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Human nasal mucosa reaction during chilling of the feet

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SUMMARY

As rhinostereometry, an optical measurement method, allows meticulous studies of changes in nasal mucosa congestion, the mucosal reaction in eight healthy volunteers was studied with this technique before, during and after 20 minutes' chilling of the feet in cold water.

In five volunteers there were no observable mucosal reactions. In three volunteers the mucosal congestion changed but not uniformly, and not in such a way that the change could be explained as an effect of chilling of the feet.

In four volunteers there was a clearly observable increased nasal secretion. This gives a possible explanation of the increased nasal breathing resistance observed in similar studies using rhinomanometry as the measuring method.

INTRODUCTION

It is said to be a common experience that chilling of peripheral parts of the body such as the back and the feet increases the risk of catching a common cold. If these observations are correct a possible explanation could be that chilling causes a compensatory congestion of the nasal mucosa followed by secretory stagnation. This retained secretion favours the establishment of viral and bacterial infections.

Conflicting results have been obtained in studies on the effect of chilling of the feet on nasal mucosa congestion. In three different studies using rhinomanometry it was shown that nasal breathing resistance decreases (Van Dishoeck, 1935; Dufton and Bedford, 1933; Lehmann, 1939). Using a plethysmographic technique Ralston and Kerr (1945) observed an initial decongestion followed by slow congestion of the nasal mucosa. A rhinoscopic study showed that the mucosa became congested when the feet were chilled (Holmes et al., 1950). This observation was confirmed by Drettner (1961) using rhinomanometry. However, plethysmography and rhinomanometry do not measure changes in nasal mucosa congestion directly; they measure changes in air flow, air pressure and volume of the nasal cavity, and from these data the changes in the mucosal congestion are deduced.

During recent years an optical measurement method, rhinostereometry, has

been developed which allows direct measurement of changes in nasal mucosa congestion (Juto and Lundberg, 1982). In the present study this measuring method was used to investigate congestion of the nasal mucosa in healthy volunteers whose feet were chilled in a cold water bath.

MATERIAL AND METHODS

Eight healthy volunteers, four males and four females, 21–40 years of age, took part in the study.

Changes in nasal mucosa congestion were determined by rhinostereometry. This is an optical measurement method in which the optical axis and the plane of focus of an ear surgery microscope are used to establish a three dimensional coordinate system. The accuracy limit of the method is ± 0.27 mm (Juto et al., 1982).

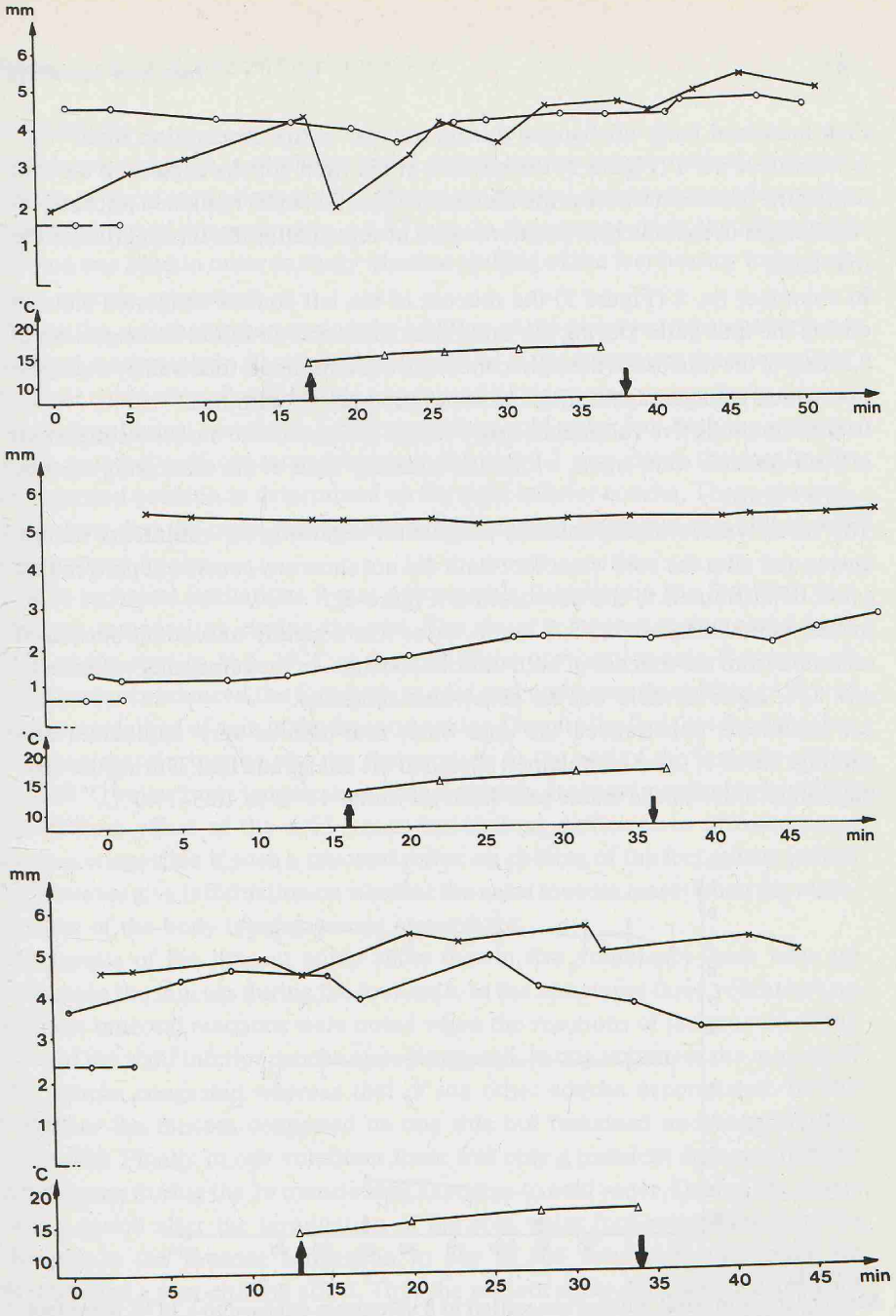
Each test started with the volunteer in the sitting position during an acclimatization period of at least 15 minutes. The air temperature in the room during the test was 21–23 °C and the relative humidity 60–65%. The position of the mucosal surface on the medial side of each inferior concha was determined approximately every 5 minutes. After the acclimatization period the volunteer put the feet into cold water with a temperature of 14 °C, so that the water reached well above the ankles. The position of the mucosal surface and the temperature of the water were repeatedly determined, approximately every 5 minutes. After 20 minutes' provocation the volunteer wiped the feet gently with a towel and put on stockings. Within 2 minutes after the termination of the cold water foot-bath the positions of the mucosal surface were determined. This was further repeated at 5 minute intervals, at least twice.

Several days after the cold water test a piece of cottonwool soaked in oxymetazolinechloride was placed in the right nasal cavity for 15 minutes and the position of the mucosal surface on the medial side of the concha inferior was then determined. This procedure was performed in all volunteers to define the position of the mucosal surface when maximally decongested (Juto et al., 1983).

RESULTS

During the 15 minute acclimatization periods the position of the observed mucosal surfaces of both inferior conchae changed moderately by 0.3–1.2 mm, with one exception when the change was 2.3 mm (Figure 1, volunteer no. 2). When comparing the mucosa of the right and the left concha respectively there was no uniform reaction in any of the volunteers, although slight mucosal congestion dominated.

As volunteer no. 2 (Figure 1) started with the cold water foot-bath the mucosa of the left concha decongested rapidly by 2.3 mm whereas the mucosa of the right concha decongested slowly by 0.5 mm. However, within 10 minutes the mucosa on both sides had regained the position it had shown before the provocation and



Figures 1, 2 and 3. (Volunteers nos. 2, 1 and 8 respectively).
The changes in position of the medial mucosal surface of the right (○———○) and the left (×———×) inferior concha before, during and after a cold water foot-bath in volunteers nos. 1, 2 and 8. The position of the mucosal surface is defined as a distance (mm) to the optical axis of the rhinostereometer.
↑ and ↓ denote beginning and end, respectively, of the foot-bath.
△———△ denotes the temperature (°C).
○———○ denotes the position of the medial mucosal surface of the right concha when maximally decongested.

then remained fairly unchanged during the rest of the observation time.
In volunteer no. 1 (Figure 2) the mucosa of the right concha congested 0.6 mm during the foot-bath whereas the mucosa of the left concha remained unchanged. No changes in the mucosal positions were observed after the termination of the foot-bath.
In volunteer no. 8 (Figure 3) the mucosa of the left concha congested 0.8 mm during the foot-bath. During the same time there was an initial decongestion of 0.5 mm, of the mucosa of the right concha for a few minutes, followed by a congestion which changed again into a decongestion after 7 minutes.
In the remaining five volunteers, nos. 3–7, the changes in the mucosal congestion of both conchae were small, within the accuracy limit of the measuring method ($\pm$ 0.27 mm).
The mean values of the mucosa congestion regarding all volunteers before, during and after the cold water foot-bath did not show any consistent pattern that could be attributed to the provocation (Figure 4).
In four volunteers, nos. 1, 2, 5 and 6, there was a clearly observable increased secretion from the mucosa of both inferior conchae. In the remaining volunteers, nos. 3, 4, 7 and 8, there was no observable secretion.
All volunteers experienced the cold water foot-bath as very unpleasant and chilling. Three of them complained of pain in the ankles and feet. During the tests the temperature of the water rose from an initial 14 °C to 16.5–17.0 °C.

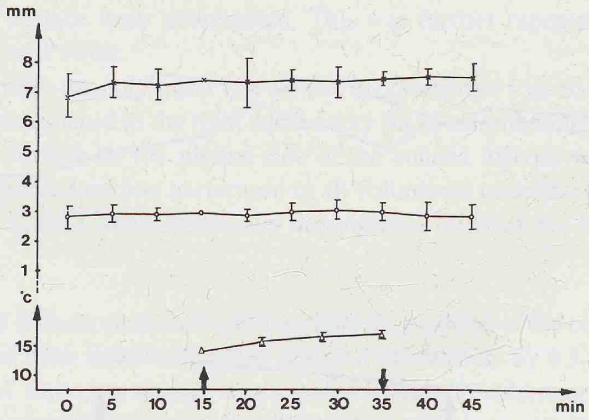


Figure 4.
Mean changes in nasal mucosa congestion in 8 volunteers exposed to a 14 °C water foot-bath for 20 minutes.
↑, ↓ denotes onset and termination of the foot-bath respectively.
○———○ denotes the mean values of the medial mucosa surface positions of the right inferior concha and ×———× of the left inferior concha.
△———△ denotes the mean values of the foot-bath temperature.
I denotes the 95% confidence intervals of the mean values.

DISCUSSION

By rhinostereometry, a newly invented optical measurement method, it is possible to perform meticulous studies of changes in nasal mucosa congestion as the accuracy limit of the method is ± 0.27 mm. In the present study the measuring method was used in order to study whether chilling of the feet has any impact on nasal mucosa congestion.

During the acclimatization period the position of the observed mucosal surfaces changed moderately in all volunteers. In several of the volunteers there was slight mucosal congestion. Possibly, this was caused by decreased sympathetic stimuli due to the physical inactivity. At the start of the cold water foot-bath the position of the mucosal surfaces ranged between 0.6 and 3.7 mm above the maximally decongested position as determined on the right inferior concha. These observations show that the nasal mucosa was not influenced by undue stimuli but was able to react freely.

Due to technical limitations it was not possible to maintain the foot-bath at a constant temperature during the test. The water temperature increased from 14 °C at the start to 16.5–17 °C at the end of the provocation test. However, all volunteers experienced the foot-bath as cold and unpleasantly chilling. A few of them complained of pain in the feet and ankles. Despite the fact that the water became warmer during the test the temperature at the end of the test was still at least 20 °C below body temperature. Consequently, it seems reasonable to regard the chilling effect of the cold water foot-bath as sufficient to provoke nasal mucosa congestion if such a mucosal reflex on chilling of the feet exists. It does not however give information on whether the nasal mucosa reacts when the maintenance of the body temperature is jeopardized.

The results of the present study show that in five volunteers there were no changes in the mucosa during the foot-bath. In the remaining three volunteers no uniform mucosal reactions were noted when the reactions of the mucosa of the left and the right inferior concha were compared. In one volunteer the mucosa of one concha congested whereas that of the other concha decongested. In one volunteer the mucosa congested on one side but remained unchanged on the other side. Finally in one volunteer there was only a transient decongestion for ten minutes during the 20 minute long exposure to cold water. During the observation period after the termination of the cold water foot-bath, there were no changes in the mucosa congestion in any of the volunteers that could be described as a post-chilling effect. Thus the present study did not reveal any consistent nasal mucosa reaction that could be attributed to the cold water foot-bath.

In four of eight volunteers there was a clearly observable increased nasal secretion from the mucosa of the observed conchae during the foot-bath. This increased nasal secretion, which is in agreement with earlier observations (Holmes et al., 1950), gives a possible explanation of the increased nasal breathing resist-

ance as observed with the rhinomanometric technique during similar tests. The increased nasal secretion can also be expected to favour the establishment of viral but more especially bacterial infections.

The present results make it hard to avoid the conclusion that chilling of the feet does not cause any change in nasal mucosa congestion when the chilling is moderate and of short duration as in the present study. However, they do not exclude the possibility that the mucosa reacts when maintenance of the body temperature is menaced. The results also revealed that in some individuals chilling of the feet causes an increased nasal secretion which may explain the observed increased breathing resistance as determined by rhinomanometric techniques.

ZUSAMMENFASSUNG

Da die Rhinostereometrie als ein optisches Messinstrument genaue Studien der nasalen Schleimhautausscheidung erlaubt, wurde die Reaktion der Schleimhaut bei acht Patienten mit dieser Messtechnik getestet, und zwar während und nach 20-minütigem Kühlen der Füsse in kaltem Wasser.

Bei fünf Patienten erwies sich keine Reaktion der Schleimhaut. Bei drei Patienten veränderte sich die Schleimhautausscheidung nur in dem Masse, dass die Veränderung nicht definitiv auf die Abkühlung der Füsse zurückgeführt werden kann.

Bei vier Patienten zeigte sich deutlich eine nasale Sekretion. Dieses deutet auf eine mögliche Erklärung der erhöhten nasalen Atemresistenz hin, die in ähnlichen Studien gemacht wurde, als man die Rhinomanometrie als Messinstrument verwendete.

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