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Efficacy of thoracic mobility and breathing exercises on chest expansion and pulmonary function values in post intra- cardiac repair surgery patients.

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Abstract

Background: Post intra-cardiac repair (ICR) surgery patients are prone to have incision or suture site pain that will interfere with the thoracic wall mobility thereby resulting in reduced pulmonary function. Thoracic mobility and Breathing exercises along with conventional chest physiotherapy have been widely demonstrated to decrease the post (ICR) pain, to increase chest expansion and increase the pulmonary functions in phase I intra cardiac rehabilitation program.

Objectives: To determine the efficacy of thoracic mobility and breathing exercises in chest expansion and pulmonary function values in post (ICR) surgery patients.

Material and Methods: Total 24 participants were discovered to be eligible as per inclusion criteria that were included in this study. Participants were randomly selected and assigned in 2 groups, Group A (n=12) received Thoracic mobility and various Breathing exercises along with Conventional Chest Physiotherapy& Group B (n=12) received Conventional Chest Physiotherapy including percussions & vibrations. Pre and Post pain on NPRS, chest expansion at axillary and xphisternum level and pulmonary function values for FVC, FEV1 and FEV1/FVC were recorded. Readings obtained on 5th & 18th post-operative day was compared.

Results: The results were significant for all outcome measures except FEV1/FVC, which was not significant, when the two groups were compared.

Conclusion: The study concludes that thoracic mobility and breathing exercises were beneficial in reducing the post-operative pain and improving the chest expansion and pulmonary function values in post (ICR) surgery patients and the results were significant in both groups (group A and B).

Keywords: Intra- cardiac repair surgery, Thoracic mobility, Breathing exercises, Chest physiotherapy, Chest expansion, Pulmonary function test (FEV1, FVC, FEV1/ FVC).

INTRODUCTION

Congenital heart disease (CHD) is the primary common cause of congenital anomalies that poses a significant global health problem.[1] The estimate of 8 per 1,000 live births is generally acknowledged as the highest estimate.[2] The Congenital Heart Disease is relatively prevalent with an incidence ranging from 3.7 to 17.5 per 1,000 live births as indicated in a status report on CHD in India.[3]

The classification of congenital heart defects are as - acynotic and cyanotic. Most of these patients with congenital heart disease require intra cardiac repair surgery (ICR).[4]

The patients undergoing these surgeries receiving anaesthesia may lead to changes in the respiratory system which may get depressed because of that most of the patients get pulmonary complications after surgery.[5]

Cardiac rehabilitation is a multipronged approach towards patient who underwent post cardiac surgery which includes early and later interventions as per the need of the patient. It includes thoracic mobility exercises and chest physiotherapy to prevent pulmonary complications and pain during in patient phase.

Chest physiotherapy plays a significant role in preventing or reducing pulmonary complications post-operatively which includes various contents such as breathing exercises, chest manipulations, huffing, coughing, percussion and vibration.[6]

Breathing exercises are usually prescribed mainly for the patients those who are having pulmonary complications such as increase in secretions and reduced mobility of chest wall.[6]

Post operatively respiratory impairments & functional limitations of children with congenital heart defects commonly have some of these impairments such as: incision (sternotomy) pain and drainage, reduced thoracic wall mobility and impaired pulmonary function values.[7] Postoperative chest wall pain is the most important characteristic that restricts post-operative recovery in stage I patients.[8]

Pulmonary function tests (PFTS) are significant instrument in the investigation and monitoring of patients with respiratory pathology. Spirometry is the most commonly used that measures Forced expiratory volume in one second (FEV1), Forced vital capacity (FVC), and the ratio of two volumes (FEV1/FVC).[9]

Lung volume limitation, changes in residual volume and functional residual capacity in post intra cardiac repair surgery patients are the most common

abnormalities.[10] The post cardiac surgery patients are prone to have incision or suture site pain that will interfere with the thoracic wall mobility thereby resulting in reduced pulmonary function.[11]

In the present study thoracic mobility and breathing exercises along with conventional chest physiotherapy are utilized to efficiently decrease the post intra-cardiac repair pain, to increase chest expansion and increase the pulmonary functions in phase I intra cardiac rehabilitation program.

MATERIAL AND METHODS

Participants

The institutional ethics committee clearance (DMIMS (DU)/IEC/2018-19/7199) was obtained before the start of the study. Total 41 post Intra Cardiac Repair (ICR) surgery patients were screened for the inclusion and exclusion criteria of the study. Inclusion criteria were post pediatric intra- cardiac repair (ICR) surgery patients such as ASD, VSD & TOF, age between 8 – 15 years. Exclusion criteria were hemodynamic instability & patients not willing to participate.

Procedure

The institutional ethics committee clearance was obtained before the start of the study. Total 41 post Intra Cardiac Repair (ICR) surgery patients were screened for the inclusion and exclusion criteria of the study, out of which 11 refused to participate and 6 participants excluded from the study on the basis of hemodynamic instability. Therefore 24 participants were discovered to be eligible as per inclusion criteria that were included in this study. The procedure was explained to all the eligible participants as well as their relatives and they were given informed written consent (n=24) before allocating them into 2 groups.

All the participants were assessed for baseline measurements (i.e 0 level) on 5th POD and at the time of discharge on 18th POD for all outcome measures such as Pain, Chest expansion, Pulmonary Function Test values.

In Group A received Thoracic mobility and various Breathing exercises along with Conventional Chest Physiotherapy. Supervised exercise programme was given for two times with 10-12 repetitions for 25 to 30 minutes session for fourteen (14) days. Intermittent rest was given after every 10 minutes. Participants were advised to repeat the exercises two times a day.

In Group B received Conventional Chest Physiotherapy including percussions, vibrations was given for the period of fourteen (14) days. Each technique was repeated 10-12 times with 2-3 sets in supine lying and side lying position for 25 to 30 minutes session. Intermittent rest was given after every 10minutes.

Pre and Post pain on NPRS, chest expansion at axillary and xphisternum level and pulmonary function values for FVC, FEV1 and FEV1/FVC were recorded. Readings obtained on 5th and 18th post- operative day was compared. All the participants were evaluated after 14 days for these outcome measures.

1. Thoracic mobility exercises are as follows:

A. **Elevating the shoulders**: In high sitting position patient is asked to slowly breathe in through nose and gradually raise both the shoulders, followed by slowly breathe out through mouth after taking a deep breath. Then relax and lower your shoulders.

B. **Stretch the Back Muscle**: In high sitting position patient is asked to hold both the hands in front of his/her chest. Then slowly breathe in through nose, move both the hands together to the front and down to stretch back muscles. Followed by slowly breathe out after deep inspiration and resume the initial position.

C. **Lower Chest stretching**: In high sitting positionpatient is asked to hold the towel end at shoulder height with both hands stretched out. Slowly move the arm in upward direction after taking a deep breath. Lower your hands and breathe usually after deep expiration.

2. Breathing exercises:

A. **Diaphragmatic Breathing exercise:** The patient is in a relaxed, comfortable position where the diaphragm is assisted by gravity, such as the semi-flower position. Hands are placed on the abdomen just below the costal margin above. The patient is asked to breathe in through the nose slowly and deeply. Ask patient to breathe out and feel the rib cage shifting downwards and inwards. As the patient breathes out, placed pressure in the ribs with the palms of your hands. Ask the patient to slowly relax and exhale through the mouth.

B. **Pursed Lip Breathing:** The patient is in hook lying position and later progresses to a sitting position. The patient is asked to breathe slowly and deeply through the nose and then breathe out gently through the slightly pursed lips.

C. **Segmental Breathing Exercises (Lateral Basal Expansion):**The patient is in hook lying position and later progresses to a sitting position. Therapist's hands are placed along the lateral side of the lower ribs to direct the attention of the patient to the areas where the movement is to occur.

3. Conventional chest physiotherapy

A. **Percussion**: Patient placement was standardized to supine flat and side lying (both side), limb placed in a neutral position. The percussion is conducted with a cupped hand over the drained lung section. Alternatively, with the cupped hands therapist rhythmically strike the patient chest wall.

B. **Vibration:** Therapists hands are placed directly on the area of the lung to be treated and above the chest wall, gently compressing and applying vibration to the chest wall as the patient breathes out.[8]

RESULTS

The data was coded and entered into Microsoft Excel spreadsheet. Descriptive statistics included computation of means and standard deviations. Inferential statistics using student's paired't' test & unpaired't' test. Software used in

the analysis was SPSS 22.0 version. The results were concluded to be statistically significant with *P<0.05, very significant **P<0.001 and highly significant ***P<0.0001.

Table 1: Comparison of mean difference pain on NPRS score in 2 groups

Group	N	Mean	Std. Deviation	Std.Error Mean	t-value
Group A	12	3.33	0.65	0.18	3.63 P=0.001,S*
Group B	12	2.08	0.99	0.28	

*S: Significant,*NPRS: Numerical Pain Rating Scale

Mean pain on NPRS score in patients of group A at was 3.33±0.65 and in group B it was 2.08±0.99. By using Student's unpaired t test statistically significant difference were found in mean pain on NPRS score in patients of group A and group B(t=3.63,P-value=0.001).

Table 2: Comparison of mean difference in axillary chest circumference score in 2 groups

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Group A	12	1.12	0.31	0.08	2.83 P=0.010,S*
Group B	12	0.75	0.33	0.09	

*S: Significant

Mean axillary chest circumference score in patients of group A was 1.12±0.31 and in group B was 0.75±0.33. By using Student's unpaired t test statistically significant difference were found in mean axillary chest circumference score in patients of group A and group B(t=2.83,P-value=0.010).

Table 3: Comparison of mean difference in Xphisternum chest circumference Score in 2 groups

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Group A	12	1.41	0.37	0.10	5.18 P=0.0001,S*
Group B	12	0.62	0.37	0.10	

*S: Significant

Mean difference in Xphisternum chest circumference score in patients of group A was 1.41±0.37 and in group B it was 0.62±0.37. By using Student's unpaired t test statistically significant difference were found in mean difference in Xphisternum chest circumference score in group A and group B(t=5.18,P-value=0.0001).

Table 4: Comparison of mean difference in FVC Score in 2 groups

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Group A	12	12.33	3.98	1.15	3.38 P=0.003,S*
Group B	12	7.16	3.58	1.03	

*S: Significant,*Forced Vital Capacity

Mean difference in FVC score in patients of group A at was 12.33±3.98 and in group B it was 7.16±3.58. By using Student's unpaired t test statistically significant difference were found in mean difference in FVC score in group A and group B(t=3.38,P- value=0.003).

Table 5: Comparison of mean difference in FEV1 Score in 2 groups

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Group A	12	15.41	5.36	1.54	4.89 P=0.0001,S*
Group B	12	6.91	2.71	0.78	

*S: Significant,*Forced expiratory volume in one second

Mean difference in FEV1 score in patients of group A was 15.41±5.369 and in group B it was 6.91±2.71. By using Student's paired t test statistically significant difference were found in mean difference in FEV1 score at pre and post treatment (t=4.49,P- value=0.0001).

Table 6: Comparison of mean difference in FEV1/FVC Score in 2 groups

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Group A	12	12.25	4.51	1.30	1.96 P=0.063, NS*
Group B	12	9.16	3.04	0.87	

*NS: Non- Significant,*the ratio of two volumes

Mean difference in FEV1/FVC score in patients of group A was 12.25±4.51 and in group B it was 9.16±3.04. By using Student's unpaired t test statistically no significant difference were found in mean difference in FEV1/FVC score at pre and post treatment (t=1.96,p-value=0.063).

DISCUSSION

The present study aims to find out efficacy of thoracic mobility and breathing exercises on chest expansion and pulmonary function values in post intra- cardiac repair surgery patients.

This study was designed as an experimental study. The total number of participants included were (n=24) with post intra cardiac repair surgery having both genders between the age of 8 to 15 years. Randomly divided into two groups (group A & B).

Group Aparticipants received Breathing and Thoracic Mobility exercises along with Conventional Chest Physiotherapy. Group B participants received only Conventional Chest Physiotherapy.

The results were significant for all outcome measures except FEV1/FVC, which was not significant, when the two groups were compared using unpaired't' test. It was observed that there was statistically significant difference in these outcome measures after breathing and thoracic wall mobility exercises.

All the participants had undergone median sternotomy, because of which there was post-operative fear of pain which inhibited the movement of thoracic rib cage. In the present study significant difference in Numerical Pain Rating Scale (NPRS) was observed with the mean pain on NPRS score in patients of group A & B (t=3.63, **P-value=0.001).Significant difference was observed in group A that shows stretching exercises in the type of thoracic mobility is an alternative and adjunctive method with conventional chest physiotherapy compared to cardiac medication alone for the pain relief and improved range of movement at costosternal & costovertebral joints.

Patients with intra cardiac repair surgery prevent taking deep breaths due to pain during thoracic cage motion, thus reducing chest expansion soon after median sternotomy incision. The findings of our research show that the expansion of the chest at both levels gradually improved at the axillary (t=2.83,**P-value=0.010) and xphisternum level(t=5.18, ***P- value=0.0001) along with the significant decrease of pain from 5^{th} - 16^{th} Post- Operative Day and the difference was statistically significant in group A.

In 18 children with rheumatic fever Michele B et al. studied pulmonary function evaluation in children and adolescents before and after surgical procedure for rheumatic valve disease.They found that pulmonary dysfunction appears to be affected by continuous sternotomy- induced pain and mechanical changes and decreased post-operative compliance.[12]

Because of the combine consequences of bed rest, anaesthesia, sternal pain, after surgical procedure pulmonary functions are often diminished. But in the present study there were significant difference found in mean difference in FVC score at pre and post treatment in group A and group B(t=3.38, **P-value=0.003).Similarly, significant difference were found in mean difference in FEV1 score at pre and post treatment in group A and group B (t=4.49,***P-value=0.0001).There was no significant difference was found in mean difference in FEV1/FVC score at pre and post treatment(t=1.96,**P-value=0.063).

All the above evidences support the current study which was conducted to determine the efficacy of thoracic mobility and breathing exercises on chest expansion and pulmonary function test values in intra cardiac repair surgery patients.

CONCLUSION

The present study concludes that thoracic mobility and breathing exercises were beneficial in reducing the post-operative pain and improving the chest expansion and pulmonary function values in post intra cardiac repair surgery patients and the results were significant in both groups (group A & B).

Conflict of interest: NIL

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