A propose of pulmonary dysfunction stratification after valve surgery by physiotherapeutic assistance level

Proposta de estratificação da disfunção pulmonar após cirurgia valvar segundo níveis de assistência fisioterapêutica

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Abstract

Objective: **a) to propose and implement an evaluation system; b) to classify the pulmonary involvement and determine levels of physical therapy; c) to check the progress postoperatively.**

Methods: **Patients underwent physiotherapy assessment preoperatively, postoperatively and after 5 days of intervention. They were classified into three levels of care: level 1 - low risk of complication; Level 2 - medium risk; Level 3 - high risk. We used analysis of variance and Kruskal-Wallis and analysis of variance for repeated measures or Friedman. Chi-square test or Fisher for proportions. We considered statistical significance level *P*<0.05.**

Results: **We studied 199 patients, 156 classified within level 1, 32 at level 2 and 11 at level 3. Thoracoabdominal motion and auscultation changed significantly postoperatively, persisting at levels 2 and 3 (*P*<0.05). Oxygenation and respiratory rate changed at levels 2 and 3 postoperatively (*P*<0.05) with recovery at the end. Significant decrease in lung volumes occurred in three levels (*P*<0.05) with partial recovery at level 1, lung collapse occurred at all levels, with recovery by 56% at level 1, 47% at level 2, 27% at level 3.**

Conclusion: **The proposed assessment identified valve surgery patients who require differentiated physical therapy. Level 1 patients had rapid recovery, while the level 2 showed significant changes with functional gains at the end. Level 3 patients, more committed and prolonged recovery, should receive greater assistance.**

Descriptors: **Thoracic Surgery. Physical Therapy Modalities. Vital Capacity.**

Resumo

Objetivo: **a) propor e aplicar um sistema de avaliação; b) classificar o comprometimento pulmonar e determinar os níveis de assistência fisioterapêutica; c) verificar a evolução no pós-operatório de cirurgia valvar.**

Métodos: **Pacientes realizaram avaliação fisioterapêutica no pré-operatório, pós-operatório e após 5 dias de intervenção. Foram classificados em três níveis de atenção: nível 1 - baixo risco de complicação; nível 2 - médio risco; nível 3 - alto risco. Utilizou-se Análise de Variância e Kruskal-Wallis e Análise de Variância para medidas repetidas ou Friedmann. Teste qui-quadrado ou Fisher para as proporções. Considerou-se nível de significância estatística *P*<0,05.**

Resultados: **Foram estudados 199 pacientes, 156 classificados no nível 1, 32 nível 2 e 11 nível 3. Movimento toracoabdominal e ausculta pulmonar alteraram significantemente no pós -operatório, persistindo nos níveis 2 e 3 (*P*<0,05). Oxigenação**

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Abbreviations, acronyms & symbols	
ECC	Extracorporeal circulation
ICU	Intensive care unit
PA	Pulmonary auscultation
PFC	Peak flow cough
SpO_2	Peripheral oxygen saturation
TxAbM	Thoracoabdominal motion

e frequência respiratória se modificaram nos níveis 2 e 3 no pós-operatório (*P*<0,05), com recuperação no final. Diminuição significante dos volumes pulmonares ocorreu nos três níveis (*P*<0,05), com recuperação parcial no nível 1. Colapso pulmonar ocorreu em todos os níveis, com recuperação em 56% no nível 1, 47% no nível 2, 27% no nível 3.

Conclusão: **A avaliação proposta identificou pacientes de cirurgia valvar que necessitam de assistência fisioterapêutica diferenciada. Pacientes do nível 1 tiveram rápida recuperação, enquanto os do nível 2 mostraram alterações significativas, com ganhos funcionais no final. Pacientes do nível 3, mais comprometidos e com recuperação prolongada, devem receber maior assistência.**

Descritores: **Cirurgia Torácica. Modalidades de Fisioterapia. Capacidade Vital.**

INTRODUCTION

The presence of postoperative respiratory dysfunction in patients after cardiovascular surgery with extracorporeal circulation (ECC), under general anesthesia, range from 50% to 100%[1-4]. Alterations in lung mechanics, such as decreased functional residual capacity, contribute to the occurrence of pulmonary collapse, increased shunt, decreased gas diffusion, and consequently, hypoxemia[5,6]. In this context, the presence of pain and chest tubes are directly implicated in keeping low lung volumes[7,8].

The use of techniques to remove bronchial secretions, as well as respiratory and early mobilization exercises, promote improvement of pulmonary function, support the correction of hypoxemia, and stimulate functional independence. However, despite that therapeutic protocols are widely used after cardiac surgery, the benefits of these protocols are not yet well established[9-16].

Evaluation and application of a classification system based on differentiated levels of physical therapy assistance comprise an alternative strategy for optimizing postoperative patient care[17-19]. The challenge is to differentiate patients according to the degree of pulmonary alterations present and to recommend appropriate therapies, with consideration of the available resources and application timing.

The use of physical therapy strategies adjusted to the severity level of respiratory dysfunction in individual patients may be beneficial in terms of inhibiting the clinical progression of respiratory dysfunction, and the organization and standardization of physical therapy assistance. Therefore, we designed this study with the following objectives: a) to propose and apply a postoperative evaluation system for patients undergoing cardiac valve surgery; b) to classify pulmonary impairment and to determine recommendable levels of physical therapy assistance; c) to monitor the postoperative clinical progress of patients who have been classified.

METHODS

Patients and Methods

This study was approved by the Research Ethics Committee of the Hospital das Clinicas at the Faculty of Medicine, University of São Paulo (approval Nº. 011/09). The informed consent was obtained from all of the subjects, who had undergone valve surgery.

The inclusion criteria for this study were as follows: patients of both sexes, patients aged 18 to 80 years, and patients hospitalized to undergo elective valve surgery who had no signs or symptoms of respiratory distress. Patients who had difficulty performing the functional tests, who were receiving oxygen therapy, or who required noninvasive ventilation in the preoperative period were excluded, as well as patients whose conditions progressed to cerebrovascular accident, who showed hemodynamic instability and worsening of clinical condition, or who died immediately after operation. Personal, anthropometric, and clinical data were collected from the patients who were hospitalized to undergo elective valve surgery.

A physical therapy evaluation that comprised eight parameters was conducted as follows:

1. Thoracoabdominal motion (TxAbM): With the patient placed in the dorsal position, the thoracoabdominal movement was evaluated during 1 minute. The TxbAM was classified as normal when the abdominal displacement predominated; mixed, when no thoracic or abdominal displacement predominated; thoracic, with predominant displacement of the rib cage; and paradoxical, when the thoracic or abdominal movements were inverted.
2. Pulmonary auscultation (PA): PA was verified based on lung sound and presence of adventitious sounds.
3. Mobility: Mobility was classified according to the degree of independence the patient had while sitting down and moving around.
4. Oxygenation: Peripheral oxygen saturation (SpO_2) was measured by using pulse oximetry (Dixtall®), with the patient breathing environment air, after 5 minutes[15] in the dorsal position, with the headrest at 45º and the sensor placed in the middle finger of the right hand.
5. Respiratory frequency (*f*): Respiratory frequency was defined as the number of inspiratory incursions occurring in 1 minute, in the dorsal position.

6. Pulmonary function: Pulmonary function was assessed by measuring forced vital capacity (FVC) in milliliters, obtained by using a ventilometer (Wright Mark 8®). While in the sitting position, the patient was guided to inhale deeply and, subsequently, to expire as fast as far he/she can through mouth piece, with the nose closed with a clip to prevent air leakage. During the procedure, the patient was encouraged to optimize performance. The procedure was repeated three times, recording the highest value.

7. Peak flow cough (PFC): PFC was measured by using a peak flow meter (Assess®), with the patient in the sitting position and the nose closed with a nose clip. The patient was encouraged to inhale deeply and, subsequently, to cough through the mouth piece. The procedure was repeated three times, recording the highest value, as long as the difference between the measurements was not greater than 20 L/min.

8. Chest radiography: Chest radiographs were analyzed by a radiologist blinded to the study. Pulmonary collapse was assessed by using the Jenkins scale as follows[11]: 0, without alteration; 1, minimum collapse; 2, pronounced collapse or consolidation at one pulmonary base; and 3, bilateral alteration.

The physical therapy evaluations were performed in the ward unit at the following time points: preoperatively (basal), when the patient returned to the unit (postoperatively), and on the fifth day of the study (final of the protocol).

In the postoperative time, the patients who were assessed were classified according to degree of risk of pulmonary impairment by using the criteria shown in Table 1. Each evaluation parameter corresponded to a point in the column. The preponderance of points in each column determined the type and level of assistance applied to the patient. At level 1, patients with low risk of complications received minimum assistance; at level 2, patients with moderate risk of complications received intermediary assistance; at level 3, patients with high risk of complications received full assistance. In cases when the number of points was equal in 2 columns, the SpO_2 criterion was used to differentiate. When paradoxical movement, tachypnea, and hypoxemia were present, level 3 assistance was provided to the patient.

In the postoperative hospitalization period in the intensive care unit (ICU), the patient was attended to according to the ICU routine, without influence of this study. During this period, data on the surgical procedure, times of extracorporeal circulation (ECC), orotracheal intubation, and length of stay in the ICU were collected.

Level of Physical Therapy Assistance

The patients received differentiated physical therapy assistance according to their classification. Patients with low risk of pulmonary complication (level 1) received physical therapy assistance for 20 minutes, once daily, with direct supervision by the physiotherapist. In this event, 3 series of 10 repetitions of therapeutic breathing exercises were performed, followed by coughing. In addition, general mobilization and walking exercises were performed. The patient was guided to repeat the breathing exercises every 2 hours, recording the results in a spreadsheet.

Table 1. Parameters for clinical and functional evaluations to define the degree of pulmonary impairment.

Parameters	Level 1	Level 2	Level 3
Thoracoabdominal motion (TxAbM)	Normal	Normal/mixed	Thoracic/paradoxical
Pulmonary auscultation	Standard pre or (sound ↓; RA+)	Abnormal sound (breathing; ↓ ↓; RA++)	Abnormal sound (breathing; ↓ ↓ ↓; RA+++)
Mobility	Sits with little help, able to walk around	Requires help to sit and walk around	Requires a lot of help to sit and walk around
Oxygenation (SpO_2)	≥92%	88% ≥SpO_2 <92%	<88%
Respiratory frequency (f)	f >15 < 25 rpm	25≥f<32	>32
Forced vital capacity (FVC)	≥50% of pre	30% ≥ FVC < 49%	<30%
Peak flow cough (PFC)	≥50% of pre	30% ≥ FVC < 49%	<30%
Chest radiography (Jenkins, 1989)	Normal Minimum collapse/atelectasis	Pronounced collapse or consolidation at one base	Bilateral alteration

The patients classified at level 2 were treated with continuous positive airway pressure (CPAP) or intermittent positive pressure associated with positive end-expiratory pressure (IPPV + PEEP) for 20 minutes, twice daily. These patients also performed breathing exercises similar to those performed by the patients at level 1, maneuvers for bronchial secretion removal, assisted coughing, and mobility exercises. The duration of the complete therapy was 40 minutes.

The patients at level 3 were treated with positive pressure at two levels of pressure (bilevel) for 60 minutes, 3 times daily. In addition, the physiotherapist applied breathing exercises, maneuvers for bronchial secretion removal, assisted coughing, and mobility exercises twice daily. The time required to assist these patients was approximately 80 minutes per session.

Five days after applying each protocol, the final evaluation was performed. The patients who remained at the same level continued to receive the same therapy until improvement or until hospital discharge. Those whose level of assistance required changed received the treatment that was proposed for the new level of assistance. The day of hospital discharge was recorded, and that was when the patients received standardized guidance of respiratory and motor care.

Statistical Analysis

The quantitative data were presented as mean and SD values; and the qualitative data, as absolute and relative frequencies. For a comparative analysis between the groups according to age, height, weight, and body mass index, the single-factor analysis of variance and Kruskal-Wallis were used to analyze the length of hospital stay. Homogeneity among the proportions was tested by using the chi-square or Fisher test. The comparison of mean values between the groups over time was performed by using the repeated-measures analysis of variance. For the analysis of the radiographic data, the Friedman nonparametric test was used. The level of statistical significance was considered as $P<0.05$.

RESULTS

Between June 2009 and October 2013, 288 patients hospitalized in the General Valve Diseases Patient Care Unit were evaluated. Among these patients, 89 were excluded and 199 were included and completed the study, of whom 156 were allocated at level 1,32 at level 2, and 11 at level 3, as shown in the flowchart in Figure 1.

The anthropometric characteristics and length of hospital stay of the patients as described above are shown in Table 2. A predominance of female patients and level 1 classification (78%) was observed, including the younger group of patients in the study.

Most of the patients did not smoke (63%) or consume alcohol (87%), and 64% of the patients did not have previous cardiac surgery. More than 90% of the patients were in the functional classes II or III.

In our study sample, mitral valve lesions (79%) were the most common cases, with valve replacement being the most frequent surgical procedure (47%), followed by mitral commissurotomy (18.5%).

The mean durations of mechanical ventilation, and ICU and hospital stay were longer for the patients at levels 2 and 3. However, no statistically significant difference was observed between the groups.

Classification of physiotherapeutic assistance level

Data regarding the TxAbM evaluation and pulmonary auscultation are shown in Table 3. The number of cases with the TxAbM altered increased significantly in the postoperative period at level 2, decreasing at the end of the study. Meanwhile, at level 3, the number of patients with this alteration increased from 64% to 82%. Pulmonary auscultation was altered in more than 85% of the cases, in all of the groups in the postoperative period. At the end of the study, a high percentage of patients at levels 2 and 3 still had significant alterations when compared with the patients at level 1.

The quantitative parameters of the physical therapy evaluation are shown in Table 4. In the analysis over time, the patients at level 1 did not show significant alterations in SpO_2 and *f*. The pulmonary function data revealed statistically significant reductions in the postoperative period, with strong improvement at the end of the study, though not returning to the original values. The radiological data shown in Figures 2–4 demonstrate that in this group, the patients had minimum collapse, with collapse in one of the lung bases predominating, which was significantly reduced on the fifth day of the study. The behaviour of the patients at levels 2 and 3 were similar. All of the parameters showed significant reductions during the postoperative period, with the pulmonary function value not returning to its original value. The relevance of lung collapse was higher in both groups. At level 2, collapse occurred in 41% of the patients, and bilateral alterations occurred in 9% of the patients, with strong reductions in these alterations by the end of the study. In level 3, collapse occurred in 64% of the patients.

In the comparison between the groups, we observed that patients at level 1 showed a significant improvement in pulmonary function by the end of the study, whereas the patients at levels 2 and 3 had the most severe respiratory impairment. In these groups, only oxygenation and respiratory frequency data showed significant improvements by the end of the study when compared with the postoperative period.

After the end of the study, all the patients continued to receive assistance until hospital discharge, and no complications were reported during this period.

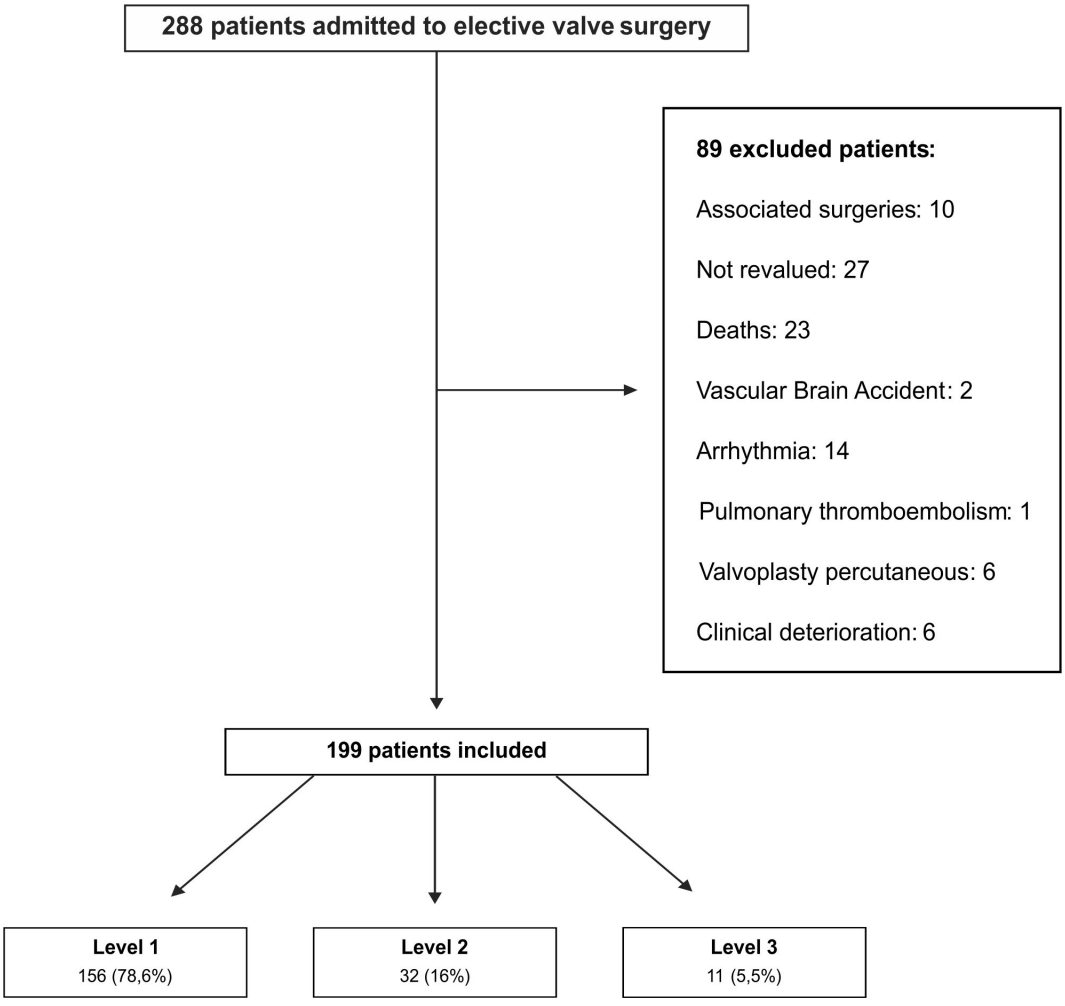

Fig. 1 - The flowchart of patients in the study protocol.

Table 2. Anthropometric characteristics and length of hospital stay of the patients classified according to level of physical assistance required.

Characteristics	Level 1	Level 2	Level 3	*P*
N	156 (78%)	32 (16%)	11 (6%)	
Sex (M/F)	52/104	10/22	2/9	
Age (years)	46±14	53±15	58±18	<0.05(1)
Height (m)	1.61±0.09	1.59±0.09	1.55±0.07	0.073(1)
Body weight (kg)	63±14	66±13	60±11	0.396(1)
BMI (kg/m^2)	24.1±4.6	25.8±4.6	24.9±5.6	0.165(1)
ECC (min)	78.3±27	87.5±25	78.8±25	0.074(2)
MV (min)	495.3±231	620.4±583	1131±1636	0.141(2)
Discharged from ICU (day)	4.7±3	5.1±3	6.8±4	0.328(2)
Hospital discharge (day)	14.2±10	16±10	18.1±9	0.099(2)

M=male; F=female; BMI=body mass index; ECC=extracorporeal circulation; MV=mechanical ventilation; ICU=intensive care unit.

(1)Probability descriptive levels of single-factor analysis of variance

(2)Descriptive level of probability of non-parametric test and Kruskal-Wallis

Table 3. Qualitative variables of the classification system in the 3 levels of assistance.

	Level 1 156 (%)	Level 2 32 (%)	Level 3 11 (%)	*P*
TxAbM (pre)				
Altered	26 (17)	7 (22)	3 (27)	0.5631
TxAbM (post)				
Altered	45 (29)	22 (69)[#]	7 (64)[#]	<0.0001
TxAbM (discharge)				
Altered	30 (19)	14 (44)[#]	9 (82)[#]	<0.0001
PA (pre)				
Altered	35 (23)	8 (25)	5 (45)	0.2301
PA (post)				
Altered	35(87)	30 (94)	11 (100)	0.3748
PA (discharge)				
Altered	86(55)	24 (75)[#]	11 (100)[#]	0.0029

[#]P< 0.05 versus level 1

TxAbM=thoracoabdominal motion; PA=pulmonary auscultation.

Table 4. Quantitative variables of the classification system of level 3 assistance.

	Level 1 (n=156)	Level 2 (n=32)	Level 3 (n=11)	*P*
Oxygenation				
SpO_2 (pre)	96.7±1.5	96±2.2	96.1±2.2	GxT: *P*<0.001
SpO_2 (post)	94.8±2.5	90.9±3.4*	88.4±2.9*	G2 and 3: *P*=0.067
SpO_2 (discharge)	96.5±1.5	94.8±3.4†	94±2.9 †	
Respiratory Function				
f (pre)	19±4	19±4	21±6	GxT: *P*<0.001
f (post)	20±4	23±5*	28±7*	G2 and 3: *P*=0.217
f (discharge)	20±4	22±4†	25±6†	
FVC (L)				
FVC (pre)	2.63±0.89	2.34±0.85	2.28±1.17	GxT: *P*<0.001
FVC (post)	1.82±0.62*	1.2±0.37*	0.90±0.43*	G: *P*<0.001
FVC (discharge)	2.02±0.69*†	1.59±0.58*†	1.05±0.39*	
FVC (%)				
FVC% (pre)	75±18	72±17	79±35	GxT: *P*<0.001
FVC% (post)	52±14*	37±10*	30±12*	G: P<0.001
FVC% (discharge)	58±15*†	49±15*	36±11	
Peak Flow Cough	(n=107)	(n=32)	(n=11)	
PF (pre)	383±130	358±148	330±137	GxT: *P*<0.001
PF (post)	303±126*	228±90*	141±72*	G: *P*<0.001
PF (discharge)	350±142†	297±127*	177±90*	

** P<0.05 versus preoperative period; † P<0.05 versus postoperative period.*

G=group; T=time, SpO2=peripheral oxygen saturation; f=respiratory frequency; FVC=forced vital capacity; FVC%=forced vital capacity in percentage predictive; PF=peak flow cough.

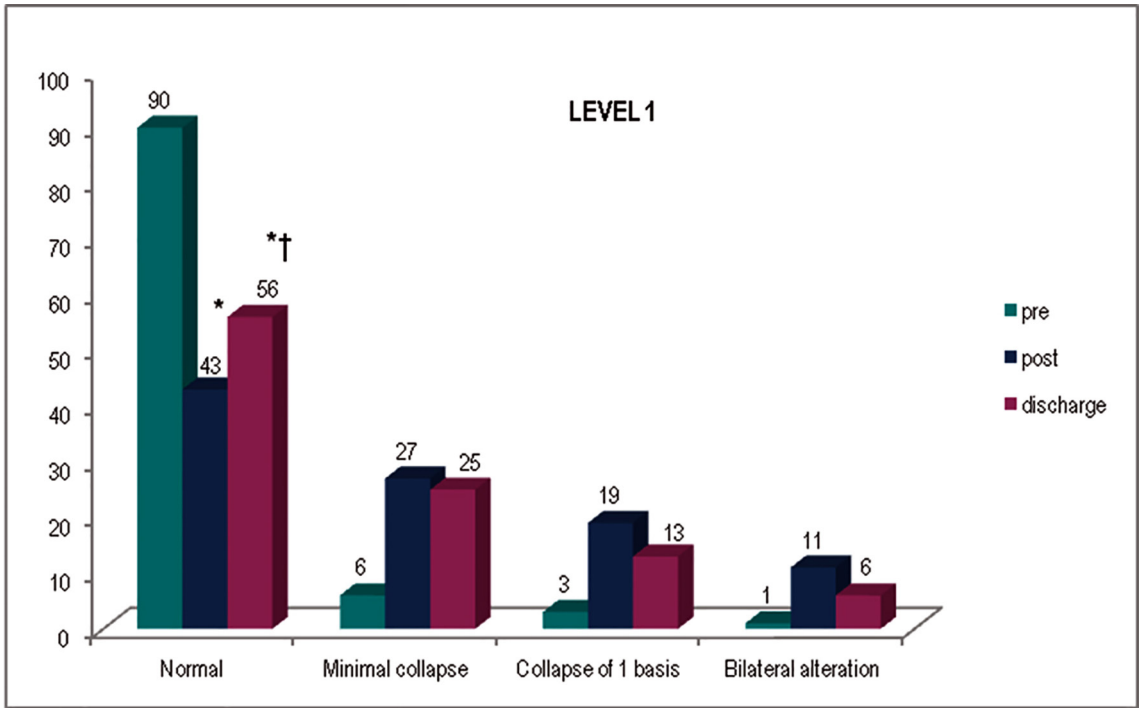

Fig. 2 - Percentage of radiological changes of level 1 in the pre, post and discharge of study.

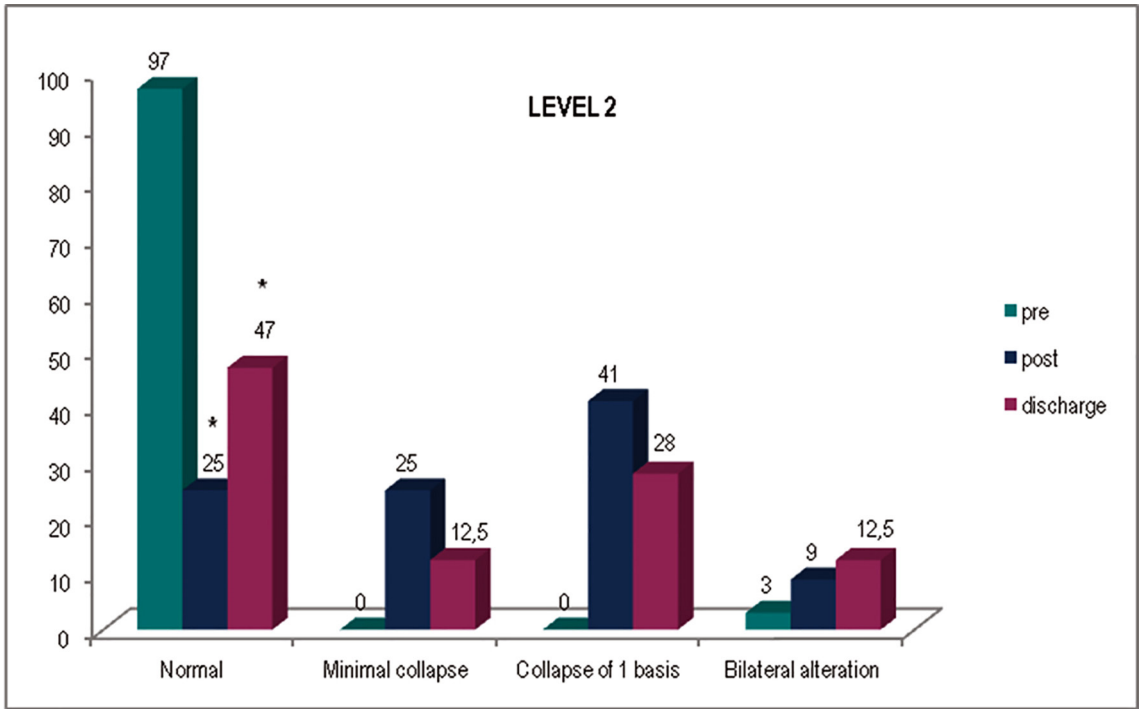

Fig. 3 - Percentage of radiological changes of level 2 in the pre, post and discharge of study.

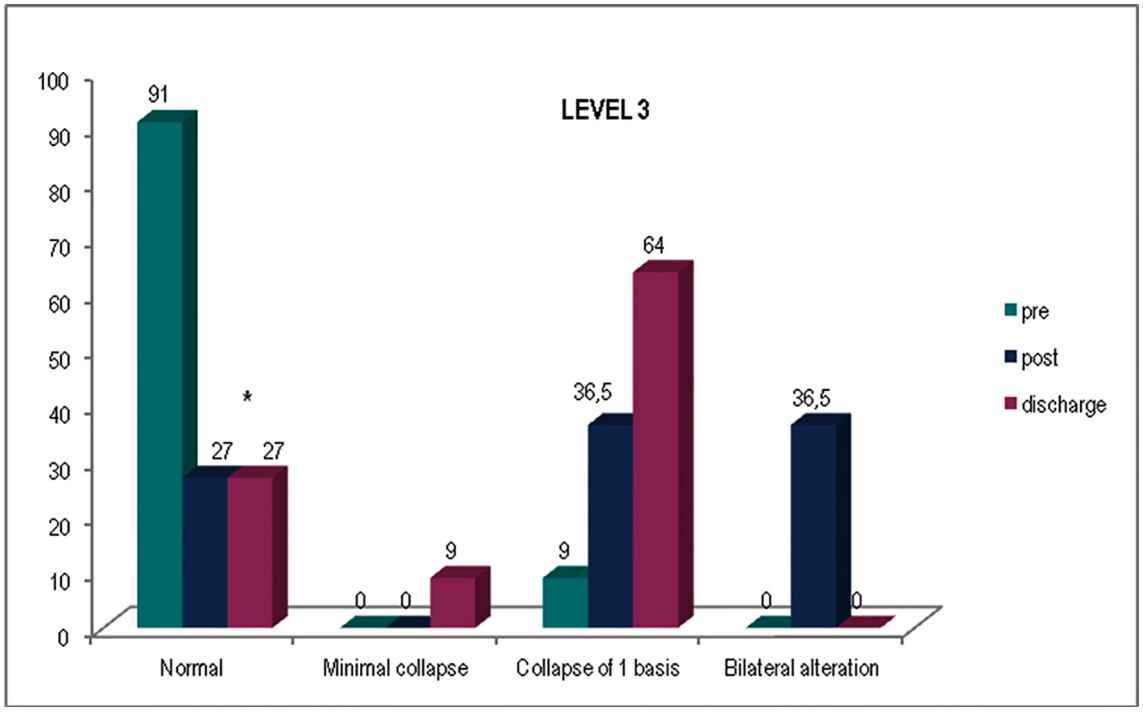

Fig. 4 - Percentage of radiological changes of level 3 in the pre, post and discharge of study.

DISCUSSION

Our results showed that the surgical event altered the pulmonary conditions in the patients who underwent valve surgery. The pulmonary volumes decreased, with smaller diaphragmatic mobility, which increased auscultatory alterations and reduced oxygenation. Moreover, the radiological images showed pulmonary collapse. After 5 days of study, pulmonary function improved; however, the preoperative values were not reached.

Our data showed that most of the patients were allocated into level 1 (78%), with a younger mean age. This may be justified by the fact that the patients with valve disease of rheumatic etiology and a first surgical intervention was most prevalent among the younger individuals[20]. Advanced age has been pointed out as a factor associated to a higher incidence of postoperative pulmonary complications (CPPO), which has observed in our study, as patients older than 50 years were included at levels 2 and 3.

In this structured evaluation, the respiratory mechanics was confirmed by the TxAbM analysis, palpation of the diaphragmatic movement, and generation of pulmonary volumes, which help the physiotherapist in detecting alterations in the muscle mobility. Our group previously observed that patients with stenosis and mitral regurgitation in the preoperative period showed normal TxAbM and breathing patterns, regardless of the type of valve lesion[21]. This was observed in our present study again. However, in the postoperative period, the TxAbM was altered, particularly in the patients at levels 2 and 3. At the end of the study, the patients at level 2 showed a normal TxAbM, and this was partially attributed to the resolution of the pulmonary collapse observed on chest radiograph. In the patients at level 3, alterations in the TxAbM (63%) were mainly associated to the diaphragmatic dysfunction, which is a complication of cardiac surgery, occurring at an incidence of 2% to 54%[22,23], depending on the research method. The lower diaphragmatic mobility increases the area of pulmonary collapse and can be triggered through rapid superficial breathing. These patients receive intensive physical therapy support and require more time for recovery, which justifies the small improvements observed at the end of the protocol for level 3.

Pulmonary function was reduced until approximately 25% at level 1, 35% at level 2, and more than 50% at level 3. At the end of the study, the patients in all the groups showed recovery but did not achieve the preoperative values. The lower decline observed at level 1 allowed a faster recovery. In previous studies[10,14,24], FVC and/or FEV_1 showed reductions of approximately 40% to 50% in regard to the expected values. Among these parameters, only age affected the results, as the younger patients presented less severe pulmonary impairment. Pain remained at the levels

slight or very slight and thus did not affect the patients' clinical progress.

Hypoxemia was present in the postoperative period, probably due to the surgical stress and reduction in the pulmonary volumes, with decreased area of gas exchange. The patients at level 1 were those with lower deoxygenation and those who recovered the original values in 5 days. The patients at levels 2 and 3, who showed higher degrees of hypoxemia, had a partial recovery but had persistent gas exchange alterations at the end of this study.

The factors that contributed to pulmonary impairment are reportedly multivariate. The presence of median sternotomy, drains, inhibition of deep breaths, hypervolemia, signs of congestive heart failure, lower complacency of the rib cage through manipulation, and diaphragmatic dysfunction may justify these pulmonary alterations[1-8]. All of these factors were present in our patients. Nevertheless, the presence of pleural changes, with consequent collapse and diaphragmatic dysfunction, was an important element in the reduction of pulmonary function.

For evaluation of pulmonary collapse, we adopted the same classification system used by Jenkins et al. [11] in patients with cardiac surgery. The authors observed the presence of collapse in 50% of the patients on the fifth day after coronary artery bypass graft surgery (CABG). In valve surgery, this incidence was 35% [14]. In our country, Vargas et al.[25] found a collapse incidence of 76% among patients on the seventh day after CABG. Our findings are not different from those reported in the literature, and we observed pulmonary collapse in the postoperative period in all of the patient groups. Among the patients who were discharged from the hospital, 56% of the patients at level 1 achieved normal radiographic data compared with 47% and 27% of the patients at levels 2 and 3, respectively. Thus, the chest radiographic parameter was useful in differentiating patients with a higher degree of impairment, as evident in the lower functional recovery.

The application of physical therapy assessment to classify patients according to lung impairment, patients requiring smaller alterations are expected to be allocated into level 1. In fact, in our study, such patients had lower pulmonary function impairment, oxygenation, and pulmonary collapse incidence. In level 2, patients who showed a greater extent of pulmonary changes were included. Meanwhile, in level 3, only 11 patients who presented with lower variation in functional gains and had longer hospital stay were included. With the classification system used in this study, it was possible to characterize the severity of pulmonary alterations and differentiate the clinical progress of the patients.

In conclusion, the proposed evaluation method was useful in identifying from among patients who underwent valve surgery, those who developed pulmonary impairment and require different levels of physical therapy assistance. The patients at level 1 showed lower decrease in pulmonary function and had rapid recovery. The patients at level 2 showed significant changes in their evolution but had functional improvement due to the treatment applied. The patients at level 3 showed higher levels of impairment, recovered slowly, and required a higher level of physical therapy assistance.

Limitations of the study

Our study has some limitations. The main limitation was the different number of patients in each group, which was due to the random distribution of the clinical cases at the valve disease group Another limitation was that the study was performed in 5 days; thus, improvements achieved by the patients until hospital discharge were not registered.

Our study sample was a convenience sample and included patients indicated for surgery at the valve disease group and those who underwent postoperative follow-up. Most of the patients showed lesions in the mitral valve, with a small number of patients with aortic lesion, which did not allow us to perform a statistical analysis among them. This fact did not allow to evaluate the impact of valve disease on the patients' progress.

Potential Conflict of Interest

The authors declare no conflict of interest.

Sources of Funding

No external funding was received for the completion of this study.

Academic Level

This study is linked to the postgraduate program of anesthesiology of the Faculty of Medicine, University of São Paulo.

Authors' roles & responsibilities	
SSF	Analysis and/or interpretation of data; operations and/or experiments conduct; writing of the manuscript or critical review of its content
LMSM	Analysis and/or interpretation of the data
MG	Conception and design
MIZF	Analysis and/or interpretation of data; statistical analysis; study design; writing of the manuscript or critical review of its content

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