Rhinology, 41, 7-10, 2003

Short-time variation in nasal mucosal swelling: a rhinostereometry study*

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SUMMARY

Rhinostereometry is an optical method to detect changes in nasal mucosal swelling. The method needs further specifications for standardised use. This study was performed in order to define the inter-individual variation, and to find whether the intra-individual short-time variation is greater, say, at the beginning of a sequence of registrations, as has been claimed. Bilateral registrations were made every 2 minutes for 30 minutes in healthy, non-smoking subjects, 15 women, and 15 men. The figures of each nasal cavity were evaluated separately. Compared with baseline, the range of changes was -2.9 to 3.0 mm, mean value 0.12 mm, with a standard deviation of 0.39 mm. No stabilisation of the variation was seen over time. There was no correlation with age or sex. The left and right nostrils changed degree of swelling independently in most cases, but in 8 cases there was a significant correlation between the nostrils. The time required for each pair of bilateral registrations varied between 15 and 90 s (mean 34 s, standard deviation 10 s). Data from the present study can be used for statistical power calculations in the planning of rhinostereometry studies using parallel groups.

Key words: nasal mucosa, congestion, rhinostereometry, normal variation, statistics

INTRODUCTION

Standardisation and guidelines for new methods are necessary for comparing the results from different studies. Specifications are needed in order to obtain values of accuracy and repeatability for the equipment used. An ambitious document on acoustic rhinometry concerning such data was recently presented (Hilberg and Pedersen, 2000).

Rhinostereometry is an optical method used to measure differences in nasal mucosal swelling. The method has been used in several studies on rhinitis medicamentosa (Graf et al., 1995; Graf and Juto, 1995; Graf, 1996), and on benzalkonium chloride (Hallén and Graf, 1995; Graf and Hallén, 1996). Measurements of reactions to histamine provocations are frequently used, and a 0.4-mm congestion 5 minutes after histamine 2 mg/ml has been proposed to differentiate hyperreactive subjects from controls (Hallén and Juto, 1993).

In all published studies, the baseline position is said to be determined by repeated recordings of the inferior turbinates. When I used the method for the first time (Ellegård and Karlsson, 1999), I frequently found it hard to obtain a stable baseline.

The aim of the present study was to define the variation in rhinostereometry registrations in men and women, and whether the variation is influenced, say, by how early the registrations come in a sequence or not, that is, if and when a stabilisation occurs.

MATERIAL AND METHOD

Fifteen women aged 25-58 (mean 43.6 years) and 15 men aged 16-58 (mean 41.3 years) were studied. They were non-smoking, with neither nasal problems nor medications. Respiratory tract infection must not have occurred within 2 weeks before the study. Three of the women and 4 of the men had a history of hayfever, but were studied months out of season.

In rhinostereometry, invented and first described by Juto & Lundberg (1982), the subject bites on a tooth splint connected to the frame of the converted eye microscope. This is done in order to maintain a stable and repeatable exposure of the nose. The microscope can be moved in three dimensions, and its angle towards the nose can be altered, giving 4 coordinates used to define the registration position for observing the nasal mucosa. As the depth of field is very narrow, the focused area observed at the registration position moves along the mm-scale in the ocular as the thickness of the mucosa changes. A Rhinostereometer type S (Rhinomed, Lidingö, Sweden) was used as recommended by the manufacturer. The coordinates were established with an accuracy of 0.1 mm. Aural examina-

* Received for publication: April 26, 2002; accepted August 13, 2002

tion funnels of appropriate sizes were used to observe the anterior borders of the inferior turbinates.

After 30 minutes of acclimatisation to the indoor climate, registration positions were selected by choosing focused areas on the anterior edges of both inferior turbinates. Further bilateral registrations were made every 2 minutes for 30 minutes, starting with the right side every time. The tooth splint was kept in the mouth between right and left registrations. Registrations were also made 15 minutes after administering a nasal spray of 100 μg oxymetazoline hydrochloride (Nezeril® 0.5 mg/ml, Draco, Lund, Sweden).

The time consumed for every pair of registrations was registered. Care was taken that no disturbing moments would occur during the study time; there was a sign on the door to prevent disturbance, no stress, and only trivial conversation was allowed.

All participants gave their informed consent. The study was approved by the Ethics Committee of Sahlgrenska University Hospital, Göteborg.

Statistical tests

Differences from baseline were used for analyses. Autocorrelation was used on every individual value and the one preceding, in order to evaluate the time dependence in every nasal cavity. The standard deviation (=SD) of the difference between the mean value of all sets of registrations and the previous one were established in order to register time dependence. The correlation between mean change over time in right and left nasal cavities was established by Pearson correlation. The relation between age and variation in mucosal swelling was established by linear regression of the logarithms of the SDs on age. In the comparison between female and male, the quotient of the mean SD was calculated.

RESULTS

No one experienced any subjective nasal obstruction during the study time.

The range of differences compared with the baseline, observed during 30 minutes, was from -2.9 mm to 3.0 mm. The mean swelling was 0.12 mm, with a total variation over time and individuals (SD) of 0.39 mm over 30 minutes. The corresponding values of the first registration, after 2 minutes, were a mean value of 0.06 mm, and a SD of 0.39 mm.

In 12 isolated nasal cavities, the autocorrelation between successive individual registrations indicated a significant dependence, given by values greater than 0.5 or smaller than -0.5 (possible values -1 to 1, range -0.16 to 0.75). The variation was not stabilised over time (see Figure 1).

In 8 subjects, there was a significant correlation between readings from the right and left nasal cavities (see example in Figure 2), given by values greater than 0.5 or smaller than -0.5 (possible values -1 to 1, range -0.51 to 0.76). However, in some cases the nasal cavities seemed to react as two separate organs (see example in Figure 3). Most noses showed small changes over time (see example in Figure 4), but in some cases the changes were more pronounced (see example in Figure 5).

There was no significant relation between age and variation in

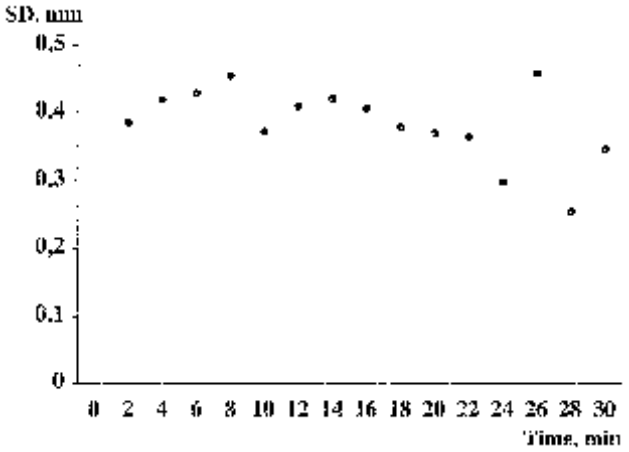

Figure 1. Variation over time. The standard deviation (=SD) of the difference between the mean value of each set of registrations and the previous one did not stabilise over time in 30 healthy subjects.

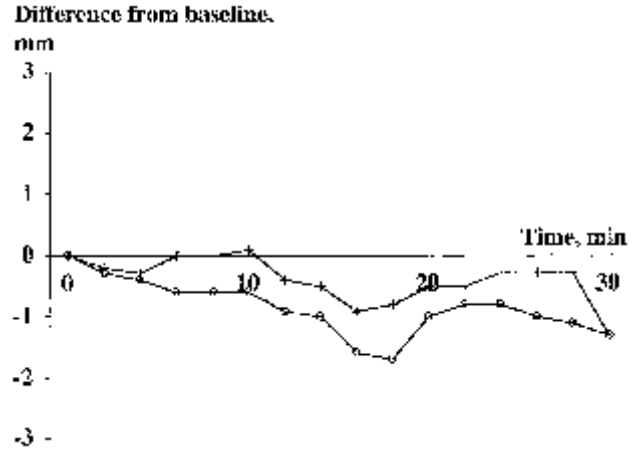

Figure 2. Registrations from a subject whose nostrils changed in parallel.

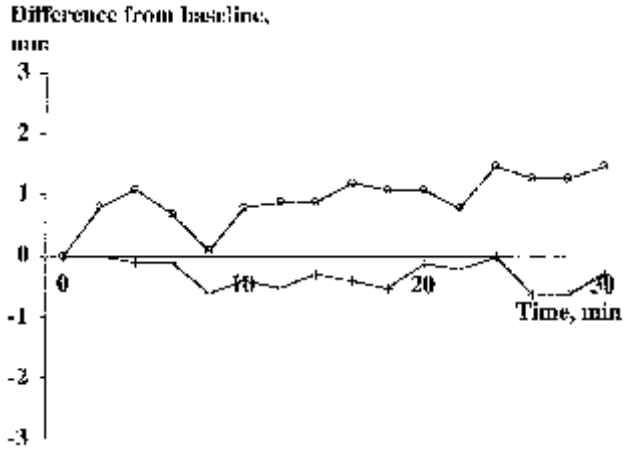

Figure 3. Registrations from a subject whose nostrils reacted as two separate organs.

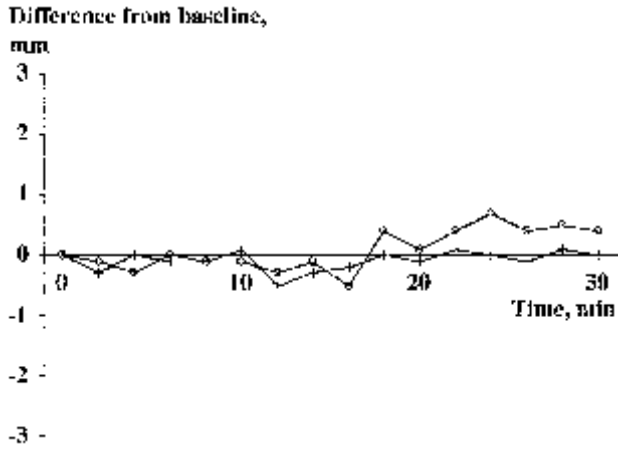

Figure 4. Registrations from a subject who showed small changes in swelling over time.

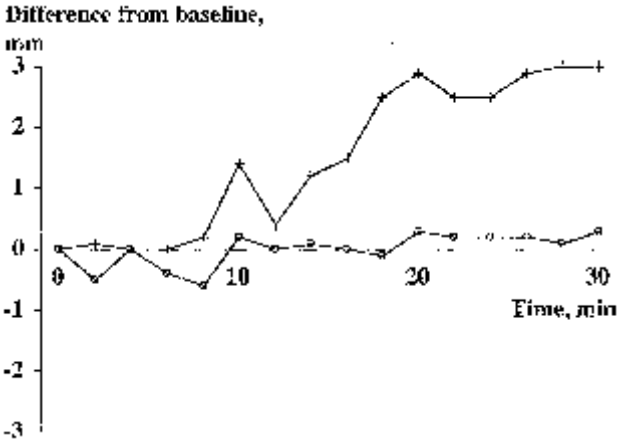

Figure 5. Registrations from a subject who showed pronounced changes in swelling over time.

mucosal swelling (R=0.01, P=0.94). Also, there was no difference found in variation due to sex. The mean SD of women / men = 0.44 / 0.35 = 1.3 (95% confidence interval 0.75, 2.21). The mean value after decongestion was -2.0 mm (SD= 1.0 mm) compared with the baseline. The time required for a bilateral registration varied between 15 and 90 seconds (mean= 34 s, SD= 10 s).

DISCUSSION

In this study of the normal variation in bilateral rhinostereometry in healthy subjects over 30 minutes, I found a mean swelling compared with baseline of 0.12 mm, ranging from -2.9 to 3 mm, with a total mean SD of 0.39 mm. The variation did not improve convincingly over time: no stabilisation was found (see Figure 1). In only 12 isolated nasal cavities was there a correlation between successive individual registrations. Therefore, the values from the first registration, at 2 minutes, can be used for calculations in the planning of studies (mean change 0.06 mm, SD 0.39 mm).

In statistical power calculation, according to Law (1993), with *parallel* groups, for an estimated power of 90%, and a significance level of 0.05, the required number of subjects in each group is 2 x ((10.5 x $(SD)^2$) / D^2) + 2, where D is the difference we seek. With our SD of 0.39, and with a difference of 0.4 mm, we will need 22 subjects in each group = 2 x ((10.5 x 0.39^2) / 0.42^2) + 2. For *crossover* studies, the intra-individual SD over days (not established in the present study) should be used in the corresponding equation: ((10.5 x $(SD)^2$) / D^2) + 2.

Juto & Lundberg (1984) studied the variation in nasal mucosa congestion during rest in 7 male and 7 female volunteers by bilateral registrations every 20 minutes for 4 hours. Unfortunately, not all results are presented, but in 3 cases there seem to have been changes of 2-3 mm, which is in the same magnitude as the results of the present study.

In a 14-minute study on 9 volunteers, Grudemo & Juto (1999) found changes of up to 2.1 mm in registrations made every 2 minutes. As rhinostereometry was combined with laser Doppler flowmetry, and registrations were made within 30 seconds, I presume they were unilateral. No data is presented as to whether the changes were influenced by time or not. The authors state that “it is obvious that in most subjects there are pronounced short term variations in congestion, especially during the acclimatisation period”. The present study did not give any evidence of stabilisation in 30 minutes.

The total inherent error of the method is reported to be 0.27 mm when the edge of the focused area on the mucosal surface moves 0 mm, and 0.37 mm when it moves 4 mm (Juto and Lundberg, 1982). The variation found in the present study includes these figures and a physiological short-time variation in nasal mucosal swelling. Thus there is an instability in the vasomotor tone, even though care was taken that no disturbing moments would occur during the study time, as discussed earlier (Rhinology, in press)[reference is now known].

As shown in this study, it takes more than a few seconds to perform a bilateral registration. The time I required for bilateral registrations varied greatly. In no case, however, did I exceed the maximum time of 2 minutes set by Juto in his 4-hour study (Juto and Lundberg, 1984).

Rhinostereometry is an important tool. It can be used to measure small changes in nasal mucosal swelling with great accuracy. In statistical power calculations for study planning the variation reported in this study should be taken into consideration. Repeated registrations on the same occasion are not needed, as the variation was not shown to change over 30 minutes.

ACKNOWLEDGEMENTS

This study was financially supported by the Göteborg Medical Society, Göteborg, Sweden. Special thanks to Professor Alvar Ellegård for revising my English, and to Professor Göran Karlsson for constructive discussions.

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