Acta Scientific Orthopaedics (ISSN: 2581-8635)

Volume 5 Issue 5 May 2022

Research Article

To Study the Effects of Assisted Cough Techniques and the Clinical Utility of a Peak Flow Meter to Measure Peak Cough Expiratory Flow in Persons with Spinal Cord Injury

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DOI: 10.31080/ASOR.2022.05.0469

Received: March 14, 2022

Published: April 25, 2022

Abstract

To study the effect of assisted cough techniques and the clinical utility of peak flow meter to measure peak expiratory flow in persons with spinal cord injury.

Objective: To find out the effectiveness of ACT in SCI.

Study Design: Convienent sampling

Methodology: The assisted cough technique applied by 3 methods. On 30 patient it was done.with the help of peak flow meter the expiratory values were recorded.

Result: It shows that ACT is effective in Spinal cord injury patient. It reduces the respiratory complication. The comparison indicated that the thoracic spinal cord injury patients performed better than cervical. The mean value of post thoracic was 281.33. whereas the mean post value of cervical was 279.33

Thus from mean value the thoracic shows better result after ACT.

Conclusion:

- ACT appear to increase the PCEF of persons with cervical and thoracic SCI
- Assisted cough technique is important and effective in spinal cord injury patient.
- Thoracic patient shows better result than cervical patient.
- An optimal ACT can be easily evaluated with peak flow meter

Keywords: Cough; Peak Cough; Expiratory; Spinal Cord

Introduction

Assisted coughing remains one of the most important techniques for airway clearance in the patient with an acute spinal cord injury.

If Spinal cord lesion between c1 and C3(ABOVE C4)the innervation of phrenic nerve and the respiratory functions get impaired or lost.

In contrast, lumbar lesions present with full innervation of both primary (diaphragm) and secondary (neck, intercostal, and abdominal) respiratory muscles.

The PRIMARY MUSLES OF INSPIRATION are diaphragm and external intercostals.

As the diaphragm contracts and descends, the intercostals normally elevate the ribs and increase the lateral anterior posterior diameter of thorax.

Paralysis of intercostal result in decreased chest expansion and a lowered inspiratory volume. With progressively higher-level lesions, increased involvement of accessory muscles of respiration. These muscles assist with elevation of ribs and include the sternocleidomastoid, trapizes, scalene, posterior minor and serratus anterior.

The primary musles of expiration

Passive expiration is through the elastic recoil properties of lung and thorax. Any loss in the expiration muscles (internal intercostal and abdominals) result in decrease expiratory efficiency.

To maintain the intra thoracic pressure abdominal muscles when they are fully inverted play important role for the effective respiration. Position of diaphragm upward during forced expiration is maintained by expiratory muscles. These muscles support abdominal viscera as well.

If this muscles get paralyzed the support is lost which make low position of diaphragm resulting in lack of abdominal pressure and to move diaphragm upward in forced expiration.

This result in decrease expiratory reserve volume.

The unusual movement of diaphragm decreases cough effectiveness and ability to expel the secretion of cough.

Paralysis of external obliques also influences expiration. Their normal is to depress the ribs and compress the chest wall to assist with the forceful expulsion of air. With higher level lesion this function becomes less efficient, with a further reduction in the patients ability to cough and expel secretions.

Thus, there is lack of normal cough mechanism in cervical and thoracic spinal cord injury patients as they suffer with paralyses of major portion of expiratory muscles.

Consequently, to maintain airway clearance the patients are depended upon caregiver support to apply suctioning, assisted coughing or on other techniques

Moreover, this makes a big morbidity and mortality rate due to adequate cough which leads to respiratory tract infections. Major cause death in population is respiratory tract infection.

The part below the injury level remains intact in most patient of spinal cord injuries. The network of neurons in the spinal cord and peripheral neuromuscular system are maintained. Therefore, to produce a functionally effective cough mechanism the expiratory muscles are amenable to various stimulation techniques to generate large positive airway pressures.

The cough mechanism

- Deep inspiration occurs.
- Glottis closes and vocal cords tighten.
- Diaphragm elevates with contraction of abdominal muscles, which causing in increase intra thoracic and intra–abdominal pressures.
- Glottis opens.
- Explosive expiration of air occurs.

This normal cough mechanism hampred in spinal cord injury patient. To maintain the cough mechanism in cervical and thoracic patients the assisted cough technique is given.

Peak flow meter [5]

Figure a

Peak expiratory flow rate (PEFR) is the maximum flow rate generated during a forceful exhalation, starting from full lung inflation. The voluntary effort and muscular strength of the patient reflects large airway flow in Peak flow.

The effort-dependent portion of the expiratory maneuver gives Maximal airflow and the low values may be caused by a less maximal effort rather than by airway obstruction.

The peak flow rate with an inexpensive small portable device as made in ease of measuring the degree of airway obstruction in patients with asthma and other pulmonary conditions.

A dynamic measure of flow used in spirometer is Forced expiratory volume over 1 second (FEV1) which shows a true indication of airway obstruction than does peak flow rate. Thus, the peak flow rate usually correlates well with FEV1.

Due to this diurnal variation, peak flow rate measured at the same time every day.

Indications

Indications for peak flow rate measurement are as follows

- Monitoring of asthma
- Monitoring effects of air pollutants on respiratory function and ozone
- Monitoring of chronic obstructive pulmonary disease

Contraindication

No contraindications exist to peak flow rate measurement.

Positioning

The peak flow rate is conventionally measured with the patient in sitting position. The mouthpiece of the peak flow rate meter is placed in the patient's mouth and tightly closed by the lips. In the front opening of meter the tongue should not be placed.

In general, a peak flow rate of less than 80% of the patient's personal best should trigger the administration of an inhaled short-acting beta2 -agonist. A peak flow rate of less than 50% of the patient's personal best should trigger both administration of an inhaled short-acting beta2 -agonist and immediate medical attention.

Complications

No complications are reported as results of measuring peak flow rate.

Need of study

For patient with spinal cord injury various techniques were used to improve the cough mechanism and airway clearance. The study was done to evaluate the effectiveness of assisted cough technique.

Aim

To study the effectiveness of ACT in cervical and thoracic spinal cord injury patients

Objectives

- To find out the effectiveness of ACT in SCI.
- To increase Vital Capacity by ACT in SCI patient
- To measure the expiratory rate with the peak flow meter
- To compare the ACT in cervical and thoracic spinal cord injury patient.

Hypothesis research hypothesis

Assisted cough techniques is effective in spinal cord injury.

Null hypothesis

ACT is not effective in spinal cord injury patient.

Review of literature

Abstract

[4] 46 neuromuscular ventilator users Peak cough expiratory flows (PCEFs) during unassisted and assisted coughing and review the long-term use of mechanical insufflation-exsufflation (MI-E). They used noninvasive methods of ventilator support for a mean of 21.1 h/d for 17.3 +/- 15.5 years. The manually assisted coughing and/or MI-E during periods of productive airway secretion conclude that manually assisted coughing and MI-E are effective which helped in the facilitating airway secretion clearance for neuromuscular ventilator depended.

[11] Reduced lung volumes and flow rates as a result of respiratory muscle weakness in individuals with spinal cord injury (SCI). 74 individuals with SCI in sitted and supine position assist changes in forced vital capacity (FVC), forced expiratory volume in 1 s (FEV1), FEV1/FVC, forced expiratory flow at 50% vital capacity (FEF50), inspiratory capacity (IC), and expiratory reserve volume (ERV).

FVC, FEV1, and IC increased with descending SCI level down to T10, below which they tended to level off; supine values of FVC and FEV1 tended to be larger in the supine compared with the seated posture down to injury level T1, caudad to which they were less than when seated these were the main findings Thus, it proves that increase in vital capacity in supine position is related to the effect of gravity on abdominal contents and increase in IC.

Reduced peak cough flows (PCFs) are considered to increase the risk of respiratory complications such as pneumonia or chronic atelectasis in neuromuscular disorders. To improve PCF different methods were used. However, regarding the use and efficacy of these methods in children with respiratory muscle weakness had limited information as study was done in adults. The hyper insufflation with an intermittent positive-pressure breathing (IPPB) device is effective in cough augmentation in patients was investigate in above study.

Spirometry (forced inspiratory vital capacity, FIVC; forced expiratory volume in 1 sec, FEV1), respiratory muscle pressures (peak inspiratory pressure, PIP; peak expiratory pressure, PEP), IPPB- assisted hyperinsufflation was taught individually to increase lung volumes (maximum insufflation capacity, MIC) above FIVC. This effect was similar in young patients (ages 6–10 years) and older patients (aged >10 years). The lung volumes augmentation from FIVC to MIC shows an increase of PCF ($R = 0.42$, $P < 0.05$). To reduce respiratory morbidity in children this technique can be used to improve airway secretion.

[12] To improves outcomes for neuromuscular disease patients with respiratory tract infections Mechanical insufflation- ex sufflation was done. The subjects during the hospital stay administered bronchoscopy-assisted aspiration was also compared. The mechanical insufflation-exsufflation group than in the conventional chest physical treatments group (2/11 vs. 10/16 cases) the treatment failure was low. The Bronchoscopy inassisted aspiration was similar in the two groups (5/11 vs. 6/16 cases).

All subjects tolerated well and no one had side effects with the use of mechanical insufflation and exsufflation. To improve the airway mucous encumbrance in neuro myopathic patients in provision of mechanical insufflation combination with standard chest physical treatments was managed.

The noninvasive approach to treatment of respiratory tract infections with impaired mucous clearance was included.

[13] To study the effect of manually assisted cough and mechanical insufflation on cough flow of normal subjects, patient with chronic obstructive pulmonary disease (COPD), and respiratory muscle weakness. The effectiveness of cough can be improved by assisted techniques. The study physiology reported that the effects of manually assisted cough and mechanical insufflation on cough flow. By manually assisted cough and mechanical insufflation technique alone or in combination in normal subjects does not improved the peak cough expiratory flow rate and cough expiratory volume. The improvement in the expulsive phase of coughing by the median increase in peak cough expiratory flow in subjects with RMW without scoliosis with manually assisted cough alone or in combination with mechanical insufflation of 84 l/min (95% confidence interval (CI) 19 to 122) and 144 l/min (95% CI 14 to 195). To assist expectoration of secretions in patients with RMW without scoliosis but not in those with scoliosis manually assisted cough and mechanical insufflation was done.

[14] To improve the expiratory muscle function in order to increase the reduced cough capacity in patients with cervical spinal cord injuries (SCI) the focus was more on pulmonary rehabilitation. However, the improvement in inspiratory muscles also important for coughing effectively.

The inspiratory muscle strength on the cough capacity in the patients with a cervical SCI this study was done. The measurement of vital capacity (VC), maximum inspiratory pressure (MIP), and maximum expiratory pressure (MEP) was done. Under three conditions unassisted peak cough flow (PCF) and assisted PCF were evaluated. Significantly there was higher value with all three assisted cough methods than the unassisted method ($P < 0.001$). The VC correlated with the voluntary cough capacity and the MIP ($R = 0.749$) correlated more significantly with the VC than the MEP ($R = 0.438$) ($P < 0.01$). A higher correlation in MIP was observe with both the unassisted PCF and all three assisted PCFs than the MEP ($P < 0.001$).

[16] A major cause of morbidity and mortality in adults and children with neuromuscular disease exhibit weak cough and are susceptible to recurrent chest infections. By increasing peak cough through Mechanical insufflation/exsufflation may improve cough efficacy. With other modes of cough augmentation the mechanical insufflation/exsufflation would produce a greater increase in peak cough flow. The interventions for acceptability was also compared. During maximal unassisted coughs, followed in random order

by coughs assisted by physiotherapy, noninvasive ventilation, insufflation and exsufflation, and exsufflation alone the Peak cough flow was recorded. With mechanical insufflation/exsufflation at 235 ± 111 $L \cdot min^{-1}$ ($p < 0.01$) the greatest increase in peak cough flow was observed. All techniques showed that to produces a cough efficacy Mechanical insufflation/exsufflation is to be used.

Materials and Method

Methodology

Population

Patient who are clinically diagnosed with SCI.

Study setting

Military Hospital, Kirkee Pune

Sample size

The total number of subject in the study is no= 30. Total 15 patient of cervical injury and 15 of thoracic injury with different level of injury level.

Study design

Comparative study.

Selection criteria

Inclusion criteria

- Age of 35-45yrs.
- Having injury level between cervical and thoracic.

Exclusive criteria

- Non cooperative patient
- Any systemic pathology
- Patient with tracheostomy

Material used

- Peak flow meter
- Mat and Bed.
- Pen
- Pencil
- Eraser
- Gloves
- Mask
- Chair

Figure b

Outcome measure

Peak expiratory flow rate

Procedure

Assisted cough technique

Manually assisted technique

- Costophrenic assist
- Abdominal thrust assist or Heimlich type
- Counter rotation assist

Costophrenic assist

Place the one hand underneath the ribs as the patient attempts to cough push inwards and upwards. The upper abdomen of the patient was crossed with one forearm of therapist which curved around the opposite side of the chest, same with the other hand is placed on the near side of the chest. Pushing simultaneously inwards and upwards with the forearm, squeezing and stabilising with the other hand is done when patient attempt s to cough.

Figure c

The lower rib cage and upper abdomen was covered with hands anetriorly. The arms and elbow kept extended to push inwards and upwards to attempt cough for the patients.

Figure d

Abdominal thrusts

Figure e

The Heimlich Maneuver or abdominal thrust assist

- Make the fist with one hand. And place the thumb side of fist against the middle of the abdomen just above the belly button. Carefull not to keep fist on your breastbone or ribs.
- The fist covered with other hand. Patient to spit out the object keep the fist into the abdomen with a quick upward push.
- Press the upper abdomen quickly over any hard surface, if patient not get cough out of airway.

Counter rotation assist

Counter-rotation Technique

Technique done with patient in left sidelying

Figure f

Patient in sidelying with knees bent with arms comfortable (relaxation is key). Therapist stands near patient's hips, stands facing the patients head. Left hand on right pectoralis region. Right hand on right gluteal fossa. The therapist follow the patient's respiratory cycle (note rate, rhythm, tone).

As the patient completes an expiratory phase.Pull left hand down and back toward the therapist's stomach.At same time, push the right hand up and forward away from the stomach. True diagonal equals counter-rotation of the trunk. A quick stretch will facilitate larger, stronger inhalation = increased TV.

Again the patient inspires therapist switches hand placement. Left hand slides back to the patient's left scapula Right hand slides forward anterior to the patient's left iliac crest. Slowly stretch during inspiration to expand chest. End of inspiration.

Technique

Measurements of peak flow rate depends significantly on patient effort and technique. It starts with the indicator moved to lowest end of the numbered scale.

The mouthpiece of the device is placed in the patient's mouth with lips closed around it. In the front hole the tongue should not placed. The patient has to blows out forcefully and rapidly in a single exhalation.

With keeping lips sealed around mouthpiece, exhale forcefully and rapidly.

more times the steps are repeted. If the patient coughs or does not perform the technique correctly, the turn is ignored and repeated. The highest number from the 3 attempts is recorded by the patient.

The therapist instruct the patient to identify his or her personal best peak expiratory flow by recording the highest number achieved within 2 weeks.

Peak flow rate is measured at least twice a day for 2-3 weeks

Result and Tables

CERVICAL

The peak flow values were measured as 'liters of air breathed out per minute'. (l/min)

Pre-Cervical	Post Cervical
242.66	279.33

Type	Mean	S.D.	P Value
Pre Cerevical	242.66	42.67	0.0282
Post Cervical	279.33	39.82	

Table a: Cervical

Graph 1

Interpretation

From above graph the PRE and POST ACT values shows the effect of ACT in cervical patient. The statically values proves that effect of ACT increases the cough mechanism.

Thoracic

Interpretation

The above graph shows the changes in values of thoracic patient after giving ACT. Post thoracic ACT values statically proves that ACT improves the cough mechanism.

Pre thoracic	Post thoracic
235.33	281.33

Type	Mean	S.D.	P value
Pre thoracic	235.33	59.26	0.028
Post thoracic	281.33	55.01	

Table b: Thoracic.

Graph 2

Post cervical	Post thoracic
279.33	281.33

Type	Mean	S.D.	P value
Post cervical	279.33	39.82	0.93
Post thoracic	281.33	55.01	

Table c

Graph 3

Interpretation

The graph shows post value of cervical and thoracic, which shows the difference between post value of ACT in cervical and post value of ACT in thoracic.

From the above table and graph the average assisted cough value is not significant but greater in thoracic level of spinal cord than cervical spinal cord injury patient.

Discussion

The study was done total 30 patients,15 patients were selected having cervical spinal cord injury and 15 patients were selected having thoracic spinal cord injury.

The pre and post ACT results were taken and compared. Post ACT results were better than the PRE ACT results in both cervical and thoracic because ACT helps to improve the expiratory flow. The manualy assisted coughing is effective and safe method for facilitating airways secretion clearance in SCI patients.

The graph 1 shows the difference between the pre and post cervical values. The ACT shows the effectivenees in stimulating the cough.

Scientist BACH proves that the ACT improves the expiratory rate and minimizes the risk of respiratory complication in cervical patient.

The 3-technique improving the expiratory muscle function in order to increase the reduced cough capacity in patient the cervical spinal cord injuries.

The graph 2 shows the difference between pre and post thoracic values. The expiratory rate were measured with the peak flow meter. The post thoracic values were better than cervical.

The graph 3 shows the difference between the post ACT cervical and post thoracic values. ACT values measured with the the help of peak flow meter.

The readings were recorded twice, one prior to ACT and other after the ACT given.

On one time 3 readings were taken after which the best value out of 3 of that individual were noted. THORACIC shows good result compared to cervical.

The table show that Individuals do experience a loss of their respiratory muscle control with complete thoracic or cervical injurie. The loss of respiratory muscle control will be greater if injury level is on higher side.

- The thoracic or cervical regions usually result in the permanent loss of respiratory muscle function below the level of injury if the injuries are complete. It is impossible to predict whether the individual will regain some or all of their respiratory function below the level of injury if the injury is incomplete.
- The control of the intercostal and abdominal muscles are affected with injuries in the thoracic area (T1-T12) of the spinal cord.
- A lower level of injury, such as a T10, results in the individual losing a small amount of muscle control. Intercostal and abdominal muscle lose control with higher level injury such as T2.
- Complete injuries in the cervical region result in a total loss of intercostal and abdominal muscle control. Again, the greater loss of additional muscle control if injury at higher level.

S.no.	Gender	Age	Pre act Tecnq	Post act Tecnq
1.	Male	32	300	300
2.	Male	34	260	300
3.	Male	34	250	280
4.	Male	31	280	300
5.	Male	33	250	260
6.	Male	42	80	200
7.	Male	46	240	280
8.	Male	33	160	200
9.	Male	39	200	260
10.	Male	40	260	300
11.	Male	37	220	280
12.	Male	36	290	320
13.	Male	43	320	330
14.	Male	42	310	330
15.	Male	41	240	260
			3640	4190
			242.66	279.33

Table d: Group a Master Chart (Cervical) with Act Technique.

S.NO.	Gender	AGE	PRE ACT TECNQ	Post Tecnq
1.	Male	39	320	330
2.	Male	36	200	250
3.	Male	40	140	250
4.	Male	45	180	200
5.	Male	31	160	210
6.	Male	37	230	320
7.	Male	32	260	300
8.	Male	43	220	280
9.	Male	40	320	360
10.	Male	35	200	280
11.	Male	44	250	280
12.	Male	40	320	370
13.	Male	36	300	360
14.	Male	32	190	220
15.	Male	35	240	270
			3530	4280
			235.33	285.33

Table e: Group B Master Chart (Thoracic) With Act Technique.

Conclusion

- Assisted cough technique is important and effective in spinal cord injury patient.
- Thoracic patient shows better result than cervical patient.

Limitation of Study and Recommendation

- Only cervical; and thoracic spinal cord injury patient were taken.
- Tracheostomy patients were not taken.
- Limited no of patient.

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