RHYTHM OF THE TURBINATES

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The inferior, middle and superior turbinates are situated on the lateral walls of the nasal cavities. The blood supply to the turbinates and the mucous membrane of the nose is abundant and derived mainly from the anterior and posterior branches of the ophthalmic artery and from the sphenopalatine branches of the internal maxillary artery.

The arterioles are placed in the deeper part of the tunica propria and are arranged in parallel rows. These supply the periglandular and subepithelial capillary networks. The efferent vessels from this superficial capillary bed open into large venous spaces. The superficial sinusoids drain into the deeper venous plexus. From this plexus the blood passes to thick walled venoles running parallel to the arterioles in the deeper part of the tunica propria. Sphincters are present at many points is this vascular network, in the arteriolae and in the in- and outlets of the sinusoids.

Arterio — venous anastomosis by — pass the capillary network as shown by Harper. This vascular organization constitutes a type of erectile cavernous tissue in the turbinates and permit several combinations of changes in mucosal temperature and volume.

The vasomotor nerve supply is derived from the autonomic nervous system. The sympathetic pre-ganglionic branches are derived from the first and second thoracic segments of the spinal cord. The postganglionic fibres pass from the superior cervical ganglion to the plexus around the internal carotid artery and then via the deep petrosal nerve and the Vidian nerve to the sphenopalatine ganglion from where they pass, without relaying to the turbinates.

The parasympathetic nerve is from the superior secretory nucleus in the brain stem. The pre-ganglionic fibres emerge in the pars intermedia of the facial nerve to reach the geniculate ganglion. From this ganglion the fibres continue in the greater superficial petrosal nerve to the Vidian nerve in the pterygoid canal. The fibres terminate in the sphenopalatine ganglion. From the ganglion the postganglionic parasympathetic fibres pass to the turbinates.

Resection or procaine-block of the cervical sympathetic ganglion is followed by hyperaemia, swelling and hypersecretion of the nasal mucosa.

Resection of the parasympathetic innervation results in a shrunken, pale mucous membrane and excessive drying followed by crusting.

The diagram shows rhinometric curves made by Spoor after resection of the greater superficial petrosal nerve. In this patient the cyclic movements of the turbinates have ceased on the denervated side.

Resection of the Vidian nerve containing both sympathetic and parasympathetic fibre is able to relieve the dysfunction of the turbinates in patients suffering from vasomotor rhinitis as shown by Golding-Wood.

The rhythm of the turbinates is influenced by several reflexes. They respond to caloric stimuli applied to the skin and to emotional stimuli resulting in vasoconstriction of the nasal mucosa. These reflexes have been well demonstrated by Drettner.

Compression of the jugular vein causes swelling of the turbinates of the same side as shown by van Dishoeck. The reaction fails to appear in case of thrombosis of the jugular vein.

The vascular response of the turbinates are very fascinating. However, the pressure variations elicited are so small that the registration for many years created a technical problem.

In 1903 Courtade used a watermanometer connected to the nose by a tube and a nasal plug. This device was very easy to apply and gave information about the maximum and minimum pressure in the nasal cavities during respiration. This equipment for anterior rhinomanometry was used for further development. The pressure-variations could be recorded by replacing the water with saline and using an electrode connected to an amplifier.

The next diagram (Figure 1) demonstrates pressure curves from the right and left nasal cavity, respectively. The first curves shown are normal curves with very different respiration rates. The inspiration curves are short with large pressure differences going abruptly over to the expiration curves which are characterized by being of a long duration with small pressure oscillations. The differences between in- and expiration curves disappear with an increasing rate of respiration.

Figure 1. Pressure-curves from the right and left nasal cavity.
I-VI. Normal curves with different respiration rate.
VII. Curves from a patient suffering from ozena.
VIII. Curves from a patient with nasal stenosis.

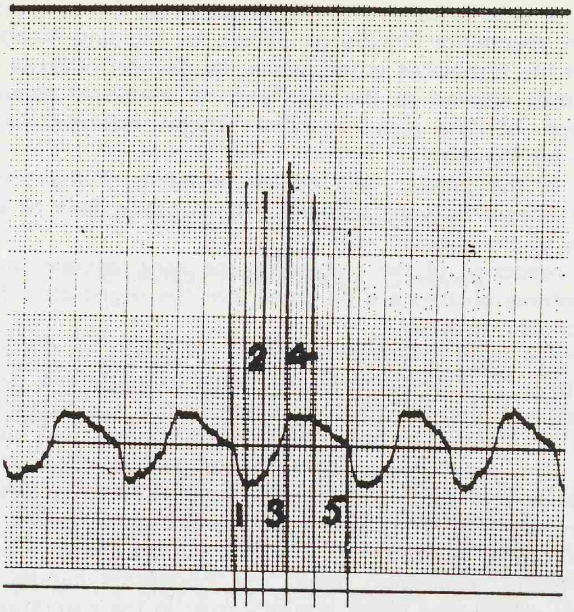

Figure 2. The parts of an average single breath. (Cottle 1968).

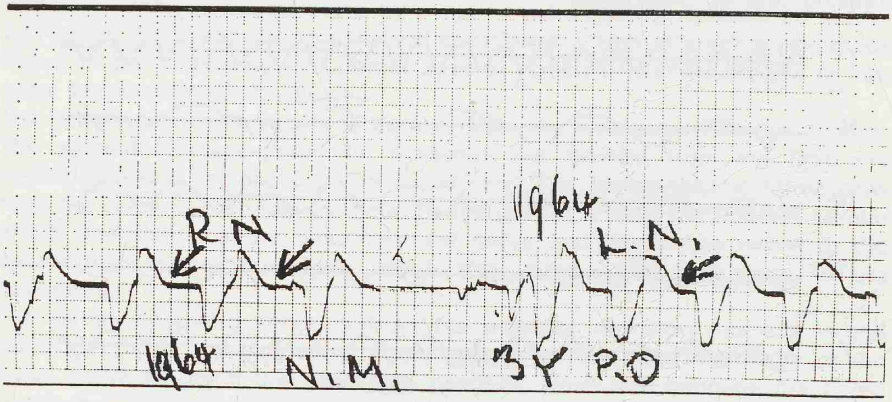

Figure 3. The mid-cycle rest. (Cottle 1968).

Cottle has made thousends of these rhinomanometrical curves and been able to extract valuable information from the different patterns of the curves. For the purpose of clearness the curves are divided into segments (Figure 2) of which no. 4 is a pause during maximum expiration; possibly a Heering Breuers reflex. The nervous mechanism tends to limit the respiration excursions. The reflex is elicted n the sensitive nerve endings in the lungs and passed up through the vagues. Curve-segment no. 5 is a gadual descent to the base-line. At times this line is flattened out, the so called mid-cycle rest (Figure 3), which Cottle has found to be a poor prognostic sign and usually an irreversible abberation.

The curves indicated as no. 6 and 7 are pathological curves. No. 6 is from a girl suffering from ozena. The oscillations are very small and the respiration rate high which indicates very low resistance in the nose. The last curves are from a patient with nasal stenosis. The curves show considerable deviations from the base-line. It is quite obvious from the curves shown that the resistance in the nose has something to do with the areas between the curve and the base-line and with the respiration rate. Later, using the experience thus gained, a rhinomanometer was constructed equipped with ratemeters which were capable of adding up the in- and expirations pressures. The ratemeters were monitored by timers which started and stopped the ratemeters at a previously determined time. It was possible to calculate the resistance during in- and expiration through the right and left nasal cavity from the recorded values and to calculate the total resistance of the nose during free respiration through both nasal cavities. The tests were made at intervals of half an hour, which was found most convenient.

The values are plotted in a coordinate system, the resistance along the ordinate and the time along the abscissa.

The diagram (Figure 4) shows resistance curves during in- and expiration from a normal subject with ample spaces in the nasal cavities and with large prominent turbinates. The test person was kept in a room with constant temperature and humidity for a period of a little more than 4 hours.

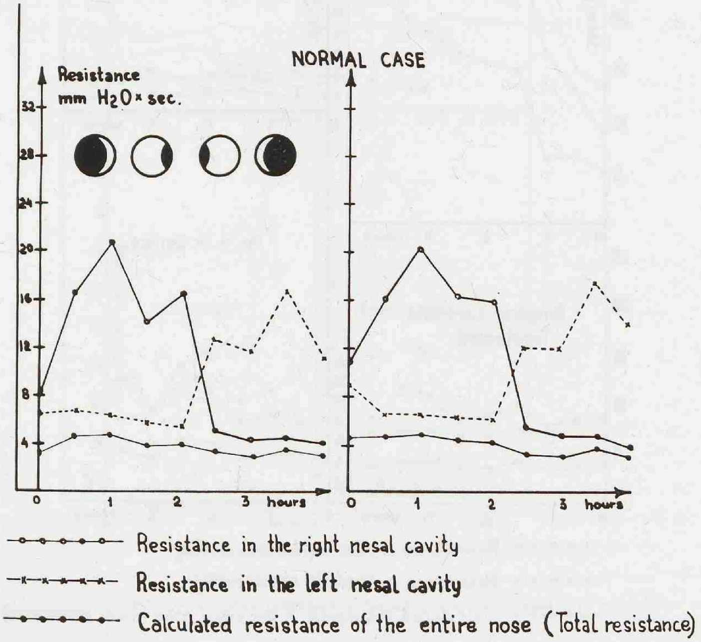

Figure 4. In an expiration curves from a normal person with ample space in the nasal cavities. The "black moons" indicate the alternating movements of the turbinates.

When the turbinates in the right side dilate, the resistance increases. At the same time the turbinates in the left side contract and the resistance decreases. To the right the condition is reversed. The time elapsing from when the turbinates are in one phase until the same phase is reached again is called according to Heetderks the cycle of the nose. The lower curves indicate the total resistance of the nose and are rather unaltered, which means that the movements of the turbinates are alternating.

The curves shown were some of the first recorded and the result could not be confirmed or compared to those of other investigators. Later Flotte and Keuning started the same type of rhinomanometrical studies and where able to obtain curves showing the same geometrical pattern of resistance and a constant total patency.

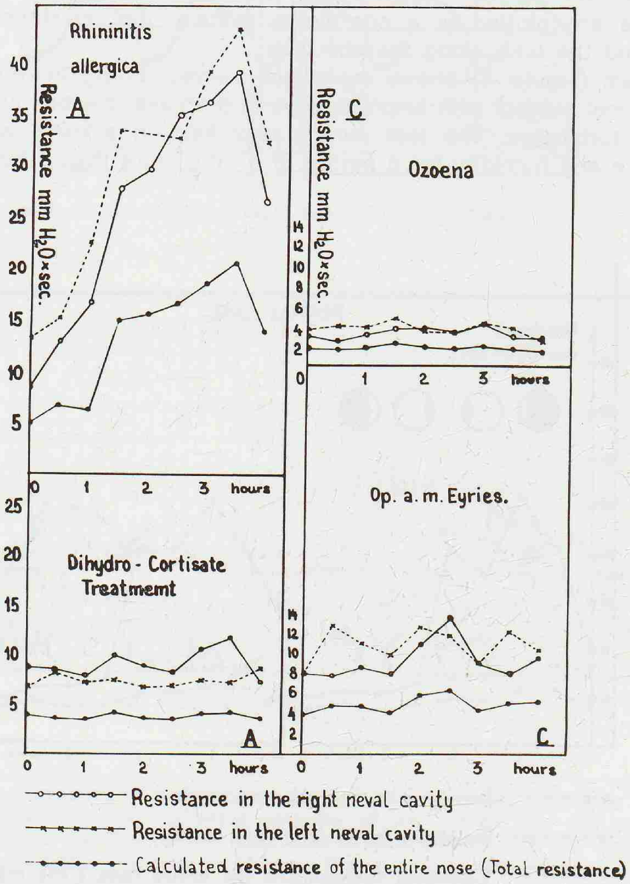

Figure 5. A. Rhinomanometric curves of a patient with vasomotor rhinitis before and after treatment with a cortison compound.
C. Rhinomanometric curves of a patient suffering from ozena before and after surgery.

We have observed alternating movements of the turbinates with the nose exposed to a constant atmosphere. Physical factors as variation in the temperature and humidity make the turbinates respond with synchroneous movements, that is to say that they contract or dilate at the same time in both sides. These movements are so pronounced that they conceal the alternating movements which will first appear again when the turbinates have become adapted to the new atmosphere. In normal cases the changes elicited will be kept within such limits that sufficient space for adequate respiration remains.

In vasomotor rhinitis (Figure 5), however, the reaction is exaggerated and the swollen phase of the turbinates is maintained over abnormally long periods. This results in an increase of the total resistance and accumulation of

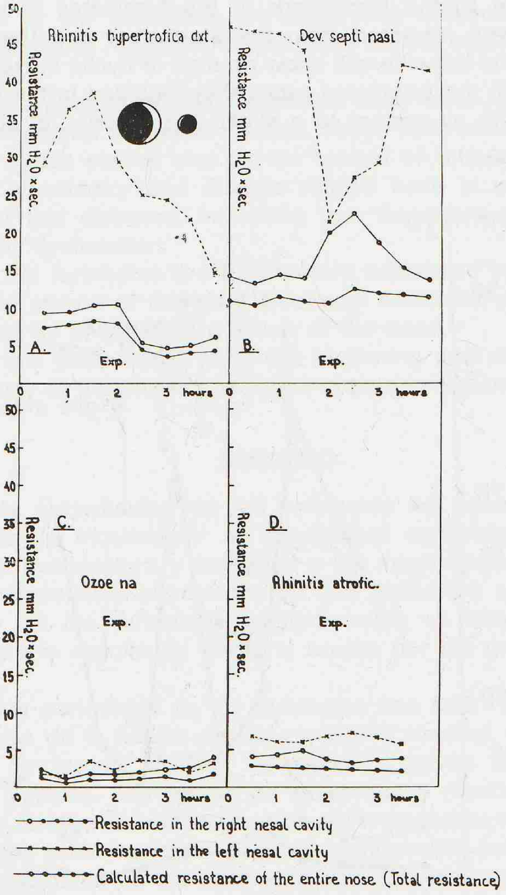

Figure 6. A. Rhinomanometric curves of a patient with hypertrofic rhinitis.
B. Deviation of the septum.
C. Ozena.
D. and atrofic rhinitis.

secretion followed by a profuse flow of watery secretion as the turbinates reach the stage of relaxation.

In this case, treatment with a cortison compound normalized the response of the turbinates. The same result could possibly have been achieved by cutting the Vidian nerve according to the method of Golding-Wood.

Rundcrantz examing patients suffering from allergic rhinitis made measurements with "head high" and "head low" positions. Most of these patients showed a remarkable increase in resistance during head low position, an increase which was not found in normal persons. Furthermore Rundcrantz was able to show that this abnormal reaction disappeared when the allergy were desensitized.

The result of these examinations and the result of Golding-Wood's nerve resection indicate, that allergic rhinitis must be a dysfunction of the autonomic nerve-system.

In ozena (Figure 6) the framework of the turbinates is usually destroyed. The turbinates are retracted from the air-current and therefore the curves from the right and left side will show no sign of cyclic movements. In atrophic rhinitis (Figure 6) the turbinates retain their position in the nasal cavities and they influence the air-current to a slight degree only. In such cases we will

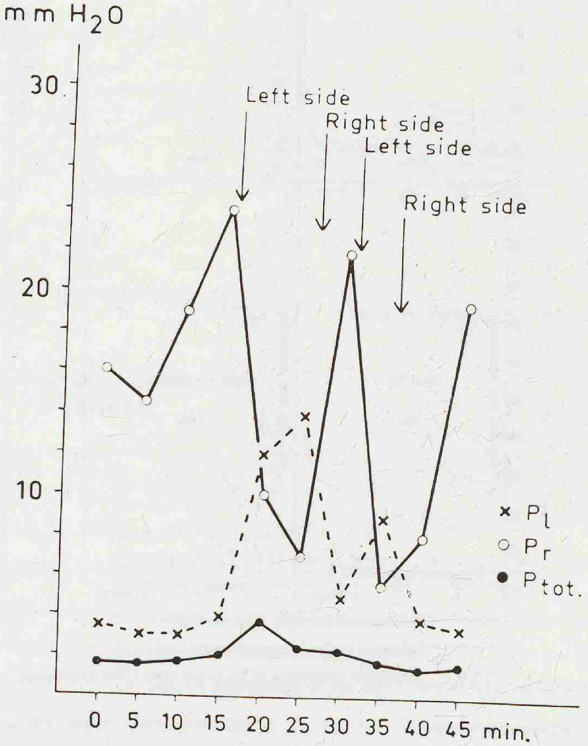

Figure 7. The rhythm of the turbinates influenced by changes in position of the head. (Keuning, 1968).

observe small movements of the turbinates and a dimished cycle of the nose. The influence of the head position has been studied by Keuning. Lying on the right side the turbinates of this side will swell and the turbinates on the left side will contract. When the position is reversed the opposite reaction will occur. The diagram (Figure 7) shows cyclic curves from a test person moving from a right to left position.

SUMMARY

When speaking about the rhythm of the turbinates it is necessary to distinguish between two types of movements. The synchronized movement elicited by changes in temperature and humidity of the surrounding air, and the cyclic movements with alternating dilations and contractions of the turbinates in a constant atmosphere.

The deflections of the turbinates are apparently influenced from a central centre, while peripheral regulation takes place via the stellate and the sphenopalatine ganglion.

The rhythmic movements of the turbinates have been recorded by rhinometric measurements of the nasal cavities. These have revealed the appearences of normal cyclic curves and curves typical of different nasal diseases. The curves of vasomotor and allergic rhinitis have in particular disclosed new aspects of this diseases, indicating that these are presumably caused by an automatic dysfunction.

The rhythm of the turbinates are furthermore influenced by different reflexes such as thermal stimuli of the skin, emotional reactions, compression of the jugular vein and by changes in position of the head.

These studies are undoubtedly only the beginning and much remains to be done before many of the puzzling features of these mechanisms are explained.

SUMARIO

Hablando de la periodicidad de los turbinatos es necesario de distinguir entre dos tipos de movimiento: el movimiento sincronizado producido por alteraciònes de temperatura y humedad y los movimientos ciclicos con dilataciònes y contracciònes alternantes en una atmòsfera constante.

El movimiento de los turbinatos evidentemente es dirigido de un centro central, mientras la regulaciòn periferal ocurre por los ganglios estrellado y esfenopalatino.

Los movimientos periodicos de los turbinatos han sido registrado por mediciòn rhinometrica de la lumina de las cavidades nasales. Estas han revelado los aspectos de curves cìclicas normales y curvas tìpicas de diferents enfermedades nasales. Las curvas de vasomotor y rhinitis alergico en particular exponian nuevos aspectos de esas enfermedades, indicando que estas presumiblemente estàn causado por una disfuncciòn autonòmica.

Ademàs la periodicidad de los turbinatos està influido por reflejos diferentes como estìmulos termales del piel, reacciònes emotionales y por alteraciònes en la posiciòn de la cabeza. Estos estudios sin duda son solamente el principio y falta mucho antes que muchas de las enigmas de estos mecanismos seran explicados.

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