ORIGINAL ARTICLE

The effect of respiratory kinesiotherapy in patients undergoing upper abdominal surgery

Efeito da cinesioterapia respiratória em pacientes submetidos à cirurgia abdominal alta

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ABSTRACT

Objective: The purpose of this study was to assess the effect of respiratory physiotherapy (walking, cough and kinesiotherapy) on lung function in patients during the postoperative period of upper abdominal surgery. **Methods:** A total of 30 patients (14 female and 16 male; mean age of 53 years) were evaluated clinically and by pulmonary function tests, measurements of respiratory muscle strength and arterial oxygen saturation. Patients were randomly included in Group A (walking and coughing) or Group B (walking, coughing and kinesiotherapy – diaphragmatic exercises during sustained and non-sustained inhaling). **Results:** Compared to preoperative values, the forced expiratory volume during the first second decreased 24% in Group A and 31% in Group B during the first postoperative day; a 7 and a 14% (non significant) decrease was maintained in the fifth postoperative day. The forced vital capacity decreased by 27% (Group A) and by 33% (Group B) in the first postoperative day; a 12% (non significant) decrease in Group A, and a 20% decrease in Group B was maintained in the fifth postoperative day. The maximum inspiratory pressure decreased 16% in the first postoperative day (Groups A and B); a 4% (non significant) drop was maintained in the fifth postoperative day (both groups). The maximum expiratory pressure decreased 20 (Group A) and 18% (Group B) in the first postoperative day; a 14% decrease (Group A) and 15% decrease (Group B) was maintained in the fifth postoperative day. **Conclusion:** The progression of Group A was similar to that of Group B (which had a higher risk of complications), suggesting that adding kinesiotherapy was beneficial.

Keywords: Physical therapy modalities; Kinesiology, applied/methods; Exercise therapy/ methods; Cough; Abdomen/surgery; Breathing exercises; Postoperative period

RESUMO

Objetivo: O objetivo do trabalho foi avaliar os efeitos da fisioterapia respiratória (caminhada, tosse e cinesioterapia) sobre a função pulmonar dos pacientes em pós-operatório de cirurgia abdominal alta. **Métodos:** Foram avaliados clinicamente 30 pacientes (14 do sexo feminino e 16 do masculino, com idade média de 53 anos), por testes de função pulmonar, medidas de força da musculatura respiratória e saturação arterial de oxigênio. Aleatoriamente, os pacientes foram incluídos no Grupo A (caminhada e tosse) ou Grupo B (caminhada, tosse e cinesioterapia – exercícios respiratórios diafragmáticos, em tempos e inspiração sustentada). **Resultados:** Comparando-se aos valores de pré-operatório, o volume expiratório forçado de primeiro segundo diminuiu 24% no primeiro dia de pós-operatório no Grupo A e 31% no Grupo B, mantendo uma redução, no quinto dia de pós-operatório de 7 e 14% (não significante); a capacidade vital forçada diminuiu 27 e 33%, no primeiro dia de pós-operatório, nos Grupos A e B, mantendo no quinto dia 12 (não significante) e 20%; a pressão inspiratória máxima diminuiu 16% no primeiro dia de pós-operatório, nos Grupos A e B, mantendo, no quinto dia, uma diminuição de 4% (não significante) em ambos; a pressão expiratória máxima diminuiu, no primeiro dia, 20 e 18% nos Grupos A e B e, no quinto dia 14 e 15%. **Conclusão:** A evolução do Grupo A foi semelhante ao Grupo B (este, porém, com maior risco de complicações) sugerindo que a inclusão da cinesioterapia foi benéfica.

Descritores: Modalidades de fisioterapia; Cinesiologia aplicada/ métodos; Terapia por exercício/métodos; Tosse; Abdome/ cirurgia; Exercícios respiratórios; Período pós-operatório

INTRODUCTION

Studies have shown that manipulating the abdominal cavity during upper abdominal surgery (UAS) decreases lung volume and capacity. This leads to shallow and rapid breathing, absence of deep breaths(1) and paradoxical abdominal movements, which may cause pulmonary complications with altered ventilation-perfusion or pulmonary shunts that result in hypoxemia and atelectasis(2). These respiratory changes reach their peak within the first 48 postoperative hours(3).

A likely explanation is diaphragmatic dysfunction due to handling of abdominal viscera, which reflexively

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Received on Jan 23, 2008 – Accepted on Jan 14, 2008

inhibits the phrenic nerve and causes diaphragmatic paresis[4].

Physical therapy offers the possibility of integrating the postoperative treatment of these patients by using a variety of techniques. Respiratory kinesiotherapy aims to improve breathing patterns in patients by increasing lung expansion, the strength of respiratory muscles, the functional residual capacity and the inspiratory reserve volume, thus avoiding or treating pulmonary complications[5]. Although benefits have been demonstrated by studies such as the present article, systematic use of physical therapy including respiratory kinesiotherapy as carried out in our patients has not been a consensus among authors.

OBJECTIVE

The purpose of this paper was to assess the effects of respiratory kinesiotherapy on pulmonary function during the postoperative period of patients undergoing UAS. The aim was to assess if respiratory kinesiotherapy, which is easily performed and inexpensive, would be effective for recovering lung function, in addition to walking and assisted cough that have their efficacy already demonstrated.

METHODS

This study was conducted at two hospitals in the city of Divinópolis, Minas Gerais state (Hospital São João de Deus – Fundação Geraldo Corrêa, and Hospital e Maternidade Santa Monica). The Human Research Ethics Committee of Centro Universitário do Triângulo – UNITRI and the Ethics Committees of both hospitals, approved this study.

We conducted an experimental study that assessed 40 patients (sample calculated after a pilot study with eight patients), of whom 30 were enrolled in the study and ten patients were excluded for the following reasons: death (two), lack of compliance with the proposed treatment (two) and reoperation (six).

Patients included in the study were aged between 35 and 65 years, had normal spirometry, absence of respiratory symptoms and the ability to perform muscle strength and spirometric physical therapy measurements.

Patients unable to perform physical therapy measures or to walk, who required prolonged mechanical ventilation (over 48 hours), smokers, patients with morbid obesity, postoperative instability or prolonged stay in the intensive care unit (ICU) were excluded.

An assistant was trained in the method, so that the examiner could remain "blinded" about the group to which each patient belonged during measurements. The same examiner evaluated the patients always using the same equipment.

Patients were evaluated before surgery and on the first, third and fifth postoperative days. Assessments were always conducted in the mornings before patients started doing any other physical activity. The patients remained at the hospital. Tests were performed randomly while they were seated on a chair.

The maximum inspiratory pressure (MIP) was measured based on the residual volume (RV); the maximum expiratory pressure (MEP) was based on the total pulmonary capacity (TPC). A manovacuometer measuring centimeters of water (GER AR Industria Brasileira) was used. Pressures were maintained for at least two seconds; the highest value was used for calculations[6].

The forced vital capacity (FVC) and the forced expiratory volume in the first minute (FEV_1) were measured (in liters) based on the TPC, using a Micro Loop ML 350 spirometer; the FEV_1/FVC ratio (%) was calculated[7]. Three measurements were performed and the best curve was chosen[8].

The peak expiratory flow (PEF) was measured based on the TPC; patients rapidly exhaled the largest possible volume with their mouths on the mouthpiece[9] of a Mini-Wright 3103 peak flow meter.

Oxygen saturation was measured using a digital pulse oxymeter (Nonim).

On every evaluation day, ten IPmax tests, ten EPmax tests, three spirometric measurements and five peak expiratory flow (PEF) tests were done.

Patients were randomly selected after the initial tests to be included in one or another therapy group; characterizing the investigation as an experimental study. Group A (GA) did walking and coughing exercises. Group B (GB) did walking and coughing exercises, and respiratory kinesiotherapy.

The GA walked during two ten-minute periods (totalizing 20 minutes) in the morning and late afternoon; these patients also underwent assisted coughing for 30 minutes, with a physical therapist.

The GB walked five minutes and undertook coughing exercises and respiratory kinesiotherapy. Each exercise consisted of three series of ten repetitions each; there was a two-minute pause between series. The full duration of exercising was 30 minutes. Respiratory kinesiotherapy was defined in this study as exercises, such as diaphragmatic breathing, and sustained and time inhaling of air, a widely used method in respiratory physical therapy[10].

As assisted coughing is beneficial and efficient, it would not be ethical to leave a group without any physical therapy. GA walked more than GB so the duration of physical therapy was similar between both groups; GA did not do kinesiotherapy.

Table 1. Mean values (standard deviations) of Maximum Inspiratory Pressure (MIP), Maximum Expiratory Pressure (MEP), Forced Vital Capacity (FVC) and Forced Expiratory Volume in the first minute (FEV_1) in Groups A (walking and coughing) and B (walking, coughing and respiratory kinesiotherapy)

Variable	Group A				Group B			
	Pre-op period	1st post-op day	3rd post-op day	5th post-op day	Pre-op period	1st post-op day	3rd post-op day	5th post-op day
MIP (cmH_2O)	56.7 (12.9)	41.7 (17.1)*	48.0 (20.9)	53.0 (33.3)	74.7 (17.3)	58.7 (19.5)*	65.7 (23.6)	70.7 (21.2)
MEP (cmH_2O)	81.0 (40.1)	46.3 (20.7)*	52.3 (19.6)*	58.0 (21.9)*	106.7 (32.6)	68.3 (39.0)*	67.7 (30.4)*	79.3 (32.6)*
FVC (L)	2.5 (0.5)	1.5 (0.7)*	1.9 (0.6)*	2.2 (0.5)	3.0 (0.7)	1.9 (0.6)*	2.0 (0.6)*	2.3 (0.5)*
FEV_1 (L)	2.1 (0.6)	1.5 (0.5)*	1.6 (0.8)*	1.9 (0.5)	2.4 9(0.6)	1.6 (0.4)*	1.7 (0.5)*	2.0 (0.5)*

* Significant difference regarding the preoperative period ($p < 0.05$)

The statistical analysis consisted of the χ^2 test for comparing Groups A and B; analysis of variance (ANOVA) for comparing pre and postoperative results in each group, followed by the Tukey test. If applicable; the t-Student test to compare Groups A and B during each day and to verify time differences in surgeries and expected duration according to the National Nosocomial Infections Surveillance (NNIS) table[(11)]. The significance level was 0.05 or 5% ($p < 0.05$).

RESULTS

GA consisted of 15 patients (seven were male) with a mean age of 55.5 ± 11.9 years; Group B consisted of 15 patients (nine were male) with a mean age of 53.4 ± 11.3 years.

The statistical analysis revealed that, weight and body mass index (BMI) were higher in GB as compared to GA ($p \leq 0.05$).

The duration of surgery was higher in both groups, compared to the expected duration according to the National Nosocomial Infections Surveillance table[(11)] ($p < 0.05$); there were significantly more patients in GB with longer operative times compared to GA ($p \leq 0.05$).

Table 1 shows mean values and the standard deviations, MIP, MEP, FVC and FEV_1.

Table 2 shows percentage changes and the statistical results of the abovementioned variables, PEF variables and pulse oxygen saturation (SpO_2).

Table 2. Mean values, standard deviations (sd) and significance levels (p) of age, height, BMI (body mass index), weight and operative time of Groups B (walking, coughing and respiratory kinesiotherapy) and A (walking and coughing)

Variable	GB		GA		p
	Mean	sd	Mean	sd	
Age (years)	53.40	11.3	55.53	11.2	0.61
Height (meters)	1.65	0.06	1.62	0.05	0.08
BMI	24.62	4.32	21.84	3.08	0.05
Weight (kilograms)	67.20	9.64	57.40	10.24	0.02*
Operative time (min)	229.00	80.54	176.00	70.00	0.07

• Weight statistically significant GB > GA ($p < 0.05$)

DISCUSSION

Pulmonary complications are a constant postoperative concern. Delayed or non-recovery of lung function (volume, capacity and strength) are the main causes of postoperative pulmonary complications. According to several studies, its incidence ranges from 10 to 80%[(1,12)].

According to the literature, overweight is a major complicating factor for postoperative loss of lung function; in such cases, the functional residual capacity (FRC) is decreased by 20 to 70% and the FEV_1 is decreased by about 60%[(13)].

The incidence of complications is 21.4% in surgeries lasting over 120 minutes, compared to 5.4% in shorter procedures[(14-16)]. The analysis of actual operative times (minutes) compared to the expected operative time for these procedures, according to the NNIS table[(11)], revealed that the duration of surgery was significantly higher than the expected time in both groups; it was, on average, about one hour longer in GB.

Although GB presented more losses of pulmonary function based on the PEF, lung capacity and volume, increased weight and BMI as measured by overweight or obesity and longer operative times, postoperative pulmonary complications were not diagnosed medically in this group, as would be expected, given the importance of these variables. This may be explained by the fact that respiratory kinesiotherapy was used in this group.

Furthermore, no patient presented hypoxemia or was excluded due to clinically diagnosed postoperative pulmonary complications. Their progression was similar to that found in some studies in the literature, in which patients benefited from various methods besides respiratory kinesiotherapy, such as continuous positive airway pressure (CPAP), intermittent positive pressure breathing (IPPB), incentive inspirometer, percussion, postural drainage, and others[(5,13,17,18,19)].

Although there is evidence that respiratory physical therapy improves postoperative lung function[(5),] the choice of the best technique is still not clear in this context. Thus, we chose to perform respiratory kinesiotherapy to attain pulmonary reexpansion; this is a widely used technique by physical therapists that does not require additional equipment. The FVC decrease was less significant regardless of the techniques used in the therapy group in this study[(13)]; in GB, the reduction in the first postoperative day was 33%, and in GA the corresponding reduction was 27%. There was no significant difference between Groups A and B (therapy and control) in the study under discussion and in the literature[13].

In the present study, the FEV_1 decreased by 31% (GB) and 24% (GA) in the first postoperative day. In the aforementioned study, these percentages were 26% (therapy group) and 37% (control group).

The PEF decreased by 36 (GB) and 34% (GA) in the first postoperative day. In the study mentioned above, these percentages were 43% (therapy group) and 41% (control group).

The MIP decreased by 16% (Groups A and B) in the first postoperative day. In the literature[3,13], the reduction reported is 30 (therapy group) and 25% (control group) in the first postoperative day. The percentage difference suggests that there was improved recovery in the therapy groups in this study.

The MEP decreased by 18 (GB) and 20% (GA) in the first postoperative day. Data in the literature shows a 30% decrease in the therapy group and a 40% drop in the control group[14]. Notwithstanding this reduction, patients had no postoperative pulmonary complications by the fifth day after surgery; in another study[13], complications arose in 6% of 172 patients in the therapy group and in 27% of 194 patients in the control group (in which no exercise was done).

No significant difference was found when comparing Groups A and B. This may be explained by the fact that both groups received therapy, and that repeated spirometries, measurements of muscle strength and early postoperative mobilizing of patients acted as a proxy for respiratory physical therapy, accelerating the recovery.

Patients recovered their lung function by the fifth postoperative day without the need for expensive devices, which preclude therapy in economically unfavored patients located far from major centers.

In the present study, in which both groups were treated with different protocols, the group that underwent respiratory kinesiotherapy had at times worse recovery than the groups with no specific respiratory exercises. The group in which respiratory kinesiotherapy was done, however, consisted of patients at a higher risk of losing pulmonary function; we may thus infer that their clinical progression was superior to that of the other group. These findings also suggest that respiratory kinesiotherapy is beneficial and accelerates recovery during the postoperative period following UAS, resulting in improved outcomes.

Walking and assisted coughing also provides improvements. This may be seen in the group that took 20-minute walks and underwent assisted coughing; while walking, patients certainly breathed in deeply, which facilitated lung reexpansion similar to respiratory kinesiotherapy, and improved lung function postoperatively.

CONCLUSION

Our results showed that respiratory kinesiotherapy with early movements (walking) and physical therapist-assisted coughing in complaint patients able to exercise actively, may be sufficient for successful recovery after UAS.

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