

Effect of manual percussion on tracheobronchial clearance in patients with chronic airflow obstruction and excessive tracheobronchial secretion

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ABSTRACT The effect of manual percussion of the thorax in nine patients with stable chronic airflow obstruction and excessive tracheobronchial secretion has been studied. Tracheobronchial clearance was measured over 50 minutes on three different days. On the first day manual percussion was applied for 10 minutes. In the period when percussion was applied the mucus clearance was slightly but significantly greater than in the periods when no percussion was applied. On the second day manual percussion was applied in combination with postural drainage, coughing, and breathing exercises for 20 minutes. This resulted in a much greater clearance than on the first day. On the third day postural drainage, coughing, and breathing exercises, but no manual percussion, were carried out for 20 minutes. There was no significant difference between the clearance of days 2 and 3. From this study it is apparent that manual percussion is a relatively ineffective procedure in patients with stable chronic airflow obstruction, but may be useful when the patient is not able to cough and cannot assume the appropriate position for postural drainage.

Physiotherapy is often used in the treatment of chronic airflow obstruction (CAO), especially in patients with excessive tracheobronchial secretion,¹ as stasis of secretions may lead to pulmonary infection. In these circumstances physiotherapy usually consists of a combination of postural drainage, breathing exercises, coughing, and percussion. The rationale of such treatment rests on the assumption that additional mechanical and gravitational forces will help in the clearance of airway secretions.

Clinically the benefit of these methods is difficult to judge. Many studies have shown that physiotherapy including percussion, postural drainage, breathing exercises, and coughing increases the expectoration of sputum and this may lead to improvement of lung function and arterial blood gases.²⁻⁹ Postural drainage or coughing alone, however, may also increase the transport of mucus in the lungs.¹⁰⁻¹⁶

Measurement of lung clearance of a radioactive

aerosol would appear to be the most direct objective method for evaluating the effect of chest physiotherapy.^{17,18}

In this report we present data on the effect of manual percussion as a single procedure, as well as in combination with postural drainage, coughing, and breathing exercises, on tracheobronchial clearance in patients with chronic airflow obstruction and excessive tracheobronchial secretions.

Methods

PATIENTS

Nine men with clinically stable chronic airflow obstruction and regular daily expectoration took part in this study after giving informed consent. Approval of the university ethics committee was obtained. All patients complained of breathlessness on exertion and none had symptoms or signs suggestive of bronchiectasis. All were smokers or ex-smokers. Some characteristics of the patients are summarised in the table. All patients used their regular treatment on the days of the measurements, no extra doses were allowed. Routine physiotherapy was withheld on each study day.

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Details of patients studied

Patient No	Age (y)	FEV ₁ % pred	FEV ₁ % VC	Smoking†	Sputum (ml)§	Treatment
1*	44	49	44	+	100 (8)	BIT
2	46	73	56	+	60 (5)	BIT
3	50	51	40	+	140 (10)	BIT
4	57	52	48	—	20 (2)	BI
5	61	70	45	+	20 (1)	BIT
6	61	57	39	—	120 (10)	BI
7*	61	47	32	+	150 (9)	BI
8†	70	51	34	+	60 (6)	IT
9	61	61	37	—	80 (7)	BIT

*protocol 1 not completed.

†protocol 3 not completed.

‡ + indicates smoker and — indicates ex-smoker.

§Mean (SD) sputum production/day of three consecutive days.

FEV₁ %pred—forced expiratory volume in one second as a percentage of the predicted value; FEV₁ %VC—FEV₁ as a percentage of the inspiratory vital capacity; B—beclomethasone; I—ipratropium bromide; T—theophylline.

RADIOAEROSOL INHALATION AND REGISTRATION OF BRONCHIAL CLEARANCE

A technetium (^{99m}Tc) aerosol was administered with an air jet nebuliser connected, in side stream operation, to an intermittent positive pressure breathing respirator (Bennet AP-5). In this way a heterodisperse aerosol was produced (95% of particles 1–15 μm). After full explanation to the patient and practice inhalations for becoming accustomed to the respirator, the nebuliser was filled with 1–1.5 mCi (35–50 MBq) ^{99m}Tc tin colloid (Amersham). After 40–50 inhalations (inspiratory pressure < 10 cm H₂O) 10–15% of the tracer was deposited on the airway mucus (fig 1b and 1c). The tracer remaining in the mouth and throat was removed by rinsing and swallowing water. With this method the radiation dose to the lungs is 60 mrad and the effective total body radiation dose amounts to 10 mrad (0.1 mGy).¹⁹

Before and after the radioaerosol inhalation peak expiratory flow (PEF) was determined to assess possible effects of the procedure on bronchial narrowing and to ensure comparable baseline pulmonary function on the days of measurement.

The patients were studied in the supine position. A gamma camera with a large field of view, positioned under the patient's chest and linked to a computer, was used for acquisition of one minute frames every 10 minutes over a period of 50 minutes. Subsequently over each lung a central (hilar) and a peripheral region was determined (fig 1a) visually, by using a light pen. Care was taken to use comparable areas in the three studies on each patient. The rate of disappearance of isotope from central and peripheral regions of both lungs was recorded and, after correction for physical decay, data were expressed as percentages of the starting values.

STATISTICAL TECHNIQUES

Differences in radioaerosol clearance at each 10 minute interval were compared by means of the paired Student's *t* test; *p* < 0.05 was taken as indicating a significant difference.

PHYSIOTHERAPY

Physiotherapy was always given by the same physiotherapist. Measurements of tracheobronchial

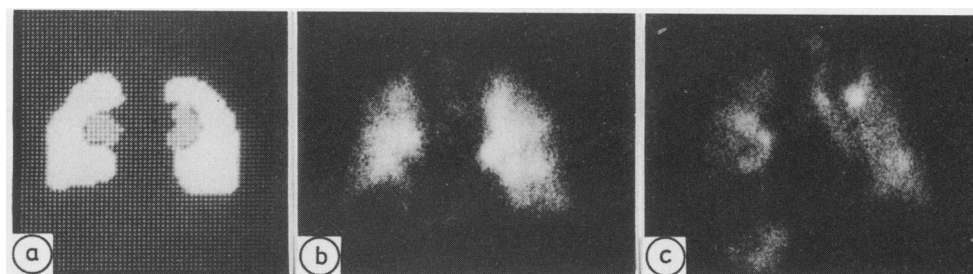


Fig 1 (a) Definition of central (darker) and peripheral (lighter) region; (b and c) example of deposition in one subject before and after physiotherapy using protocol 2 (manual percussion, breathing exercises, coughing, and postural drainage).

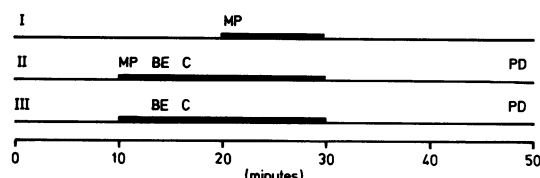


Fig 2 The three different physiotherapy protocols. MP—manual percussion; BE—breathing exercises; C—coughing; PD—postural drainage.

clearance were made over 50 minutes, always between 1 pm and 3 pm. The methods of physiotherapy were manual percussion, postural drainage, breathing exercises, and coughing. The different protocols were not used in a randomised order. All patients were accustomed to different types of physiotherapy; a learning effect was therefore improbable.

The following three protocols were performed on separate days (fig 2):

1 During the first day the patient was lying horizontally in the supine position. For the first 20 minutes he breathed quietly, manual percussion was then applied for 10 minutes, followed by a further 20 minutes of undisturbed breathing. Manual percussion was performed with cupped hands¹ on the ventral side of the thorax at a frequency of about 180 beats a minute.

2 On the second day the patient lay supine in a 20° head down position. For the first 10 minutes he breathed quietly; this was followed by 20 minutes of manual percussion, breathing exercises, coughing, and rest (each for one minute and repeated five times). Thereafter the patient again breathed quietly for 20 minutes. Postural drainage was performed with the patient lying in the supine 20° head down position. During the breathing exercises the patient was asked to breathe deeply in a relaxed manner. If he was wheezing he was instructed to practice lip pursing. During the coughing period the patient was asked to cough as productively as possible. During expiration the thorax was supported manually. After coughing the patient drank some water to clear the oesophagus of radioactive tracer.

3 On the third day the same protocol as on day 2 was used, but without percussion; additional one minute rest periods were substituted for the periods of manual percussion.

Results

There was no significant difference in PEF between the three days of measurement; both before and after radioaerosol inhalation mean values were 266 (SE 93) l min^{-1} .

MANUAL PERCUSSION VERSUS QUIET BREATHING

The first protocol was completed by only seven patients as two patients were unable to lie horizontally for 50 minutes (table). During this day (figs 3 and 4, graph 1) the clearance of the radioaerosol tracer was greater in the period when percussion was applied (20–30 min) than when the patient was breathing quietly (0–10, 10–20, 30–40, and 40–50 min). With clearance from the peripheral zones the percussion period was significantly different from the periods 10–20 minutes ($p < 0.01$), 30–40 minutes ($p < 0.01$), and 40–50 minutes ($p < 0.05$). In the central zones it was significantly different from the periods 0–10 minutes ($p < 0.02$), 30–40 minutes ($p < 0.02$), and 40–50 minutes ($p < 0.02$).

PHYSIOTHERAPY VERSUS MANUAL PERCUSSION ALONE

All nine patients completed protocol 2 and comparison with protocol 1 was made for the seven patients who completed both. The clearance of the tracer after 50 minutes was significantly greater on day 2 (figs 3 and 4, graph 2), when manual percussion, postural drainage, breathing exercises, and coughing were performed, than on day 1 (figs 3 and 4, graph 1), when only manual percussion was used. The difference was significant both in the peripheral ($p < 0.01$) and in the central zones ($p < 0.001$).

PHYSIOTHERAPY WITH AND WITHOUT MANUAL PERCUSSION

The third protocol was completed by eight patients as one patient could not lie in a 20° head down position for 50 minutes (table). Comparison between protocols 2 and 3 was made for the eight patients who completed both. There were no significant differences

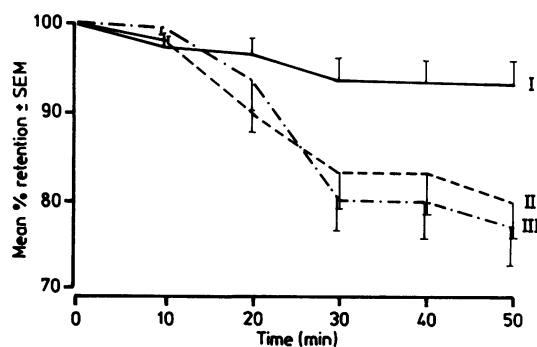


Fig 3 Clearance of the radioactive tracer from the peripheral airways expressed as percentages of the starting values (means and standard errors) on the three days of measurement (I, II, and III).

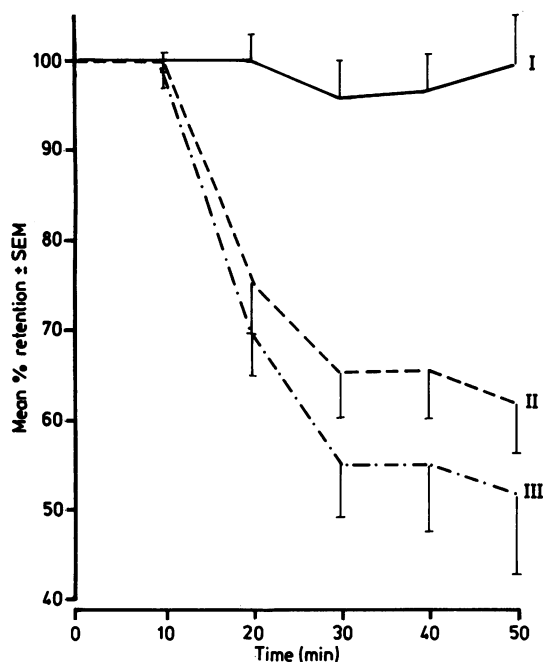


Fig 4 Clearance of the radioactive tracer from the central airways expressed as percentages of the starting values (means and standard errors) on the three days of measurement (I, II and III).

($p > 0.05$) between day 2 (figs 3 and 4, graph 2), when physiotherapy, including manual percussion, was applied and day 3 (figs 3 and 4, graph 3), when physiotherapy without manual percussion was applied.

Discussion

The results of this study show that manual percussion as a single procedure can slightly but significantly improve the tracheobronchial clearance in patients with chronic airflow obstruction and excessive secretions. Postural drainage and coughing with or without manual percussion can improve mucociliary clearance much more than manual percussion alone.

We used measurements of the clearance of a radioactive aerosol to evaluate the different physiotherapy protocols. The clearance of radioactive particles reflects the movement of the airway mucus on which they have been deposited. Peripheral deposition in part represents spillover from bronchiolar cilia in respiratory bronchioles and alveoli. We therefore divided the gamma camera fields into peripheral and central regions, but since the separation between the central and the peripheral fields was made in two

dimensions the central field also contains some peripheral airways.

The increase in radioactive tracer seen between 30 and 50 minutes on day 1 in the central field (fig 4) probably reflects transport from the peripheral airways. The absence of any significant differences in mucociliary clearance between days 2 and 3 suggests that manual percussion does not add to the efficiency of the combination of postural drainage, coughing, and breathing exercises. This conclusion is similar to that of Rossman *et al*¹⁴ in patients with cystic fibrosis. Bateman *et al*¹³ found that coughing alone did not accelerate peripheral lung clearance. In the present study we showed that coughing, when combined with postural drainage and breathing exercises, improves central as well as peripheral lung clearance. Because of differences in definition of the lung fields in our study and that of Bateman *et al*, however, direct comparison of the results may not be valid.

In conclusion, the effect of pulmonary physiotherapy in patients with chronic airflow obstruction and excessive tracheobronchial secretions probably results from a combination of coughing, postural drainage, and breathing exercises. Manual percussion may be useful when the patient is not able to cough and cannot tolerate postural drainage. Manual percussion should not, however, be the treatment of choice of physiotherapists for patients with chronic airflow obstruction in a stable phase of their disease.

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