Successful lung volume reduction surgery brings patients into better condition for later lung transplantation

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Received 17 November 2001; received in revised form 28 May 2002; accepted 29 May 2002

Abstract

Objectives: Lung volume reduction surgery (LVRS) is accepted as a potential alternative therapy to lung transplantation (LTX) for selected patients. However, the possible impact of LVRS on a subsequent LTX has not been clearly elucidated so far. We therefore analyzed the course of 27 patients who underwent LVRS followed by LTX in our institution. Methods: Twenty-seven patients (11 male, 16 female, mean age 51.9 ± 2.2 years) out of 119 patients who underwent LVRS between 1994 and 1999 underwent LTX 29.7 ± 3.2 months (range 2–57 months) after LVRS. Based on the postoperative course of FeV1 after LVRS (best value within the first 6 months postoperatively compared with the preoperative value) patients were divided into two groups: Group A (n = 11) without any improvement (FeV1 <20% increase), and Group B (n = 16) with FeV1 increase ≥20% after successful LVRS which declined to preoperative values after 8–42 months. Subsequent LTX was performed 22.9 ± 5.6 months after LVRS in Group A and 34.3 ± 4.9 months after LVRS in Group B (P < 0.05). Patients were analyzed according to the course of their functional improvement and of their body mass index (BMI) after LVRS and to survival after LTX, respectively. Values are given as the mean ± SEM and significance was calculated by the χ²-test whereas continuous values were estimated by Student’s t-test. Results: Patients in Group A without improvement in FeV1 after LVRS had no increase in BMI as well and this resulted in a high perioperative mortality of 27.3% after LTX. On the contrary, patients in Group B, who had a clear increase of FeV1 after LVRS, experienced a significant increase of BMI of 23.2 ± 4.5% as well (P < 0.05). This improvement in BMI remained stable despite a later deterioration of FeV1 prior to LTX. After LTX, these patients had a significantly lower perioperative mortality of 6.3% as compared to Group A (P = 0.03). Conclusions: Successful LVRS delays the need for transplantation, improves nutritional status and brings patients into a better pretransplant condition, which results in decreased perioperative mortality at LTX. Patients after failed LVRS, however, should be considered as poor candidates for later transplantation. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Lung volume reduction; Lung transplantation; Pulmonary emphysema

1. Introduction

Lung volume reduction surgery (LVRS) is accepted as a possible alternative treatment to lung transplantation (LTX) for selected patients with end-stage emphysema [1–5]. To answer the question of whether LVRS is a permanent alternative to LTX, long-term results of multi-center trials are required. In addition, the role of LVRS as temporary bridging to later LTX remains not yet clearly defined. We therefore reviewed our institutional experience with patients undergoing LTX after prior LVRS.

2. Patients and methods

2.1. Patient demographics

Between September 1994 and December 2000, 119 patients (68 male, age 53.8 ± 2.4 years, range 39–79 years) underwent LVRS in our department. Out of 119 patients, 27 patients later underwent LTX at variable points of time (Table 1).

Indications for later LTX were either lack of functional improvement after LVRS (Group A: n = 11) or temporary improvement after LVRS (increase of FeV1 ≥20%) followed by later deterioration of lung function (Group B: n = 16). The patient demography of these two groups is shown in Table 2.
2.2. Surgical technique

The techniques used for the operation performed have previously been described [6]. Out of 92 patients in the LVRS group, 15 patients were operated unilaterally, 77 bilaterally. The surgical approach in this group was sternotomy in ten patients, videoendoscopy in 54 patients and anterior thoracotomy in 28 patients.

In the LVRS-LTX group six patients underwent unilateral LVRS whereas 21 had bilateral LVRS by median sternotomy (n = 5), by video-assisted thoracoscopy (VATS, n = 17) and by anterior thoracotomy (n = 5), respectively.

The subsequent LTX performed in 11 patients was unilateral and in 16 patients bilateral [7].

2.3. Assessment of parameters

The following parameters were analyzed: operative morbidity and mortality, course of FeV1, blood gases, body mass index (BMI).

2.4. Statistical analysis

Data were expressed as the mean ± standard error of the mean. Values were compared with the χ²-test and continuous data were analyzed by Student’s t-test. The mortality was assessed with the log-rank statistic. A P value <0.05 was considered as significant.

3. Results

3.1. Functional results after LVRS

Patients in Group A, with less than 20% improvement in FeV1, had no reduction of elevated preoperative pCO₂ levels and no increase of their reduced BMI after LVRS. Patients in Group B, who had an increase of >20% of FeV1 after LVRS, also experienced a normalization of their blood pCO₂ levels together with a significant increase of their preoperatively reduced BMI. Both improved BMI and pCO₂ remained stable until subsequent LTX, despite the recurrent deterioration of FeV1 prior to LTX (Figs. 1–3).

3.2. Operative morbidity after LTX

Patients were extubated 58.9 ± 18.7 h (median 23.6 h, range 7–120 h) (Group A: 60.2 ± 18.9 vs. Group B: 58.0 ± 16.8, n.s.) after LTX. The mean stay in the ICU was 9.1 ± 3.1 days (median 5 days, range 2–31 days) (Group A: 9.7 ± 3.5 vs. Group B: 8.7 ± 2.9, n.s.), and the mean length of hospital stay was 22.9 ± 4.5 days (median 18.1 days, range 12–53 days) (Group A: 24.1 ± 4.8 vs. Group B: 21.2 ± 4.0, n.s.).
Group B: 22.1 ± 4.4, n.s.). The mean duration of chest drainage was 4.6 ± 1.7 days (median 3.2 days, range 2–16 days) (Group A: 4.8 ± 1.6 vs. Group B: 4.5 ± 1.7, n.s.). Significant adhesions at the time of transplantation were observed in almost all patients, especially in those who had LVRS with bovine pericardium reinforced staplers. Two patients had to undergo a rethoracotomy for treatment of hemothorax. Despite the fact that surgical preparation was rendered more difficult, no phrenic nerve injury was observed.

3.3. Operative mortality after LTX

Three months mortality in Group A was 27.3% (one patient died due to primary graft failure, one patient due to ongoing rejection and one patient due to sepsis, respectively). This was significantly higher (P = 0.03) than in Group B where only a 6.3% 3 months mortality was observed (one patient died due to primary graft failure).

Kaplan–Meier survival curves of both groups are shown in Fig. 4.

4. Discussion

The role of LVRS as a possible alternative treatment to LTX in selected patients with end-stage emphysema has already been described by many authors in the literature [1–5]. Due to the limited number of available donor organs world-wide, which leads to long waiting periods and considerable mortality on the waiting-lists [8], LVRS has in addition increasingly been considered as a potential bridging therapy to LTX. However, so far the published information about the impact of such a bridging strategy on morbidity and mortality of a later transplant procedure remains limited.

The concept of a staged procedure, LVRS followed by a later LTX, was first described by Zenati and colleagues in 1995 when they reported on a 60-year-old patient who received a single lung transplant 17 months after laser ablation of emphysematous bullae [9]. In 1996, the same authors...
already reported on seven patients who were bridged with LVRS to subsequent LTX [10]. The mean interval between LVRS and LTX in these patients was 11 ± 4 months. All LTX were single lung transplants and four patients had LTX on the same side as LVRS without any operative complications. All patients were alive after LTX with a follow-up of 6.7 ± 5 months.

Meyers and colleagues reported on their experience with 15 patients who were transplanted 3.8 ± 1.1 years after previous LVRS (range 2.1–60.0 years) [1]. All 15 patients survived transplantation. Three have subsequently died, and each death occurred more than 1 year after transplantation. However, no detailed information about the functional course of the patients between the two procedures is given.

The aim of this retrospective study was therefore to analyze the impact of LVRS on morbidity and mortality of a later LTX and to define circumstances after LVRS which are in favour of a good outcome after transplantation.

By comparing our institutional patient cohort which had LVRS only to the group of patients who underwent LTX at a later point of time after LVRS, striking differences in the type of distribution of emphysema were observed. A total of 66.3% of the LVRS only group had a pronounced heterogeneous distribution pattern in either the upper or lower lobe. On the contrary, 51.9% of the LVRS-LTX group had either indifferent or a completely homogenous pattern of distribution. This finding supports the view that patients with pronounced heterogeneity will more likely experience a better functional improvement after LVRS [11] and that this improvement has a higher potential to last for longer.

Another finding was a higher percentage (36.4%) of patients after unilateral LVRS in the group with less than 20% improvement in FeV1, compared to only 12.5% unilateral LVRS patients in the group with pronounced (>20% FeV1) improvement. Similar to this, it has been frequently reported that unilateral LVRS might not have the same potential for functional improvement as a bilateral procedure [12–16].

One major concern for LTX after a previous LVRS operation is the possibility for significant pleural adhesions which might render the second operation more difficult. Though in all our patients some sort of adhesions at the time of transplantation were detected, no major operative problem resulted from that. The incidence of rethoracotomy was two out of 27 (7.4%) for management of postoperative bleeding and no case of phrenic nerve palsy was observed.

Splitting the whole cohort of 27 patients into those who experienced a clear functional improvement after LVRS and those who did not allowed us to analyze the impact of LVRS on a later LTX more clearly. As one would expect, patients who did not benefit from LVRS and therefore had their subsequent LTX early thereafter did have a higher perioperative risk at LTX. Reasons for that can be seen in the still limited respiratory function, which prevented patients from improving their general condition and their nutritional status. In particular the later finding was clearly reflected in the lack of improvement of BMI.

Opposite to that, patients who had a pronounced improvement in FeV1 also showed clear improvements in pCO2 and BMI as well. Both parameters remained stable until LTX, despite the recurrent reduction of FeV1 until that time. Finally, the perioperative mortality in these patients at LTX was clearly lower than in the other group. In our opinion, the later finding can be seen as the consequence of the improved general condition of the patients, and therefore demonstrates that a successful LVRS procedure can bring the patient into a better condition for a later LTX.

In conclusion, LVRS is an accepted therapeutic option in selected patients with chronic obstructive pulmonary disease, although the duration of functional improvement remains difficult to predict. Successful LVRS has the potential to bring patients into better nutritional condition, which consequently reduces the risks for a later LTX, and no severe technical problems result from the prior LVRS procedure. Delayed LTX after successful LVRS therefore seems to be a safe procedure.

On the contrary, patients after failed LVRS should be considered as poor candidates for later transplantation.

References


Appendix A. Conference discussion

Dr J. Hasse (Freiburg, Germany): How do you now exclude patients who are not good candidates for lung volume reduction the first time?

Dr Senbaklavaci: When we analyzed our results, we saw that approximately 70% of these 27 patients who were transplanted after LVRS underwent volume reduction in the first period of our experience, in our early experience, when we tried to push the indication criteria for lung volume reduction. In the later part of our experience, the number of transplanted patients was significantly lower when we optimized our indication criteria for LVRS.

Dr J.-F. Velly (Bordeaux, France): Regarding your results, did you change your policy in the choice of the patient you kept for transplantation even after good preparation, and what are the criteria you choose to do lung volume or transplantation?

Dr Senbaklavaci: We considered lung volume reduction as a good bridging therapy to transplantation especially in patients with marked heterogeneity and not as a permanent alternative, so we were real liberal in making the decision to offer them lung volume reduction. But I have to add that we do not have donor organ problems like the rest of Europe and like North America, resulting in an average waiting time of approximately six months, which gives us, of course, the liberty of making this decision. On the other hand patients with homogenous emphysema and additional contraindications were considered as poor candidates for LVRS and were evaluated for transplantation.

Dr F. Venuta (Rome, Italy): Do you tend to choose unilateral lung volume reduction in patients that can undergo lung transplantation or you choose the bilateral procedure selectively also for these patients?

Dr Senbaklavaci: We had both unilaterally and bilaterally volume reduced patients who underwent later transplantation. The technique of LVRS was not an indication criteria for subsequent transplantation.

Dr W. Kupis (Warsaw, Poland): Did you find any tests or any examination for the particular value for finding whether the patients will be a good candidate for, first of all, the lung volume reduction and, next, for the lung transplantation just to divide them the very first time for taking them for surgery?

Dr Senbaklavaci: All 27 patients were eligible for transplantation, having been evaluated for volume reduction as well, and at the time when they needed transplantation after LVRS, they still were eligible for the transplantation, and so the indication criteria were similar.

Dr Kupis: They were the same for the whole group you mean?

Dr Senbaklavaci: For these 27 patients, yes.

Dr Kupis: So there is actually no way to say at the start whether the patient will be better or worse?

Dr Senbaklavaci: No, we can’t say so far. In patients with marked heterogeneity we expect of course an improvement after LVRS. But the duration of this possible improvement is unfortunately not predictable.

Dr Kupis: You didn’t find any particular test, for example? You didn’t use any new test?

Dr Senbaklavaci: No.

Dr O. Kshivets (Siauliai, Lithuania): The question is what is the sense of lung transplantation if the patient lives after volume reduction surgery 30, 36 months without pulmonary insufficiency, what is the sense of lung transplantation?

Dr Senbaklavaci: If the patient is still at an age which is eligible for transplantation and he has pulmonary insufficiency, we offer him the transplantation, of course. For example if we have a 60-year-old patient with deterioration after successful LVRS, who shows no contraindication for lung transplantation, we offer him the transplantation since we know that the perioperative morbidity after lung transplantation following volume reduction is not higher than in other patients who underwent lung transplantation without previous volume reduction.