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Spirometric forced volume measurements in the assessment of nasal patency after septoplasty. A prospective clinical study

Knud Larsen and Henrik Oxhøj, Esbjerg, Denmark

SUMMARY

Methods for assessing the nasal patency are needed in the evaluation of patients with symptoms of nasal stenosis. Apart from the commonly used rhinomanometric method spirometric forced volume measurements as well as nasal peak flow rate have gained interest especially in studies concerning allergic rhinitis and nasal hyperreactivity. We have measured the expiratory and inspiratory forced volume in 0.5 second through the mouth and nose in 12 patients before and after septoplasty and in ten controls. A nasal patency index (NPI) was calculated from the ratio between nasal and oral measurements. The expiratory and inspiratory NPI for the preoperative worst cavity and the expiratory NPI for the total nose showed significant improvement. These indices from the patients preoperative measurements also differed significantly from controls. We found the method easy to handle and sensitive enough to detect changes of the nasal patency after septoplasty.

The commonly used method for measuring nasal patency is rhinomanometry. Other methods, both more complicated ones as bodyplethysmography and the opening interrupter method, as well as simple ones as nasal peak flow and spirometric measurements have been studied. The simpler methods have particularly been applied in nasal challenge studies. The purpose of the present study was to evaluate the nasal patency by spirometric measurements before and after nasal surgery for nasal stenosis.

MATERIAL AND METHODS

Twelve patients undergoing septoplasty because of nasal stenosis and ten controls without nasal complaints voluntered for the study (Table 1). A McDermott digital bellows spirometer (Garw Electronic Instruments) connected to a Hewlett Packard x-y recorder (HP 7744 A) was used for the measurements of forced expiratory and inspiratory volumes in 0.5 second (FEV 0.5 and FIV 0.5). An anaesthesia mask, Mc Hesson Hood no.5, was used as mouthpiece for both nasal

Table 1. Median and range date for 12 patients (ten males, two females) and ten controls (seven males and three females).

	age (years)	height (cm)	weight (kg)
patients	33.5 (15-48)	176.5 (168-196)	72 (56-104)
controls	35.5 (25-44)	175.5 (159-181)	70 (57- 77)

and oral measurements. The spirometer was calibrated before every test session. Volumes are reported at ambient temperature, atmospheric pressure and saturated with water vapour (ATPS). The starting point of the forced ventilatory manoeuvre was obtained by backward extrapolation to zero volume change of the steepest part of the volume time-curve. The best of three readings was taken as the result. Expiratory and inspiratory nasal patency index (NPI) was calculated. Expiratory NPI= nasal FEV 0.5/oral FEV 0.5. Inspiratory NPI=nasal FIV O.5/oral FIV 0.5. NPI was calculated for the total nose and for the preoperatively worst and best sides respectively. Postoperatively the same sides were measured and compared. Measurements were obtained preoperatively and three months postoperatively. No decongestants were used. During measurements of a single nasal cavity the other side was occluded with water soaked cotton fitted to the vestibulum and fixed with tape, care being taken not to deform the open cavity. To investigate the stability of the indices 11 test persons had repeated measurements through the mouth and total nose immediatly after the termination of the test session. Postoperatively the patients were asked to give an all over subjective judgement of the change in nasal patency as either improved, unchanged or worsened.

The forced ventilatory manoeuvres were performed with good cooperation from all test persons. During maximal nasal expiration a few were in some instances incapable of relaxing the soft palate which resulted in a "broken" non usable curve. By repeated trials all test persons were able to deliver a technically satisfactory curve. A few test persons found the forcing of the Eustachian tube a little uncomfortable. In no case in the present study was observed total occlusion on nasal inspiration. For paired comparisons Wilcoxon's test for paired differences was used. Mann Withney's test was applied for the comparison of two means. The data samples did not show evidence of non normal distribution. $P<0.05$ was considered statistically significant.

RESULTS

The expiratory and inspiratory NPI for the preoperatively worst cavity showed the most pronounced improvement (Figure 1) and were also the parameters that most clearly differentiated patients from controls (Table 2). Also the preoperative expiratory NPI for the total nose showed significant improvement postoperatively. NPI for the preoperatively best side and the inspiratory NPI for the total

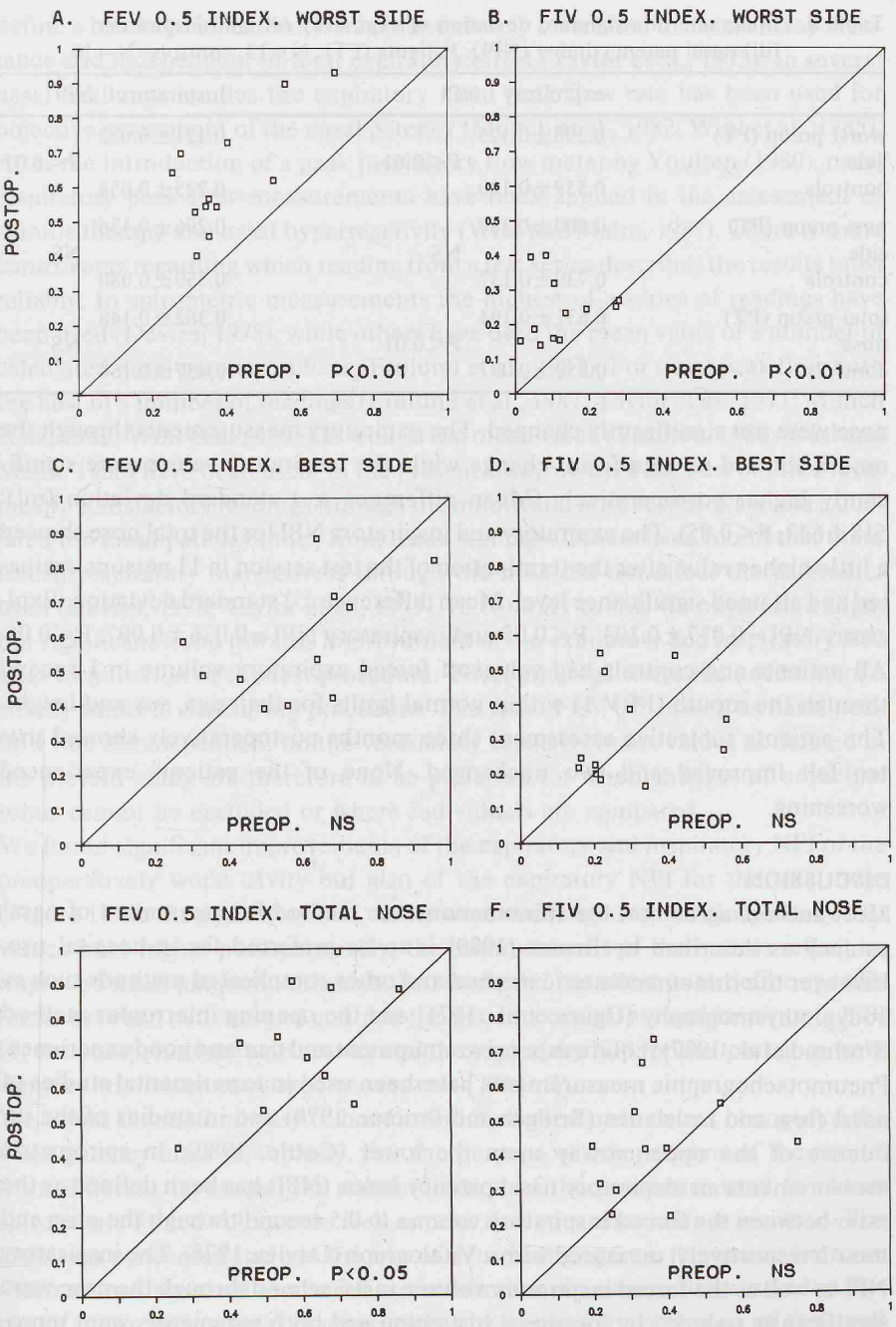

Figure 1. Pre- and postoperative nasal patency index (NPI).

The changes of the expiratory NPI (A, C and E) and the inspiratory NPI (B, D and F). Results above the line of identity denotes postoperative improvements of the NPI.

Table 2. Mean and one standard deviation of expiratory (dl) and inspiratory (dl) nasal patency index (NPI). Patients (PT): N = 12, controls: N = 10.

	expiratory	NPI	inspiratory	NPI
worst preop (PT)	0.398 ± 0.125		0.121 ± 0.082	
side		P < 0.01		P < 0.01
controls	0.559 ± 0.120		0.225 ± 0.054	
best preop (PT)	0.600 ± 0.184		0.296 ± 0.136	
side		NS		NS
controls	0.739 ± 0.137		0.350 ± 0.080	
total preop (PT)	0.631 ± 0.194		0.362 ± 0.148	
nose		P < 0.01		NS
controls	0.851 ± 0.097		0.457 ± 0.164	

nose were not significantly changed. The expiratory measurements through the mouth showed no significant change while the inspiratory values were significantly higher postoperatively (Mean difference ± 1 standard deviation (ml): 518 ± 643, $P < 0.05$). The expiratory and inspiratory NPI for the total nose showed a little higher value after the termination of the test session in 11 persons evaluated and attained significance level. Mean difference ± 1 standard deviation: Expiratory NPI = 0.077 ± 0.103, $P < 0.05$ and inspiratory NPI = 0.076 ± 0.097, $P < 0.05$. All patients and controls had values of forced expiratory volume in 1 second through the mouth (FEV 1) within normal limits for their age, sex and height. The patients subjective assessment three months postoperatively showed that ten felt improved and two unchanged. None of the patients experienced worsening.

DISCUSSION

Most authors agree that the rhinomanometric method for assessment of nasal patency as described by Broms (1980) is to be preferred for in-hospital use. However the rhinomanometric method and other complicated methods such as bodyplethysmography (Ogura et al., 1971) and the opening interrupter method (Frølund et al., 1987) require expensive equipment and demand good experience. Pneumotachographic measurements have been used in experimental studies of nasal flow and resistance (Bridger and Proctor, 1970) and in studies of the influence of the upper airway upon the lower (Cottle, 1980). In spirometric measurements an inspiratory nasal patency index (NPI) has been defined as the ratio between the forced inspiratory volume in 0.5 second through the nose and mouth respectively, measured with a Vitalograph (Davies, 1978). The inspiratory NPI as well as the forced inspiratory volume in 0.5 second through the nose were significantly reduced by intranasal histamine and both parameters were reproducible and sensitive indices of nasal patency. Peak expiratory flow rate through the mouth and nose measured with a Wright peak flow meter have been used to

define a blockage index which was found closely correlated to nasal airway resistance and independent of total expiratory effort (Taylor et al., 1973). In several nasal challenge studies the expiratory nasal peak flow rate has been used for objective assessment of the nasal patency (Munch et al., 1982; Wihl et al., 1985). After the introduction of a peak inspiratory flow meter by Youlten (1980), nasal inspiratory peak flow measurements have been applied in the assessment of rhinitis therapy and nasal hyperreactivity (Wihl and Malm, 1987). There is some controversy regarding which reading from a test series describes the results most reliably. In spirometric measurements the highest of a series of readings have been used (Davies, 1978), while others have used the mean value of a number of calculated nasal patency indices (Frølund et al., 1987). For nasal peak flow both the best of a number of readings (Frølund et al., 1987; Taylor et al., 1973; Munch et al., 1982; Wihl et al., 1985) as well as the mean value (Youlten, 1980; Wihl and Malm, 1988) have been used. In the present study we used the best of three technically statisfactory readings through the mouth and nose respectively and calculated the nasal patency index from these readings. Others have found that these forced respiratory manoeuvres through the nose did not affect the parameter used (Davies, 1978; Taylor et al., 1973). In contrary to this we observed a slight but significant trend towards improvement of the expiratory and inspiratory NPI after termination of the test procedure. These findings stress the necessity of a strictly uniform measuring procedure. The nasal FEV 0.5 as well as nasal peak flow rate also dependent on the ventilatory capacity. Index values as defined in the present study are therefore to be preferred for when changes of bronchial tonus cannot be excluded or where individuals are compared.

We found significant improvements of the expiratory and inspiratory NPI of the preoperatively worst cavity but also of the expiratory NPI for the total nose (Figure 1). As the expiratory oral values were unchanged and the inspiratory oral values were higher postoperatively, the improvements of the indices reflect an improved nasal patency. Although the results did not allow us to define specific limits between patients and controls the patients expiratory and inspiratory NPI for the preoperatively worst cavity and the expiratory NPI for the total nose were significantly lower compared to controls (Table 2).

We found the method easy to handle and it allowed us to detect changes of the nasal patency after septoplasty. For the purpose of comparisons of the results from different investigations standardisation of the procedure used to obtain spirometric forced volumes as well as peak flow measurements is required. The problems concerned include the use of detumising agents, the option between mean or maximum value of a series, the number of readings to be included, the use of index versus nasal readings only, the method for occlusion of the nasal vestibulum when the opposite side is measured, the use of nose clips in oral measurements, and type of mouthpiece used for connection to the instrument.

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K. Larsen, M.D.
Rosenvaenget 9
DK-6710 Esbjerg V
Denmark