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Directed cough manoeuvres in the early period after open abdominal surgery

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Abstract

Introduction. Postoperative pulmonary complications are a common cause for morbidity and mortality after open abdominal surgery (OAS). Incisional pain and restrictive lung dysfunction may impair cough effectiveness, leading to secretion retention. Ineffective cough is a most important factor in the development of postoperative pulmonary complications. The aim of this study was to determine the most effective directed cough manoeuvre early after OAS.

Methods. The study involved 41 patients (19 females, 22 males; median age: 44.0 years) who underwent OAS. Cough effectiveness was assessed by measuring peak cough flow on the 1st postoperative day with a portable flow meter in 4 different cough manoeuvres: (1) baseline cough 1: patients were asked to cough as effectively as possible; (2) supported cough; (3) supported cough after maximum inspiration; (4) baseline cough 2. Pain intensity during the measurements was evaluated with the Visual Numeric Scale (0–10).

Results. When the 4 cough conditions were compared, peak cough flow was significantly different ($p < 0.001$). This difference was due to the superiority of supported cough after maximum inspiration in comparison with the other 3 manoeuvres ($p < 0.001$). Pain did not significantly differ among the 4 measurements ($p = 0.869$).

Conclusions. Coughing with abdominal support after maximum inspiration in a semi-recumbent position provides the most effective cough flow after OAS, without increasing incisional pain intensity. Patients who underwent OAS should be encouraged to practise this manoeuvre in the early postoperative period in order to help bronchial drainage and prevent postoperative pulmonary complications.

Key words: cough, abdominal surgery, peak cough flow

Introduction

Postoperative pulmonary complications are common after open abdominal surgery (OAS), lengthening hospital stays and increasing health care costs [1]. Patient's inability to cough effectively is one of the main reasons for the development of pulmonary complications due to postoperative incisional pain and restrictive lung dysfunction [2]. Impairment of cough effectiveness results in mucus retention, contributing to postoperative atelectasis and pneumonia [3].

Normal cough has 4 phases, including irritation, inspiration, compression, and expiration [4]. It involves taking a deep breath, closing the glottis, compressing abdominal and thoracic muscles in order to generate approximately 100 cm H_2O pressure, and, finally, an explosive gas release as the glottis opens [5]. Cough effectiveness deteriorates if any of these phases fails. After abdominal surgery, abdominal muscle contraction is impaired owing to incisional pain and psychological stress of the patient that a strong cough may aggravate pain and damage the incision site. This leads to a fail in the compression and expiration phases of cough. Colucci et al. [2] investigated peak cough flow (PCF) after open upper abdominal surgery, identifying PCF as a relevant assessment of cough effectiveness as mucus clearance was largely dependent on the magnitude of expiratory flow during cough. They found that the decrease in PCF was 54% on the first postoperative day and 72% on postoperative day 5 in comparison with preoperative values [2].

Airway clearance techniques are an integral part of postoperative interventions in the early period after OAS. Cough manoeuvres help to improve cough effectiveness and prevent pulmonary complications, providing bronchial drainage. According to the guideline of the American Association for Respiratory Care (AARC) for standardization of cough manoeuvres in different clinical populations, patients should be encouraged to cough effectively with maximum inspiration while supporting the incision after abdominal surgery [6]. In this context, Fiore et al. [7] investigated the effect of directed cough manoeuvres after thoracic surgery and determined coughing preceded by maximum inspiration as the most effective manoeuvre. Nevertheless, directed cough manoeuvres have not been examined after OAS in spite of the AARC clinical guidelines. Therefore, we designed this prospective study to establish the most effective directed cough manoeuvre in the early postoperative period in patients who underwent OAS.

Subjects and methods

Participants

A total of 41 patients aged > 18 years who had undergone OAS at Dokuz Eylul University Hospital, Department of General Surgery, were included in the study. Routine daily clinical assessment, including neuromuscular, cognitive, and haemodynamic stability evaluations, was performed by a physician. Patients were excluded if they had postoperative neuromuscular or cognitive impairment, previous abdominal surgery, or haemodynamic instability prior to cough measurements (mean arterial blood pressure < 70 mm Hg and/or heart rate > 120 beats/min). Subjects were withdrawn from the study in the case of haemodynamic instability (mean arterial blood

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pressure < 70 mm Hg and/or heart rate > 120 beats/min) or any signs of dyspnoea (respiratory rate > 35 breaths/min and/or use of accessory respiratory muscles) during the measurements.

Cough measurements

We performed PCF measurement in order to evaluate cough effectiveness using a portable flow meter (Mini Wright peak expiratory flow meter) consisting of a mouth-piece. All assessments were carried out by the same trained physiotherapist while the patient was sitting in a semi-recumbent position (60°). The participants did not receive any orientation or training on the testing procedure preoperatively or at any time before the measurements. Cough effectiveness was measured in 4 different conditions, as described in a previous study [7]: (1) baseline cough 1: patients were instructed to take a deep breath and cough as forcefully as possible; then, in a random sequence: (2) supported cough; (3) supported cough after maximum inspiration; and (4) baseline cough 2 (Figure 1). The 3 cough conditions after baseline cough 1 were randomly chosen by the patient by using the sealed envelope method in order to prevent the possible learning effect. A pillow was placed on the incisional region to provide abdominal support and the patient was asked to hold it tightly during the cough manoeuvre. Three measurements were performed for each cough condition with 30-second intervals. The highest PCF values of the 3 measurements were considered for analysis.

Pain intensity at the incisional site during cough measurements was evaluated with the Visual Numeric Scale, ranging from 0 (minimum) to 10 (maximum). The patients scored the pain intensity they felt before the PCF evaluation (at rest) and after the 3 attempts for each condition.

The measurements were carried out on the first postoperative day. The participants were administered the same postoperative analgesia procedure. Traditional postoperative care and standardized physiotherapy sessions, including chest physiotherapy and early mobilization, were implemented in all individuals.

Statistical analysis

The SPSS software, version 20 (SPSS Inc., Chicago, IL, USA) was applied for data analysis. Descriptive statistics and frequencies were used to present demographic and clinical features. Normality of the data distribution was tested with the Shapiro-Wilk test. The test revealed that most of the variables were not normally distributed. Therefore, non-parametric tests were used for statistical analysis. Medians and interquartile ranges (25^{th}–75^{th} percentile) were applied for descriptive analyses of quantitative variables. PCF and pain intensity derived from the 4 different cough measurements were compared with the use of Friedman variance analysis. The Wilcoxon test was performed to indicate the significance of pairwise differences, with the Bonferroni correction to adjust for multiple comparisons. The significance level was set at 0.05, except for post-hoc analysis, in which the significance level was assumed at 0.0125 (0.05/4) after the Bonferroni correction.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Ethics Committee of Scientific Research of the Faculty of Medicine, Dokuz Eylul University (approval number: 1469-GOA).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

Overall, 41 patients (19 females, 22 males; median age: 44 years) who had undergone OAS were able to complete all the measurements without any withdrawal. Table 1 shows the demographic and clinical features of the participants.

Table 2 presents the comparisons of PCF values and incisional pain intensity among the 4 directed cough manoeuvres. When all the cough conditions were compared, the difference was significant for PCF values ($p < 0.001$), but not for pain intensity ($p = 0.869$).

With regard to pairwise comparisons, PCF value in supported cough after maximum inspiration was significantly higher than for all other cough manoeuvres ($p < 0.001$). There was not any statistically significant difference between the baseline cough 1, supported cough, and baseline cough 2 conditions ($p > 0.05$). Table 3 shows pairwise comparisons of PCF between the 4 different cough manoeuvres.

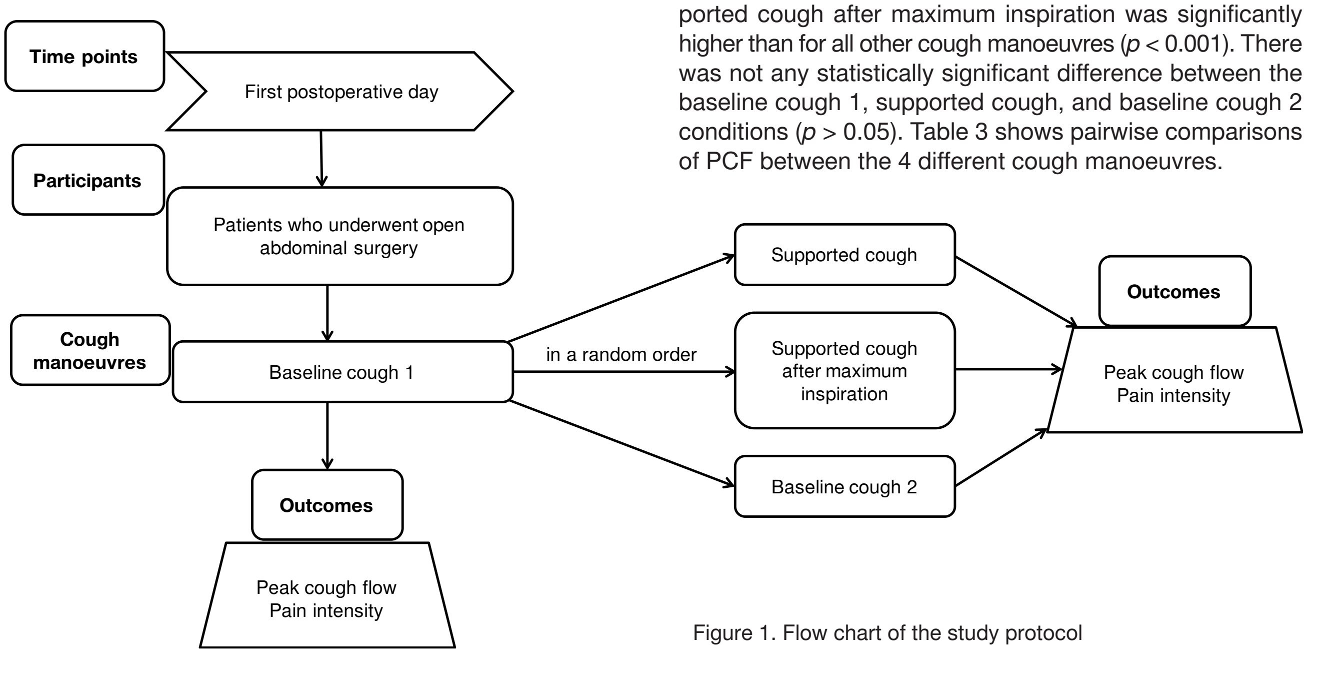

Figure 1. Flow chart of the study protocol

Table 1. Demographic and clinical features of the patients (n = 41)

Characteristics	Value
Gender, *n* (%) Male Female	 22 (53.7) 19 (46.3)
Age, years	44.0 (56.0–66.5)
Body weight, kg	75.0 (61.0–82.5)
BMI, kg/m^2	26.9 (22.54–29.68)
Surgery type, *n* (%) Gastrointestinal Hepatobiliary Colorectal Other	 14 (34.1) 10 (24.4) 16 (39.1) 1 (2.4)
Incision location, *n* (%) Lower abdominal Upper abdominal Upper and lower abdominal	 11 (26.8) 22 (53.7) 8 (19.5)
Incision type, *n* (%) Vertical Transverse	 26 (63.4) 15 (36.6)
Surgical procedure, *n* (%) Elective Emergency	 37 (90.2) 4 (9.8)
ASA status, *n* (%) 1 2 3	 2 (4.9) 36 (87.8) 3 (7.3)
Duration of surgery, min	185 (125–337)

Values expressed as median (interquartile range) or number of patients (%).
BMI – body mass index
ASA – American Society of Anesthesiologists

Discussion

The results of the current study imply that coughing with an abdominal support after maximum inspiration in a semi-recumbent position provided the most effective cough flow after OAS, without increasing incisional pain intensity.

Effective cough requires the compression of abdominal and thoracic muscles to generate approximately 100 cm H_2O pressure, which can be deteriorated after major surgeries. Colucci et al. [2] evaluated PCF before and after open upper abdominal surgery and revealed a 54% decrease on the first postoperative day and a 72% decrease on postoperative day 5 in comparison with preoperative values. We did not measure preoperative cough effectiveness; median postoperative PCF values in all cough manoeuvres except supported cough after maximum inspiration stayed below 160 l/min, which was previously defined as inefficiency in cough [8].

In addition to its mechanical composition, cough impairment in postoperative patients also depends on the neurologic control of cough [3]. Increases in the cough threshold result in a decrease in cough reflex sensitivity, which is a risk factor for secretion retention and pneumonia [9]. Dilworth et al. [10] reported raised cough threshold on the first postoperative day after upper abdominal surgery, which returned towards preoperative values by the fourth postoperative day. Cough sensitivity was also found to be decreased up to 4 hours after Caesarean section under spinal anaesthesia [11]. These results imply that it is important to restore cough effectiveness in the early periods after abdominal surgeries. During these early stages, directed cough manoeuvres help to encourage patients who underwent OAS to cough effectively as they may feel excessive pain and distress due to their abdominal incision.

In our study, we evaluated individuals in a very early postoperative period, on day 1, similarly to Fiore et al. [7]. All of our patients managed to finish cough measurements for the directed manoeuvres without any withdrawal due to haemodynamic or respiratory problems. As in the study by Fiore et al. [7] concerning open heart surgery, supported cough

Table 2. Comparisons of peak cough flow and incisional pain among 4 cough manoeuvres

Variable	Baseline cough 1	Baseline cough 2	Supported cough	Supported cough after MI	*p*
Peak cough flow (l/min)	150 (110–185)	150 (110–190)	150 (130–190)	200 (155–240)	< 0.001*
Incisional pain (0–10)	5 (3–6.5)	5 (3–6.5)	4 (3–6)	5 (3–6.5)	0.869

Values expressed as median (interquartile range).
MI – maximum inspiration
* statistically significant at $p < 0.05$ (Friedman test: p-value indicates the comparisons among 4 cough manoeuvres)

Table 3. Pairwise comparisons of peak cough flow between 4 different cough manoeuvres

Variable	Baseline cough 1 (I)	Baseline cough 2 (II)	Supported cough (III)	Supported cough after MI (IV)
Peak cough flow (l/min)	150 (110–185)	150 (110–190)	150 (130–190)	200 (155–240)

p					
$p_{I–II}$	0.438	$p_{I–IV}$	< 0.001*	$p_{II–IV}$	< 0 .001*
$p_{I–III}$	0.086	$p_{II–III}$	0.149	$p_{III–IV}$	< 0.001*

Values expressed as median (interquartile range).
MI – maximum inspiration
* post-hoc Wilcoxon signed-rank test with Bonferroni correction resulting in a significance level of $p < 0.0125$

after maximum inspiration provided the most effective cough flow in our patients after OAS. This was an expected result as lung volume had been reported to be the major determinant of peak expiratory flow [12]. Parallelly to our findings, previous studies revealed increases in cough expiratory flow after maximum inspiration in normal subjects [13], as well as in patients with neuromuscular diseases [14] and after thoracic surgery [7].

According to our results, other implemented cough manoeuvres did not significantly differ in terms of cough effectiveness. We measured twice for baseline cough in order to prevent the possible learning effect and no difference occurred, which represents consistency. Surprisingly, we did not find any effect of supported cough (without maximum inspiration) on PCF, although we expected that supporting the wound would enhance cough efficiency by decreasing pain and patient's fear of damaging the surgical incision. In contrast to our observations, Cheifetz et al. [15] found an enhancement in walking performance in patients after major abdominal surgery using abdominal support with an elasticized abdominal binder, providing control for pain and distress. Several other studies also concluded that postoperative use of abdominal binders decreased pain scores and improved mobility in both obstetric and abdominal surgery patients [16, 17]. Nevertheless, in our patients, pain intensity was moderate during all measurements and it was not altered during the directed cough manoeuvres. This was probably due to the usual analgesia procedure that the individuals were administered in the very early postoperative period. A recent prospective cohort study of 1278 patients analysed postoperative pain scores in the first 96 hours after various abdominal surgeries and revealed that pain was controlled adequately during the first 4 postoperative days [18]. Therefore, we believe that solely supporting the incision might not affect the amount of cough flow without preceding maximum inspiration.

Limitations

Our study has some limitations, one of which is the lack of preoperative measurements. Therefore, we were unable to compare our results and discuss the effect of surgery in the early postoperative period on cough effectiveness, even if it was not the aim of our study. We also did not perform consecutive measurements after the first postoperative day, which could probably present a progressive improvement in cough effectiveness until discharge. The small sample size is another limitation of the presented study.

Conclusions

Coughing with an abdominal support after maximum inspiration in a semi-recumbent position provided the most effective cough flow after OAS, without increasing incisional pain intensity. Patients should be encouraged to practise this directed cough manoeuvre in the early postoperative period in order to help bronchial drainage and possibly prevent pulmonary complications. This manoeuvre could also be the part of patient preoperative education programs, if applicable, to provide better performance as the individual would be in a painful and stressful state early after the surgical process. Further studies including more subjects are needed to address the relationship between cough effectiveness and postoperative pulmonary complications; these should include preoperative assessments and follow-up measurements.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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