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Original Research Article

Incentive spirometry versus active cycle of breathing technique: effect on chest expansion and flow rates in post abdominal surgery patients

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ABSTRACT

Background: The patients undergoing abdominal surgery has characteristic post-operative mechanical abnormality in respiration like restrictive pattern of ventilation. Spontaneous deep breaths to restore functional residual capacity are abolished by pain. Incentive spirometry (IS) promotes frequent maximum inspiratory effort and is used for the prophylaxis and treatment of respiratory complications in post-surgery wards. Aim of the study was to compare the effect of incentive spirometry (IS) versus active cycle of breathing technique (ACBT) on flow rates and chest expansion in patients following abdominal surgery.
Methods: It was prospective comparative interventional study. 90 patients posted for abdominal surgery and satisfying the inclusion criteria were included in the study. They were randomly divided through simple random sampling into two groups. Group A-IS group and Group B-ACBT group. Outcome measures were recorded as Peak inspiratory flow rate [PIFR], Peak expiratory flow rate [PEFR], Forced expiratory volume in 1 sec [FEV1] and chest expansion on pre and post-operative day five. Comparison of pre and post-operative day 1 and pre and post-operative day 5 was done using Wilcoxon signed Ranks Test for both group A and group B, further post hoc analysis was done by Tukey's test at significance level of $p<0.05$. Inter as well as Intra group comparison was done. The comparison between group A and B for all the parameters was done by Mann- Whitney U test. At Statistical level of significance for Mann- Whitney U $p<0.001$.
Results: Both IS and ACBT improve the peak flow rates and chest expansion in post abdominal surgery patients. Active cycle of breathing techniques is better technique compared to incentive spirometry in post abdominal surgery patients.
Conclusions: ACBT (active cycle of breathing technique) has better results than incentive spirometry in post abdominal surgery cases.

Keywords: Abdominal surgery, Active cycle of breathing technique, Chest expansion, Incentive spirometery

INTRODUCTION

The patients undergoing abdominal surgery has characteristic post-operative mechanical abnormality in respiration like restrictive pattern of ventilation.[1] Spontaneous deep breaths to restore functional residual capacity are abolished by pain.[2] Incentive Spirometry (IS) promotes frequent maximum inspiratory effort and is used for the prophylaxis and treatment of respiratory complications in post-surgery wards.

Active cycle of breathing technique (ACBT) is used for airway clearance and consists of breath holding, thoracic expansion exercises and huffing. It is known that the

Functional Residual Capacity and flow rates reduce post operatively however the effect of breathing technique on improving flow rates has not been extensively studied. Hence the aim was to study the effect of Incentive Spirometry vs Active cycles of breathing technique (ACBT) on peak flow rates and chest expansion in post-abdominal surgery patients.

METHODS

The study was approved by the Ethics Committee for research on human subjects (ECRHS) of the institute. Written informed consent was taken from patients, explaining the study procedure, possible benefits of the study, risks and discomfort of participating, compensation for participation and study right to withdraw from the study.

It was a hospital based Prospective, comparative interventional study where a group of abdominal surgery patients received intervention in the form of Incentive spirometer (IS) and a parallel group with Active cycle of breathing technique (ACBT).

130 patients in the age range of 14-65 years posted for abdominal surgery (mid- line incision) were screened from the surgery wards during a six-month period for the study. Patients with pre- existing pulmonary complications and those operated for laparoscopic surgery were excluded from the study.

Patients having post-operative complications as fever, with signs of infection like rise in temperature, excessive pain at the midline incisional suture site or on mechanical ventilator for more than 7 hours were discontinued or withdrawn from the study.

90 patients satisfying the inclusion criteria were included in study and were randomly divided through simple random sampling into two groups A and B. The patients' basic demographic data, surgery and treatment details were recorded. Patients were randomly divided into two groups. The patients were taught the respective techniques maintaining the duration of treatment for 15 mins.

Group A

In these group patients were positioned half crook lying, shoulders relaxed, patients were asked to hold the incentive spirometer and to inspire with full effort through the mouth piece such that the ball of the spirometer goes up.

Initially the flow rate was maintained at 200cc/sec as marked on the spirometer and gradually it was increased according to the capacity of the patient. After every 5 breaths the patients were asked to breath normally for a few breaths. Cycles were repeated for treatment duration of 15 min.

Group B

Patients were positioned half crook lying, shoulders relaxed and active cycle of breathing techniques was explained. The cycle included breathing control followed by 4 thoracic expansion exercises, 1-2 huffs in the mid to low lung volumes, breathing control then cough with expectoration. Cycles were repeated for the duration of 15 min.

Both groups were treated 15 min once daily for 5 days and advised to carry out the protocol every 6 hourly. Daily compliance was checked and maintained with the help of a chart in which the patient had to tick when done. The Peak inspiratory flow rate [PIFR], Peak expiratory flow rate [PEFR], Forced expiratory volume in 1 sec [FEV1] was measured in centimeter, pre-operatively, post-operative day one and day five. Chest expansion was measured at 3 levels- axilla, nipple and at the level of xiphisternum.

Statistical analysis

The data was analyzed using SPSS software version 15, Sigma plot version 11.

RESULTS

Normality was tested using Shapiro Wilk test, and as the data was not normally distributed, non-parametric test were applied. Comparison of pre and post- operative day 1 and pre and post-operative day 5 was done using Wilcoxon signed Ranks Test for both group IS and group ACBT, further post hoc analysis was done by Tukey's test at significance level of $p<0.05$. Inter as well as Intra group comparison was done. The comparison between groups IS and ACBT for all the parameters was done by Mann- Whitney U test at level of significance $P<0.001$.

The mean age of patients in Group A was 42.13yrs and in Group B was 39.33years. There were 31males and 14females in Group A and 29 males and 16 females in Group B. The patients in Group A were discharged at a mean of 6.40 days while that of group B on 6.16 days.

The groups, IS and ACBT were comparable at baseline. As seen in the Table 1, the change in PIFR ($p<0.05$), PEFR ($p<0.05$), FEV 1 ($p<0.05$) and Chest expansion at axilla ($p<0.05$), nipple ($p<0.05$) and Xiphisternum level ($p<0.05$) was statistically significant between post day 1 and day 5, Post op day 5 and pre in Group A (Incentive Spirometry).

While the comparison between, post op day 1 and pre values, was not significant ($p>0.05$). Similarly in Group B (ACBT), change in PIFR ($p<0.05$), PEFR ($p<0.05$), FEV 1 ($p<0.05$) and Chest expansion at axilla ($p<0.05$), nipple ($p<0.05$) and Xiphisternum level ($p<0.05$) was statistically significant for post day 1 and day 5, day 5 and pre op, while not significant ($p>0.05$) for post op day

1 and pre. On inter group comparison with Mann Whitney test as seen in Table 2, the difference between the two groups were statistically significant (p<0.001) for the parameters PIFR, PEFR, FEV1 and chest expansion at the axillary level.

Table 1: Intra group comparison of group A and B of PIFR, PEFR, FEV1 and chest expansion at 3 levels.

	Group A pre	Group A post	Group A			Group B pre	Group B post	Group B		
	Mean± SD	Mean ± SD	Day 5 Vs Day 1#	Day 5 Vs Pre#	Day 1 Vs Pre#	Mean± SD	Mean±SD	Day 5 Vs Day 1#	Day 5 Vs Pre#	Day 1 Vs Pre#
PIFR	121± 37.8	122.1± 34.8	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)	108.56± 21.4	114.22± 21.2	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)
PEFR	115.3± 40.6	151± 35.6	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)	140.3± 40.8	142.56± 37.6	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)
FEV1	0.77± 0.4	0.74± 0.38	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)	0.72± 0.34	0.77± 0.36	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)
Chest Exp (Axilla)	1.27± 0.39	1.20± 0.44	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)	1.34± 0.41	1.22± 0.38	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)
NIPPLE	1.32± 0.41	1.21± 0.45	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)	1.41± 0.44	1.23± 0.38	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)
XIPHI STERNUM	1.28± 0.38	1.16± 0.41	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)	1.38± 0.47	1.22± 0.38	P<0.05 (S)	P<0.05 (S)	P>0.05 (NS)

#all pair wise comparison- Turkey test; S- Significant; NS- Non significant.

Table 2: Intergroup comparision between group A and B.

		Mean	SD	Median	Range	Man Whitney	P- value
PIFR (Vmin)	Group A	43.81	24.21	50	-30 to 85	72	<0.001
	Group B	100.33	23.96	105	40 to 150	Significant	
PEFR (Vmin)	Group A	42.74	24.94	50	-55 to 80	140	<0.001
	Group B	111.11	39.48	115	-50 to 170	Significant	
FEV1 (ml)	Group A	0.34	0.30	0.25	-0.1 to 0.1	500.5	<0.001
	Group B	0.61	0.29	0.6	0.1 to 1.25	Significant	
Chest expansion Level 1 (cm)	Group A	0.58	0.47	0.5	-1 to 1.5	660.5	0.008
	Group B	0.83	0.40	1	0 to 1.5	Significant	
Level 2	Group A	0.69	0.41	0.5	0 to 1.5	831.5	0.302
	Group B	0.76	0.42	0.1	0 to 1.5	Not significant	
Level 3	Group A	0.66	0.47	0.5	-0.5 to 2	852	0.401
	Group B	0.73	0.42	0.7	0 to 1.5	Not significant	

DISCUSSION

The results of Incentive spirometry (Group A) treatment vs Active cycle of breathing techniques (Group B) in post abdominal surgery patients showed a statistically significant improvement in the peak flow rates (PIFR, PEFR and FEV1) and chest expansion at level 1 (axilla).

As seen in Table 2 when inter group comparison was done, median value for PIFR (l/min) was 50 (-30 to 85) in Incentive spirometry Group (Group A) and 105 (40 to 150) in Active cycle of breathing technique group (Group B) which was statistically significant (P value< 0.001). Median value PEFR (l/min) was 50 (-55 to 80) in Incentive spirometry (Group A) and 115 (-5 to 170) in Active cycle of breathing technique (Group B) which was statistically significant (P value<0.001).

FEV1 (ml) was 0.25 (-0.1 to 1) with Incentive spirometry (Group A) and 0.6 (0.1 to 1.25) with Active cycle of breathing technique (Group B) which was statistically significant (P value<0.001). Chest expansion at level 1 was 0.5 (-1 to 1.5) cm in incentive spirometry group (Group A) and 1 (0 to 1.5) cm in active cycle of breathing technique (Group B) which shows that ACBT was more effective technique than the incentive spirometry (P value< 0.001). The chest expansion at the nipple level and the xiphisternum level did not show a statistical

significant difference between the two techniques. Incentive spirometry improves the peak flow rates as post operatively diaphragmatic movement increases encouraging the increase in lung volume while using the pattern of breathing control.[3]

Incentive spirometry devices encourage deep breathing and sustained inspiration which leads to collateral ventilation. Incentive spirometry has been used to prevent post abdominal surgery pulmonary complications.[5]

A sustained maximal inspiration causes the pleural pressure to drop well below normal. This increases the transpulmonary pressure gradient, which is sustained for a few seconds with a breath hold. Atelectasis can frequently be prevented or treated by increasing the transpulmonary pressure gradient and further expanding the alveoli.[4]

Active cycle of breathing techniques (ACBT) improves the peak flow rates as thoracic expansion exercises recruit the collateral ventilatory system assisting, the movement of air distal to mucus plugs in the peripheral airways. Increasing tidal volume also utilizes the interdependence or mutual force of adjacent alveoli to re expand collapsed alveoli. The ACBT combines airway clearance with the promotion of ventilation.

ACBT is more beneficial than Incentive spirometry due to the fact that it combines thoracic expansion and forced expiratory technique or huffing. The exercises of thoracic expansion - hold of breath, result in air been transported behind the obstructed areas with better secretion removal. The forced expiratory technique or huffing cause a great compression, which aims to bring the secretions upwards and to activate the cough reflex.[6]

In active cycle of breathing techniques, breath control is involved and thus the flow rates which themselves are volume dependent and effort independent are improved; whereas in Incentive spirometry the breathing volumes at different levels are not targeted but overall ventilation improves.[7] Thus, though improvement in flow rates is noted in both the groups; active cycle of breathing techniques has more impact on improving alveolar ventilation as well as volumes and thus better improvement in flow rates.

Present study also supports the findings of Savci S, et al evaluated the efficacy of incentive spirometer (IS) and active cycle of breathing techniques (ACBT) following coronary artery bypass graft (CABG) surgery in which they concluded that both treatments improved arterial oxygenation from the first day post-operatively.[8]

Thus both IS and ACBT improve the peak flow rates and chest expansion in post abdominal surgery patients. Active cycle of breathing techniques improves PIFR, PEFR, FEV1 and chest expansion at the axilla level significantly as compared to IS group. ACBT is better technique compared to incentive spirometry in post abdominal surgery patients. Incentive spirometer though has an advantage of being goal oriented feedback mechanism which ensures adequate ventilation in absence of therapist; the cost factor cannot be ignored. ACBT is a simple technique associated with arm mobilization and forced expiratory maneuver which ensures airway clearance.[9,10] There were no complications seen in any of the patients in either of the group.

CONCLUSION

Both Incentive spirometry and ACBT improves the peak flow rates and chest expansion in post abdominal surgery patients. Active cycle of breathing techniques is statistically more significant compared to Incentive Spirometer in post abdominal surgery patients and does not require purchase of any particular device.

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REFERENCES

1. Stock MC, Downs JB, Gauer PK, Alster JM, Peter B. Prevention of Postoperative Pulmonary Complications with CPAP. Incentive Spirometry, and Conservative Therapy. 1985;87(2):151-7.
2. Miranda AS, Novaes RD, Ferreira AE, Neves MP, Corrêa CL, Mendonça VA. Assessment of respiratory muscle strength, peak expiratory flow and pain after open cholecystectomy. Acta Gastroentero Latinoam. 2009;39(1):38-46.
3. Chuter TA. Diaphragmatic breathing maneuvers and movement of the diaphragm after cholecystectomy. Chest. 1990;97(5):1110-4.
4. Warner DO, Warner MA, Ritman EL. Mechanical significance of respiratory muscle activity in humans during halothane anesthesia. Anesthesiology. 1996;84(2):309-21.
5. Hall JC, Tarala R, Harris J, Tapper J, Christiansen K. Incentive spirometry versus routine chest physiotherapy for prevention of pulmonary complications after abdominal surgery. Lancet. 1991;337(8747):953-6.
6. Hristara-Papadopoulou A, Tsanakas J. Results of active cycle of breathing techniques and conventional physiotherapy in mucociliary

clearance in children with cystic fibrosis. 2007;11(4):202-4.
7. Lebowitz MD. The Use of Peak Expiratory Flow Rate Measurements in respiratory Disease. Pediatric Pulmonology. 1991;11:165-74.
8. Savci S, Sakinç S, İnce DI, Arikan H, Can Z, Buran Y, Kuralay E. Active cycle of breathing techniques and incentive spirometer in coronary artery bypass graft surgery. Fizyoterap Rehabilitasyon. 2006;17(2):61-9.
9. Restrepo RD, Wettstein R, Wittnebel L, Tracy M. Incentive Spirometry: 2011. AARC Clinical practice guideline. Respir Care. 2011;56(10):1600-4.
10. Lewis LK, Williams MT, Olds TS. The active cycle of breathing technique: A systematic review and meta-analysis. Respiratory Medicine. 2012;106(2):155-72.

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