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*Surgical treatment of severe emphysema – analysis of own
material*

Chronic obstructive pulmonary disease (COPD) is a heterogeneous disease with a variable pathophysiologic basis manifested by varying degrees of chronic airflow obstruction and hyperinflation which leads to pathomorphological changes known as emphysema. Over the past 50 years, many advances have been made in the management of COPD. Despite these advances, many patients continue to experience incapacitating breathlessness and exercise limitation which accompany developing diffuse emphysema. Since the very beginning of thoracic surgery, numerous surgical approaches have been devised to ameliorate symptoms in these patients. Lung volume reduction surgery (LVRS) originally proposed by Brantigan and colleagues and revived by Cooper and colleagues, has become a new therapeutic option for patients with severe, end-stage emphysema, a disease that is frustratingly difficult to treat (2,3). They hypothesized that surgical removal of lung volume could restore radial traction on the terminal bronchioles and thereby improve expiratory airflow obstruction and diaphragmatic position and function. Also, global inspiratory muscle strength was noted to improve after LVRS. These effects are believed to be related to reduced hyperinflation. Significant strides have been made in understanding the mechanisms for the improvements after LVRS. Although a heterogeneous response has been noted, an increased static lung elastic recoil pressure has been most frequently implicated as a mechanism of physiologic improvement following LVRS. Factors other than improved elastic recoil may play a role in improving airway tethering in some patients (1,5). Unfortunately, incomplete knowledge of these mechanisms renders accurate predictions of response to surgery very difficult. This lack may in part be related to the presence of intrinsic airway disease that can be seen in smokers with advanced emphysema (12).

Although many physicians have greeted LVRS with enthusiasm, skepticism on the safety and efficacy of this surgical intervention in comparison to conventional medical therapy has arisen (8, 10). LVRS is a palliative intervention which may be offered, as a therapeutic option to highly compliant patients not helped by the best medical therapy. The impact of LVRS on survival, also an exciting question, seems of secondary consideration in this population of desperate patients (4,6,7, 9,11).

The aim of the study was to retrospectively evaluate the results of surgical treatment of patients with severe diffuse emphysema who underwent such

a treatment in the last five years in the Department of Thoracic Surgery of Medical University of Lublin.

MATERIAL AND METHODS

We retrospectively analyzed the data of 99 patients with a diagnosis of Diffuse Severe Emphysema (DSE) who underwent surgical treatment in the Department of Thoracic Surgery of Medical University of Lublin from 1st January 1995 to 31st December 2001. Their age and sex distribution is shown in Table 1.

Most patients (86) were men and more than half of them were more than 60 years old and 12 were above 70. Among 13 women there were only five older than 60. The average age for both sexes was 56.6, for men it was 57 and for women 53.5. Eighty-four of 86 men were smokers (97.7%), while only seven women smoked (53.8%).

Table 1. Age and sex distribution of patients

Age	Male	Female	Both sexes
<40	11	3	14
41 - 50	18	3	21
51 - 60	11	2	13
61 - 70	34	4	38
>70	12	1	13
All	86	13	99

Most of our patients (54/54.5%) were urgently operated because of coexisting and life threatening pneumothorax which had emerged in the course of severe emphysema (Group 1). These patients were for obvious reasons not fully evaluated before surgery. Therefore, none of them had CT chest scan or spirometry.

We had to exclude two patients from further evaluation because of incomplete postoperative assessment.

All other patients (43; 43.4% – Group 2) were qualified for LVRS according to the following criteria: (1) very severe airflow obstruction with dyspnea grade between three and four according to Medical Research Council Dyspnea Scale, (2) $p\text{CO}_2 > 50\text{mmHg}$, (3) $\text{FEV}_1 \leq 35\%$, (4) areas of vanishing lung detected on radiological and perfusion lung scan evaluation; Hypercapnia, whatever its level, or pulmonary hypertension were not considered as exclusion criteria.

Patients from both groups were surgically treated. Patients from Group 1 were operated on between one to seven days after admission. In most cases the procedure was limited to resection of ruptured bullae and pleurodesis or pleurectomy. In 13 cases the operation was conducted with videothoroscopic technique. All the others were operated on through a standard posterolateral thoracotomy. In 26 cases we performed surgical treatment on the left lung and in 27 on the right one.

In this group we were not able to compare and evaluate subjective and objective results of treatment because of the lack of initial data.

Patients from Group 2 were carefully diagnosed before surgery. After clinical examination including assessment of dyspnea degree (according to MRCDS) and routine diagnostic procedures i.e. chest radiography, spirometry, gasometry, CT scan selected patients also had perfusion and ventilation scintigraphy of the lung performed and pulmonary artery pressure estimated.

Patients were selected for LVRS according to the above mentioned criteria.

The operative procedure consisted of reduction in lung volume by plication or applications of the linear stapling devices. Lung volume reduction was directed to the most destroyed areas of the lung as judged by visual inspection and preoperative findings. In all cases, great care was taken to preserve as much functioning tissue as possible, therefore, we tried to limit the resection to 20–25% of lung volume.

Type and side of surgical approach are shown in Table 2.

Table 2. Type and side of surgical approach of patients in Group 2

Surgical approach	Left side	Right side	Bilateral
Thoracotomy	13	16	5
Videothoracoscopy	2	1	
Sternotomy	0	0	3
Clamshell-thoracotomy	0	0	2
All	15	17	10

RESULTS

We observed three perioperative deaths. Two patients died because of acute cardiopulmonary insufficiency, 1 because of septic shock. All deaths happened in Group 1. The mortality rate was 3.03%. The most common complications are collected in Table 3.

Table 3. Most common complications

Type of complication	Group 1	Group 2
Air leak > 5 days	12	6
Emphysema	4	4
Pneumonia	9	8
Respiratory insufficiency	5	4
Death before 30 days since surgery	3	0
Other	5	2
All	38	24

The most frequent complications were air leak > 5 days, cardiopulmonary insufficiency and pneumonia. The overall morbidity rate for both groups was 59.6%. It was significantly higher for patients in Group 1.

We selected some of the preoperative data of Group 2 patients and compared it to those achieved on the day of discharge. A comparative analysis of subjective health and dyspnea status revealed significant improvement on the day of discharge. Before surgery most of the patients (25 cases, 58 %) were classified as stage 4 of dyspnea status according to Medical Research Council Dyspnea Scale. The other 18 patients were staged as grade three. On the day of discharge virtually all patients reported much better general health status and the analysis of dyspnea revealed 12 (28%) patients classified as fourth grade, 26 (60.5%) as third and fifth (11.5%) as grade two.

A comparative analysis of objective measures was not so optimistic. The change in pCO_2 was not significant ($p=0.09$), although the average value fell down from 54.17 to 53.83. The improvement in FEV1 was more evident. The average value before surgery was 877.86 ml, it rose up to 1067.26 and the difference was significant according to t test for correlated variables.

Graphic analysis of this parameter is shown in Figure 1
Group 2

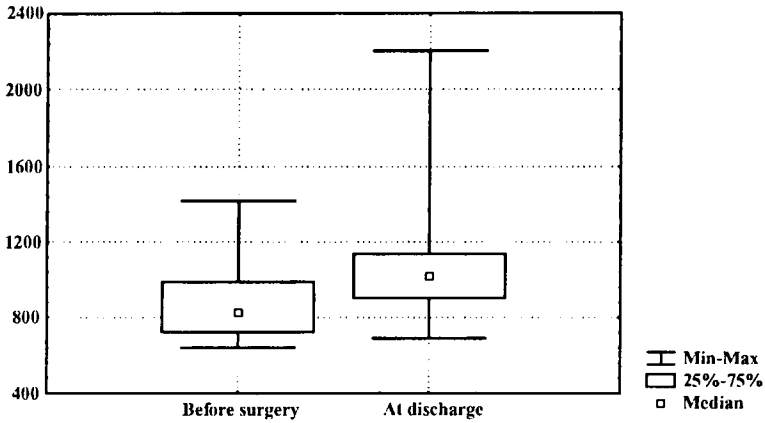


Fig. 1. Comparison of preoperative and postoperative FEV₁ for patients who were treated in a scheduled way – analysis of median values and distribution

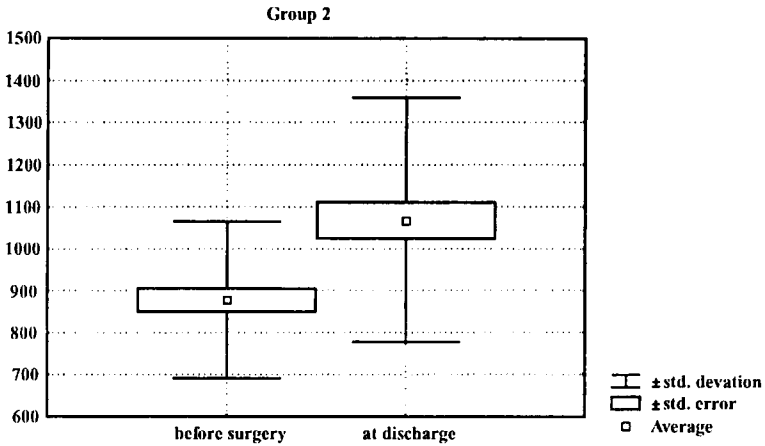


Fig. 2. Comparison of preoperative and postoperative FEV₁ for patients who were treated in a scheduled way – analysis of average values

We did not perform a detailed analysis of the above parameters in Group 1 due to lack of preoperative data to compare, as those patients were emergency treated and not fully evaluated before surgery.

DISCUSSION

For many years, the surgical approach to severe diffuse pulmonary emphysema has been quite variable, reflecting the evolution in the physiopathologic concepts of the disease. Thoracoplasty, costochondrectomy, phrenic neurotomy, sympathectomy, and resection of costal

cartilages are some of the methods which have been performed. In general, the clinical results were poor. Currently, with the exception of pulmonary transplantation, the only type of surgery commonly considered as effective for patients with diffuse pulmonary emphysema is resection of large bullae. The generally accepted concept underlying this procedure is that it counteracts the deleterious effects of bullae, which are compression of the adjacent parenchyma, decreased respiratory muscle efficiency due to hyperinflation, or even right heart compression. The objective of this surgery is to remove the bullous lesions while at the same time sparing the adjacent nonbullous parenchyma. The LVRS procedure targets selected regions of emphysematous lung for resection in order to reduce lung capacity to less than the thoracic cavity volume. This results in the rearrangement of the chest wall and diaphragm geometry and of lung mechanics. An improved pulmonary function follows because of the increased lung recoil that contributes to airway patency and stability. Successful surgery will not improve oxygenation in all, and as we have shown, does not diminish the retention of carbon dioxide, suggesting that the net perfusion level and match with ventilation are not factors in the success of LVRS. In long-term follow up it does not seem to improve objective spirometric measures, either. The only inevitable benefit would probably be the subjective improvement and better life comfort of patients. It is not to disregard that it can preserve from further life-threatening complications like pneumothorax and pulmonary hypertension, although this was not undoubtedly proven.

CONCLUSIONS

During the last seven years 99 patients were offered surgery for severe diffused emphysema and its complications. Most of them were urgently treated for life threatening pneumothorax. Among them, we observed relatively high morbidity and perioperative mortality. The corresponding figures were much higher than for the group of patients qualified to LVRS according to strict criteria and in possible good general status. In this group we were able to perform a more detailed analysis of short-term results of surgical treatment that showed relatively good recovery after operation and satisfying results, mainly in subjective measures. We have not yet obtained our own long-term results of surgical treatment of diffuse severe emphysema, so we can not clearly judge the therapeutic value of LVRS. Confronting our results to those reported by other authors we are able to recognize them as comparable. According to this, we dare to suggest that better results could be achieved with a surgical attempt to emphysema when it is considered as planned treatment before it causes pneumothorax, as forthcoming complications during postoperative care are much more frequent and hazardous in these cases.

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SUMMARY

The aim of the study was a retrospective analysis of effectiveness of surgical treatment of severe diffuse emphysema, including urgent cases with symptomatic pneumothorax. We analyzed 99 patients with severe diffuse emphysema who underwent surgical treatment in Department of Thoracic Surgery in Lublin between 1995 and 2001. The evaluated group consisted of 86 men and 13 women aged from 27 to 83 (mean age 56.6). Among them 54 were operated on due to sudden pneumothorax, which was a result of bursted emphysematous parenchyma. Those patients were not evaluated with spirometry and CT of the chest. All the other patients were carefully examined and qualified for surgical treatment according to precise criteria: presence of clinical and radiological symptoms of diffuse severe emphysema (DSE), $FEV_1 < 35\%$, $pCO_2 > 50\text{mmHg}$. Those 43 patients eligible for Lung Volume Reduction Surgery (LVRS) also did not have any main contraindications for lung surgery. In the whole analyzed population 89 resections were unilateral, limited to 20-25% of the most destructed tissue. In 10 cases operation was bilateral, among them four were simultaneous and the remaining six were not. In our study we evaluated the frequency and degree of complications, early results of treatment, influence of surgery on selected parameters: FEV1, pCO2, subjective dyspnea according to Medical Research Council Dyspnea Scale. We observed three perioperative deaths. The most common complications were air leak > five days, cardiopulmonary insufficiency, pneumonia. Early results showed subjective decrease of dyspnea and in most cases improvement of the analyzed parameters. Conclusions: The early results are optimistic and correspond to the observations of other authors. Further analysis of the collected data and long term results will allow establishing the role of LVRS in treatment of Diffuse Severe Emphysema.

Leczenie chirurgiczne ciężkiej rozedmy płuc – analiza materiału własnego

Celem pracy była retrospektywna ocena wyników leczenia operacyjnego chorych z powodu zaawansowanej uogólnionej rozedmy płuc (ZURP), w tym także powikłanej samoistną, objawową odmą opłucnową. Analizą kliniczną objęto 99 chorych operowanych w Klinice Chirurgii Klatki Piersiowej AM w Lublinie w latach 1995- 2001. W badanej grupie było 86 mężczyzn i 13 kobiet w wieku od 27 do 83 lat (średnia 56,6). U 54 chorych zabieg przeprowadzono w następstwie pęknięcia płuca i następowej odmy opłucnowej i w przypadkach tych nie przeprowadzono przedoperacyjnej oceny spirotegraficznej ani nie wykonano KT kłp. Planowe leczenie operacyjne wykonano u 43 chorych. Wskazaniem do operacyjnej redukcji objętości płuc (LVRS) było stwierdzenie klinicznych i radiologicznych cech ZURP, obniżenia $FEV1 < 35\%$ oraz $pCO_2 > 50\text{mmHg}$. 43 chorych kwalifikowanych do planowej LVRS spełniało także inne kryteria kwalifikacji operacyjnej. W całej poddanej analizie grupie u 89 przeprowadzono jednostronne częściowe (redukcja objętości 20-25%) wycięcie tkanki płucnej w zakresie najbardziej nasilonych zmian rozedmowych na drodze torakotomii. U 10 wykonano operację obustronną jedno- (cztery) lub dwuczasiową (sześć przypadków). Oceniono rodzaj i ilość powikłań, a także przebieg okołoperacyjny i wczesne wyniki leczenia, opierając się na ocenie parametrów spirometrycznych ($FEV1$), gazometrycznych (pCO_2) oraz zmodyfikowanej skali duszności wg Medical Research Council Dyspnea Scale. W całym zbiorze chorych zanotowano trzy przypadki zgonów. Najczęstszym powikłaniem leczenia operacyjnego były w kolejności: przedłużony przeciek powietrza, zaburzenia rytmu serca lub zmiany zapalne płuc. Uzyskane wyniki pozwalają na pozytywną ocenę wczesnych wyników klinicznych i czynnościowych, co zgodne jest z obserwacjami piśmiennictwa i opracowanymi w USA algorytmami postępowania terapeutycznego. Obecnie w Klinice prowadzona jest ocena wyników odległych, których analiza pozwoli na bardziej precyzyjne określenie roli i możliwości LVRS w planowym leczeniu ZURP.