

Ostium resistance in acute maxillary and frontal sinusitis

W. Mann, K. Schumann and F. Schier, Freiburg, West Germany

SUMMARY

Ostium function tests were performed in 18 normal maxillary and 6 normal frontal sinuses. Further 57 patients with acute maxillary and 16 patients with acute frontal sinusitis were followed using sinumanometry until resolution of infection occurred. After initial obstruction of the ostium, resistance decreased exponentially until complete decongestion. Respiratory pressure changes in the sinus during forced nasal breathing are a positive sign for healing of sinusitis. The amplitude of these fluctuations should be documented during each lavage and facilitates indication for drainage procedures.

The function of the ostium is one of various factors with impact on the pathophysiology of sinusitis.

In case of inflammation or reactive mucosal swelling of the paranasal sinus, there is an obstruction of the ostium. This is more often true with a small ostium diameter than with a large one. Normally the ostium is patent. Respiratory pressure fluctuations are noticeable in all sinuses. Their magnitude is determined by the breathing volume, type of flow, mode of breathing as well as by anatomical variations. As in the middle ear, function tests like valsalva, toynbee or reversed Valsalva, sniffing or blowing are of use. Posterior septal variations decrease their magnitude on the side of the deviation more than on the opposite side.

The incitement of this study was to examine sinus ventilation during acute maxillary and frontal sinusitis using a very sensitive method and simultaneously to test the liability of a simple method for clinical practice (Mann et al., 1975).

MATERIAL AND METHODS

We examined 18 normal maxillary and 6 normal frontal sinuses after puncture from the inferior meatus or after Beck's drilling. Septum findings as well as

nasal airway resistance were unremarkable. Pressure registration in the nose and in the sinus was obtained using electromechanical transducers.

Further 57 patients with acute maxillary and 16 patients with acute frontal sinusitis and normal nasal airway resistances were examined, using the method of sinumanometry in a pressure chamber (the speed of pressure change during a simulated flight was 10 mm Hg/min.).

All patients were measured at short intervals with silicon tubes placed in the frontal and in the maxillary sinus during the course of the infection. Mean age of the patients with frontal sinusitis was 26 years, of the patients with maxillary sinusitis 35,5 years.

RESULTS

Table 1 is showing the amplitudes of pressure changes within the maxillary sinus during various types of breathing and for some function tests.

After initial obstruction of the ostium, the mean time interval until restoration of normal sinus ventilation in maxillary sinusitis was 22,9 days, in frontal sinusitis the rate was 16,8 days. The distribution of single measurements plotted over the mean duration of the infection suggested the comparison with an exponential function curve. This was the case in acute frontal sinusitis for the first opening pressure, the mean opening and the mean residual pressure in both, sinu-nasal and naso-sinal direction, the latter being somewhat smaller. In acute maxillary sinusitis and in sinu-nasal direction this was pertinent for all three parameters before and after sinus lavage (Figure 1). Measurements of ostium resistance in the initial period of infection showed obstruction even for very high differential pressures progressing exponentially towards patency in the recovery phase. Ostium resistance before irrigation was most of the times lower than after sinus irrigation (Figure 2). Correlating the resistance defined in the pressure chamber with eventually registered respiratory fluctuations within the sinus, first but small amplitudes were found in the frontal sinus below a resistance of 280 mm H₂O and in the maxillary sinus below 180 mm H₂O re-

Tabel 1. Pressure recordings in the sinus during breathing and function tests.

	Expiration	Inspiration
forced mouth breathing	+5 mmH ₂ O	-12 mmH ₂ O
speaking	+4	-20
nose breathing, calm	+10	-15
nose breathing, forced		
maxillary sinus	+45	-127
frontal sinus	+50	-100
Toynbee	+70	-120
Valsalva	+400-600	
Sniffing		-600-800

acute frontal sinusitis

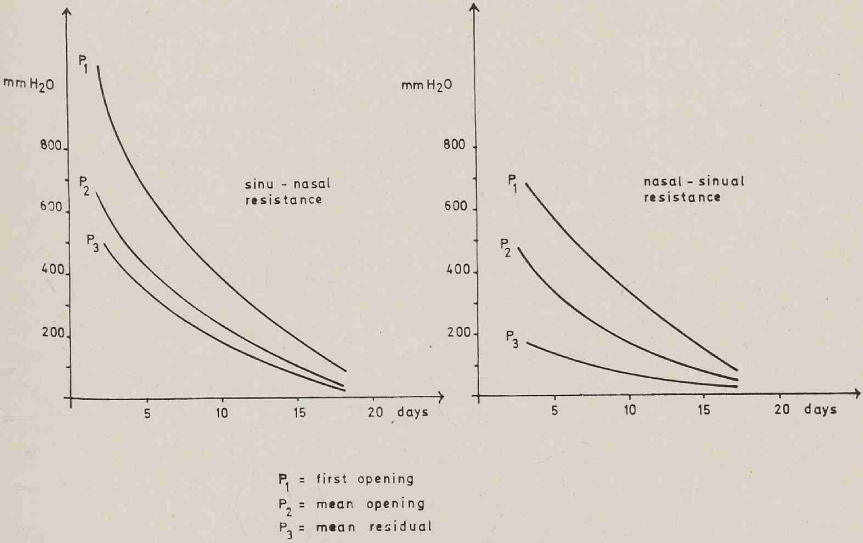


Figure 1. Resistance of the naso-frontal duct in sinu-nasal and nasu-sinal direction in relation to the day of infection.

acute maxillary sinusitis

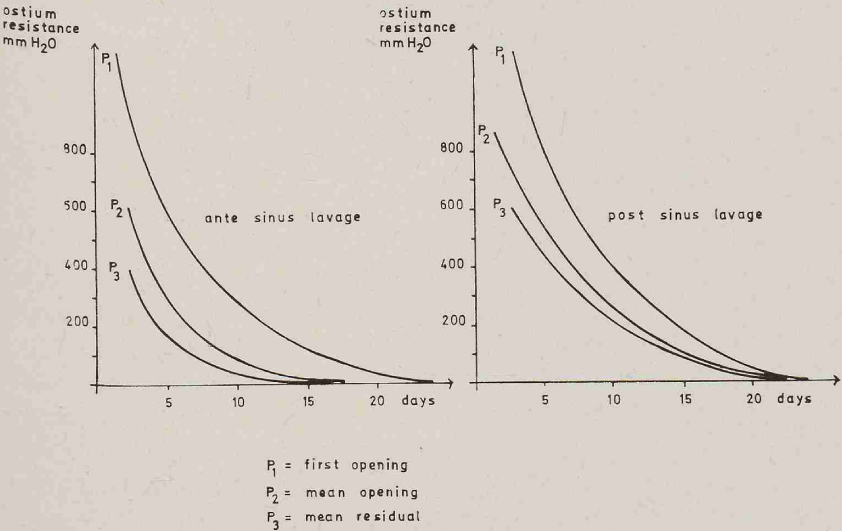


Figure 2. Ostium resistance before and after lavage in relation to the day of infection.

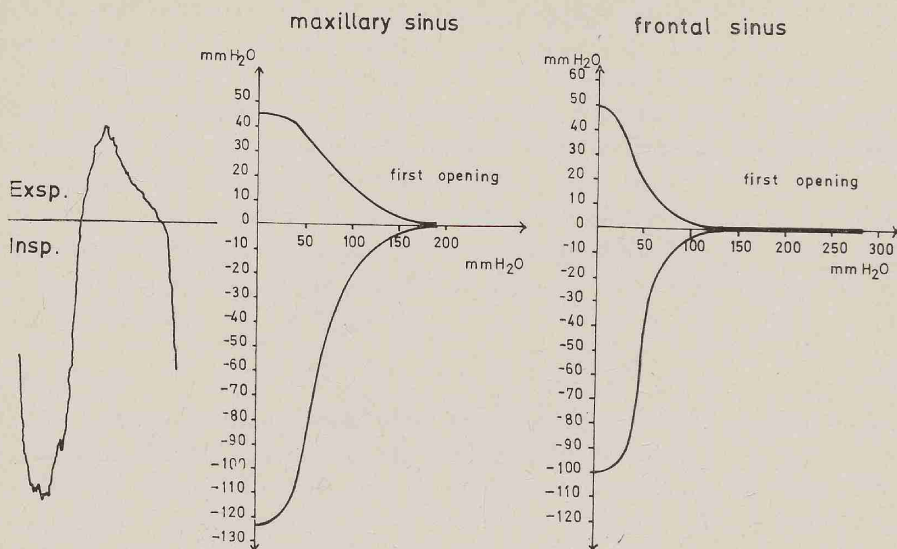


Figure 3. Amplitudes of intrasinal pressure fluctuations (y-axis) in relation to the ostium resistance (x-axis).

spectively (Figure 3). The magnitude of these pressure fluctuations remained limited in the frontal sinus until 128 mm H₂O naso-frontal duct resistance and then increased rather suddenly. In the maxillary sinus fluctuations were noticeable approximately 5 days before complete ostial patency. Pressure recordings were obtained during valsalva at values below 250 mm H₂O ostial resistance. Intrasinal overpressure amounted to 10–20 mm H₂O while ostium resistance was 200 mm H₂O and amounted to 100 mm H₂O with ostial resistance of 100 mm H₂O. Below a resistance of 50 mm H₂O, overpressure of 400–600 mm H₂O was found in the sinus during valsalva.

DISCUSSION

The registration of intrasinal respiratory fluctuations in patients with acute maxillary and frontal sinusitis is of prognostic value (Aronsky, 1959; Stachurski, 1959; Lamm and Schaffrath, 1967; Drettner, 1965; Rantanen, 1974). Also in this study, the decrease of ostial resistance was found to be indicative for resolution of infectious sinus disease. In maxillary sinusitis, resistance was lower before than after sinus lavage. This may represent the effect of a surface tension lowering substance in sinus secretions, correlating with the morphological evidence of lamellated bodies in the sinus mucosa (Mann and Leupe, 1976). During healing of sinusitis, the amplitude of pressure fluctuations and function

tests in the sinus was related to the resistance of the ostium and the naso-frontal duct respectively.

Unlimited fluctuations were found in the maxillary sinus below an ostium resistance of 20–25 mm H₂O and in the frontal sinus below a resistance of 15–20 mm H₂O. With such a resistance effective mucociliary clearance may be expected. The exponential decrease of ostium resistance during healing of sinusitis, leads from total obstruction to complete patency. Presuming a predictable duration of an ordinary sinusitis, datas obtained at the begin of the infection are lowered when control is performed some days later. The lowering of the resistance is an indication for the healing process. As the resistance decreases, the amplitude of respiratory fluctuations is increasing. In our experience, a small graded tube (Figure 4), attached to the irrigation system, helps in observing the increase of the amplitude during each sinus lavage in the office and may be documented. A lacking increase indicates persistant obstruction and facilitates the decision to alternate therapy or to progress towards surgical drainage procedures. In frontal sinusitis the silicon tube may not be removed before unlimited fluctuations occur. In some patients unrestricted fluctuations are observed, but still there is a high recurrency rate of sinusitis. Function tests in the pressure chamber sometimes revealed a small ostium resistance of 15–25 mm H₂O and control endoscopy of the sinus showed an ostium with a small functional diameter. In these cases, prophylactic antrostomy may be a very beneficial procedure.

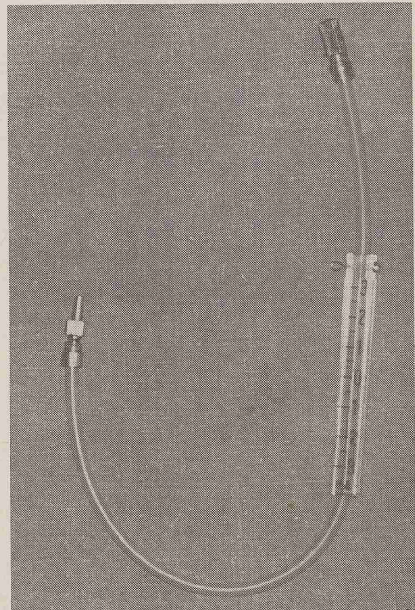


Figure 4. Small tube attached to the irrigation system for measuring the amplitudes of respiratory fluctuations.

ZUSAMMENFASSUNG

Ostiumfunktionsteste wurden an 18 normalen Kieferhöhlen und an 6 normalen Stirnhöhlen durchgeführt. Weitere 57 Patienten mit akuter Sinusitis maxillaris und 16 Patienten mit akuter Sinusitis frontalis wurden mittels der Methode der Sinumanometrie bis zu Ausheilung der Sinusitis überwacht. Nach initialem Ostiumverschluß verringert sich der Ostiumwiderstand bis zur völligen Ab-schwellung exponentiell. Atemsynchrone Druckschwankungen in den Neben-höhlen während forcierter Nasenatmung sind von prognostischer Aussagekraft, ihre Amplitude erleichtert die Indikation zu weiterreichenden operativen Maß-nahmen.

REFERENCES

1. Aronski, A. I., 1959: Untersuchungen über den Luftaustausch im sinus maxillaris bei sinu-sitis. Vestn. Oto-rhino-laring., 21, 68.
2. Drettner, B., 1965: Measurements of the resistance of the maxillary ostium. Acta oto-laryng. (Stockholm), 60, 304.
3. Lamm, H., Schaffrath, H., 1967: Druckwechselforgänge im gesunden Sinus maxillaris bei verschiedenen Atmungstypen. Z. Laryng. Rhinol. 46, 1972.
4. Mann, W., Pedersen, P., Schumann, K., 1975: Die objektive Sinumanometrie. Laryng. Rhinol. 54, 708.
5. Mann, W., Leupe, M., 1976: Lamellated bodies in the normal paranasal sinus mucosa. TEM observation. Arch. oto-rhino-laryng. 214, 91.
6. Rantanen, F., 1974: Clinical function tests of the maxillary sinus ostium. Acta otolaryng. (Stockh.) Suppl. 328, 1.
7. Stachurski, H., 1959: Die Bedeutung der Untersuchung der Ostien für die Diagnostik und Therapie der Erkrankungen der Nasennebenhöhlen. Otolaryng. pol. 13, 103.

Priv.-Doz. Dr. W. Mann

Priv.-Doz. Dr. K. Schumann

HNO-Klinik, Killianstr. 5

D-7800 Freiburg, West-Germany