PATHO-PHYSIOLOGY OF THE NASAL AIRFLOW

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The physiology and patho-physiology of the nasal aircurrent has been invesigated for the last 80 years (Franke, Paulsen, Zwaardemaker, Mink, Proetz, Van Dishoeck).

Based on experimental studies the pathway of the aircurrent in the nose has been described as a parabolic curve; the air passing mainly through and in front of the middle meatus. In expiratory direction Proetz described a turnover of the airflow of 360 degrees, filling the whole nasal cavity. In 1936 Van Dishoeck observed that the plane of the nostrils determines the height of the nasal airflow in relation to the nasal floor.

From an aerodynamical viewpoint it is quite questionable whether the flow would go mainly through the upper part of the nose because the flow prefers



Figure 1. Expiratory central streamline. Water flowrate of 0,75 lit./min. - The streamline passes through the middle meatus in the direction of the vestibule.

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Figure 2. Expiratory lateral streamline (Flowrate - see above). A certain deflection in the orifice of the Eustachian tube is evident. The streamline passes along the nasal floor.

always the line of least resistance. It is more believable that the airflow would pass the nose using the whole nasal capacity.

We have made our own experiments in order to handle this problem. Following Reynolds number a waterflow with marked streamlines was used. The flow rate for a good visible laminar flow was found at 0,75 - 1,0 liter/min., i.e. 13,3 times slower than a corresponding airflow of the same flow rate of air would be. In this way a most convenient photographic recording was possible. The cross-section of the flow was checked at 4 different point (central - lateral dorsal and ventral) in inspiratory and expiratory direction.

It was found that — according to Proetz and Van Dishoeck — the central streamline of the flow passes through the upper part of the model of the nose. Other streamlines, such as the ventral and dorsal inspiration passed through the lower part of the nose. In expiratory direction the dorsal streamline goes high up to the olfactory area whereas the lateral stremline whirls around in the pharyngeal ostium of the Eustachian tube, deflects and contines along the floor of the nose.

These findings confirm the assumption that the pathway of the inspiratory and expiratory airflow shows a very complicated picture which is not comparable to the drawings found in well-known textbooks. It seems evident that the lower area of the nasal cavity must be as important as the upper part in the aerodynamical function.

Under patho-physiological conditions the marked streamlines change the normal flow-picture in a specific manner. Stenosis of the vestibule produce increased turbulences. Experimental narrowing of the valve area turns the flow



Figure 3. Inspiratory ventral streamline (Flowrate - see above). The Col-du-sac produces a deflection of the streamline towards the floor of the nose.



Figure 4. Inspiratory central streamline in an experimental saddle-nose. Notice the changing of the streamline.



Figure 5. Expiratory central streamline while blocking the middle meatus with a simulated polyp. The flow passes more downwards to wards the vestibule.



Figure 6. Expiratory ventral streamline by a simulated hypertrophy of the inferior turbinate. The flow changes position and passes more upwardly.

more downward. Similar pictures can be observed in cases of saddle-noses. Obstructions of the middle or inferior meatus do not change the pathway of the flow too much. Otherwise an experimental removal of one or two turbinates shows an unco-ordinated flow with dissolved streamlines. The physiological task of the turbinates seems to be an aerodynamical correction and bundling of the flow. The flow seems to be during quiet breathing turbulent, according to the rhinomanometrical investigations by Drettner, Spoor and Masing, but there must be a difference in a turbulent flow containing eddies and whirls as shown in a wide nose.

SUMMARY

Experimental studies of the nasal airflow in a model of a nose has been made. With marked streamlines in a waterflow it was shown that the flow spreads ou in he whole nasal cavity. It is impossibe to define a mainflow passig mainly through the middle meatus. The patho-physiology of the nasal airflow is described on this basis. Certain flowpictures were observed and discussed.

Zusammenfassung

Experimentelle Studien über die Strömung im Nasenmodel wurden gemacht. Mit markierten Stromfäden in einer Wasserströmung zeigte sich, da die Strömung durch die ganze Nasenhöhle fliesst. Es ist unmöglich, eine Hauptströmung im Bereich des mittleren Nasenganges zu definieren. Auf grund dieser Erkenntnisse wird die Patho-Physiologie der Nasenströmung untersucht. Für die einzelnen Formfehler der Nase konnten charakteristische Strombilder beobachtet werden.

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