



Original Research Article

## Comparison of Quake and RC-Cornet for Airway Clearance in Bronchiectasis: A Randomized Crossover Trial

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Received: 24/08/2012

Revised: 10/09/2012

Accepted: 15/09/2012

### ABSTRACT

**Objective:** the objective of study is to compare between the effectiveness of Quake versus RC-cornet on mucous clearance and to determine patient preference between the two devices.

**Material and Method:** A randomised cross over trial was conducted. The mean age of 35 cases were  $52.29 \pm 13.9$  Diagnosed to have bronchiectasis, were included in the study by block randomization with inclusion criteria of Sputum volume more than 20ml per 24hours.

**Results:** Quake was more effective in airway clearance as compared to RC-cornet with no carry over effect p value of 0.475. Sputum collected after Quake was greater than RC-cornet with mean difference of 2.78ml. Patient preference is RC cornet.

**Conclusion:** Quake has a high pulsatile pressure and strong pressure pulses with a raspberry sound produced with oscillation during both phases of respiration, promoting more mucous production, On the contrary RC-Cornet produces high frequency oscillations at low flow with PEP generated by valve sequence. Though Quake has a higher sputum production than Rc cornet but the patient preference is predominant towards RC cornet.

**Key words:** chest physiotherapy, Quake, RC-cornet, bronchiectasis, oscillation ,positive expiratory pressure, secretion clearance.

### INTRODUCTION

Bronchiectasis refers to the abnormal, irreversible dilatation of the bronchi caused by destructive and inflammatory changes in airway walls. (1,2) It

is usually acquired, but can also result from underlying genetic or congenital defects of airway.

The prevalence of bronchiectasis is 5 to 7 times greater in persons over 55 years of age. There are limited studies, suggesting

it's occurrence in individual between 60-80 years of age. <sup>(3, 4)</sup> In Indian adult it is the third commonest Non-tubercular respiratory disease with the incidence of 71 per lakh. <sup>(4)</sup>

Bronchiectasis is associated with irreversible dilatation of bronchi, destruction of muscular and elation components of the bronchial wall which leads to inflammation. <sup>(2, 5)</sup> The distended bronchi have tendency to retain secretion, symptoms include a chronic cough, fever, hyper secretion of airways which predominate in the morning or with changes in position along with a wheeze and fatigue. <sup>(3, 6, 7)</sup>

Bronchodialators and corticosteroid therapy is indicated in these cases, surgical intervention may be used when symptoms persist in spite of conservative treatment, this includes lobar resection and bilateral lung transplant. <sup>(5)</sup> Life expectancy in bronchiectasis has increased in the recent years due to improved pharmacological and surgical therapies. <sup>(1, 2)</sup> However chest physiotherapy constituting airway clearance devices are regarded as an integral component of bronchiectasis management. <sup>(2, 3, 8, 9)</sup>

Many self-administered mechanical devices are used in the management of bronchiectasis to increase effectiveness of chest physiotherapy. Routinely used airway devices are Positive Expiratory Pressure (PEP) therapy, Flutter therapy, and Chest wall oscillation therapy, Acapella, RC-Cornet and Quake. <sup>(2, 3, 10, 11-13)</sup> Quake being a handheld device delivering PEP and oscillation in both phases of respiration to help loosen the secretion, while RC-Cornet is another hand held device which generates oscillatory PEP only during expiration. <sup>(3, 8, 10, 14)</sup> Both devices can be used in any position as they are independent of gravitational forces.

Recent study done comparing Acapella, Flutter and Quake has concluded that Quake produce stronger vibratory

pulses than the other two devices and so help in loosening secretion more effectively. <sup>(15)</sup> Another study done comparing RC Cornet & Flutter has shown that RC Cornet has positive effect on expectoration of mucus. <sup>(12)</sup>

We hypothesized that Quake will be more effective than RC-Cornet for airway clearance. To our knowledge, no studies have compared the Quake and RC-Cornet on airway clearance in bronchiectasis. Therefore the purpose of the study was to compare the effects of the Quake versus RC-Cornet on mucous clearance in bronchiectasis.

## **MATERIALS AND METHODS**

The study was approved by the Scientific Committee and Time Bound Research Ethical Committee of KMC, Manipal University, Mangalore. Written informed consent was obtained from all the patients. Thirty five patients with a history of sputum expectoration of more than 20 ml per day, diagnosed to have bronchiectasis, were recruited from hospital setting at Kasturba Medical College Hospitals. Patients with uncontrolled hemoptysis, rib fractures, or history of recent myocardial infarction were excluded from the study

The patients diagnosed with bronchiectasis (stable and with acute exacerbation) and fulfilling the inclusion criteria were included in the study. Two patients with active tuberculosis were excluded. The intervention order was defined according to block randomization (4 blocks of 8 chits). The results were kept in numbered and sealed identical envelopes. Patients were asked to pick up a single chit from the envelope and then were allocated to the respective group written on the chit. The outcome variables measured before the interventions were sputum volume and patient were instructed about the correct use

of device. Post allocation to their respective group patients performed either Quake (Fig

1) or RC-Cornet (Fig 2) breathing.



(Fig.1) Quake



(Fig.2) RC-Cornet

### Patients Performed Quake

In Quake breathing, patients were advised to take a deep breath and hold it for 3-5 seconds. The patient had the mouthpiece firmly sealed to the lips and were asked to inhale and exhale completely, while the handle was rotated at a steady and comfortable rate of (half to one rotation/sec.) This allows control of vibrations as it depends on a hand-turned crank, like a fishing reel. This is a manually turned cylinder which fits into another cylinder. Airflow occurs only when slots within two cylinders lines up, the rate at which the device is cranked will determine the frequency of flow interruption. Rotating the handle quickly provides faster oscillations while decreasing the pulsatile expiratory pressure. <sup>(15)</sup> For this reason rotating the handle quickly was avoided by advising them to rotate at 30-60 revolution per minute(RPM). It was recommended that the procedure to be repeated at 6 times, this constituted one set and 10 such sets were given interspersed with a rest period for 10 min. Patients were advised to suppress the desire to cough during these cycles. Later

they were advised to exhale forcefully to aid airway clearance.

### Patients Performed RC- Cornet

Patients were instructed to hold their lips firmly onto the mouthpiece and take a deep breath in through nose and blow through RC-Cornet. A low pitched harsh sound and vibration would be felt in the chest, this was repeated 10 times for 10 minutes or 6 sets of 10 repetitions with a rest period when needed, followed by huff and cough. The PEP & vibration in the airway was increased by twisting the mouthpiece of the RC-Cornet. Turning the mouth piece into positions 1-4 diagonally twists the valve hose, this gradually reduces the effectivity of the second valve. Besides pressure oscillation, airflow oscillations are also generated during expiration. These pressure and airflow oscillation are imparted to the bronchial tree through the mouthpiece. <sup>(16, 17)</sup>

Post treatment by both the devices outcome variables were taken, like the quantity of sputum recorded for 24 hours using a volumetric-jar. A wash out period of 24 hours was maintained to neutralize the effect of given intervention, later the

patients were crossed-over to other group. At the end of treatment for each group patient preference was obtained using patient preference scale to know the overall utility and performance of the device. (13, 16)

This scale has four components rated on a 5 point scale. The PPS components include (1) Usefulness in clearing secretions; (2) Convenience; (3) Comfort; & (4) Overall performance. It was scored as much better (+2); better (+1); no difference (0); worse (-1); and much worse (-2).

The end of the treatment session was determined when the patients were treated for a maximum of 12 min, or when the

patients were no longer expectorating sputum or when they felt too tired to continue the treatment.

### Statistical Analysis

Statistical analysis of the study was done and the data was interpreted by Statistical Package for Social Sciences (SPSS 16). The level of significance of  $p < 0.05$  was considered to be statistically significant with 95% confidence interval. Analysis was done within group by comparing pre and post values using paired t- test. Mann Whitney-U test was done for analyzing the patient preference scale.

## RESULTS

Present study has 35 subjects (11 males, 24 females) with the mean age of  $52.29 \pm 13.96$  years. The baseline characteristics of the patients are given in Table 1.

**Table 1: Baseline characteristics**

Characteristics	N=35
Age, mean	52.29± 13.9 (yrs)
Duration of disease	8.6± 3.2 (yrs)
Gender, Male/Female	11 /24
B.M.I	17.78±3.74
H/O Tuberculosis	22
Acute Infection	13
Smokers	7
Medications:	
Inhaled $\beta$ agonist	18
Inhaled corticosteroids	6
Oral antibiotics	16
Oral corticosteroids	5

The carry over effect was analysed between intervention which shows  $p$  value  $>0.05$ , implying there was no carry over effect of one treatment over the other, given in Table 2.

**Table 2: Showing carry over effect between both intervention**

Pre Sputum Collection	Group	N	Mean $\pm$ S.D	$p$ value
	Quake	35	32.8 $\pm$ 5.8	0.398
	RC-Cornet	35	31.7 $\pm$ 12	

The difference in the mean of sputum collected between both the intervention was 2.39 ml with CI-95% (4.39 - 1.03) as shown in Table 3. A great proportion of patient preferred RC-

Cornet, when compared to Quake for usefulness in sputum clearance, convenience, comfort and overall performance as shown in Table 4.

**Table 3: Comparison of sputum volume between equipments**

Group	N	Sputum collection (ml) Mean ± S.D.	Mean difference (ml)	p value
Post Quake	35	36.23 ± 15.4	2.39	0.021
Post RC-Cornet	35	33.84 ± 12.4		

**Table 4: Showing values of Patient Preference Scale**

	Device	Mean ± S.D	Test value	p value
Usefulness in clearing	Quake	0.48 ± 0.928	4.57	00.24
	RC-Cornet	1.71 ± 0.611		0.00
Convenience	Quake	0.10 ± 1.091	5.04	.269
	RC-Cornet	1.57 ± 0.514		0.002
Comfort	Quake	1.52 ± 1.078	3.35	0.140
	RC-Cornet	1.50 ± 0.519		0.001
Overall	Quake	0.52 ± 1.078	3.61	0.12
	RC-Cornet	1.57 ± 0.51		0.006

## DISCUSSION

Our study showed that the Quake was more effective in airway clearance in cases of bronchiectasis than RC-Cornet. The carry over effect was analysed between groups, which showed a *p* value of 0.398 suggesting there was no carry over effect of one treatment over the other and the effect was only due to treatment. Sputum collected after Quake was greater than RC-Cornet with mean difference of 2.39ml (*p*<0.05). A study done comparing RC-Cornet and Acapella in bronchiectasis concluded RC-Cornet to be more effective in sputum clearance with mean difference of 1.95ml. (16)

In the present study, we hypothesized that the Quake will be more effective than RC-Cornet in mucous clearance for bronchiectasis cases. The Quake showed potentially more mucous production than RC-Cornet which may be because Quake provides strong vibratory pulses during both exhalation and inhalation which may help in secretion removal more than the RC-Cornet which provides

oscillation only during exhalation. (8) The quake delivers higher pressure pulses in airways causing vigorous percussion thereby helping to reduce viscosity of mucous and loosening secretions for patients with low tidal volumes. (15)

Vibration pulse of quake is not determined by the patient's rate of flow, so this may be more helpful for patients with severe obstructive lung disease who are unable to generate high peak expiratory flow rates. (10) Also the frequency of flow interruption is determined by the rate at which the device is cranked and this requires coordination as patient turns the crank, both during inhalation and exhalation. (18) Oscillation frequency depends on how quickly the handle is rotated. Fast rotation gives low pulsatile expiratory pressure, while slow rotation of the handle creates higher pulsatile expiratory pressure and stronger pressure pulses. (15) So patients in our study were made to crank slowly between 30-60 RPM to achieve optimal effect.

An earlier study comparing the strength of pressure pulses generated by

Acapella, flutter and Quake during the exhalation phase of simulated low-volume tidal breathing, concluded that Quake generated significantly stronger pressure pulses at handle turning of 30-120 RPM, yielding a mean pressure wave amplitude of  $(9.1 \pm 1.4 \text{ cm H}_2\text{O})$  which was significantly larger than that produced by other two devices. <sup>(15)</sup>

Quake may alter the rheology of mucous and increase the ciliary beat through stimulation of the ciliated epithelial cells. The oscillation frequency of Quake (6-24Hz) is closer to the optimal frequency for secretion clearance. <sup>(15)</sup> The natural frequency of the ciliary beat is 11 to 15 Hz and if airflow oscillates at a similar frequency, this resonance may increase the amplitude of cephalad ciliary beat, which could in turn increase mucous transport. As the Quake demonstrated a wide range of vibration frequencies which facilitates vibrations delivered to the airways, this translates more vigorous airway percussion and causes effective secretion loosening.

RC-Cornet works on the principal of pressure oscillation at three different frequencies. The low frequency at 20Hz, middle frequency at 80Hz and high frequency pressure oscillation of 300Hz. <sup>(12, 16)</sup> The oscillating PEP therapy dilates the bronchi, shears the mucous from the bronchial walls and reduce mucous viscosity. <sup>(17)</sup> On blowing the RC-Cornet the valve hose is forced into two compartments with a flexible valve at each compartment end.

On exhalation if the critical pressure of the first valve is exceeded the air enters the second compartment which is still closed by its valve, while the second valve opens the first valve is shut again. This induces a constant PEP with superimposed pressure fluctuations. Turning the mouth piece into different positions twists the valve hose, this gradually reduces the effectivity of second

valve which reduces the static positive pressure and may increase the amplitude of the pressure oscillation. <sup>(11, 19)</sup> The Initial two positions create PEP with added pressure oscillations successfully and the latter two creates a slow rising pressure with a sudden pressure drop. These oscillations and the pressure drop mechanism along with valve sequence technology help induce a stop and go of airflow which supports removal of bronchial secretion. <sup>(19, 17)</sup>

One of probable reason for the airflow oscillation producing more mucous production is that it might have caused unfolding of the physical entanglements between the primary network of mucous glycoprotein and other structural macromolecules, the rupture of cross-linking bonds such as disulfide bridges or perhaps fragmentation of larger molecules, leading to increased viscoelasticity and thereby further enhancing the mucous transport. <sup>(13, 20)</sup> The probable reasons given above have led to more mucous production in these patient populations and thus can be clinically applied for such cases.

A patient preference scale was taken as an outcome measure to determine which device is preferred by the patient. <sup>(13, 21)</sup> The present study showed that a great proportion of subjects preferred the RC-Cornet to the Quake for usefulness in sputum clearance, convenience, comfort and overall performance.

This scale (PPS) has previously been used in the assessment of treatment effect in patients with bronchiectasis. <sup>(13)</sup> A recent study carried out on Acapella and RC-Cornet also used the Patient Preference Scale suggested that patients preferred RC-Cornet for its usefulness in clearing secretion, convenience, comfort and overall performance. <sup>(16)</sup> Present study also showed the same preference. This probably is because of increased discomfort involved in using Quake while rotating the crank both

during inspiration and expiration which could lead to increased demand on upper limb musculature. Also, as this device required coordination between crank rotation and both phase of respiration it could have resulted in a significantly increased perception of dyspnea. The RC-Cornet seems to be more user friendly in terms of handling, usage and can be coordinated easily therefore is preferred by patients.

One of the limitations of study is the possibility of bias, as the same physiotherapist delivered both interventions and collected sputum volumes, A single treatment design may not truly reflect clinical practice where treatments are carried out over a long period of time. Sputum volume was recorded as the primary outcome measure rather than sputum weight, as volume provides information that establishes short-term clinical efficacy.

Further studies should address the Comparative study between Quake and other oscillatory PEP devices could be done on pathological conditions with voluminous sputum production. The long term effects of these devices should be seen in diseases in which they are indicated with a larger population group. Future studies can be done taking a better outcome measure for sputum weight.

## CONCLUSIONS

Quake has a high pulsatile pressure and strong pressure pulses with oscillation during both phases of respiration, promoting more mucous production. On the contrary the RC-Cornet produces high frequency oscillations at low flow with PEP generated by valve sequence. Though the quake has a higher sputum production than RC-Cornet the patient preference inclines towards RC-Cornet.

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