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The effects of preoperative pulmonary rehabilitation on early postoperative period following lung transplantation

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Abstract:

CONTEXT: Although pulmonary rehabilitation (PR) has become a preoperative standard practice, the fact that studies do not include groups of patients who do not receive preoperative PR restricts to introduce the real benefit of the rehabilitation process in lung transplantation (LTx).

AIMS: We aimed to investigate the effect of preoperative PR before LTx on postoperative period.

SETTINGS AND DESIGN: Retrospective, parallel design.

SUBJECTS AND METHODS: Between March 2012 and October 2014, medical records of patients who underwent LTx were analyzed. There were two parallel groups. (1) Study group (n = 15) included the patients with received preoperative PR for at least 8 weeks. (2) Control group (n = 12) included the patients with underwent LTx without preoperative PR as appropriate donor was found. Time to intubation, length of intensive care unit (ICU) stay, and postoperative early mortality were evaluated.

STATISTICAL ANALYSIS USED: Shapiro–Wilk, Fisher' exact test, Mann–Whitney U-test, Wilcoxon rank test.

RESULTS: A total of 27 patients with LTx surgery, whose mean age was 40.6 (11.4) and 40% of females were included in the study. There were no significant differences in demographic characteristics between two groups, except the age (P = 0.005). The study group intubation time (2 [0–7] days) was shorter than control group (3 [1–12] days) (P = 0.02). There was no significant difference in the length of ICU stay postoperatively (P = 0.19) and postoperative early mortality rate (P = 0.65).

CONCLUSIONS: Our study results suggest that preoperative PR may shorten time to intubation in patients undergoing LTx. Therefore, referral of LTx to PR centers and preoperative PR is of utmost importance for postoperative LTx.

Keywords:

Intensive care, intubation, lung transplantation

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Introduction

Pulmonary rehabilitation (PR) is one of the most important components in the treatment of chronic respiratory patients.[1] It is also know that preoperative PR is beneficial in the thoracic surgery process.[2-5] It has been shown in the literature that preoperative chest physiotherapy increase oxygen saturation, reduce hospital stay in patients with thoracotomy.[2] Lung transplantation (LTx) is one of the most

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difficult procedures in thoracic surgery. It can be predicted that preoperative PR, which has proven successful in other thoracic surgery procedures, will positively affect patients' clinical status in LTx process. However, there is limited number of studies about this issue.

The originality of our study is that there was a control group that did not undergo preoperative PR. As it is not ethical to create a group that does not undergo preoperative PR as a random, our control group was spontaneously formed as appropriate donors were found which allowed us to examine the effect of preoperative PR on LTx. Therefore, in the present study, we aimed to investigate the effect of preoperative PR for 8 weeks in the supervised outpatient PR program before LTx on postoperative period.

Subjects and Methods

Between March 2012 and October 2014, records of 27 patients who underwent LTx in… Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital were retrospectively reviewed. Fifteen patients were admitted to the regular PR training program for at least 8 weeks in the transplant waiting period and called study group. Twelve patients were operated without being included in the PR program due to the availability of donors earlier and called control group. Ethics approval was obtained from Local Ethic Committee and was conducted in accordance with the Helsinki Declaration. The study flow chart was given in Figure 1.

The study group could be evaluated at the beginning and at the end of the PR in the preoperative period. The 6-min walking test was performed to assess functional capacity following the American Thoracic Society Guidelines.[6] Participants walked along an enclosed 30-m corridor and were instructed to walk at their own pace to cover as much distance as possible in 6 min. The patient's walking distance and Borg scores were recorded. Dyspnea perceptions during the activities of daily living was assessed with Medical Research Council Scale.[7] In addition, the distance covered by ergometers during exercise training was noted.

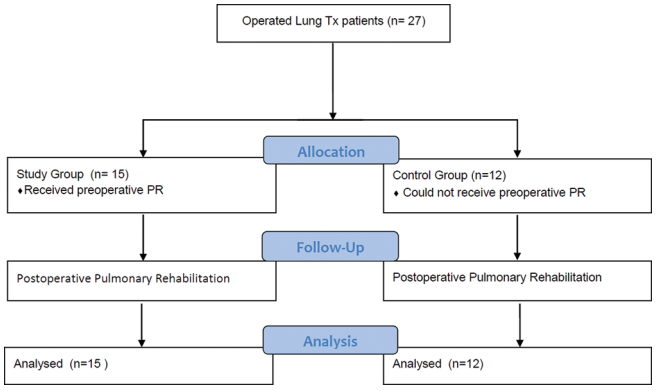

Figure 1: Study flow chart

In addition, the patient' intraoperative anesthesia and total ischemia duration, the duration of mechanic ventilation and stay in intensive care unit (ICU), and mortality rates (including 1 month) were retrospectively recorded in both the groups.

Exercise program

The study group underwent a preoperative PR exercise program for 8 weeks, 2 days/week in the hospital, and 3 days at home. The exercise program included breathing exercises, upper and lower extremity strengthening, and aerobic exercises. Diaphragmatic breathing and lateral basal breathing exercises were taught as breathing exercises. There were treadmill walking (15 min/day), bicycle (15 min/day), and arm ergometer (15 min/day) in aerobic exercises in hospital. The aerobic exercise workload was calculated using the target heart rate method and at least 60% of the maximal heart rate. Free weights were used for strengthening exercises. The load was increased progressively with respect to tolerance by starting with 20% of the maximum one repetition weight calculated.

In addition to the supervised exercise program that was administered on 2 days at the hospital, the patients were asked to perform the home exercise program for 3 days a week. The program included breathing exercises, free walking, upper and lower extremity strengthening exercises with Thera-Band. A follow-up form was given, and weekly chart follow-ups were performed by the responsible physiotherapist.

Both groups underwent chest physiotherapy in the postoperative ICU. Passive in-bed mobilizations and positioning were done if the patients were to be sedated. If the clinical status was awake, respiratory exercises, assisted coughing, percussion, and gradual mobilization were performed from the 1st day as soon as the clinical conditions were stabilized.

Statistical analysis

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version IBM Statistic 15.0 (SPSS Inc., Chicago, IL, USA). The normalizations of the data were examined using the Shapiro–Wilk test ($P > 0.05$). If the data were distributed normally, it was expressed as "mean (standard deviation)" and if it is not normally distributed, it is expressed as "median (minimum-maximum)." The categorical variables were expressed as percentage (%). Wilcoxon signed-ranks test was used for the comparison of the

pre- and post-treatment measurable values of the same group. The Mann–Whitney U-test performed to test the significance of pairwise differences between groups. The analysis of categorical data was performed using Chi-square and Fisher's exact tests. $P < 0.05$ is considered statistically significant.

Results

Patient groups had similar exercise capacities ($P = 0.3$) and body mass index score ($P = 0.11$). However, the study group was younger ($P = 0.005$) than control group. According to diagnosis distributions, the majority of cases were bronchiectasis in the study group and interstitial lung disease in the control group. It was seen that the study group waited longer than the control group on the transplantation list ($P = 0.03$) [Table 1].

When the pre- and post-rehabilitation values of the patients undergoing preoperative PR program were compared, a statistically significant improvement was observed in 6-min walking distance ($P = 0.03$), dyspnea perception ($P = 0.003$), and distances recorded in all exercise ergometers ($P < 0.05$). The comparison of preoperative PR efficacy in terms of exercise capacities and dyspnea perception in the study group was given in Table 2.

The number of intubation days was shorter in study group (mean: 2 days), compared to control group (mean: 3 days) ($P = 0.02$). The durations of intraoperative anesthesia and total ischemia time were similar in both the groups. There was no significant difference between the duration of stay in ICU, and the mortality rates of the groups are given in Table 3. The length of ICU stay was shorter in study group, although it did not reach statistical significance.

Table 1: Comparison of the groups with respect to baseline demographic characteristics, diagnostic distributions, exercise capacities, initial pulmonary, and cardiac functions

Variables	Study group (*n*=15)	Control group (*n*=12)	*Z*	*P*
Demographics				
Gender (male/female), *n* (%)	9/6 (66/34)	7/5 (71/29)		0.336**
Age (year)	33.00 (19-52)	51.50 (26-59)	−2.836	0.005*
BMI (kg/m^2)	23.14 (14.86-31.14)	20.01 (13.67-28.12)	−1.569	0.11*
Diagnosis, *n* (%)				
Bronchiectasis	7 (46.7)	2 (16.7)		0.154**
ILD	2 (13.3)	5 (41.7)		
COPD	2 (13.3)	4 (33.3)		
Sarcoidosis	2 (13.3)	1 (8.3)		
Silicosis	2 (13.3)			
Exercise capacity: 6MWD (m)	297.50 (130-454)	266.50 (40-524)	−1.025	0.30*
Dyspnea perception: MRC	4 (2-5)	4 (2-5)	−1.516	0.130*
LTx waiting time (day)	124 (42-314)	48 (6-470)	−2.124	0.03*

Data are expressed as median (minimum–maximum) or percentage.*Mann–Whitney U-test, **Fisher's exact test, *P*<0,05 statistically significant. BMI: Body mass index, ILD: Interstitial lung disease, COPD: Chronic obstructive lung disease, 6MWT: 6 min walking test, 6MWD: 6 min walking distance, MRC: Medical research council dyspnea scale, LTx: Lung transplantation

Discussion

Our study outcomes showed that preoperative PR may shorten time to intubation in patients undergoing LTx. In addition, preoperative PR increases the exercise capacity and improves dyspnea perception.

Organ transplantation is an intervention that saves lives and increases the quality of life in individuals with terminal organ insufficiency.[8] LTx is administered to prolong survival in patients with an advanced pulmonary disease such as chronic obstructive pulmonary disease, cystic fibrosis, idiopathic pulmonary fibrosis, and pulmonary hypertension.[9]

PR in LTx candidates optimizes the physical functions of individuals[10] and facilitates adaptation to the new lung after transplantation and recovery.[11] The clinical and surgical evaluation is a long process.[11] Fifty percent of LTx candidates are being lost or waiting on the waiting list.[12] In a retrospective study[12] conducted a 10-year data search, 103 LTx candidates data were examined. Twenty-three percent of these patients were lost in the waiting period, and 27% were still on waiting lists. The prolongation of the waiting period is a disadvantage for the transplant candidates carrying the potential to worsen their general condition despite optimal medical care. In our study, the mean LTx waiting duration of

Table 2: The immediate effects of preoperative pulmonary rehabilitation on exercise capacity and dyspnea perception in the study group

	Mean (SD)		*P*
	Before PR	After PR	
Exercise capacity			
6MWD (m)	294.50 (87.57)	341.14 (78.40)	0.03*
Initial of test Borg (0-10)	2.14 (1.46)	0.92 (1.12)	0.02*
End of the test Borg (0-10)	4.92 (2.09)	2.82 (2.07)	0.006*
Dyspnea perception: MRC (0-5)	4 (2-5)	3 (2-5)	0.003**
Distance covered by treadmill (m)	270 (207.69)	613.57 (186.03)	0.00*
Distance covered by bicycle (km)	1.82 (0.85)	3.28 (0.70)	0.00*
Distance covered by arm Ergometry (km)	1.68 (0.36)	2.23 (0.54)	0.002*

*Paired *t*-test, **Wilcoxon rank test. *P*<0.05 statistically significant. Results are shown change between postpulmonary rehabilitation and baseline levels. PR: Pulmonary rehabilitation, 6MWT: 6 min walking test; 6MWD: 6 min walking distance, MRC: Medical research council dyspnea scale, SD: Standard deviation

Table 3: Comparison of the groups with respect to intra- and post-operative conditions and mortality rates

Variables	Study group (*n*=15)	Control group (*n*=12)	*Z*	*P*
Anesthesia time (h)[a]	11.50 (7-17)	12.25 (8-14)	−0.125	0.90*
Total ischemia time (s)[b]	501 (243-751)	479.50 (122-647)	−0.517	0.60*
Intubation time (day)[c]	2 (0-7)	3 (1-12)	−2.285	0.02*
Length of stay in ICU (day)	8.50 (2-21)	11 (5-112)	−1.291	0.19*
Operation type, *n* (%)				
Single side	4 (26.7)	3 (25)	−0.096	0.92**
Bilateral	11 (73.3)	9 (75)		
Mortality rates				
Survival	10	7		0.706**
Exitus	5	5		

Data are expressed as median (minimum–maximum) or percentage. *Mann–Whitney U-test, **χ^2 Fisher's exact test. Significance level $P<0.05$. [a]The time taken for the patient to be anesthetized for transportation and to be anesthetized, [b]The time from the donor until the lung is removed and placed in the recipient and blood circulation is restarted, [c]Number of days of postoperative invasive ventilation. ICU: Intensive care unit

patients was 124 days in study group and 48 days in control group. The study group was found to wait longer. PR can serve as a bridge until the LTx in the waiting period act as a bridge to the LTx operation.[11]

Preoperative clinical condition may be predictive of postoperative period. A study showed that exercise capacity and resting carbon dioxide in arterial blood values are directly related to the rate of success in LTx.[13] In our study, patient groups were similar in terms of exercise capacity at the baseline. We aimed to have a positive effect on the postoperative process by increasing exercise capacity with exercise training and optimizing the patients' clinical status before the surgery. Another study showed that baseline parameters can affect mortality and hospital stay after surgery, and preoperative PR can decrease ICU days, mechanical ventilation days, and chest tube days.[14] A single-center experience study showed that improvements in posttransplant survival might have been originated from pretransplant PR along with other factors such as better medication and decreased blood (transfusion) needs.[15] Our study showed that pretransplantation PR shorten the time of intubation (posttransplant). In addition, although not statistically significant, the length of ICU stay in study group was shorter which was clinically significant. We thought that this could be affected by the positive effect of aerobic exercise on general clinical status. In addition, we considered that learning breathing exercises prior to surgery could improve compliance with physiotherapy techniques in ICU, and this situation could affect the patient clinical status.

There are some studies indicating that exercise training in LTx in the preoperative period improves postoperative outcomes and reduces the length of stay in the hospital.[16] However, the effect of preoperative PR on intraoperative process has not been sufficiently investigated. In this study, we observed that the preoperative PR group and the nonpreoperative PR group comparisons were similar in terms of intraoperative anesthesia, total ischemia, and ICU stay and also there was no difference between the mortality rates. We could not associate preoperative PR with the intraoperative course. This situation may be associated with relatively small number of patients in our study. Moreover, this situation can be affected by numerous factors including; age, gender, or diagnosis type of LTx. On the other hand, the groups look the same (except age) as the content, they are statistically comparable.

PR plays an important role for the maintenance of physical condition before and after LTx.[17-19] A systematic review[20] demonstrated that exercise should be included in the regular management of patients for LTx. Some researchers have suggested that the clinical benefits of PR for patients with advanced lung disease make the engagement in a PR program required for patients for LTx in the preoperative time period.[21] In our study, preoperative PR improved fatigue ratio, exercise capacities, and dyspnea perception of the patients preoperatively. We believe that these gains also contribute to the postoperative process.

Limitations of our work

A retrospective study of work, a relatively small number of patients. Further, large-scale, prospective studies are needed to confirm these findings.

Conclusions

Our study results showed that preoperative PR may shorten time to intubation in patients undergoing LTx. In addition, preoperative PR increases the exercise capacity and improves dyspnea perception. Referring preoperative LTx candidates to PR is important in improving the patient's preoperative clinical status, preparing for surgery, and optimizing the postoperative process.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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