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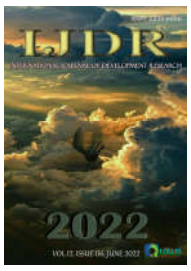

RESEARCH ARTICLE OPEN ACCESS

RESPIRATORY FUNCTIONAL REPERCUSSIONS OF POSITIVE PRESSURE THERAPY IN THE POSTOPERATIVE PERIOD OF BARIATRIC SURGERY: A SYSTEMATIC REVIEW

Ana Beatriz da Silva Ribeiro[1,*], Maria Eduarda Rodrigues Silva Cardoso[1], Eric da Silva[2], Igor Almeida Silva[3], Ana Cláudia Medeiros Serra[4], Marle Araújo Luz de Carvalho[5] and Francirraimy Sousa Silva[6]

[1]Physiotherapy student at Centro Universitário Santo Agostinho – UNIFSA, Teresina, Piauí, Brazil; [2]Adult Intensivist Physiotherapist from ASSOBRAFIR, Master in Biomedical Engineering from Univap – SP, Professor at the Department of Physiotherapy at Centro Universitário Santo Agostinho; [3]Physiotherapist Specialist in Intensive Care by ASSOBRAFIR, Residency in high complexity by HU-UFPI, Master in Science and Health by UFPI; [4]Physiotherapist in Intensive Care at UCM – MedImagem, Physiotherapist at Unimed Hospitals, Military Police and Monte Castelo – Teresina, Brazil; [5]Nurse at HU-UFPI, Master in Environmental Sciences and Health at PUC-GOIÁS; [6]Specialist in Trauma-Orthopedic and Sports Physiotherapy from FACINTER-IBPEX, Professional Specialist in Physiotherapy in Adult Intensive Care from ASSOBRAFIR, Master in Science and Health from UFPI

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Corresponding author:
Ana Beatriz da Silva Ribeiro

ABSTRACT

Bariatric surgery is an alternative intervention for individuals with morbid obesity, a pathology that compromises lung function due to its inflammatory and systemic character. As it is an upper abdominal wall surgery, it generates changes in the individual's respiratory mechanics, making it necessary to use Non-invasive Mechanical Ventilation. This study is a systematic review that aims to investigate the respiratory repercussions of positive pressure therapy in the postoperative period of bariatric surgery. A search was carried out in the following databases: SciELO, LILACS and MEDLINE, using the descriptors: "Continuous Positive Airway Pressure", "Postoperative Care" and "Bariatric Surgery", in addition to their correspondents in Portuguese. A total of 83 articles were identified and 78 were excluded due to duplicates or not meeting the eligibility criteria, with only 5 being selected to compose the review. The studies showed, regarding the use of Bipap, a reduction in atelectasis, less loss of residual expiratory volume and fewer postoperative complications, and regarding the use of Cpap, an increase in pulmonary oxygenation was observed. The subject lacks research with high methodological quality on the subject.

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INTRODUCTION

Bariatric Surgery - BS is an invasive method used as an alternative treatment for morbidly obese individuals (Body Mass Index BMI ≥ 40 kg/m²). Obesity compromises lung function, as it is a chronic systemic inflammatory disease (Melo *et al*., 2016). Thus, respiratory changes are inherent to obese people, such as: increased metabolic requirements, with a consequent increase in respiratory work, oxygen consumption and carbon dioxide production.

These factors increase respiratory rate while decreasing functional residual capacity and expiratory reserve volume. Bariatric surgery aims to help improve these and other comorbidities caused by obesity and morbid obesity, such as systemic arterial hypertension and diabetes mellitus (Schumann, 2022). Despite the benefits arising from bariatric surgery, it is common that respiratory complications still result from its performance, such as atelectasis, bronchospasm and pneumonia. Loss of muscle integrity by the incision, the use of neuromuscular blockers in anesthesia, reflex inhibition of the phrenic nerve with diaphragmatic paresis, general anesthesia and pain

increase the chances of postoperative disorders. In surgical procedures of the upper abdominal wall, the deleterious effects on respiratory mechanics are expected, undergoing changes in gas exchange, oxygenation, ventilation, volumes and respiratory capacities, which explains the use of Non-invasive Mechanical Ventilation - NIMV or NIV - by the physiotherapy (Baltieri *et al*., 2014; Hyzy & McSparron, 2021; Pazzianotto-Forti *et al*., 2012; Peixoto-Souza *et al*., 2012). NIMV can be applied in two main modes, generally the most used in clinical practice are: 1. BiPAP - Bi-Level Positive Airway Pressure, corresponding to two pressure levels, or 2. CPAP - Continuous Positive Airway Pressure/Continuous Positive Airway Pressure in airways (Cavalcanti *et al.,* 2018). Continuous Positive Airway Pressure - CPAP, associated with traditional methods of respiratory physiotherapy (diaphragmatic reeducation, vibrocompression, equipment with inspiratory and expiratory resistive load, among others), prevents and/or attenuates atelectasis, pneumonia and length of hospital stay. postoperative period of bariatric surgery, restores lung volumes and capacities, especially functional residual capacity, and increases thoracoabdominal mobility (Pazzianotto-Forti *et al.,* 2019; Rocha *et al.,* 2018). Lim (2022) reports that more than 1.4 billion adults in the world are overweight or obese, alarming and growing numbers. In Brazil, surveys carried out in mid-2019 by the Ministry of Health found that 51.2% of women were overweight and, among men, this rate reached 57.3%, demonstrating a clear public health problem, often circumvented only with the help of bariatric surgery, making it equally necessary to know about the benefits of NIV and the role of the physical therapist in this scenario (Pazzianotto-Forti *et al.,* 2019).
This study aims to elucidate and investigate, through a systematic review, the respiratory functional repercussions of positive pressure therapy in the postoperative period of bariatric surgery, without restriction regarding its surgical types, postoperative time and methods used in NIV.

METHODOLOGY

Preliminarily, the study was submitted to the Prospective International Registry of Systematic Reviews (PROSPERO), which was accepted on May 2, 2022, with the following registration number CRD42022322097. In order to give credibility, the study was structured according to the PRISMA checklist (Galvão *et al*., 2015). Regarding eligibility criteria, only randomized clinical trials, without time restriction, addressing the use of NIMV in adults after bariatric surgery were included in this study, and articles published in duplicate, incomplete or without scientific basis were excluded. From May 5, 2022 to May 10, 2022, a search was carried out in the databases through Randomized Clinical Trials, with no limitations in terms of time or languages, in the LILACS and MEDLINE databases, through the Library in Health (BVS), and in SciELO, using the descriptors: Continuous Positive Airway Pressure, Postoperative Care and Bariatric Surgery, in addition to their corresponding Portuguese language: *Pressão Positiva Contínua nas Vias Aéreas, Cuidados Pós-Operatórios* and *Cirurgia Bariátrica*. The search strategy in MEDLINE occurred through the BVS using the descriptors Bariatric Surgery AND Continuous Positive Airway Pressure AND Postoperative Care, in addition to making use of filters to direct to the database. The screening of the articles found was aided by the Rayyan Software, a tool that aims to accelerate and collaborate with scientific research through the classification of studies (Ouzanni *et al*., 2016). The selection of articles was carried out independently by two researchers (Cardoso & Ribeiro) and, in case of disagreement or discrepancy in the results, they would be discussed and evaluated by the third researcher (da Silva), which was not necessary. The researchers read the included studies in full and collected the relevant data: titles, authors, years of publication, main results, samples, interventions and comparisons. Data were sought in the results that indicated the influence of the use of NIV with Positive Pressure in individuals in the postoperative period of bariatric surgery, observing the ethical and legal aspects. The two authors (Cardoso & Ribeiro) performed the qualitative analysis of the articles and their risk of bias independently, using the PEDro - Physiotherapy Evidence Database scale, which categorizes studies numerically as to methodology and is composed of 11 criteria that are scored, with the exception of the first and, in the present study, the score obtained was considered of high quality when from 10 to 8, medium quality when from 7 to 6, and low quality when from 5 to 0. When analyzing the quality of the articles selected by the two authors (Cardoso & Ribeiro), there was a discrepancy in the results, with the third evaluator (da Silva) having to discuss and evaluate to give the 'minerva vote'. Subsequently, through a search in the Google browser for the title of the articles already selected, a search was carried out for them on the PEDro platform, in order to collect the score given to the study in question, since this is the database that created the scale used to quality analysis of articles in the present study. However, only two articles were found on this platform, namely those by Baltieri *et al.* (2014) and Wong *et al.* (2011). The collected data were exposed in a flowchart and tables. The flowchart contains information on the number of articles found and those that actually meet the criteria to be part of the study, pointing out the criteria that led to the exclusion of the articles. As for the tables, the first summarizes the pertinent information about the articles included in the research, with the author data, year of publication, results, sample, intervention and comparison used in the study; the second table shows the evaluation of articles according to the PEDro scale and their respective notes; and in the third table there are reproducible positive pressure therapy data: pressure value, application time per day, number of times per week, and total therapy time.

RESULTS

The electronic search in the databases based on the previously established descriptors resulted in a total of 83 articles found. Of these, 16 were excluded due to duplicity and 45 were excluded because they were non-randomized clinical trials. Thus, 22 articles remained for analysis of titles and abstracts and, after this was carried out, 17 articles were excluded under the criterion of non-adequacy to the theme (Figure 1 - Flowchart). In the end, 5 articles were included (Table 1 – Characteristics of the included studies), totaling a sample of 235 participants. The articles were evaluated using the PEDro Scale (Table 2 - Evaluation of the articles included through the PEDro Scale), considering one article of low quality (score 4/10), one of medium quality (score 6/10) and three high quality (scores 8/10 and 10/10).

DISCUSSION

After careful analysis and reading of the articles, matching them to the eligibility criteria previously defined for this review, five were included. In these, the population is obese of both sexes (female and male, without consideration of gender fluidity), with a Body Mass Index ≥ 40 kg/m², mean age of 39.4 years, who underwent bariatric surgery of any type (in one study the surgery was by laparotomy, in the others it was by Roux-en-Y gastric bypass) with subsequent physical therapy intervention using NIV in any mode (BiPAP, CPAP, PEEP), in all studies being assigned a statistical significance level of $p<0.05$. In the study by Wong *et al.* (2011) 81 participants were gathered, distributed in a Boussignac group and a Venturi group, not presenting a control group, in order to limit their study. Both groups received the interventions immediately after extubation for 1 hour (Table 3 – Reproducible data from positive pressure therapy), and their effects were evaluated 1 and 2 hours after extubation. In the 1st hour of evaluation, the value of PaO_2 was higher in the Boussignac Group than in the Venturi Group ($p<0.001$), being equal in the 2nd hour. The same situation is repeated for the FiO_2 values ($p=0.003$). There was an improvement in pulmonary oxygenation in the Boussignac group, while the Percentage of Forced Expiratory Volume in the First Second ($\%FEV_1$) and the Percentage of Forced Vital Capacity (%FVC) were similar between the groups. With a score of 4/10, the article is considered of low quality according to the PEDro Scale, not meeting the criteria: "initial similarity between subjects in terms of prognostic indicators, blinding of subjects, therapists and evaluators, analysis of intention to treatment, and measures of

Table 1. Characteristics of the included studies

ARTICLES	RESULTS	SAMPLE	INTERVENTION	COMPARATION
WONG *et al.* (2011)	In the PO of Roux-en-Y bariatric surgery, the use of the Boussignac mask showed improvement in pulmonary oxygenation (PaO_2 p<0.001 and FiO_2 p=0.003). $\%FEV_1$ and %FVC proved to be equivalent to the application in both groups.	81	Boussignac Group: Positive pressure. Venturi Group: Positive pressure.	Absence of control group. One hour and 2 hours after application of positive pressure, and intergroups.
BALTIERI *et al.* (2014)	The PO, immediately after extubation, was the best moment for the application of positive pressure, as it reduced the prevalence of atelectasis - Gpré 10%, Gpós 0%, Gintra 11.1% and Gcontrole 25%, and generated less loss of ERV - Gpré (0.29 *vs* 0.14:p<0.05), Gpós (0.40 *vs* 0.14:p<0.05) and Gintra (0.37 *vs* 0.14:p<0, 05).	40	Gpré: BiPAP for 1 hour preoperatively. Gpós: BiPAP for 1 hour postoperatively. Gintra: PEEP during surgery.	Gcontrole: Conventional respiratory physiotherapy.
GUIMARÃES *et al.* (2016)	In the PO of Roux-en-Y BS, the application of positive pressure with the Boussignac for 2 hours post-extubation improved oxygenation, maintaining it for 24 hours (p<0.001), not influencing FVC and FEV_1.	24	Boussignac Group: Positive pressure. Venturi Group: Positive pressure.	Absence of control group. Preoperative, 1 hour, 2 hours and 24 hours after application of positive pressure, and intergroups.
CAVALCANTI *et al.* (2018)	In the PO of Roux-en-Y BS, preventive NIV provided faster recovery in inspiratory capacity and PEF (p<0.030; p<0.0001) and fewer postoperative complications.	50	NIV group: Same guidelines passed on to the control group + Positive pressure (BiPAP).	Control group: Recommendations regarding posture, early ambulation and cough stimulus.
PAZZIANOTTO-FORTI *et al.* (2019)	In the Roux-en-Y BS PO, using positive pressure in BiPAP immediately after post-anesthetic recovery promoted a reduction in atelectasis (p=0.0027) and brought benefits to ERV maintenance (p=0.4446 *vs*. =0.0191).	40	PAR-G: BiPAP for 1 hour in post-anesthetic recovery. 1PO-G: BiPAP for 1 hour on the first postoperative day.	Absence of control group. Pre and postoperative intragroups and intergroups.

Source: Authors (CARDOSO & RIBEIRO, 2022).

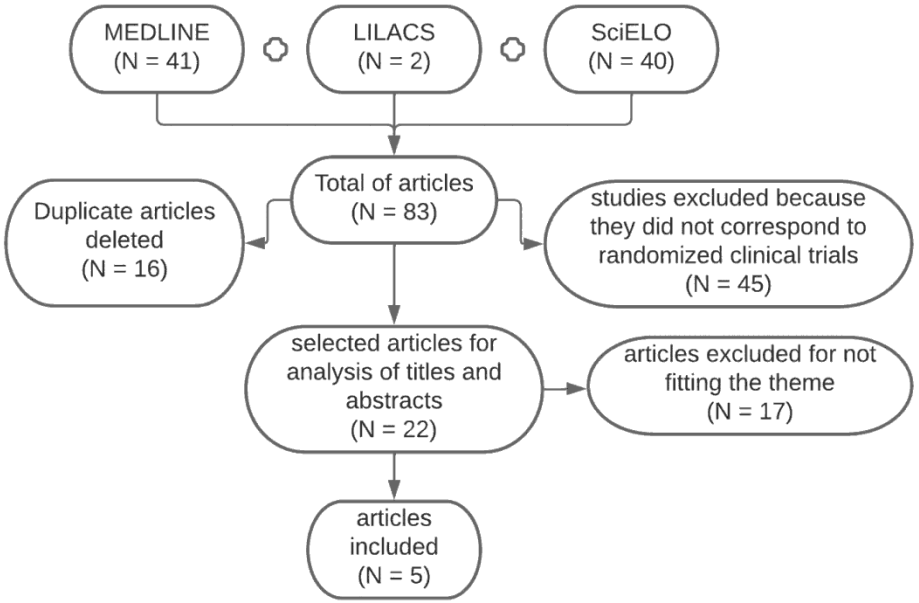
Table 2 – Evaluation of the articles included through the PEDro Scale.

PEDro Scale / Article / Year	WONG *et al.*(2011)	BALTIERI *et al.* (2014)	GUIMARÃES *et al.* (2016)	CAVALCANTI *et al.* (2018)	PAZZIANOTTO-FORTI *et al.* (2019)
1 Eligibility criteria were specified	YES	YES	YES	YES	YES
2 Subjects were randomly allocated to groups	1	1	1	1	1
3 Allocation was concealed	1	0	1	1	1
4 The groups were similar at baseline regarding the most important prognostic indicators		1	1	1	1
5 There was "blinding" of all subjects	0	0	0	1	1
6 There was blinding of all therapists who administered the therapy	0	0	0	0	1
7 There was blinding of all assessors who measured at least one key outcome	0	1	1	0	1
9 Analysis of intention to treat according to subject allocation	0	0	1	1	1
10 Statistical comparisons between groups	1	1	1	1	1
11 Precision and Variability Measures for the Study	0	1	1	1	1
TOTAL SCORE	4/10	6/10	8/10	8/10	10/10

Source: Authors (CARDOSO & RIBEIRO, 2022).

Table 3 . Reproducible data from positive pressure therapy

ARTICLE	VALUE OF PRESSURES	APPLICATION TIME PER DAY	NUMBER OF TIMES PER WEEK	TOTAL THERAPEUTIC TIME
WONG *et al.* (2011)	**Boussignac:** CPAP with O_2 flow of 15 L/min. **Venturi:** Mask with FiO_2 of 0.40. If SpO_2 was <92% for +5 min during the 1st hour post-extubation, subjects in the Boussignac group were switched to the Venturi group protocol.	**Boussignac e Venturi:** One hour.	Single care, post-extubation.	Single attendance (evaluation 1 and 2 hours post-extubation).
BALTIERI *et al.* (2014)	**PEEP:** 10 cmH_2O during surgery. **BiPAP:** IPAP adjusted to 12 cmH_2O and readjusted according to the patient's tolerance, with RF kept below 30 ipm, tidal volume between 8 and 10 mL/kg of ideal weight, and PEEP set at 8cmH_2O.	**PEEP:** Surgery duration time. **BiPAP:** One hour.	Single care, pre- or post-operatively, according to the allocation group.	Single care.
GUIMARÃES *et al.* (2016)	**Boussignac e Venturi:** Positive pressure of 5 to 8cmH_2O, FiO_2 of 0.5, with the head elevated at 30º.	**Boussignac e Venturi:** Two hours.	Single care, post-extubation.	Single care.
CAVALCANTI *et al.* (2018)	**BiPAP:** Target tidal volume of 7mL/kg of predicted weight, with inflation pressures limited to 20cmH_2O, IPAP ranging from 14 to 16cmH_2O and fixed EPAP of 7cmH_2O.	Sixty minutes.	Three days (from the first to the third postoperative day).	Three days.
PAZZIANOTTO-FORTI *et al.* (2019)	BiPAP: IPAP adjusted to 12 cmH_2O and readjusted according to the patient's tolerance, with RF maintained between 12 and 20 ipm, tidal volume between 8 and 10 mL/kg of ideal weight, and PEEP set at 8cmH_2O.	BiPAP: One hour.	BiPAP: Single care, postoperative.	Single care.



Source: Authors (CARDOSO & RIBEIRO, 2022).

Figure 1 – Flowchart

precision and variability". The study by Baltieri *et al.* (2014) consisted of a sample of 40 participants who underwent bariatric surgery by laparotomy, divided into the Gpré group, which received NIV in the Bilevel/BiPAP mode for 1 hour preoperatively; Gpós, who also received BiPAP for 1 hour, but in the postoperative period; Gintra, for which PEEP (Positive End Expiratory Pressure) of 10cmH_2O was offered during surgery; and Gcontrole, who received conventional respiratory physiotherapy, covering lung re-expansion, ambulation, breathing exercises – deep and fractional inspirations, and use of Respiron (Table 3 – Reproducible data from positive pressure therapy). When analyzing the data from the groups, it was observed that the prevalence of postoperative atelectasis in Gcontrole was considerably higher, with a percentage of 25%, followed by Gintra (11.1%), Gpré (10%) and Gpós, respectively, the latter with 0% prevalence. Among the groups, diaphragmatic mobility did not undergo considerable changes. Meanwhile, compared to the Gcontrole group, there was less loss of Expiratory Reserve Volume (ERV) in the groups that received additional treatment from pre to postoperative: Gpré (0.29 *vs* 0.14: p<0.05), Gpós (0.40 *vs* 0.1: p<0.05) and Gintra (0.37 *vs* 0.14: p<0.05). Thus, it was found that the most opportune moment to apply positive pressure is immediately after extubation of the patient who underwent the bariatric surgery procedure. The limitations of this study are: the non-specification of the secret allocation and blinding of its subjects, the non-specification of the blinding of its therapists, and there is no description of the intention-to-treat analysis. Thus, the score of the article in PEDro is 6/10, being considered of medium quality. Guimarães *et al.* (2016) gathered a sample of 24 participants, divided into the Boussignac Group and the Venturi Group, dispensing with a control group, a limiting factor for their study. PaO_2 and PaO_2/FiO_2 values were measured preoperatively (Tpre), 1 hour (T1), 2 hours (T2) and 24 hours (T24) after extubation. Both groups received the application of their respective masks (Boussignac and Venturi) to supply oxygen according to the prescribed parameters for a period of 2 hours, in the immediate postoperative period, as soon as they were extubated (Table 3 - Reproducible data from the positive pressure therapy). The Boussignac group showed a significant difference of p=0.006 in the PaO_2/FiO_2 ratio at Tpre and T1. In the Venturi group, there was a significant difference in the PaO_2/FiO_2 ratio between Tpre and T1 (p<0.001) and between T1 and T2 (p=0.034). In the Boussignac group, PaO_2 and PaO_2/FiO_2 were higher than in the Venturi group at T1 (p<0.013), T2 (p<0.001) and T24 (p<0.001). The study showed that the application of CPAP with Boussignac for 2 hours improved oxygenation, maintaining the effect for up to 24 hours, but did not influence Forced Vital Capacity (FVC) and Forced Expiratory Volume in the First Second (FEV_1). The study was considered of high quality, receiving a score 8/10 by the PEDro Scale, with the lack of blinding of subjects and therapists as limiting points.

Cavalcanti *et al.* (2018) gathered a sample of 50 participants, dividing them into a control group, which received recommendations regarding early ambulation and posture, and cough stimulation, and a NIV group, which, in addition to the aforementioned guidelines, received BiPAP application once a day for 60 minutes, from the first to the third postoperative day – 1st to 3rd POD (Table 3 – Reproducible data from positive pressure therapy). To assess respiratory function, the groups were evaluated preoperatively, on the 1st and 3rd POD regarding Inspiratory Capacity - IC, Peak Expiratory Flow - PEF, Slow Vital Capacity - SVC, Minute Volume - MV, Tidal Volume - VT and Maximum Inspiratory Pressure - Pimax. Baseline IC and PEF values returned more quickly in the NIV group, and this group also showed fewer postoperative complications. In the NIV group, there was an improvement in SVC (1033.85 ± 253.16 *vs* 1366.4 ± 380.79: p<0.001) and MV (9.22 ± 1.20 *vs* 9.97 ± 1.33: p< 0.039) on the 1st POD, IC at the three evaluated moments and, on the 1st and 3rd POD, PEF improvement (1DPO – 112.88 ± 23.29 *vs* 132.4 ± 36.94: p<0.030; 3DPO – 148, 65 ± 32.84 *vs* 203.92 ± 53.76: p<0.0001). However, with regard to the length of hospital stay and intensive care, there was no significant difference between the groups. The study scored 8/10 on the PEDro Scale, considered of high scientific and methodological quality. The limiting points of the article are the lack of blinding of therapists and evaluators. Pazzianotto-Forti *et al.* (2019) did not have a control group, limiting their study. However, by the criteria of the PEDro Scale, it received a score of 10/10, being considered a high quality article. The study has a sample of 40 participants, divided into groups PAR-G (Post Anesthetic Recovery) and 1PO-G (First Postoperative Day); both received BiPAP for 1 hour postoperatively, equivalent to their group (Table 3 – Reproducible data from positive pressure therapy). Data were collected from pulmonary function tests and chest radiography. The SVC variables (3.34 *vs* 2.78: p=0.0007; 3.63 *vs* 2.47: p<0.0001), IRV - Inspiratory Reserve Volume (2.17 *vs* 1.57: p =0.0016; 2.18 *vs* 1.37: p=0.0026) and FVC (3.54 *vs* 2.95: p=0.0013; 3.61 *vs* 2.49: p<0.0001) were reduced in both groups when compared to preoperative values, while the ERV value was maintained only in the PAR-G (p=0.4446 *vs* p=0.0191). When comparing the groups, there were significant differences in the treatments regarding SVC (p=0.0027) and FVC (p=0.0028), with the PAR-G group showing a smaller decline in these abilities. The prevalence of atelectasis in 1PO-G was 30%, while in PAR-G it was only 10% (p=0.0027). The application of BiPAP after post-anesthetic recovery could be considered beneficial for the reduction of atelectasis and maintenance of the ERV. In addition, in the immediate PO (Postoperative) of both, conventional respiratory physiotherapy was offered twice a day and, in the 1PO, 2 times, performing series of 15 repetitions for each exercise, lasting from 20 to 30 minutes per session, which included inspirations. deep and fractionated, diaphragmatic reeducation, breathing exercises combined with upper limb movement, incentive spirometry and prevention of deep vein thrombosis. Only two studies reported sources of funding, namely: Pazzianotto-Forti *et al*. (2019), funded by the São Paulo Research Support Foundation (Fapesp); and Wong *et al.* (2011), funded by the Physicians' Services Incorporated (PSI) Foundation and the Department of Anesthesia, Toronto Western Hospital, and the Boussignac masks used in the study were provided by Vitaid Ltd, Toronto, ON, Canada. In all studies there was a declaration of absence of conflict of interest.

CONCLUSION

According to the studies analyzed, NIV in BiPAP mode with a minimum therapy of 1 hour, after anesthetic recovery or immediately after extubation, reduces the prevalence of atelectasis and benefits the maintenance of the ERV; when used on the first postoperative day after bariatric surgery, there is the possibility of a faster recovery in inspiratory capacity and PEF, in addition to a reduction in postoperative complications. The use of NIV in CPAP mode through the Boussignac interface, immediately after extubation, could show an increase in PaO_2 and in the PaO_2/FiO_2 ratio, promoting an improvement in oxygenation, when applied during a period of 1 to 2 hours. In accordance with the data analyzed in this review, it is clear that the subject lacks studies that address it and that comprise a high methodological quality, in order to achieve a legitimate outcome. Nevertheless, there is still a need for uniformity regarding the ideal postoperative period to start NIV and its application parameters. The authors of this review declare no funding and no conflicts of interest.

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