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Dynamic response of intrapulmonary and extrapulmonary stretch receptors in the dog

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Fisiologia. — *Dynamic response of intrapulmonary and extrapulmonary stretch receptors in the dog* (*). Nota di GIUSEPPE SANT'AMBROGIO, GIUSEPPE MISEROCCHI, JACOPO MORTOLA e DONALD BARTLETT JR. (**), presentata (***) dal Socio R. MARGARIA.

RIASSUNTO. — Abbiamo studiato la relazione fra frequenza istantanea di scarica dei tensorecettori a lento adattamento delle vie aeree e la pressione transmurale in condizioni dinamiche. Nel caso dei tensorecettori delle vie aeree extrapolmonari la frequenza di scarica era sempre in anticipo sulla pressione transmurale, mentre nel caso dei tensorecettori localizzati nelle vie aeree intrapolmonari questo si verificava in circa la metà dei casi. Nel rimanente dei tensorecettori intrapolmonari la frequenza di scarica era in fase con la pressione transmurale. Questo diverso comportamento viene messo in relazione con le diverse proprietà meccaniche delle vie aeree extra- ed intrapolmonari.

The dynamic behaviour of pulmonary stretch receptors is of considerable interest since these receptors normally operate during the respiratory cycle (Adrian, 1933; Widdicombe, 1954; Davis, Fowler and Lambert, 1956).

We have studied in 11 dogs, anaesthetized with pentobarbital and with their chests opened, the response of 30 receptors during sinusoidal volume changes of the respiratory apparatus at a frequency of 10 cycles/min, relating their instantaneous frequency of discharge to the tracheal pressure. We have recorded from single afferent fibres dissected from the peripheral cut-end of the vagus nerve and have studied fifteen extra-and fifteen intrapulmonary stretch receptors.

The frequency of discharge always led pressure for all the extrapulmonary stretch receptors (fig. 1 A) and for 7 of the 15 intrapulmonary ones. For the remaining 8 intrapulmonary receptors (53 %) the frequency of discharge was found to be in phase with the tracheal pressure (fig. 1 B). No correlation was found between the behaviour of the receptor and its classification as Type I or Type II (Miserocchi and Sant'Ambrogio, 1974).

These results reflect both the mechanical characteristics of the airways in which the receptors are placed and the intrinsic properties of the receptors.

The volume-pressure relationship of any airway during a breathing cycle is such that at the same transmural pressure a greater circumferential tension is present in expiration than in inspiration due to the larger volume of the airway (fig. 2). Therefore, if stretch receptors sensed only circumferential

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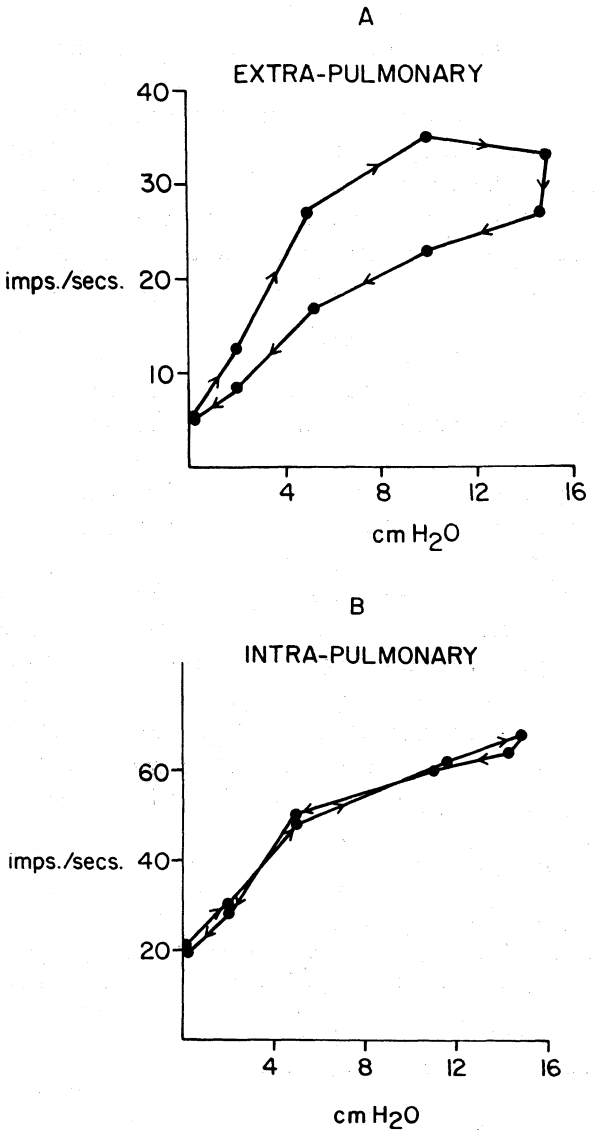

Fig. 1. – Relationship between instantaneous frequency of discharge and tracheal transmural pressure for a slowly adapting stretch receptor placed in the trachea (A) and for a stretch receptor placed in an intrapulmonary airway (B). Note that the discharge frequency leads the pressure in A but is in phase with it in B.

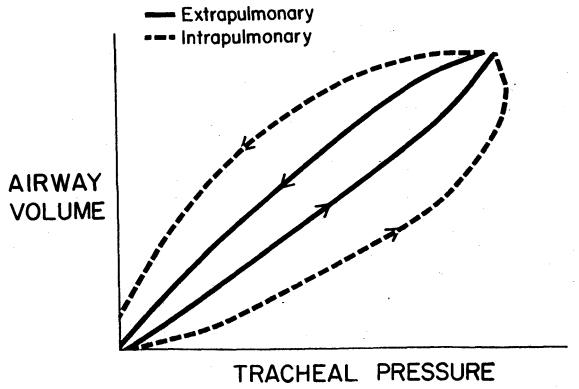

Fig. 2. – Schematic diagram showing P — V loops of intra- and extrapulmonary airways during sinusoidal inflations. The hysteresis of the extrapulmonary airways is due principally to intrinsic properties of their walls. The wider loop of the intrapulmonary airways reflects in addition the effect of parenchymal forces acting on the airways and of flow-resistance.

tension, we would expect a greater frequency of discharge, at any given pressure, during expiration: i.e. the frequency of discharge would lag behind pressure.

Hughes *et al.* (1975) showed that in quasi-static conditions the hysteresis of intrapulmonary airways is greater than that of the extrapulmonary ones because of an " extrinsic " factor related to parenchymal forces. Furthermore in our experimental conditions, in which only the transmural pressure in the trachea is considered, a flow-resistive component between the trachea and the more peripheral airways would increase the phase lag between pressure and frequency of discharge (fig. 2).

The dynamic component of the response of the receptor, i.e. its responsiveness to the rate of change of the transmural pressure, counteracts the effects of the mechanical factors on the phase relationship between frequency of discharge and tracheal pressure.

For all the extrapulmonary receptors and for ca. 50 % of the intrapulmonary ones the dynamic component must be responsible for the reversal of the phase relation between frequency of discharge and pressure. For the remaining 50 % of the intrapulmonary receptors the balance between this dynamic component and the mechanical properties of the intrapulmonary airways seems to be such that frequency of discharge is in phase with tracheal pressure.

Another possible explanation could be found in a smaller dynamic response (dP/dt sensitivity) of the receptors placed in the intrapulmonary airways.

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