

Original Article

Effects of cruroraphy and laparoscopic Nissen fundoplication procedures on pulmonary function tests in gastroesophageal reflux patients

Ismet Ozaydin¹, Ali Nihat Annakkaya², Cigdem Ozaydin³, Metin Aydın¹

Departments of ¹General Surgery, ²Respiratory Diseases, Duzce Medical Faculty, Duzce University, Düzce; ³Department of Microbiology, Duzce Ataturk State Hospital, Düzce

Received December 24, 2013; Accepted January 22, 2014; Epub February 15, 2014; Published February 28, 2014

Abstract: Gastroesophageal reflux disease plays a role in the etiology of asthma, chronic bronchitis, aspiration pneumonia, bronchiectasis and interstitial lung fibrosis by affecting the upper respiratory system. To investigate the changes in pulmonary function tests in patients who underwent cruroraphy and laparoscopic Nissen fundoplication for gastroesophageal reflux disease. Between January and October of 2012, cruroraphy and laparoscopic Nissen fundoplication have been carried out on 40 patients with gastroesophageal reflux disease in the Department of General Surgery, Faculty of Medicine, Duzce University. Patients had pulmonary function tests were measured pre-operatively and on postoperative day 20. Increases in forced vital capacity, forced expiratory volume in 1 second/forced vital capacity and forced expiratory flow between 25-75% of vital capacity were observed postoperatively in all patients and these increases were found to be statistically significant ($p=0.001$). Change in the forced expiratory volume in 1 second was not statistically significant ($p=0.182$). We conclude that treatment of reflux in early stages by surgical procedures could prevent development of chronic lung disease by safeguarding the pulmonary system functions.

Keywords: Gastroesophageal reflux, cruroraphy, Nissen fundoplication, pulmonary function tests

Introduction

Passage of gastric contents from the cardia into the esophagus is referred to as gastroesophageal reflux (GER). GER is a physiological process that can happen in normal individuals 8-10 times a day as long as they occur after meals. However, this process can progress to pathological levels, termed as gastroesophageal reflux disease (GERD), if it causes signs and symptoms and/or irritates and injures mucosal layer of the distal esophagus [1].

The clinical manifestations are considered typical of GERD and characterized by heartburn and regurgitation. However, it is also associated with pulmonary symptoms and lower airway diseases, such as asthma, chronic cough, bronchitis, aspirate pneumonia, idiopathic pulmonary fibrosis. It also is related to hoarseness, laryngitis, subglottic stenosis, granuloma and laryngeal carcinoma, and other extra-esophageal manifestations such as noncardiac chest

pain, dental erosion, sinusitis, pharyngitis, and sleep apnea [2].

To date, management of GERD includes sleeping while the head is elevated, regulation of the eating habits, weight loss, avoiding tight clothing, medical treatment with antacids, prokinetic agents, H₂ receptor blocking agents, proton pump inhibitors, and reflux surgery. Response to medical treatment in these cases is over 90%. However, when the medical treatment is terminated, recurrence occurs in 80% of the cases and these patients become dependent to medications nearly for the rest of their lives. Therefore, surgical procedures have gained popularity to treat classical symptoms of GERD and prevent complications related to the pulmonary tissue. Unresponsiveness to medical treatment, atypical symptoms, Barrett esophagus, stricture, severe esophagitis, decreased lower esophageal sphincter pressure and high Demeester score during pH monitoring comprise the indications for surgery in GERD [2, 3].

Table 1. Demographic and baseline characteristics of the patients

Characteristics	
Sex (M/F) n (%)	18/22 (45/55)
Age (year)*	43.9 ± 14.6
BMI (kg/m ²)*	26.5 ± 4.3
Duration of GER* (year)	5.4 ± 1.8
Level of Ig E* (IU/MI) (M/F)	320 ± 11.0/195 ± 7.0
History of Allergy n (%)	11/40 (27.5)

*Values are expressed as mean ± SD.

In recent decades, several surgical techniques have been developed to treat it. Nowadays, the Nissen and Nissen-Rossetti procedures are most used due to its high efficiency [4, 5].

This study was designed to compare the results of pre- and postoperative pulmonary function tests (PFT) given to patients with GERD, who were scheduled to undergo surgical treatment. We hypothesized that performing cruroraphy and Nissen fundoplication in earlier stages of GERD, i.e. before the occurrence of pulmonary complications would yield beneficial effects, as depicted by PFT.

Material and method

Population

Forty patients scheduled for surgery in the Department of General Surgery, Faculty of Medicine, Duzce University for GERD between January and October 2012 were included in the study.

Study design

This study was undertaken in accordance with the Helsinki Declaration and approved by the Local Ethics Committee. Histories of the patients were taken, demographic data such as age, sex, occupation were recorded and patients underwent physical examination. All patients gave up smoking or they stopped smoking had been ten years. All patients had esophagogastrosopy to determine a possible hiatus hernia and esophagitis. Further, PA and lateral chest radiographs and electrocardiogram were obtained and Ig E test and Prick test for any allergy were carried out. All patients had cruroraphy and laparoscopic Nissen fundoplication. Pulmonary function tests were performed preoperatively and postoperatively on

day 20 to measure forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), FEV1/FVC, forced expiratory flow between 25-75% of vital capacity (FEF 25-75).

Statistical analysis

Descriptive statistics of numerical variables were calculated as mean ± SD and categorical characteristics were calculated as frequency (count and percent). Kolmogorov-Smirnov test was used for normally test of numerical characteristics. Paired t-test was used for comparison pre and post operative, FVC, FEV1, FEV1/FVC, FEF 25-75 values. The results were recorded by the principal investigator and analyzed statistically upon completion of the study. The statistical analysis was performed using SPSS software, version 11.5 (SPSS, Inc., Chicago, IL). P value less than 0.05 was considered statistically significant.

Results

A total of 40 subjects, 22 females (55%) and 18 males (45%), with an overall mean age of 43.9 ± 14.6 years (range: 22-74) were included in the study. Mean duration of reflux was 5.4 ± 1.8 years. Mean Ig E level was 320 ± 11.0 IU/mL in males and 195 ± 7.0 IU/mL in females. Eleven patients (27.5%) had elevated IgE levels. IgE levels of subjects with positive “prick” test were significantly high. Six patients were allergic to mites, four patients were allergic to pollens while one patient had allergic rhinitis. Demographic and baseline characteristics of the patients are summarized in **Table 1**.

Pre-operative and post-operative FVC, FEV1, FEV1/FVC and FEF 25-75 values were measured and compared statistically. We found that FVC (p=0.001), FEV1/FVC (p=0.001) and FEF 25-75 (p=0.001) increased in the post-operative period in all cases and this increase was statistically significant. Changes in FEV1 were not statistically significant (p=0.182). Results of pulmonary function tests are presented in **Table 2**.

Discussion

This study highlighted three points: a) IgE levels are high in a significant proportion of subjects with GERD, all of whom were positive for “prick” allergy tests. b) Postoperative FVC, FEV1/FVC and FEF 25-75 were significantly higher than

Nissen pulmonary function tests gastroesophageal reflux

Table 2. Ventilatory pulmonary function parameters in patients with preoperative and postoperative

Variables	Preop	Postop	p
FVC, % pr.*	91.47 ± 10.19	96.77 ± 9.90	0.001
FEV1, % pr.	88.70 ± 13.04	115.88 ± 19.63	0.182
FEV1/FVC, % pr.	79.78 ± 11.89	81.00 ± 8.12	0.001
FEF25-75, % pr.	86.05 ± 17.77	93.23 ± 18.41	0.001

*% pr. - % of predicted value.

preoperative values in all cases. c) Changes in FEV1 measurements of the subjects before and after the operation were not statistically significant.

In the present study, we compared the results of preoperative and postoperative PFTs and investigated the effects of clinical improvement achieved by surgery on the respiratory system. GERD is considered to be an important risk factor in the development of pulmonary diseases [6-8]. Various studies reported edema, inflammation of the upper and lower respiratory tract and increased pulmonary resistance secondary to chronic aspiration. Associations between GERD and chronic coughing, asthma, chronic obstructive lung disease and other pulmonary diseases have been reported in the literature [9, 10]. The primary objective of the present study was to explore if surgical correction of the chronic passage of gastric contents to the respiratory system could prevent permanent damage in the respiratory epithelia as a result of chronic irritation.

We observed statistically significant improvements in FVC, FEV1/FVC and FEF 25-75 postoperatively. These results suggested that the pulmonary functions improved though absence of significant improvement in FEV1 casts a doubt. In that case, clinical improvement observed in pulmonary functions gives hope. We attributed the absence of significant improvement in FEV1 to performing the postoperative pulmonary function tests relatively early. It would be a promising and satisfactory result if pulmonary function tests made in the future show significant improvement in FEV1, which suggests that restoration of pulmonary functions in the postoperative period in patients with GERD is a continuous process. As such, beneficial effects of surgical procedures on pulmonary functions in reflux patients can be dem-

onstrated by more detailed clinical studies.

Preoperative pulmonary function tests of some patients with pathological GER were within normal range. This is possibly due to prevention of aspiration into the lungs by some defense mechanisms of the upper respiratory tract. Still, these patients experienced improvements in postoperative pulmonary function tests as well.

Embryological developments of the respiratory tract and the esophagus are related and both are innervated by the vagus nerve [11, 12]. A few researchers argued that acid reflux to the distal esophagus stimulated the local receptors at the esophageal mucosa. It is believed that this stimulus is conveyed to the central nervous system by the afferent fibers of the vagus nerve and elicits bronchospasm via the efferent fibers of the same nerve. Therefore it is not surprising to observe edema, inflammation and increased pulmonary resistance both in the upper and lower respiratory tracts [10, 13]. Acid reflux to the esophagus, which is significantly diminished in the postoperative period, does not cause vagal stimulation. Absence of excessive vagal stimulation, in turn, rectifies bronchospasm and improves FVC, FEV1/FVC and FEF 25-75.

High Ig E levels in 27.5% of the cases and positive "prick" allergy tests among these patients led us to conclude that GER causes more respiratory problems in individuals with allergy than in the normal population [14].

The present study has clear limitations. Limited number of cases stands at the forefront of these constraints. Furthermore, carrying out a single type of surgical procedure, performing the postoperative pulmonary function test in early stages, not assessing the pre-operative and post-operative exercise capacities by tests and not measuring the pre-operative and post-operative arterial gases are the other constraints. We believe that the results obtained from this study would be more meaningful when supported by multicenter studies including higher number of patients. Studies which employ different anti-reflux surgical procedures perform postoperative pulmonary function tests in later stages, measure exercise capacities and arterial blood gas levels would yield more detailed information.

Nissen pulmonary function tests gastroesophageal reflux

In conclusion, significant improvements in pulmonary function tests can be acquired in patients with GERD by crurography and laparoscopic Nissen fundoplication. We conclude that solving the reflux-related problems in early stages by surgical interventions can prevent development of chronic lung diseases by preserving the pulmonary system functions.

Disclosure of conflict of interest

The authors have nothing to disclose.

Address correspondence to: Ismet Ozaydin, Department of General Surgery, Duzce Medical Faculty, Duzce University, Konuralp, Duzce Turkey 81620. Tel: 90 3805421390; Fax: 90 380 5421387; E-mail: drcozaydin@hotmail.com; Ali Nihat Annakkaya, Department of Respiratory Diseases, Duzce Medical Faculty, Duzce University, Düzce. E-mail: annakkaya@gmail.com

References

- [1] Moss SF, Armstrong D, Arnold R, Ferenci P, Fock KM, Holtmann G, McCarthy DM, Moraes-Filho JP, Mutschler E, Playford R, Spechler SJ, Stanghellini V, Modlin IM. GERD 2003: A consensus on the way ahead. *Digestion* 2003; 67: 111-7.
- [2] Nassif PA, Pedri LE, Martins PR, Foani MM, Justen Mda S, Varaschim M, Bopp DS, Malafaia O. Incidence And Predisponent Factors For The Migration Of The Fundoplication By Nissen-Rossetti Technique In The Surgical Treatment Of Gerd. *Arq Bras Cir Dig* 2012; 25: 75-80.
- [3] Knol EK, Costel DO. Clinical spectrum and diagnosis of gastroesophageal reflux disease. In: Costel DO, Richter JE, eds. *The Esophagus*. 4th ed. Philadelphia: Lippincott Williams and Wilkins, 2003. pp: 375-81.
- [4] Townsend MC, Beauchamp RD, Evers BM, Mattox KL. *Sabiston, tratado de cirurgia: a base biológica da moderna prática cirúrgica*. 17ª. ed. Rio de Janeiro: Elsevier; 2005. Vol. 1, pp: 1158-1160.
- [5] Salihoglu Z, Demiroglu S, Dikmen Y, Taksin M. Intramucosal pH Measurements for Extremely Obese Patients During Laparoscopic Bariatric Surgery. *Anesth Analg* 2004; 98: 265-6.
- [6] Irwin RS, Curley FJ, French CL. Chronic cough. The spectrum and frequency of causes, key components of the diagnostic evaluation, and outcome of specific therapy. *Am Rev Respir Dis* 1990; 141: 640-7.
- [7] Irwin RS, Zawacki JK, Curley FJ, French CL, Hoffman PJ. Chronic cough as the sole presenting manifestation of gastroesophageal reflux. *Am Rev Respir Dis* 1989; 140: 1294-300.
- [8] Sifrim D, Dupont L, Blondeau K, Zhang X, Tack J, Janssens J. Weakly acidic reflux in patients with chronic unexplained cough during 24 hour pressure, pH, and impedance monitoring. *Gut* 2005; 54: 449-54.
- [9] Atalay F, Dagli U, Kuran S, Ozin Y, Ernam D, Sahin B. Does acid reflux cause pulmonary disease? *Turk Gastroenterol* 2005; 16: 199-202.
- [10] Ing AJ, Ngu MC, Breslin AB. Pathogenesis of chronic persistent cough associated with gastroesophageal reflux. *Am J Respir Crit Care Med* 1994; 149: 160-7.
- [11] Napierkowski J, Wong RK. Extraesophageal manifestations of GERD. *Am J Med Sci* 2003; 326: 285-99.
- [12] Mansfield LE, Hameister HH, Spaulding HS, Smith NJ, Glab N. The role of the vagus nerve in airway narrowing caused by intraesophageal hydrochloric acid provocation and esophageal distention. *Ann Allergy* 1981; 47: 431-4.
- [13] Schan CA, Harding SM, Haile JM, Bradley LA, Richter JE. Gastroesophageal reflux-induced bronchoconstriction. An intraesophageal acid infusion study using state-of-the-art technology. *Chest* 1994; 106: 731-7.
- [14] Scordamaglia A, Passalacqua G, Ruffoni S, Parodi MN, Ciprandi G, Canonica GW. Two secreting methods for detection of specific IgE to inhalant allergens. Comparison with skin prick tests and RAST. *J Invest Allergol Clin Immunol* 1991; 1: 324-329.