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Research Article

INDUCTION OF COUGH THRESHOLD THROUGH CHEMICAL IRRITANTS (CAPSAICIN AND CITRIC ACID) AFTER UPPER ABDOMINAL SURGERY

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ABSTRACT

Cough is a major defence reflex of the airways and is necessary for the effective clearance of excess bronchial secretions. The two distinct types of cough receptors are rapidly adapting mechanoreceptors (RAR) and C-fibre receptors. The study was conducted to determine the efficacy of capsaicin versus citric acid on cough threshold to improve chest clearance and decrease retention of secretions in patients after upper abdominal surgery. Thirty patients were enrolled in the study based on inclusion and exclusion criteria. Selected subjects were assigned into two groups: Group A (patients received capsaicin to induce cough) and Group B (patients received citric acid to induce cough). Cough was stimulated by giving two irritants then various parameters were noted. All variables were compared between the two groups for pre and post value to determine the difference in variables. There was a significant depression in sensitivity to inhaled irritants on the post op day 3 and almost return of normal cough threshold was seen on post operative day 4.

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INTRODUCTION

Cough is a major defence reflex of the airways and is necessary for the effective clearance of excess bronchial secretions. Cough receptors are widely distributed throughout the airways from the pharynx to the bronchi. The two distinct types of cough receptors are rapidly adapting mechanoreceptors (RAR) and C-fibre receptors (Pavia *et al.*, 1986).

The RAR are activated by mechanical stimulation, such as inflation and deflation of the lungs or acute mechanical distortion of the airway walls. In contrast, C-fibres are activated by a variety of chemical stimuli, including cigarette smoke, bradykinin, citric acid and the vanilloid, capsaicin, and are much less sensitive to mechanical stimulation (Pounsford *et al.*, 1985). Cough receptors become hypersensitive when the nerve terminals are exposed by loss of epithelial cells due to airway inflammation.

Suppression of cough in the postoperative period, it has been suggested, that may help to cause pulmonary complications of surgery, but there have been no studies of the cough reflex in such patients.

The study comprises of the effect of upper abdominal surgery under general anaesthesia on the cough response to two inhaled chemical irritants (capsaicin and citric acid) and examines the cough threshold. Along with the effect of these chemical

irritants was examined on SpO₂, heart rate, blood pressure and capacity (Garibaldi *et al.*, 1980)

Purpose of The Study

The purpose of the study is to determine whether cough threshold is better with capsaicin or citric acid (chemical irritant) after upper abdominal surgery.

Statement of Question

Is there a significant difference in cough threshold in post-operative upper abdominal surgery patients after giving capsaicin versus citric acid on third and fourth post-operative days.

MATERIALS AND METHODS

A total of 30 subjects were selected on the basis of inclusion and exclusion criteria. Subjects were divided into 2 groups with 15 subjects in each group. Subjects who underwent different abdominal surgeries were selected from Intensive Care Unit of Gastro-Intestinal surgery department, Govind Ballabh Pant Hospital, New Delhi. Convenience sampling technique was used, subjects who were admitted in the department for G.I. Surgery were enrolled (Karlsson *et al.*, 1988).

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Inclusion Criteria

1. Elective upper abdominal surgery (above umbilicus)
2. Retention of secretions (seen on X-rays)
3. Respiratory disease with chronic sputum production or airflow obstruction or both
4. Decrease in cough reflex and breathing due to anaesthetic effect
5. Weight < 80 kg.
6. Age: 18-75 years
7. Median duration of surgery- 2.5 hours (1.5-5 hours)
8. Should follow same anaesthetic regimen
9. Pulmonary function tests show moderate to severe restriction
10. No history of cardiac complications like CAD, MI.
11. No previous abdominal surgery
12. Neurologically stable
13. Cooperative
14. Pain on Visual Analogue Scale
15. Nutrition by Feeding Jejunostomy or oral liquids or normal feed

Exclusion Criteria

1. Emergency surgery
2. Cough syncope
3. Cough reflex, if normal
4. Pulmonary function tests- mild restrictions
5. Normal X-ray findings
6. Previous history of cardiac complications like CAD MI.
7. Patient on bronchodilators, using ACE- inhibitor drugs
8. Neurological unstable
9. Patients with Ryle's tube in situ without Feeding jejunostomy
10. Pain on VAS

Study Design

After selection, subjects were divided into two groups:

Group A -15 patients - received capsaicin (*Oleoresin capsaicin*) to induce cough

Group B - 15 patients - received citric acid to induce cough

Material used

1. Citric acid dissolved in normal saline/distilled water in ratio of 1:10
2. Capsaicin in aerosol form (in hot pepper spray)
3. Face mask (percent oxygen lock mask)
4. Oxygen port
5. Nebulizer kit
6. Stop watch
7. Heart rate from monitors attached to the patients through leads.
8. Blood pressure from monitors attached to the patient through arterial line.

Protocol

A total of 30 subjects were included on postoperative days (3rd and 4th day) following upper abdominal surgery from the intensive care unit of gastro-intestinal surgery department, Govind Ballab Pant Hospital, New Delhi based on above inclusion and exclusion criteria. Then subjects were informed about nature, procedures and application of the study. Informed consent was sought from the subjects. Primary medical tests

were made to get a complete medical history of the health status of each patient to know if the patient is allowed to undergo the experiment or if there is any contraindication. A brief description about the assessment procedure including technical steps to obtain pulmonary function data and variables were explained (Karlsson *et al.*, 1980).

Cough Threshold

Cough was stimulated by giving two irritants capsaicin and citric acid and was determined on post-operative day 3rd and 4th. Measurements were made at the same time of the day to avoid diurnal variations.

Group - A: Capsaicin was given by hot pepper spray in aerosol form in form of puffs at 1 minute intervals, the dosage was doubled if the cough threshold was not present. One puff was administered within nasal mask to induce cough, if it was not significant, 2 puffs were administered to induce cough but not more than that. The 3 consecutive cough reflexes were noted.

Group - B: The study was repeated in an identical manner with citric acid monohydrate dissolved in normal saline/ distilled water in concentration in the ratio of 1: 10 (citric acid : normal saline or distilled water). Along with the CT (cough threshold) or CR (cough reflex), the SpO₂ (oxygen saturation), RR (respiratory rate), BP (blood pressure) and IC (inspiratory capacity) were also noted.

Intervention

Subjects were trained to breathe through a mouth piece, exhale to residual volume and then inhale total lung capacity over 5 seconds at a constant flow rate, during which the irritant was administered via a Wright's nebulizer.

The patients were asked to cough 3 times consecutively once the irritant was administered. It was noted as Cough present in 1st time (C1), 2nd time (C2) and 3rd time (C3) on post-op day 3 and 4 (POD-3 AND POD-4).

Cough before operation, sputum production and chest signs were also noted. Chest radiographs were taken in pre-operative period, 3rd and 4th post operative days. Type and duration of surgery was noted. Anaesthetic regimen was also noted.

RESULTS

Demographic data and clinical data

A total of 30 subjects participated in the study. Subjects had a mean age of 45.05± 6.02 ranging from 18 to 75 years.

Cough Threshold

	POD-3	POD-5	Improvement
GROUP-A	9	8	1
GROUP-B	14	9	5

There is a significant decrease in level of cough for both the groups on POD-5 as compared to POD-3. Improvement is more in Group-B who receive citric acid than Group-A, who receive capsaicin to induce cough.

Saturation of Oxygen in Blood

	Mean Value		Independent t-TEST Value	
	PRE	POST	t-VALUE calculated	t-VALUE critical
GROUP-A	96.4	96.2	2.241	2.228
GROUP-B	94.2	96.4	3.456	3.792

There is a no significant increase in oxygen saturation level in group A whereas it shows significant increase in group- B. The mean increase being 0.2 in Group-A and 2.2 in Group-B. Thus, mean improvement is in GROUP-B who receives citric acid but no effect in group-A who receive capsaicin.

Inspiratory Capacity

	MEAN VALUE		Independent t-TEST VALUE	
	PRE	POST	t-VALUE calculated	t-VALUE critical
GROUP- A	860	886.6	2.28	1.415
GROUP- B	872	892.3	3.782	1.337

There is a significant increase in Inspiratory Capacity for both the groups. The mean improvement being 26.6 in GROUP A and 20.3 in Group-B. Thus, mean improvement is more in GROUP-A, who receive CAPSAICIN than GROUP-B who receive citric acid.

Respiratory Rate

	MEAN VALUE		independent t-TEST VALUE	
	PRE	POST	t-VALUE calculated	t-VALUE critical
Group-A	23.4	25.1	3.021	2.539
Group-B	29.2	27.1	3.457	2.064

There is a significant increase in respiratory rate in Group A and significant decrease in respiratory rate in group B. Thus, mean increase is in GROUP-A, who receive capsaicin than GROUP-B who receive citric acid. It means more increase in RR is due to capsaicin as compare to citric acid.

Mean Blood Pressure

There is significant increase in M.B.P. in both the groups. The mean increase was 7.6 in group A and 4.9 in group B. Thus, mean increase is in both the groups but more increase is in GROUP- A who receives capsaicin than GROUP-B who receives citric acid.

The results of this study pointed out that there were Significant differences in the value of cough threshold, inspiratory capacity, SpO₂, RR, BP between the two groups. By comparing the results of the 2 groups it revealed that there was significant difference (P>0.05) in variable on 3rd and 4th post operative day in patients administered with capsaicin when compared with patients administered with citric acid.

There is a significant decrease in level of cough for both the groups on POD-5 as compared to POD-3. This shows there is improvement in cough reflex and in cough expulsion both by capsaicin and citric acid but more effective was citric acid administration as compared to capsaicin

There is a non significant increase in oxygen saturation group A but significant increase in group- B. This shows there is increase in oxygen saturation when citric acid is administered as compared to capsaicin There is a significant increase in inspiratory capacity for both the groups. mean improvement is more in GROUP-B who receive citric acid than GROUP-B who receive capsaicin.

DISCUSSION

Cough is responsible for the expulsion of inhaled foreign bodies and aids mucociliary clearance in the presence of excess bronchial secretions. Postoperative chest infection occurs frequently in patients with chronic bronchitis and suppression of cough at the time of surgery might be an important risk factor (Collier and Fuller, 1984).

Cough is initiated by stimulation of airway receptors located in larynx and major airways. Three types of receptors play a part in the afferent limb of the cough reflex like myelinated, rapidly adapting receptors, smooth muscle receptors, and non-myelinated fibre receptors- but the role of each is still not clear (Empey *et al.*, 1979). Animal data suggests that capsaicin, an extract of red pepper, is primarily a C-fibre stimulant, whereas citric acid and other inorganic acids act primarily on rapidly adapting receptors (Adelhoj *et al.*, 1985). Rapidly adapting receptors may be the principal afferent receptor in cough reflex and C-fibres may have a role in the modification of this response. Both capsaicin and citric acid induce a reproducible cough in man (Tatar, 1986).

This study was conducted to determine the efficacy of capsaicin versus citric acid on cough threshold to improve chest clearance and decrease retention of secretions in patients after upper abdominal surgery.

CONCLUSION

Patients undergoing surgical procedures display substantial alterations in cough threshold. Citric acid and capsaicin (both chemical irritants) are effective in inducing cough and increasing in cough threshold but citric acid is more effective than capsaicin. The cough threshold was higher on post operative day 3 as compared to post operative day 4 but the pattern of change in cough threshold was similar in both capsaicin and citric acid. There was a significant depression in sensitivity to inhaled irritants on the post op- day 3 and almost return of normal cough threshold was seen on post-operative day 4.

Limitations

1. Using single breath inhalation technique the tolerance to citric acid and capsaicin cannot be determined.
2. The study cannot draw conclusion on other factors that influence the cough threshold by altering the sensitivity of the afferent airway receptors- including anaesthetic agents, endotracheal intubation, and transient increase in bronchial secretions.
3. Hypoemia is also well recognised after surgery, and this may have reduced cough by a direct effect on the "cough centre" in the brainstem

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