

THE OBSTRUCTED MAXILLARY OSTIUM *

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Introduction

Methods for the measurement of various functions or dysfunctions in oto-rhino-laryngology have become increasingly important. The progress made in otology has depended to a large extent on good methods of hearing measurement, which have widened our knowledge of the pathophysiology of the middle ear. In rhinology it is now common for measurements of the nasal passage to be included in the examination of patients with nasal obstruction. But when dealing with patients with disorders of the paranasal sinuses, it is only rare that measurements of the permeability of the outlets are performed, in spite of the fact that obstruction of the outlets is considered to be of great importance for the origin and course of most diseases of the sinuses.

Methods for study of ostial permeability and resistance

Various methods for studying the **permeability** of the maxillary ostium have been used for about 90 years (Braune and Clasen, 1876). Proetz (1932) performed investigations concerning the alterations in ostial permeability, and several other studies have also been published on this subject (Döderlein, 1932; Schmücker, 1932; Kerekes, 1934; Metz, 1939; Daure, 1943; Flottes et al., 1960; Drettner, 1965 a). All these investigations were based on measurements of the respiratory changes of the pressure in the sinus, and some also comprised measurements (Proetz, 1932) or recordings (Drettner, 1965 a) of the nasal pressure.

Until recent years no methods appear to have been available for measuring the **resistance** of the maxillary ostium. Flottes et al. (1960) measured this resistance by injecting air into the maxillary sinus, but the ostial obstruction in pathological cases usually resisted a pressure of up to 20 cm H₂O, which was the highest pressure used due to the risk of air embolism. Better evaluation of the ostial resistance is obtained by the instillation of water or isotonic salt solution into the maxillary sinus, if this is performed slowly with an identical procedure each time, for example by raising a bottle containing irrigation fluid, by means of an electrically driven elevator, up to a height at which the fluid begins to drop from the nose (Drettner, 1965 b).

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Various kinds of ostial obstruction

Ostial obstruction is an inadequate term, since most obstructions of the maxillary ostium can be overcome if the pressure is high enough. The manoeuvres during which an ostial obstruction has been observed, must therefore be described.

When the ostium is open, the respiratory fluctuations in pressure are identical in the maxillary sinus and nasal cavity, and sniffing and blowing also give identical changes in antral and nasal pressure.

A partial obstruction gives smaller changes of the antral than of the nasal pressure, but this kind of recording also occurs when there is fluid in the ostium or in the maxillary sinus above the level of the needle.

An obstruction of the maxillary ostium can sometimes be overcome by sniffing or blowing. In some cases the ostium then remains patent, probably indicating that it was blocked originally by mucus. The pressure required to open the ostium can be calculated from the recordings.

The ostium sometimes has a valvular function on sniffing or blowing. This function may be of different kinds. It may be directed towards or away from the maxillary sinus, giving a stepwise increase or decrease of the antral pressure on blowing or sniffing with increasing intensity. It may be air-tight or work as a safety valve; in the latter case the residual antral pressure only reaches a certain level, positive or negative, in spite of more intense blowing or sniffing. The resistance of the ostium is equal to the nasal pressure at the opening moment. When the ostium works as a safety valve, the resistance in both directions of the valve can be calculated; the resistance in the reverse direction to the main one is equal to the residual antral pressure.

More pronounced obstructions of the maxillary ostium resist the nasal pressure during breathing, sniffing and blowing. In an investigated series the latter kind of obstruction was found in all patients with chronic maxillary sinusitis, and in half of those with acute sinusitis; most of the remaining patients with acute sinusitis had some other kind of permeability disturbance. A patent ostium was found only rarely, either in catarrhal sinusitis or in the recovery period of an acute purulent sinusitis.

Ostial resistance

Since in the majority of cases with sinusitis the maxillary ostium is obstructed during breathing, sniffing and blowing, the ostial resistance in these cases cannot be measured by simultaneous recordings of the nasal and antral pressures during these manoeuvres. The method mentioned previously, with an elevated bottle of irrigation fluid connected to a needle introduced into the maxillary sinus, is useful in these cases. An error in this method is the time required to fill the sinus up to the level of the ostium, since the bottle is also raised during this time. This error is considerable in a normal sinus with a large capacity and a patent ostium, but it is negligible when the air volume in the sinus is small and the ostium obstructed. This small air volume is further reduced by compression during the raising of the bottle, until the ostial obstruction is overcome. These latter cases also represent those in

which most other methods for measurements of the ostial resistance fail and where the described method therefore has a special value.

The resistance of the maxillary ostium is significantly lower in acute sinusitis than in chronic. In acute sinusitis it is correlated with the result of the antral lavage; patients with mucus or pus in the sinus having a higher ostial resistance than those without. In chronic sinusitis this resistance is equally high in patients with as in those without mucus or pus in the lavage. It is impossible to judge, however, whether this high ostial resistance in chronic sinusitis is the cause of the chronic course of the condition or only a result of a persistent infection. According to Flottes et al. (1960), concerning the pathophysiology of sinusitis, there is a vicious circle in which infection and ostial obstruction interact. A pronounced ostial obstruction may thus give rise to a persistent infection, and vice versa.

Effects of ostial obstruction

Experiments by Doiteau (1955) and Flottes et al. (1960) have shown that the content of carbon dioxide in the frontal sinus of dogs increases, and the oxygen content decreases after an occlusion of the naso-frontal duct. The pressure in the sinus first increases and then decreases. This decrease in pressure is, however, counteracted by swelling of the mucosa, transudation and secretion, which all give an increase of the pressure in the sinus. When measuring the pressure in human maxillary sinuses with obstructed ostia, it was found that the antral pressure was positive more often than negative (Table 1). The distribution of positive and negative antral pressures was almost identical among cases with, as among those without pain in the maxillary region.

Experiments with aspiration of air from the maxillary sinus in human subjects with an obstructed ostium, to a negative pressure of several hundred mm H₂O, did not cause any pain (Flottes et al., 1960; Drettner, 1966). These observations contradict the old hypothesis of vacuum sinus (Sluder, 1927), based on the assumption that pain in the region of the paranasal sinuses may be provoked by a negative pressure in the sinus caused by absorption of oxygen.

Initial antral pressure	Pain	No pain
+	46 %	43 %
0	37 %	30 %
-	17 %	27 %

Table 1. Antral pressure immediately after puncture of the maxillary sinus in cases with (n = 39) and without pain (n = 53) in the maxillary region. + = positive antral pressure. 0 = antral pressure identical with the ambient atmospheric pressure. — = negative antral pressure.

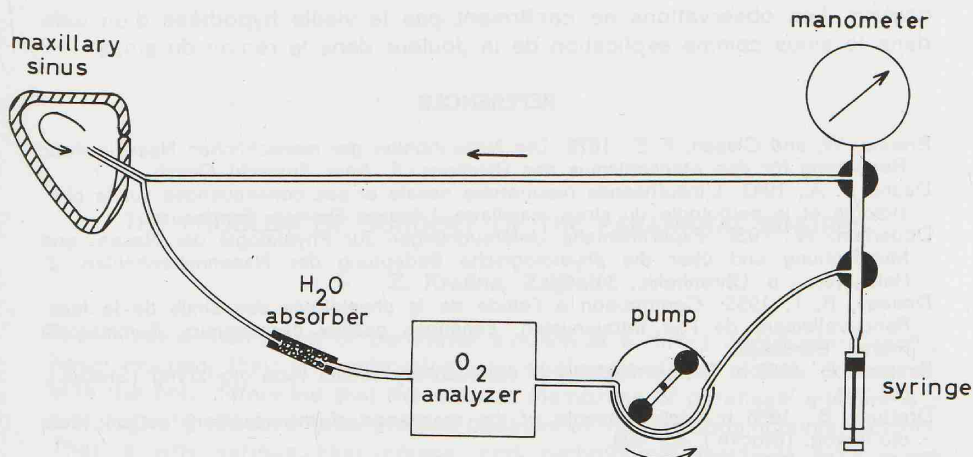


Figure 1. Schematic drawing of the set-up for analysis of the absorption of oxygen from the mucosa in the human maxillary sinus.

The results of investigations in animals concerning the exchange of oxygen and carbon dioxide in an occluded but otherwise normal sinus cannot be directly applied to man, where infection and swelling of the mucosa may influence the exchange. Measurements of the oxygen content in human maxillary sinuses during a sinusitis have been started (Fig. 1), but the technical difficulties have been so great that no definite conclusions can be drawn as yet. Absorption of oxygen was found in a few cases, but not all. It would seem of interest to obtain further information about the effect of an infection upon the gas exchange in paranasal sinuses with an obstructed ostium.

RÉSUMÉ

Des méthodes d'étude de la perméabilité de l'orifice du sinus maxillaire existent depuis 90 ans, mais c'est seulement au cours des dernières années qu'ont été élaborées des méthodes pour la mesure de la résistance de l'orifice obturé. Un simple dispositif d'élévation pour un flacon d'eau de lavage couplé à une aiguille introduite dans le sinus peut servir pour cette sorte de mesures. Il est rendu compte de diverses formes d'obstruction de l'orifice du sinus maxillaire: obstruction partielle, obstruction se transformant en l'ouverture permanente de l'orifice après mouchage ou aspiration, fonction de soupape étanche ou fonctionnant comme soupape de sûreté, obstruction résistant à la pression même lors de mouchage et d'aspiration. Cette dernière forme d'obstruction s'est présentée lors de toutes les ponctions exécutées sur diagnostic de sinusite chronique mais seulement dans la moitié des cas lors de ponctions pour sinusite aiguë.

La résistance de l'orifice obturé du sinus maxillaire était aussi plus grande lors de sinusite chronique que lors de sinusite aiguë.

Il n'existait pas de corrélation entre la présence de douleurs dans la région du sinus et la pression positive ou négative dans le sinus. L'abaissement expérimental de la pression à l'intérieur du sinus ne provoquait pas de

douleur. Les observations ne confirment pas la vieille hypothèse d'un vide dans le sinus comme explication de la douleur dans la région du sinus.

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