Background: Crural diaphragm (CD) is currently suggested as an external esophageal sphincter (EES) localized in a high-pressure zone (HPZ) area. Impaired CD function is an independent predictor of gastro-esophageal reflux disease (GERD). Abnormalities of diaphragm function in GERD patients have not been ever followed. Moreover, a functional impairment of crural (posterior) part of diaphragm in HPZ during maximum inspiratory/expiratory maneuvers (Plmax/Pe max) has not been followed, too.

Aims and objective: Hypothesis 1: Patients with GERD have impaired both total diaphragmatic function and Plmax/Pe max values. Hypothesis 2: Subnormal intraesophageal pressures of LES part during Plmax/Pe max maneuvers will be detected in those subjects in whom reduced respiratory muscle strength was primarily detected. Hypothesis No. 3: Possibly, we might discriminate a pattern of diaphragmatic response during Plmax/Pe max maneuvers. Hypothesis No. 4: The maximum force of crural part of the diaphragm encompassing the LES part of esophagus might be quantified (by a manometrical approach).

Methods and patients: Twenty patients with endoscopically/pH-metrically verified GERD were tested at the age of 43.6±11.1 (mean±SD, y) EES activity during standard Plmax/Pe max maneuvers (respiratory drive measurement, RDM) was used. An extended multi-probe esophageal manometry was used; pressure changes in the HPZ area of the esophagus were assessed. After the exclusion of manometric probe/sonde by the probands was also performed classical spirometry.

The following methods: PFT were used: standard spirometry including FVC curve, respiratory muscle (RM) drive measurements (maximum inspiratory (PImax)/expiratory (PEmax)) pressures. Spirometric recordings of PFT were performed on the same day for all subjects with a spirometer MasterScope Jaeger (version 4.5, Jaeger, VIASYS, Wuerzburg, Germany) with a special module for the respiratory muscles (RM) drive assessments. All subjects were properly instructed and coached by an experienced technician. Procedures and quality criteria of the American Thoracic Society and were used for these measurements. The following PFT parameters were measured: FEV1, FVC, FEV1/FVC, PImax, PEmax. PFT results are presented as percentages of reference values.

Esophageal manometry is an additional, non-invasive imaging method, which aims to determine the pressure in the lower esophageal sphincter (LES), including the relaxation response to swallowing, and to describe esophageal peristalsis. The benefit of HRM is: easy of the realisation of the examenees reproducibility of the examination completely interceptive of the whole esophagus, including the upper and lower esophageal sphincter with the possibility of online assessment and coordination/dyscoordination before-mentioned structures, as well as clear identification of the so-called transition zone, 4 more detailed observation of the LES.

Results: Twenty patients with endoscopically/pH-metrically verified GERD were tested at the age of 43.6±11.1 (mean±SD) y. EES activity during standard Plmax/Pe max maneuvers (respiratory drive measurement, RDM) were used. An extended multi-probe esophageal manometry was used; pressure changes in the HPZ area of the esophagus were assessed. Decreased Plmax (p<0.00001) and just slightly diminished Pe max (p=0.053) was found. The pressure in the esophagogastric junction (EGJ) increased from rest value (of 14.6±7.1 mm Hg) during both Plmax and Pe max. Pl max to 62.5±24.6 mm/Hg, p<0.00001; Pe max 55.4±22.5 mm Hg, p<0.00001.

Correlation of the spirometric and manometric data showed a correlation between Pe max and a positive increase in LES pressure (p = 0.0104). Correlation between Pl max and an increase in LES pressure was not statistically significant (p = 0.47).

At the same time we observed the reaction of CD in the LES part of esophagus by maximum respiratory maneuvers. During Plmax maneuver we observed two types of reactions in diaphragm: in the first case during a maneuver occurred increase of pressure on the LES – the diaphragm made a concentric contraction. Only at the beginning of the maneuver (by maximum tinge), 7 of the probands (35%) were observed following a paradoxical decrease of pressure in LES (eccentric contraction).

Discussion: The diaphragm activation is decisive for proper EGI function. There is a significant increase of the pressure in EGI during Plmax and Pe max maneuvers. The maximum peak of pressure in EGI was 179 mm/Hg. The diaphragm has the function of the external esophageal sphincter and therefore, is serving as an anti-reflux barrier. There is significant impairment of respiratory muscles strength (especially of the diaphragm) during Pl max maneuver in GERD patients. Pe max was also decreased, but not significantly. There is no correlation between the decrease of Pl max and the degree of CD strength impairment in GERD patients. On the contrary, there was a significant correlation between CD and Pe max - the more PEmax is reduced, the more reduced was the strength of CD and also its effect to EGI pressure and versa. Paradoxically, the decrease of EGI pressure during Pl max was observed in 8 patients. This may be explained as a paradoxical eccentric contraction of the diaphragm during Plmax maneuver, associated with defective breathing patterns. There was also recorded an impaired diaphragm activity and defective breathing patterns during the normal respiration by manometric examination. The majority of these pathological findings were normalized during the facilitation of abdominal breathing (by special RHB technique). Diaphragm dysfunction in GERD patients is evident.