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A comparison of the sensitivity of manometric rhinometry, acoustic rhinometry, rhinomanometry and nasal peak flow to detect the decongestant effect of xylometazoline

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A study has been undertaken to compare the sensitivity of manometric rhinometry, rhinomanometry, nasal peak flow and acoustic rhinometry to detect the decongestant effect of xylometazoline. Twenty healthy volunteers were investigated before and after decongestion. The sensitivity of all four methods varied from 80 to 95%. These differences were not significant. Manometric rhinometry, a new method of investigating nasal physiology, is as sensitive as more established methods.

Keywords *acoustic rhinometry* *manometric rhinometry* *nasal peak flow* *rhinomanometry* *xylometazoline*

Manometric rhinometry is a new method of investigating the nose and paranasal sinuses. It measures the volume of the airspace within a closed cavity limited posteriorly by the elevation of the soft palate against the nasopharynx and anteriorly by a mask placed over the nose or a plug inserted into the nostrils. When air is removed from this closed space there is a resultant pressure change from which the original volume can be calculated. The method has been described in greater detail elsewhere.[1]

In a previous experiment we were able to demonstrate that manometric rhinometry was capable of demonstrating the decongestant effect of xylometazoline.[1] This sympathomimetic is well known for the intense vasoconstrictor effect on the inferior turbinate as demonstrated by clinical observation, rhinomanometry and Laser Doppler studies.[2–4]

If one assumes that xylometazoline causes a decongestion in all subjects then the sensitivity of each method is given by the percentage of subjects that show a change in the expected direction after application. Specificity cannot be measured as one assumes there will be no true negatives. The purpose of this experiment was to determine the sensitivity of manometric rhinometry compared with acoustic rhinometry, rhinomanometry and nasal peak flow to detect the decongestant effect of xylometazoline.

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Materials and methods

Twenty healthy adult volunteers were studied (M:F = 13:7, age 21–44 years). All were questioned to exclude a history of intercurrent nasal or sinus disease, previous nasal surgery or current medication. Before decongestion the following investigations were performed.

MANOMETRIC RHINOMETRY

This gives a reading of the pressure change resulting from the extraction of air in the nose and sinuses. Subjects held an anaesthetic mask (Dentmed Ltd) to their face and breathed against a resistance of 40 mbar. Ten readings were taken from each subject and the average used to calculate nasal volume.

ACOUSTIC RHINOMETRY

The rhinometer (GM instruments) was calibrated before each set of readings and set to record the nasal volume at 5, 7, 9 and 13 cm from the end of the nose piece. A cylindrical 7 cm nose piece inserted into the nasal vestibule was used. The

subjects sat up in a chair and the angle between the subject and the acoustic rhinometer was kept constant. Five readings were taken for each side of the nose with the mouth open and the subjects holding their breath. The average was used to calculate the nasal volume for each side once the graphs had been inspected and incompatible readings edited. The value for left and right was added together to calculate total nasal volume.

RHINOMANOMETRY

Active anterior rhinometry (Mercury Instruments MK III) was used to calculate total nasal resistance during inspiration and expiration. The resistances were calculated according to the committee report on standardization in rhinomanometry.[5] The resistance for each side was measured separately at the reference pressure of 150 Pa. The average of three breathing cycles was used in order to calculate the total nasal resistance.

NASAL SPIROMETRY

A respiratory spirometer was converted to nasal use by connecting it to a dental anaesthetic mask (Dentmed Ltd) identical to the one used for the manometric rhinometer. Each subject was instructed to take in a deep breath then breath out through the nose as hard as possible, then inhale as fast as possible. Three recordings were made from each subject and the largest value used to describe the peak inspiratory nasal flow and peak expiratory nasal flow.

As it is possible that the degree of nasal congestion or resistance might be affected by the investigative procedures, it was desirable to vary the order in which each test was performed. Both the manometric rhinometer and nasal spirometer require a good seal using an unfamiliar mask. However, only the former gives a display which indicates any degree of leakage around the mask. It was therefore decided that manometric rhinometry would always precede nasal spirometry so that subjects could be taught how to hold the mask without causing a leakage of air.

Ten subjects had their investigations in the following order: acoustic rhinometry; rhinomanometry; manometric rhinometry; nasal spirometry; and in 10 the order was changed so that manometric rhinometry and nasal spirometry preceded acoustic rhinometry and rhinomanometry.

After the above measurements had been made the subjects took an application of a commercially available preparation of xylometazoline in each nostril. After 5 min the four investigations were repeated in exactly the same way and order as they had been performed before decongestion.

The results were analysed by comparing the reading for each method of investigation before and after decongestion then calculating the percentage change in each individual. The average percentage change for each method was also calculated.

If xylometazoline causes a decongestion then it is to be expected that manometric rhinometry should record an increased volume, acoustic rhinometry should record an increase in volume, rhinomanometry should record a fall in total resistance and nasal spirometry should show an increase in nasal peak flow. The results therefore can also be expressed as a percentage for those subjects where the recorded parameter changed in the predicted direction. In order to determine whether these differences were significant 95% confidence limits were calculated.

Results

Table 1 shows the percentage change for each measurement in each subject plus the mean and standard deviation for each method. This shows that the mean change for each method varies from 14% (manometric rhinometry) to 52% (peak inspiratory flow). For all methods there is a wide range of results and the standard deviation is similar to the mean change.

Table 2 gives the sensitivity of each method as a percentage and the 95% confidence limits. Sensitivity ranged from 80% (manometric rhinometry and peak nasal expiratory flow) to 95% (volume 0–5 cm from acoustic rhinometry). The 95% confidence limits vary from 62% to 100% and all ranges overlap.

Discussion

The results show that no method is 100% sensitive in detecting the decongestant effect of xylometazoline, given the assumption that all subjects are affected by the drug. In some cases subjects showed no change or a change in the direction opposite to that predicted. It is possible that some subjects did not react to xylometazoline. If this were the case then one would expect that there would be a consistent lack of response from all methods of investigation. This is not found to be the case.

When one considers the 95% confidence limits one sees that although the sensitivity of manometric rhinometry and peak expiratory flow at 80% are lower than other methods such as the volume derived by acoustic rhinometry to 5 cm (95% sensitivity), there is no statistical difference between these methods.

The investigators had far greater experience in using the manometric rhinometer and it could be argued that this biased the results in favour of the manometric rhinometry. Against this must be balanced the fact that manometric rhinometry is still in its infancy. Both the hardware and software associated with it are much less sophisticated than that of more established methods of investigating nasal physiology. It has been the authors' practice to take 10 readings in order to achieve a reliable figure to convert into a volume although recent studies

Table 1. Percentage change of each measurement for 20 subjects. MR, manometric rhinometry; PF insp, peak nasal inspiratory flow; PF exp, peak nasal expiratory flow; RM insp, inspiratory nasal resistance during active anterior rhinomanometry; RM exp, expiratory nasal resistance during active anterior rhinomanometry; V 0–5, volume in first 5 cm from tip of acoustic rhinometer; V 0–7, volume in first 7 cm from tip of acoustic rhinometer; V 0–9, volume in first 9 cm from tip of acoustic rhinometer; V 0–13; volume in first 13 cm from tip of acoustic rhinometer

Subject	MR	PF insp	PF exp	RM insp	RM exp	V 0–5	V 0–7	V 0–9	V 0–13
1	30	60	42	−20	−7	39	43	39	44
2	−10	77	85	−27	−38	−17	−19	−16	−6
3	25	−19	−11	−16	−24	53	59	43	49
4	3	−4	1	−50	−51	78	74	65	88
5	2	40	−4	−58	−53	11	93	100	85
6	−9	0	−39	9	0	13	10	7	11
7	2	45	3	−60	−59	52	66	64	71
8	19	39	−2	−56	−51	66	67	65	74
9	25	40	57	−64	−61	104	112	109	122
10	24	98	36	−43	−33	56	46	50	45
11	11	48	164	−15	−27	32	24	0	3
12	32	35	22	−60	0	61	57	47	53
13	34	67	32	−41	−29	8	−2	−14	−19
14	15	60	86	−51	−49	67	69	79	93
15	27		37	−35	−9	52	53	45	46
16	−2	58	39	−36	−31	48	51	42	53
17	10	4	49	11	7	48	47	36	34
18	12	64	11	−8	−10	14	17	12	11
19	41	28	22	−56	−49	79	74	66	39
20	−4	240	63	−59	−58	5	5	11	1
Mean	14	52	35	−37	−32	44	47	43	45
SD	15	54	44	23	22	30	33	35	37

Table 2. Sensitivity of each method to detect xylometazoline.

Method	Measurement	Sensitivity (%)	95% Confidence limits
Manometric rhinometry	Nasal and sinus volume	80	62–98
Rhinomanometry	Resistance inspiratory	85	69–100
Rhinomanometry	Resistance expiratory	90	76–100
Nasal spirometry	Peak flow inspiratory	85	69–100
Nasal spirometry	Peak flow expiratory	80	62–98
Acoustic rhinometry	Nasal volume to 5 cm	95	85–100
Acoustic rhinometry	Nasal volume to 7 cm	90	76–100
Acoustic rhinometry	Nasal volume to 9 cm	90	76–100
Acoustic rhinometry	Nasal volume to 13 cm	85	69–100

have demonstrated that equally reliable results can be obtained from only five readings (unpublished observations).

Measuring nasal peak flow using a spirometer proved to be quite easy. Three measurements were made on each occasion as subjects had to learn the technique, however, most results were fairly consistent. No more than three readings were made as the technique of forced inspiration followed by forced expiration is tiring.

There are few studies in the literature directly comparing the ability of different investigative techniques to detect the effects of either a nasal decongestant or challenge. Gleeson *et al.*[6] compared rhinomanometry peak flow and a method of assessing nasal volume by filling the nose with saline and tipping it out. They investigated the effect of a decongestant cocaine and a histamine challenge.

Their method of measuring nasal volume was 100% sensitive (in 12 subjects) in detecting the effect of cocaine. Passive anterior rhinomanometry had a sensitivity of only 64% (seven out of 11) and peak inspiratory flow a sensitivity of 50% (six out of 12). It would appear that nasal volume is a sensitive way to measure nasal decongestion but has received little attention in the past. Unfortunately filling the nose with saline

was not well tolerated by most subjects (M. Siodlak, pers. comm.) and this method has not been widely adopted. In contrast manometric rhinometry was well tolerated by all those who agreed to take part in this study.

Acoustic rhinometry is a recent development and few studies have compared it with other methods. Scadding *et al.*[7] compared it with anterior rhinomanometry as a method of assessing the response to an allergic challenge. Using 10 patients with allergic rhinitis they found that whilst all patients showed an increase in nasal resistance after a challenge that increase was barely demonstrable when the patient was already very congested and had a high nasal resistance. Acoustic rhinometry showed a more uniform change in minimal cross-sectional area (volumes not quoted) but two of the subjects showed a rise. This gives a sensitivity for acoustic rhinometry of 80%.

The conclusion is that manometric rhinometry is as sensitive as other described methods of investigating nasal physiology and pharmacology at detecting the decongestant effect of a sympathomimetic such as xylometazoline. It measures a different aspect of the nose compared to spirometry and rhinomanometry and unlike acoustic rhinometry, the volume of air in the sinuses is also measured. It can therefore be seen as complementary to the other methods. Further advances in the technological aspect of this method should produce a useful new tool for use by both scientists and clinicians.

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