Analysis of mucociliary transport of the maxillary sinus mucosa after surgical trauma and in the presence of chronic inflammation

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Abstract

Background: The membrane of the maxillary sinus actively participates in the protective function of the upper respiratory tract through the mucociliary transport carried out by its ciliated epithelium. The presence of pathological changes in the sinus cavity directly affects the ability of the Schneider's membrane to effectively perform its drainage function. The activity of mucociliary transport is reduced and the time required for the cleansing activity of the maxillary sinus is increased.

Methods: In the study we are introducing, a total of 20 patients were included, divided into two groups. Patients were scheduled for local maxillary sinus plastic surgeries. Group 1 included patients in whom we did not find a change in the thickness of the mucosa of the maxillary sinus on CBCT. In group two we selected patients with radiological data for thickened mucosa of the maxillary sinus between 5 mm and 7 mm. Before closing the communication, we placed a saccharin granule in the maxillary sinus. We assessed the activity of mucociliary transport by measuring the time for which patients registered a sweet taste in their mouth.

Results: In all of the 20 patients, we found prolonged drainage function of the maxillary sinus mucosa. For group 1, this time was recorded in the interval from 115 minutes to 238 minutes (average 137 minutes). In group 2, the time reported was between 210 and 345 minutes (average value 270.75 minutes).

Conclusions: Based on the results obtained, we can conclude that surgical trauma and chronic inflammation of the membrane of the maxillary sinus affect the efficiency of the mucociliary transport.

Key words: Mucociliary transport, Maxillary sinus mucosa, Chronic maxillary sinuitis

Background

The maxillary sinus is the largest of all the paranasal cavities. It is an air cavity resembling a pyramid, repeating the shape of the upper jaw (6, 7).

Inner surface of the maxillary sinus is covered by the Schneider's membrane, formed by pseudostratified ciliated clonal (respiratory) epithelium, the underlying vascular lamina propria and the underlying periosteum (8). Cubic cells in the epithelium and mucus cells of the lamina proria secrete a protective mucus layer (mucus), which plays an essential role in keeping the upper respiratory tract clean. The mucus captures particles, inhaled from the air, and due to the synchronous movement of the cilia of the epithelium, it is transported, along with particles captured, to the natural opening of the maxillary sinus in the middle nasal passage, nasopharynx and through the pharynx passes to the stomach (2, 9, 10). This ability of the Schneider's membrane to perform the primary protective function of the upper respiratory tract is called mucociliary transport of the sinus mucosa (13). The normal mucociliary clearance, measured in healthy individuals without pathology in the surrounding nasal cavities, is 6-9 minutes (11, 12). When pathological processes in the maxillary sinus are present, it should be assumed that the clearance would be affected (1, 3, 4, 5, 14, 15, 16).

Methods

Our target group included 20 patients who were scheduled for local maxillary sinus plastic surger-

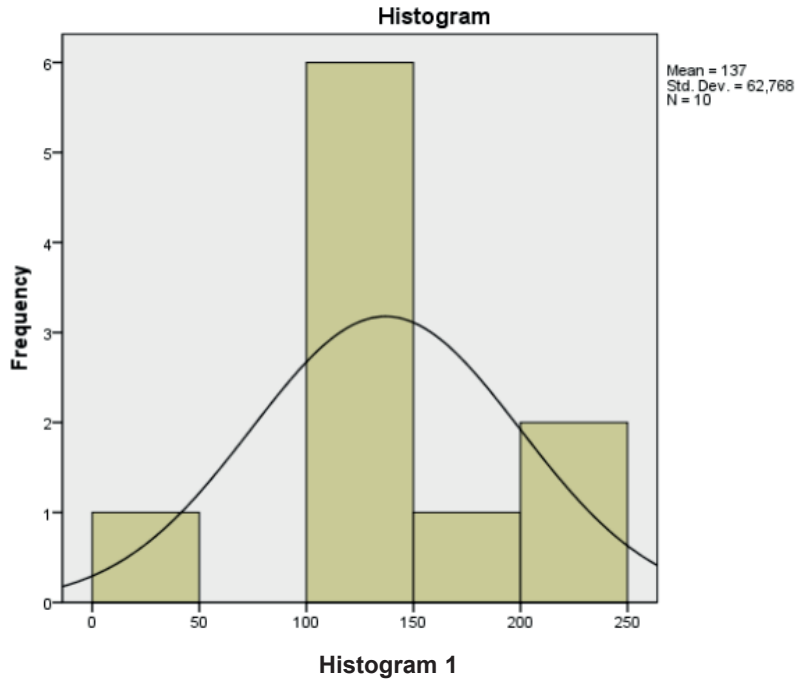
ies. We divided the patients into two groups.
Group 1 included patients with teeth located in the area of the maxillary sinus, whose roots were in intimate contact with the floor of the sinus cavity. All teeth were planned for extraction due to therapeutic, prosthetic and orthodontic indications. No clinical or radiological evidence of pathologically thickened maxillary sinus mucosa was observed in patients in this group. Group 2 included patients with maxillary distal teeth protruding into the maxillary sinus with no possible therapeutic treatment. In all patients from this group on CBCT we diagnosed a thickened 5-7 mm membrane of the maxillary sinus.
After the extraction of the non-perspective teeth and registration of oroantral communication, we placed a small saccharin granule on the sinus mucosa, covering the lateral wall of the maxillary sinus, using micro-tweezers. The communication was closed with a trapezoidal mucoperiosteal flap, which we mobilized, adapted and sewed (Reherman's flap).
During the test, the patient is asked not to exhale, not to smoke, not to inhale or exhale deeply, not to eat or drink, and to swallow every 30-40 seconds until a sweet taste appears in the mouth.
We evaluated the activity of the mucociliary transport by measuring the time from the placement of the saccharin granule to the registration of sweet taste by the patient. Patients who did not report a sweet taste within 50 minutes were referred to their homes and asked to let us know as soon as they registered a sweet taste.

Results

For group 1 – patients without radiological data for pathologically thickened mucosa of the maxillary sinus (clinically healthy mucosa is considered when its thickness is from 0 mm to 2 mm.) we received the following data: in 9 of the patients we reported a positive saccharin test – these patients reported a sweet taste after the saccharin pellet was placed. One patient did not report sweet taste, although a 6-hour interval of no eating and drinking was observed. From the attached table 1, we can summarize the following results: the maximum required time for the saccharin test is noted on the table with the parameter Maximum, was 238 minutes, the minimum time interval (Minimum) was 115 minutes and the average value (Mean) was 137 min.
The results obtained can be clearly seen on histogram 1.
For group 2 – patients with radiological data for pathologically thickened mucosa of the maxillary sinus from 5 mm to 7 mm, we received the following data: in 8 of the patients we reported a positive saccharin test – these patients reported a sweet taste after the saccharin granule was placed, while 2 patients reported no sweet taste, although a 6-hour interval with no eating and drinking was observed. From the attached table 2 we can summarize the following results: the maximum required time for the saccharin test is noted on the table with the parameter Maximum, was 345 minutes, the minimum

Table 1.

N	Valid	10
	Missing	10
Mean		137,00
Median		131,50
Mode		0
Std. Deviation		62,768
Variance		3939,778
Skewness		-,654
Std. Error of Skewness		,687
Kurtosis		2,481
Std. Error of Kurtosis		1,334
Range		238
Minimum		115
Maximum		238



Histogram 1

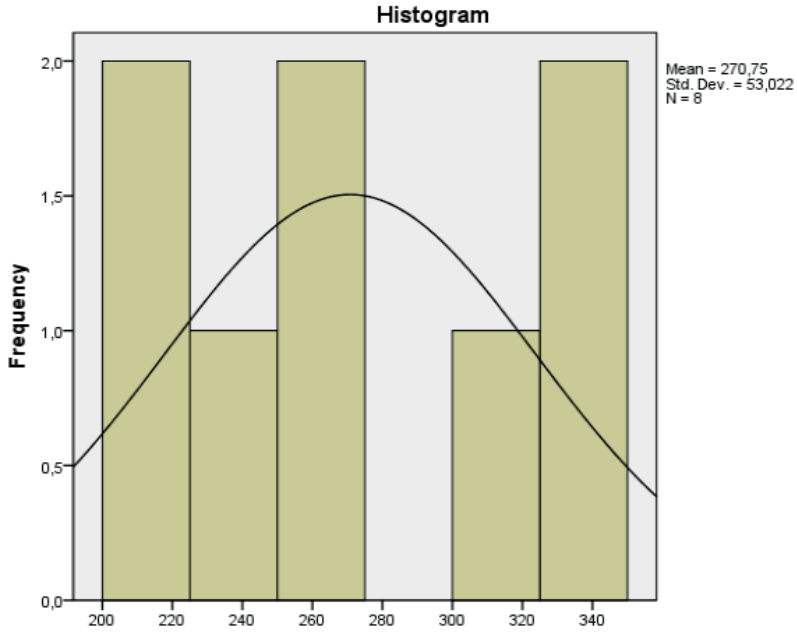
Table 2

N	Valid	8
	Missing	12
Mean		270,75
Median		255,50
Mode		210
Std. Deviation		53,022
Variance		2811,357
Skewness		,346
Std. Error of Skewness		,752
Kurtosis		-1,786
Std. Error of Kurtosis		1,481
Range		135
Minimum		210
Maximum		345

time interval (Minimum) was 210 minutes and the average value (Mean) was 270,75min.
On Histogram 2 results can be seen.

Discussion

The evaluation of the mucociliary transport by Andersen (26) by the saccharin test is considered to be the gold standard in otorhinolaryngology. It is widely used in the literature, as it is cheap and easy to implement, and the data obtained from it are characterized by considerable accuracy (19, 21, 22, 23, 24, 25). A number of authors place the saccharin granule in the lower nasal concha of the patient and report the activity of mucociliary transport according to the data obtained by the patient from the time of placement of the saccharin granule to the registration of sweet taste (17, 18, 20).
S. M Birdi et al. (27) studied young individuals between 18 and 20 years of age, without pathology in the surrounding cavities by the Andersen's method. They obtained values from the saccharin test of 6.99 min. Fifteen years later, Singh et al. (12) repeated this method of research and got similar results – 6.61 min. According to the authors, the disadvantage of this method is that it is not accurate for clearance studying of the maxillary sinus, because



Histogram 2

the granule is placed in the nasal cavity, and for the mucociliary transport of the maxillary sinus it can only be guessed what it could be. Strommberger (28), during endoscopy of the maxillary sinus, noticed that when the trocar penetrates, the cilia stopped moving for a few minutes, which indicates that the trauma leads to a decrease in mucociliary transport activity. The present study aims to examine the extent to which mucociliary transport is altered as a result of surgical trauma and inflammation. In group 1, which included patients without evidence of pathological changes in the maxillary sinus and sinus mucosal thickness from 0 mm to 2 mm, measured on CBCT, we found a mean time required for the saccharin test 137 min. In this case, the surgical trauma from the local plastic surgical procedure to close the oroantral communication is the reason for the increase in the time for reading the result of the saccharin test about 20 times.

In group 2, where we included patients with radiological data for thickened sinus mucosa from 5 mm to 7 mm, we obtained an average value of saccharin test 270.75 min. Based on that, it can be concluded that chronic inflammation of the maxillary sinus membrane in combination with surgical trauma lead to an even more pronounced reduction in the activity of mucociliary transport. Compared to the data obtained from the study of Birdi (27) and Singh (12), the values are about 41 times higher, and compared to those of patients in group 1, the values are twice as high.

The authors of the publication suggest that the lack of a positive saccharin test in three of the patients (one in group 1 and two in group 2) is due to the fact that, apparently, their clearance is prolonged for more than 6 hours and can no longer be accurate, because of the intake of food and fluids by patients thereafter.

Conclusions

Based on the results obtained, we can conclude that mucociliary transport of the maxillary sinus membrane is a highly sensitive mechanism, which is influenced by both pathological changes in the sinus cavity and trauma to epithelial cells and their cilia, during its surgical treatment, which consists of reducing the activity of the functional mucociliary apparatus and, accordingly, of reducing the effectiveness of its drainage function.

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