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Respiratory mechanics behavior after heart surgery: an experimental study

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ABSTRACT. Changes in ventilatory mechanics and their consequent pulmonary complications are common after surgical procedures, particularly in cardiac surgery (CS), and may be associated with both preoperative history and surgical circumstances. This study aims to compare ventilatory mechanics in the moments before and after cardiac surgery (CS), describing how pulmonary complications occurred. An experimental, uncontrolled study was conducted, of the before-and-after type, and with a descriptive and analytical character. It was carried out in a private hospital in the city of Salvador, Bahia, Brazil, and involved 30 adult patients subjected to CS. In addition to clinical and epidemiological variables, minute volume (VE), respiratory rate (RR), tidal volume (VT), forced vital capacity (FVC), maximum inspiratory pressure (MIP), and peak expiratory flow (PEF) were also recorded. Data were collected in the following moments: preoperative (PRE-OP) period, immediate postoperative (IPO) period, and 1st postoperative day (1st POD). The sample was aged 48.1 ± 11.8 years old and had a body mass index of 25.5 ± 4.9 kg m^{-2}; 60% of the patients remained on mechanical ventilation for less than 24 hours (17.5 [8.7-22.9] hours). There was a significant reduction in VT, FVC, MIP and PEF when PRE-OP versus IPO, and PRE-OP versus 1st POD were compared ($p < 0.05$). There were no significant changes between IPO and the 1st POD. The highest incidence of pulmonary complications involved pleural effusion (50% of the patients). This study showed that patients subjected to CS present significant damage to ventilatory parameters after the surgery, especially in the IPO period and on the 1st POD. It is possible that the extension of this ventilatory impairment has led to the onset of postoperative pulmonary complications.

Keywords: thoracic surgery; respiratory mechanics; functioning; postoperative complications.

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Introduction

Changes in ventilatory mechanics and their consequent pulmonary complications are common after surgical procedures, particularly in cardiac surgery (CS) (Beluda & Bernasconi, 2004). The advancement of science and technology has favored an improvement in the survival and functional status of patients after CS. However, 10 to 25% of the latter still present pulmonary complications, requiring special attention to changes in the ventilation-perfusion ratio and lung volumes that directly impact respiratory mechanics (Zochios, Klein, & Gao, 2018).

Lung function impairment after surgical procedures has a multifactorial character that ranges from the patient's preoperative condition to events inherent to the surgical technique performed (Wynne & Botti, 2004; Guizilini et al., 2005). Major preoperative risk factors responsible for negative outcomes in the postoperative period include age above 65, kidney failure, chronic obstructive pulmonary disease, repeated surgery, emergency surgery, functional class 2 or higher, in accordance with the New York Heart Association's classification, and left ventricular ejection fraction lower than 30% (Huffmyer & Groves, 2015; Cordeiro et al., 2018). These factors can lead to disorders in the integrity of the respiratory system, compromising respiratory mechanics and gas exchange (Wynne & Botti, 2004; Ambrozin & Cataneo, 2005).

Regardless of these risk factors, other events intrinsic to surgical procedures affect the physiology of the lungs, being decisive in the post-surgical evolution of cardiac patients and in the genesis of gas pulmonary complications (Wynne & Botti, 2004; Ambrozin & Cataneo, 2005; Morsch et al., 2009). Among said events, cardiopulmonary bypass (CPB) has the greatest potential to cause ventilatory problems, being closely related to systemic and lung-capillary inflammatory response. This local response causes neutrophils to stay trapped in the pulmonary vasculature, leading to congestion and keeping this effect for 2 to 4 hours after weaning from CPB. Associated with this, activated leukocytes increase capillary permeability, causing the accumulation of fluid in the interstitium and directly affecting pulmonary mechanics (Apostolakis, Filos, Koletsis, & Dougenis, 2010; Huffmyer & Groves, 2015).

When it comes to mechanical ventilation (MV), its use during CPB still needs more consistent evidence. Schreiber et al. (2012) recommend using protective strategies combined with positive end-expiratory pressure (PEEP) between 5 and 10 cm H_2O, and maximal alveolar recruitment maneuvers with decremental PEEP during CPB. Wang, Huang, and Tu (2018), in their turn, while assessing the use of continuous positive airway pressure (CPAP) during CPB, did not report any relevant effect on the outcomes assessed.

Ventilatory imbalances can also be linked to anesthetic factors, such as drug applied, type and time of anesthesia, in addition to surgical factors related to incision site, surgical modality, use of chest drains, and postoperative MV (Barbosa & Carmona, 2002; Ng, Wan, Yim, & Arifi, 2002; Yende & Wunderink, 2002; Ragnarsdóttir et al., 2004; Hedenstierna & Edmark, 2005; Herlihy, Koch, Jackson, & Nora, 2006; Morsch et al., 2009; Batista Neto et al., 2021). Anesthetic agents can induce hypoxemia, decreasing lung volumes and capacities, thus worsening the ventilation-perfusion ratio (V/Q) and mucociliary clearance (Hedenstierna & Edmark, 2005).

Regarding surgical time, studies show that prolonged supine position can cause a reduction of up to 20% in the forced vital capacity (FVC), having its critical point on the 1st postoperative day (POD), and full recovery may take 6 to 17 weeks. In addition, surgical trauma impairs respiratory mechanics, as the opening of the chest prevents negative intrathoracic pressure, hindering lung expansion, which can lead to alveolar collapse (Ragnarsdóttir et al., 2004).

The formation of atelectasis impacts both the intraoperative and postoperative periods. During surgery, the alveoli close through the lung paralysis strategy or ventilation with large tidal volumes associated with zero end-expiratory pressure, increasing the production of inflammatory mediators with systemic impact (biotrauma) and alveolar damage caused by shear (cyclic opening and closing). After surgery, the appearance or maintenance of atelectasis may result from the presence of pain and impaired lung expansion, more specifically from the ability to maintain adequate lung volumes (Badenes, Lozano, & Belda, 2015; Huffmyer & Groves, 2015; Cordeiro et al, 2018). This postsurgical pain is considered an additional stress to the deterioration of the ventilatory function (Caséca, Andrade, & Britto, 2006; Giacomazzi, Lagni, & Monteiro, 2006).

In light of the foregoing, it becomes important to identify the epidemiological profile of these patients, establishing a link between their presurgical clinical condition and likely changes in the properties of pulmonary mechanics. Thus, this study aims to compare respiratory mechanics in the moments before and after cardiac surgery, describing the pulmonary complications that occurred.

Material and methods

This is an experimental, uncontrolled study, of the before-and-after type, and with a descriptive and analytical character, carried out in a private hospital in the city of Salvador, Bahia, Brazil.

It involved adult cardiac patients, of both sexes, who underwent CS and agreed to participate in the research by signing the Free and Informed Consent Term. The investigation excluded patients with neurological or cognitive deficit (due to their difficulty in understanding the instructions for the pulmonary function tests); those who evolved with hemodynamic instability (represented by fever, severe hypoxemia, major change in blood pressure or heart rate) at any stage of the study; those with previous lung disease (such as asthma, bronchitis or pneumonia), severe pulmonary hypertension or surgical re-approach; and those who had been under a sedative effect or presented a decrease in their level of consciousness.

The following clinical and epidemiological variables were collected: age, gender, weight, height, Body Mass Index (BMI), personal history (hypertension [SAH], diabetes [DM], tobacco smoking, pneumopathy and obesity), systolic blood pressure (SBP) and diastolic blood pressure (DBP), heart rate (HR); respiratory rate (RR); admission diagnosis, surgical procedure performed, surgical and CPB time, presence/site/removal of the chest tube, length of stay on MV; length of hospital stay; and postoperative complications.

As for the pulmonary mechanics variables, in the expiratory branch of the unidirectional valve, minute volume (VE), RR, tidal volume (VT) and FVC were collected with the aid of a ventilometer. In the inspiratory branch of the same valve, using a manovacuometer, the maximum inspiratory pressure (MIP) was measured, and the patient was asked to perform forced inspirations for 30 seconds. Peak expiratory flow (PEF) was measured using a peak flow meter; the patient was asked to perform a maximum inspiration followed by a forced expiration, while in the supine position – Fowler's position (45°). Pulmonary mechanics measurements used the protocols validated by Caséca et al. (2006), for VE, VT, RR and PEF, by Guizilini et al. (2005), for FVC, and by Beluda and Bernasconi (2004), for MIP.

The variables were measured in three moments: in the preoperative (PRE-OP) period, in the immediate postoperative (IPO) period, and on the first postoperative day (1^{st} POD). In the three moments, the measurements were performed with the patient on spontaneous ventilation, by means of disposable mouthpieces, with their nostrils occluded by a nose clip. In all measurements, the patients were evaluated in bed, in Fowler's position at 45º, in accordance with the protocol suggested by Caséca et al. (2006).

In the IPO period, when the patient was admitted to the Intensive Care Unit (ICU), an orotracheal tube was attached to the mechanical ventilator (Viasys, Vela model), with extubation following the unit's protocol. Then, when the patient was extubated and an adequate level of consciousness was maintained, the variables were measured. Both in the IPO period and on the 1^{st} POD, the patients received basic analgesia, in accordance with the ICU's protocol, with caution being taken so that it did not depress their level of consciousness, while being enough for the pain not to impact their respiratory mechanics. It is important to highlight that, only after analgesia was optimized, and with the patient lucid and collaborative, measurements were performed in the IPO period, with the patient already on spontaneous ventilation, for a brief interval after extubation.

In order to avoid bias during the evaluation, all parameters were measured three times, with an interval of 1 minute between measurements, with the highest value being recorded. The measurements were performed by the researcher responsible for the study and by previously trained assisting physiotherapists.

Data were collected using: disposable mouthpieces (Microlab brand), nose clips (Healthscan brand), unidirectional valve (Protec brand), ventilometer (Ferraris brand, Mark 8 model), manovacuometer (GER-AR brand), peak flow meter (Healthscan brand) and oximeter (NONIN brand).

The statistical analysis was run by means of the software IBM SPSS, version 26.0. The numerical variables that followed normal distribution were presented in arithmetic mean (AM) and standard deviation (SD). Only length of stay on mechanical ventilation was presented in median and interquartile range (IqR, 25%-75%), as it showed asymmetrical distribution. Categorical data were presented in absolute and relative frequencies. Repeated measures ANOVA was performed for data analysis. The level of statistical significance was set at 0.05, or 5%.

This study was approved by the Research Ethics Committee of the Universidade Salvador (UNIFACS), under legal opinion No 04.10.77, in compliance with Resolutions 466/12 and 510/16 of the Brazilian National Health Council.

Results

A total of 32 patients were identified in the preoperative period of CS, of which two were excluded, one for evolving with hemodynamic instability and reintubation in the IPO period (n = 01), and the other for presenting cardiorespiratory arrest associated with septic shock, which culminated in death (n = 01).

The final sample was composed of 30 patients aged 48.1 ± 11.8 years old, with a BMI of 25.5 ± 4.9 kg m^{-2}; 57% were men, 77% were hypertensive, 13% were diabetic, and 10% were obese. None of the patients studied had pneumopathy (Table 1).

Concerning clinical diagnosis, 50% of the patients had angina pectoris, 20%, multiple valvular heart disease, 20%, mitral insufficiency, and 10%, rheumatic heart disease. As for the etiology of the heart condition, angina pectoris caused by ischemic cardiomyopathy (arteriosclerosis) was the most prevalent, being present in 50% of the cases (n = 15). About preoperative symptoms, dyspnea from moderate exertion was the most prevalent, occurring in 20 patients (68%).

Considering the surgical procedure performed, 63% of the patients underwent myocardial revascularization (MR) surgery, 3%, aortic valve replacement, 17%, mitral valve replacement, and 17%, mitral and aortic valve replacement. The surgical procedure lasted 216.9 ± 36.9 minutes. All patients used CPB during surgery, lasting 82.3 ± 21.8 minutes. The anoxia length was 72.3 ± 15.7 minutes.

All patients used some type of drain in the postoperative period, with 57% using only a mediastinal drain, 33%, drains in the left chest and in the mediastinum simultaneously, and 10%, bilateral chest drains.

All patients were admitted to the ICU on MV and stayed there for 17.5 hours (IqR, 25%-75%, 8.7-22.9 hours). It was found that 18 of the patients studied (60%) remained on MV for less than 24 hours, the measures of whom were taken in the IPO period. About the length of hospital stay, the patients were discharged after 4.4 ± 1.1 days.

Table 1. Demographic and clinical characteristics of the patients assessed.

Demographic and clinical characteristics	Sample (n = 30)
Age, AM ± SD (years)	48.1 ± 11.8
Male gender, n (%)	17 (57)
BMI (Kg m^{-2})	25.5 ± 4.9
Diagnosis, n (%)	
Angina pectoris	15 (50)
Multiple valvular heart disease	6 (20)
Mitral insufficiency	6 (20)
Rheumatic heart disease	3 (10)
SAH, n (%)	23 (77)
DM, n (%)	4 (13)
Tobacco smoking, n (%)	10 (33)
Pneumopathy, n (%)	0 (0)
Obesity, n (%)	3 (10)
Surgical procedure, n (%)	
Myocardial revascularization	19 (63)
Aortic valve replacement	1 (3)
Mitral valve replacement	5 (17)
Mitral and aortic valve replacement	5 (17)
Length of the surgical procedure (min.)	216.9 ± 36.9
CPB length (min.)	82.3 ± 21.8
Anoxia length (min.)	72.3 ± 15.7
SBP (mm Hg)	136.6 ± 11.8
DBP (mm Hg)	87.1 ± 6.9
HR (bpm)	83.2 ± 17.7
RR (ipm)	18.3 ± 2.4
Length of stay on MV, MD (IqR, 25%-75%) (hours)	17.5 (8.7-22.9)
Length of hospital stay (days)	4.4 ± 1.1

BMI: Body Mass Index; SAH: Systemic Arterial Hypertension; DM: Diabetes Mellitus; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; HR: Heart Rate; RR: Respiratory Rate; CPB: Cardiopulmonary bypass; MV: Mechanical ventilation.

Regarding respiratory mechanics, there was a statistically significant reduction in VT, FVC, MIP and PEF in comparison with the values in the PRE-OP period versus IPO period, and in the PRE-OP period versus 1st POD. However, the comparison of the values obtained in the IPO period and on the 1st POD did not show any statistically significant difference for any of these variables. Comparing the values obtained for VE and RR, no statistically significant differences were found (Table 2).

As for the incidence of pulmonary complications in the postoperative period, the presence of restrictive and obstructive changes was found, with 50% of the patients presenting pleural effusion, 13%, pneumonia, 43%, respiratory distress, 30%, dyspnea, and 17%, atelectasis. Only 1 patient (3%) did not present pulmonary complications in the postoperative period. Of the patients who presented pulmonary complications, 80% had more than one associated complication (Table 3).

Table 2. Respiratory mechanics in the preoperative period, in the immediate postoperative period, and on the 1st postoperative day.

Variables	PRE-OP (n = 30)	IPO (n = 18)	1st POD (n = 30)	p
VE (mL)	10,272.40 ± 3,490.1	8,922.6 ± 3.499.5	9,290.4 ± 3,142.7	0.28
VT (mL)	581.3 ± 208.8*, #	462.9 ± 159.9	464.1 ± 155.3	0.01
RR (ipm)	17.8 ± 3.7	19.8 ± 4.5	20.3 ± 4.0	0.05
FVC (mL Kg^{-1})	51.8 ± 14.7*, #	26.4 ± 11.0	29.7 ± 13.1	< 0.001
MIP (cm H_2O^{-1})	-47.6 ± 17.5£, ¥	-26.9 ± 14.7	-32.1 ± 13.7	< 0.001
PEF (L $min.^{-1}$)	370.0 ± 136.6*, #	188.8 ± 78.4	215.6 ± 72.6	< 0.001

*PRE-OP > IPO; # PRE-OP > 1st POD; £ PRE-OP < IPO; ¥ PRE-OP < 1st POD; PRE-OP: Preoperative Period; IPO: Immediate Postoperative period; POD: Postoperative Day; VE: Minute Volume; VT: Tidal Volume; RR: Respiratory Rate; FVC: Forced Vital Capacity; MIP: Maximum Inspiratory Pressure; PEF: Peak Expiratory Flow.

Table 3. Incidence of pulmonary complications in the postoperative period.

Pulmonary complication*	n (%)
Pleural effusion, n (%)	15 (50)
Pneumonia, n (%)	4 (13)
Respiratory distress, n (%)	13 (43)
Dyspnea, n (%)	9 (30)
Atelectasis, n (%)	5 (17)

*Presence of pulmonary complications, either associated or not.

Discussion

This research found lung function impairment in the postoperative period of CS, more specifically in MR and/or valve replacement, evidenced by the significant reduction in VT, FVC, PEF and MIP, especially when comparing the PRE-OP period with the IPO period and the 1st POD.

Pathophysiological interferences following a cardiac surgery, the deterioration of the aforementioned parameters and consequent pulmonary complications have been continuously studied. However, their etiologies remain an object of incessant exploration (Ng et al., 2002; Yende & Wunderink, 2002; Babik, Asztalos, Peták, Deák, & Hantos, 2003; Wynne & Botti, 2004).

Corroborating with other published studies, the sample of this research was mostly composed of men over 45 (Snowdon, Haines, & Skinner, 2014). However, some similar studies have used samples of patients aged 60 to 80 years old (Lagier et al., 2019). Regarding comorbidities, the existence of 77% of hypertensive patients in the studied sample corroborates with the profile described by other studies (Guizilini et al., 2005; Herlihy et al., 2006; Leme et al., 2017). More recently, Leme et al. (2017) reported a higher prevalence of hypertension than that in this study, corresponding to 88%.

Still about comorbidities, some studies attribute pulmonary dysfunction after cardiac surgery (Yende & Wunderink, 2002; Leguisamo, Kalil, & Furlani, 2005) to chronic tobacco smoking, which is a determining factor in delayed ventilatory weaning (Yende & Wunderink, 2002). In the present study, despite the minority of the sample being tobacco smoker (33%), pulmonary dysfunction after cardiac surgery was also evident.

Studies show that, of the patients who need to return to the ICU, 43% of them do so for pulmonary reasons. The complications most frequently mentioned in the literature include pleural effusion, respiratory insufficiency, atelectasis, pneumonia, as well as symptomatic and asymptomatic hypoxemia (Zochios et al., 2018). This study showed a higher incidence of complications from pleural effusion (50%). This high incidence can be attributed to surgical trauma (intraoperative manipulations, median sternotomy, and mediastinal and/or intercostal drainage in the entire sample) or to the administration of Ringer's lactate solution to which the studied patients were subjected (Vargas et al., 2002; Leguisamo et al., 2005; Groeneveld, Jansei, & Verheij, 2007).

Respiratory distress and dyspnea were frequent complications too. Their etiology may be associated with the surgical circumstances already elucidated (Leguisamo et al., 2005), as well as with ventilator-dependent pain (Giacomazzi et al., 2006), and with clinical manifestations deriving from atelectasis (Auler Junior et al., 2007; Duggan, & Kavanagh, 2007), or, to a greater extent, with pleural effusion (Vargas et al., 2002; Leguisamo et al., 2005), since this was the most frequent complication in this study. In the analysis by Roosens et al. (2002), dyspnea was the most common sign in patients who underwent CPB, especially in the first 3 hours after admission to the ICU, which is due to an increase in the dynamic and static elastances of the respiratory system.

Associated with complications, Zochios et al. (2018) point out anesthesia as an important factor in reducing FRC and in respiratory mechanics. In this study, a significant reduction in VT was found, which may be due to a decrease in FRC induced by the anesthesia. Renault, Costa-Val, and Rossetti (2008) reiterated this correlation between the deterioration of secondary respiratory mechanics and significant reduction in FRC and VT, showing that changes in volumes and capacities can lead to hypoxemia and reduced diffusion capacity.

In addition, the literature shows that there are factors associated with the surgical technique and the patient themselves, which are also considered risk factors for the development of complications. According to Leme et al. (2017), factors such as BMI, CPB length and need for open surgeries, with exposure of the lungs, have a direct influence on the risk of atelectasis.

The length of the surgery, as well as its type and intraoperative treatments can contribute to a deficiency in the respiratory function by changing the mechanics of the chest wall, thus impairing lung expansion (Ball, Costantino, & Pelosi, 2016). These factors alter the chest wall and ventilatory mechanics, in addition to causing a dysfunction in capillary permeability, resulting from the inflammation generated by CPB, and in the lung tissue itself (Huffmyer & Groves, 2015).

Considering the surgical procedure, sternotomy is one of the factors responsible for deteriorating ventilatory mechanics, with the resulting manifestation of postoperative pain. Guizilini et al. (2005) found the presence of ventilator-dependent pain with an overall drop in FVC until the 5th POD, with this pain being more intense around the intercostal drain compared to the subxiphoid drain. These authors consider that, regardless of the position of the drain, the surgical procedure causes pulmonary dysfunction, with a greater impact on intercostal insertion, due to the constant irritation of the intercostal and periosteum nerves during respiratory movements.

Giacomazzi et al. (2006), while verifying the persistence of pain until the 5th POD, observed deterioration of the PEF on the 1st POD, which rose after this period, but remained much below the preoperative values. The present study corroborates these authors, since a reduction was shown not only in FVC and PEF, but also in VT and MIP.

A decrease in these ventilatory markers seems to be associated with quite similar causes; however, even under basic-analgesia protocol, it is not possible to guarantee that pain was not present in the studied patients. This inference is corroborated by the fact that all patients were using some type of drain in the postoperative period, which may have contributed to the exacerbation of the painful symptom during the manipulations, both around the drain(s) and in the surgical incisions. Thus, a greater difficulty was evidenced while FVC and MIP were measured, due to the effort made by the patients, a fact that may have had an impact on the reduction of the parameters in the postoperative period in relation to the preoperative period.

Urell, Emtner, Hedenstrom, and Westerdahl (2016), when evaluating MIP two months after CS, do not bring evidence as to changes in muscle strength, or as to whether this marker can be masked by pain, motivation or ability to undergo the test in the immediate postoperative period. However, much is discussed about the previous state of MIP, as evidenced by Rodrigues et al. (2011) when stating that a low preoperative MIP led to prolonged mechanical ventilation in patients in the postoperative period following valve replacement surgery. Unlike in the study by Rodrigues et al. (2011), in the present one the baseline MIP was below the predicted value, but the patients did not remain on prolonged MV. Nonetheless, a 50% reduction in MIP in the IPO period compared to the baseline was shown, a fact that may be linked to the patient's motivation or ability to undergo the test, as suggested by Urell et al. (2016). However, pain is not believed to be a major factor in the result found, since the patients were under analgesia.

It is important to note that other factors may be associated with loss of inspiratory muscle strength, such as diaphragmatic paralysis during surgery, and phrenic nerve damage caused by cooling devices or direct surgical injuries. In a recent study, Moury et al. (2019) showed that diaphragm thickening often decreases after elective cardiac surgery, without impacting respiratory outcomes. In said study, 75% of the patients evaluated showed a reduction in diaphragmatic thickness, a factor that may have had a direct impact on MIP. Moreover, an altered thickness pattern was associated with a longer ICU stay, with contractile activity having influenced the thickness evolution (Moury et al., 2019).

With regard to PEF, the significant reduction presented in this study corroborates with the results found by Scheeren et al. (2016). However, these authors associated this reduction with patient-related factors, such as old age and tobacco smoking. It is worth stressing that, in the present study, despite the minority of the patients being smokers and not elderly, a reduction in PEF was evidenced as well.

As for the pulmonary complications associated with the surgical procedure, the role of physiotherapy in minimizing harmful effects is highlighted, as it promotes early weaning from MV and the mobilization of the patient in bed, thus reducing the incidence of complications. In this study, in the preoperative assessment, an individualized physiotherapeutic treatment plan was already recommended. After admission to the ICU, in agreement with the medical team, ventilatory adjustments would be made, aiming at early weaning, since dependence on endoprosthesis increases the risk of pulmonary complications (Yende & Wunderink, 2002; Nozawa et al., 2003; Arcêncio et al., 2008). Furthermore, kinesiotherapy was performed in association with breathing exercises focusing on early removal from the bed, through gradual changes in posture (raised headboard, sitting with the limbs hanging, in the armchair, assisted or independent walking) (Soares et al., 2010). It is worth noting that endotracheal aspiration was performed only before extubation, and that respiratory muscle training was not implemented.

This study presented as a limitation the fact that the follow-up of the patients was restricted to the 1st POD, in an attempt to minimize methodological bias, since medical and nursing procedures could interfere in the measurements. In addition, a previous pilot study observed that the majority of the patients were not receptive to tests as of the 2nd POD, which resulted in significant losses. It is believed that the period studied was not enough for a quantitative improvement in the variables to be achieved, which may explain the absence of statistical significance between the IPO period and the 1st POD. However, these factors do not compromise the critical analysis of the results obtained.

Conclusion

The present study evidenced a significant impairment in respiratory mechanics after CS, with deterioration in most of the ventilatory parameters analyzed, especially in the IPO period and on the 1st POD. It is possible that this ventilatory impairment was reflected in the high prevalence of postoperative pulmonary complications. Preoperative clinical conditions and transoperative factors contribute to this fact, resulting in a satisfactory prognosis in most of the patients selected.

A thorough assessment in the preoperative period with a view to identifying abnormalities in respiratory mechanics is paramount for an effective surgical preparation. Comparison between the preoperative and the postoperative conditions is proven to be very useful to define specific interventions, favoring the return of the function to the impaired system.

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