomia la frequenza respiratoria si riduce molto (circa 25% della condizione prevagotomia), e non diminuisce più nell'animale verticale a testa in su'. È perciò possibile interpretare il calo di frequenza nella posizione verticale come il risultato del riflesso all'insufflazione polmonare. È anche evidente che le influenze inibitrici vagali a partenza polmonare sono già presenti nel periodo neonatale e capaci di influenzare sostanzialmente l'attività dei centri respiratori.

The effects of changes in body posture on the breathing frequency of newborn animals have never received much attention. In newborn infants a slight increase in breathing rate was observed in the prone position, and this was even more apparent in premature babies (Kravitz *et al.*, 1958). However, in a later study, no particular differences were noted (Dahl and Välimäki, 1972). One difficulty in these studies in infants is the common irregularity of breathing rate and the alternance of waking and sleep states, both factors which complicate the analysis of the results.

In the present study the breathing frequency of anaesthetized newborn puppies has been measured in different postures; the effect of bilateral vagotomy on the breathing rate has also been investigated.

METHODS

Seven newborn puppies, between 1 and 8 days old where anaesthetized with an injection of sodium pentobarbital (25 mg/kg, i.p.). A threeway tracheal cannula was inserted just below the larynx. One arm was connected to a pressure transducer, the other left open to the atmosphere. Breathing frequency was measured by recording the motion of the abdomen, which occurs during breathing, with a couple of coils of the magnetometer described

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by Mead *et al.* (1967). The coils were placed one facing the other one at the level of the umbilicus. The respiratory rate was measured with the animal in right lateral, left lateral, prone, supine, head up and head down postures. The sequence of changes in postures was randomly chosen and varied among animals. In each position measurements were taken one minute after the postural change in order to obtain steady state values. The vagi nerves were then cut in the neck and the measurements repeated. In 3 animals at the end of the experiments the airways were closed at end expiratory volume (FRC) and tracheal pressure (P_{TR}) recorded. After a series of inspiratory efforts an apnea (" primary apnea ") lasting several minutes occurred before a series of gasps began (Lawson and Thach, 1977). During the " primary apnea " the animal's position was varied in order to measure the changes in P_{TR}. From these, on the basis of pressure-volume curves of the respiratory system of newborn puppies previously obtained (Fisher and Mortola, 1979), the changes in lung volume for the different body postures could be estimated.

RESULTS AND DISCUSSION

In Fig. 1, open symbols, the breathing frequencies measured in different body postures are shown for a representative newborn puppy. The values are expressed as percent of the mean frequency in the right lateral position, which was arbitrarily defined as control condition. It can be noticed that in the vertical head up position the respiratory rate decreases markedly; in the different animals this reduction was from 80 % to 0 % of the control values (mean 51 % ± 27 S. D.). No statistical differences were observed in the other postures. After bilateral vagotomy the breathing frequency in the right lateral posture dropped down to about 25 % of the control value (Fig. 1, filled symbols) and no statistical differences were observed by changing body posture.

These findings suggest that the drop in respiratory rate observed in the intact animal in the head up position was mediated by inhibitory influences coming from the lungs, possibly as the result of the increase in end expiratory volume which accompanies the head up tilting. In order to test this hypothesis in 3 puppies we occluded the airways at FRC and measured the tracheal pressure (P_{TR}) in the different postures during the " primary apnea ", when the animal is alive but no breathing movements occur (Lawson and Thach, 1977). The actual record of P_{TR} in different postures, after occlusion at FRC in right lateral position, is shown in Fig. 2. It can be observed that P_{TR} remained fairly constant in all the postures but in head up position, where P_{TR} dropped of about 2.5 cm H_2O (mean 2.8 cm H_2O ± 0.4 S.D.).

On the basis of pressure-volume curves of the respiratory system previously obtained in newborn puppies (Fisher and Mortola, 1979), it can be estimated that, as the effect of the head up tilting, the lung volume increased by approximately 2.8 ml, which represents 15 % FRC.

In conclusion these experiments indicate that in the head up posture the breathing rate of anaesthetized newborn puppies markedly decreases as the result of the vagally mediated inflation reflex. It can be also concluded that the inhibitory vagal influences coming from the lungs are already developed at birth and capable of a substantial influence on the activity of the respiratory centers.

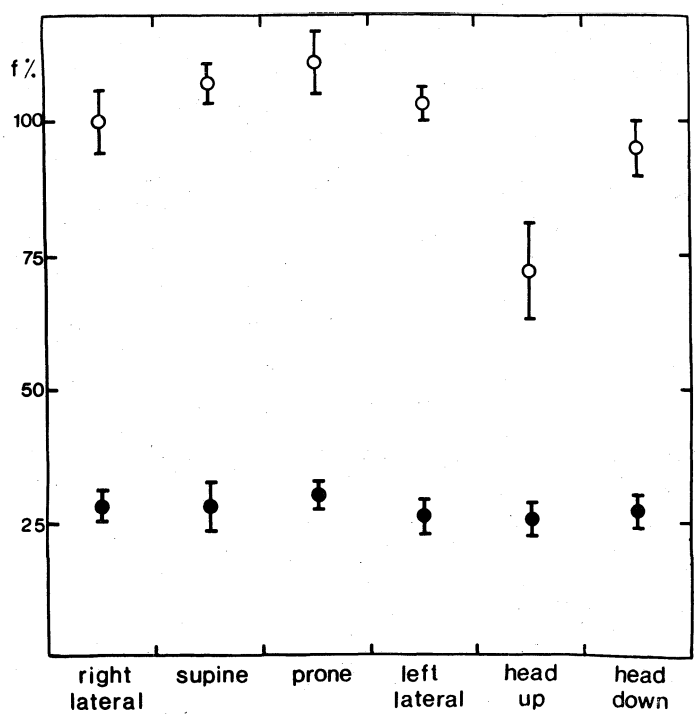

Fig. 1. – Breathing frequency (f, ordinate) measured in different body postures in an anaesthetized newborn puppy before (open symbols) and after (filled symbols) bilateral vagotomy. The values are expressed in percent of the mean value in the right lateral position. In the intact animal in head up position f drops to about 70%. After vagotomy f decreases to about 25% and no differences can be observed with body postures.

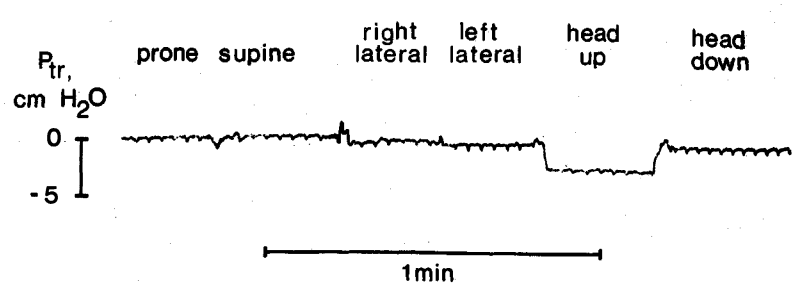

Fig. 2. – Continuous record of tracheal pressure (P_{TR}, cmH_2O) in various body postures, after closure of the airways at FRC in the right lateral position, obtained during the "primary apnea". The rhythmic signals represent the heart beats. P_{TR} remains fairly constant in all the postures but in the head up position, where it decreases by about 2.5 cmH_2O.

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