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Acoustic rhinometry used as a method to monitor the effect of intramuscular injection of steroid in the treatment of nasal polyps

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Abstract
Acoustic rhinometry is a new method which describes the geometry of the nasal cavity and the epipharynx. The method, based on the reflection of an acoustic signal entered into the nasal cavity, can be used to evaluate the cross-sectional area of the nasal cavity as a function of distance from the nostril. The method has, together with nasal expiratory peak flow (NPF) and nasal index based upon a self assessment score, been used to evaluate, in an objective and dynamic way, the effect of systemic treatment of nasal polyps with steroids in a series of eight patients with recurrent nasal polyposis. The study shows a significant relationship between these three parameters before and after systemic treatment of nasal polyps with steroids. It is concluded that in this study acoustic rhinometry had an accurate and objective method for measuring the geometry of the nasal cavity before and after treatment for processes which block the nasal cavity.

Introduction

Acoustic rhinometry is a new method which describes the geometry of the nasal cavity and the epipharynx. In this study it is used, together with NPF and nasal index to monitor in an objective and dynamic way the effect of systemic treatment with steroids on nasal polyps.

The method initially described by Hilberg, *et al.* (1989) is based upon the reflection of an acoustic signal entering the nasal cavity. It can be used to evaluate the cross-sectional area of the nasal cavity as a function of the distance from the nostril. The method is a potent tool in characterizing the geometry of the nasal cavity because of direct access to the cavity and because it requires little co-operation from the subject. Furthermore, the measurement does not require any flow through the nose and therefore it can be used when the nasal airway is totally occluded.

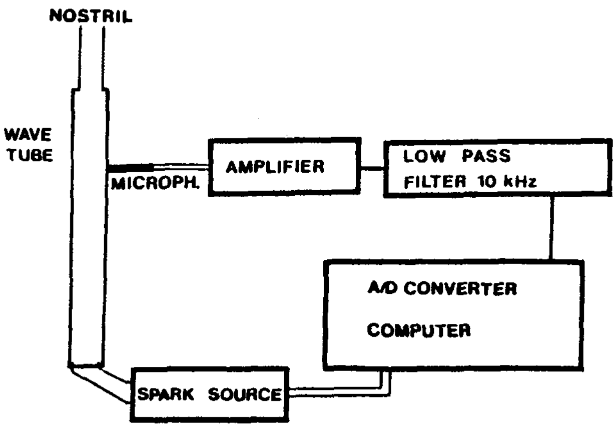

Fig. 1

Diagram of acoustic rhinometry equipment.

Methods

Equipment for acoustic rhinometry

The experimental equipment for acoustic rhinometry

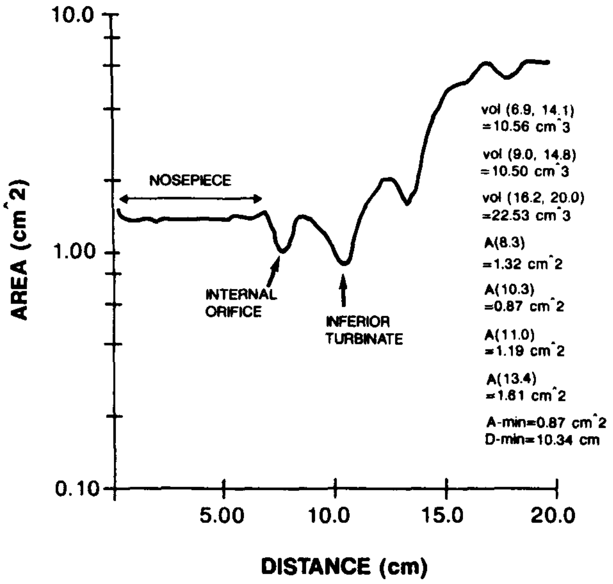

Fig. 2

Normal acoustic rhinometry curve. To the right the volumes in three different segments of nasal cavity and the epipharynx are indicated. Also the cross-sectional areas in four different parts of the nasal cavity and the minimum cross-sectional area and its localization in cms from the anterior part of the nosepiece.

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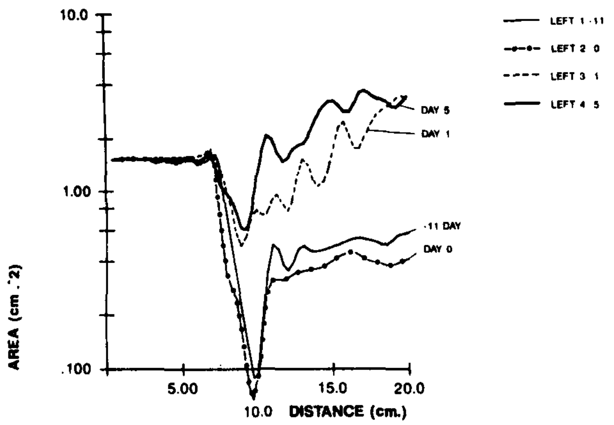

FIG. 3

Acoustic rhinometry curves before (day 11, day 0) and after (day 1, day 5) injection of steroid.

reflection measurements is briefly described here (Fig. 1). The equipment includes a computer with an analogue-to-digital converter for data acquisition and processing; a trigger module, which produces the acoustic pulse; a wave tube made of bakelite; a piezo-electric microphone, a 20 dB amplifier and a 10 kHz low pass filter. A spark, generated by the trigger module is discharged between two electrodes, placed in the end of the wave tube. This creates an acoustic pulse, which propagates down the wave tube. It passes the microphone and enters the nasal cavity via a 7 cm long brass nosepiece. The free end of the nosepiece is inserted a few millimetres into the nostril. A tight fit into the nostrils is important, and therefore different sizes of nosepiece were used. The sound is reflected by changes in the cross-sectional areas of the nasal cavity. The analogue signal from the microphone is amplified, lowpass filtered and digitized at a sampling rate of 40 kHz. Data are converted to an area/distance function by the software. Area is plotted on the y-axis in a logarithmic scale. This seems best suited to depict the narrower portions of the nasal cavity. The cross-sectional areas are determined

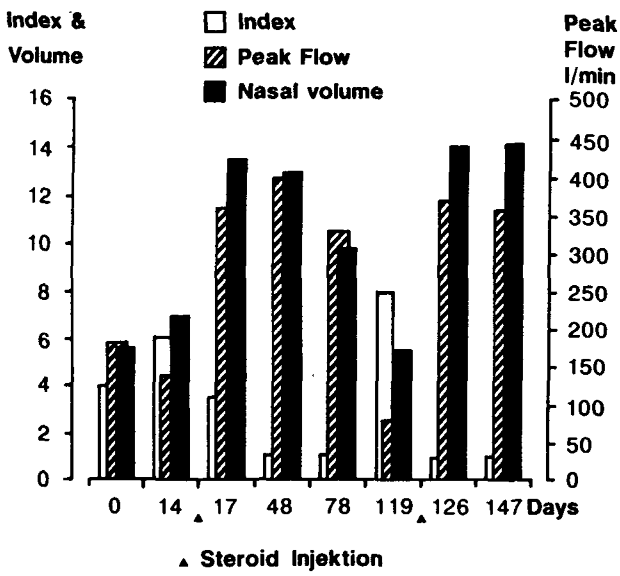

FIG. 4

Variation of volume in the nasal cavity, the nasal index and NPF (nasal expiratory peak-flow) over 147 days.

for a distance of up to 20 cm with a spatial resolution of 0.4 cm. The measurements last 8 msec. Figure 2 shows a typical normal area distance curve, the volumes in the three segments of the nasal cavity and the nasopharynx, together with the cross-sectional areas at four different distances from the anterior end of the nosepiece, the minimal cross-sectional area and its location in centimetres from the anterior end of the nosepiece. On the abscissa, the first 7 cm depict the cross-sectional area of the nosepiece. As its dimensions are known, this part of the curve provides an easy control of the reliability of the registration. This part should always be straight and horizontal. After the straight part the registration of the nasal cavity starts. On the x-axis the distance from the nostrils is expressed in centimetres. On the y-axis the cross-sectional areas are calculated in a logarithmic scale.

Nasal expiratory peak flow measurements (NPF)

A Wright Peak Flow Mini-Meter fitted with an anaesthesetic face mask, covering the upper lip and external nose while the mouth was closed, was employed. The highest value of three measurements of NPF was used. Nasal index scores (graded from 0–10) were recorded by each patient, based on self-assessment, (Borum, *et al.* 1983).

Systemic medical treatment with steroids was given as a single dose of a 2 ml suspension of betamethasone dipropionate and betamethasone disodium phosphate intramuscularly (Deprospan, Essex Pharma).

Material

Eight patients (three female and five male, age range 35 to 62 years) with a long-term history of nasal polyps repeatedly treated by surgery (2–29 times) were selected for the study. Acoustic rhinometry, NPF and nasal index were used to demonstrate the shrinking effect of systemic steroid treatment on the nasal polyps.

Curves obtained by acoustic rhinometry in a patient with nasal polyps are shown in Figure 3. Total occlusion of the nasal cavity, due to polyps was demonstrated twice by acoustic rhinometry, before the intramuscular injection of steroid was given. Acoustic rhinometry was then applied one day and five days after the injection and it is clearly demonstrated that there is a significant shrinkage of the polyps and consequent increase of the passage of air through the nasal cavity.

For long-term follow-up of the effect of systemic steroid treatment the total volume of the nasal cavity (9.0–14.8 cm, see Fig. 2) was used. This gives a more objective picture of the changes and the patency of the nasal cavity than that obtained by just looking at the total curve produced by acoustic rhinometry.

Figure 4 shows the variation of the volume of the nasal cavity, the nasal cavity, the nasal index and NPF in patient one over 147 days. The results from all eight patients are indicated in Table I. At the initial visit symptoms and signs were recorded along with baseline measurements of nasal volume, nasal index and NPF. The values of the three parameters from the first two visits depicted the results before intramuscular injection of steroid and acted as a control of the effect of steroid.

TABLE I

Number of patients	Sex and age		Visit 1	Visit 2	Visit 3	Visit 4	Visit 5	Visit 6	Visit 7	Visit 8
Patient 1	♂ 45	Nasal vol peakflow	5,66	6,90	13,51	13,03	9,69	5,54		
		index	180	140	360	400	330	80		
			4	6	–	1	1	8		
Patient 2	♂ 56	Nasal vol peakflow	5,42	6,56	7,98	7,67	12,69	—	6,82	6,40
		index	280	295	350	310	270	275	260	230
			5	4	1	1	3	2	1	1
Patient 3	♂ 61	Nasal vol peakflow	5,18	5,90	6,92	9,31	—	10,62	11,19	13,14
		index	70	90	120	150	120	150	160	130
			7	7	—	2	2	1	1	1
Patient 4	♂ 34	Nasal vol peakflow	4,13	4,27	10,06	11,39	6,15	9,72	10,58	
		index	110	180	355	450	—	360	380	
			6	6	1	1	1	1	1	
Patient 5	♂ 57	Nasal vol peakflow	7,17	8,72	14,66	13,10	10,47	12,68	12,61	
		index	200	140	190	230	210	220	140	
			5	6	2	1	2	2	2	
Patient 6	♂ 62	Nasal vol peakflow	13,51	12,75	16,47	15,58	16,34	13,62	13,02	
		index	210	480	320	340	250	300	280	
			4	4	2	2	2	2	2	
Patient 7	♂ 37	Nasal vol peakflow	3,37	4,20	8,32	9,12	5,04	6,85	3,82	
		index	30	90	150	180	100	100	40	
			6	6	1	1	1	1	5	
Patient 8	♂ 39	Nasal vol peakflow	11,11	9,64	14,68	15,40	16,22	12,65		
		index	40	130	190	180	180	150		
			7	6	2	2	1	1		

From the third and subsequent visits the effect of steroid on the three parameters was seen. There was a significant correlation between the three parameters before and after the intramuscular injection of steroid. In all cases the effect of the steroid was manifested by an increase of nasal volume, an increase of NFP and a decrease of nasal index. In all cases there was also an improved sense of smell. No side effects of the intramuscular injection of steroid were recorded.

Discussion and conclusions

Surgical removal of nasal polyps is usually recommended when they interfere with nasal respiration, but it is well-known that in many patients repeated surgery is unnecessary. The efficiency of systemic medical treatment with steroids in nasal polyposis has been described earlier and Fogstrup *et al.* (1988) showed that medical treatment with systemic steroid can be an alternative to surgical removal. Usually the effect has been evaluated by subjective observations but in this study acoustic rhinometry has been used to monitor, in an objective and dynamic way, the effect of an intramuscular injection of steroid in nasal polyposis. In this study acoustic rhinometry has also been shown to be an accurate and objective method of measuring the geometry of the nasal cavity. It is easy to perform and possesses a high potential for investigating physiological and pathological change in the nasal cavity.

Key words: Acoustic rhinometry; Rhinometry; Nasal polyps

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