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Is Chest Physiotherapy Effective For Extremely Preterm Newborns With Respiratory Distress Syndrome? : Randomized Controlled Study

KEYWORDS: Chest physiotherapy, Extremely preterm, Mechanical ventilation, Respiratory distress syndrome

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ABSTRACT *Mechanical ventilation is life saving for extremely preterm babies. Prolonged intubation is associated with complications. The chest physiotherapy is one of the interventions having been tested to facilitate earlier extubation. Therefore, the purpose of this study was to evaluate the efficacy of chest physiotherapy on extremely preterm newborns. Sixty extremely preterm neonates with respiratory distress syndrome and mechanically ventilated were enrolled in the study. They were divided into two equal groups (control and study). The control group received medical treatment, routine suctioning and positioning while the study group received the same medical treatment in addition to the selected chest physical therapy program. Arterial blood gases and vital signs were measured. Cranial ultrasound and chest x-ray were done to diagnose any cerebral injuries or rib fractures. All measurements were recorded pre treatment, after 2 days and after 7 days (post treatment). Significant improvement was recorded in all measuring variables for the study group. Significant differences were observed between both groups in favor of the study one. No incidence of rib fractures or cerebral injury were recorded in the study group. These clearly indicate the efficacy and safety of Chest physiotherapy for extremely preterm neonates with respiratory distress syndrome.*

1. Introduction

During the last few decades, the survival of preterm infants has increased dramatically. This improvement is mainly due to advances in perinatal medicine and neonatal intensive care **[1]**. Respiratory distress syndrome(RDS) in the neonate is a common problem **[2].** The RDS was reported in approximately 0.5% to 1% of newborns. The incidence and severity are directly related to prematurity degree. It affects around 50% of preterm newborns lighter than 1500 gram (g). Deaths, associated to the disease, usually occur during acute phase of respiratory failure and is largely limited to extremely immature newborns which birth weight is lower than 1000 g [**3**]. In fact, nearly all infants born before 28 weeks of pregnancy develop RDS **[4].** Sequelae of RDS include the following: septicemia, bronchopulmonary dysplasia, patent ductus arteriosus, pulmonary hemorrhage, apnea/bradycardia, necrotizing enterocolitis , retinopathy of prematurity, Hypertension, Failure to thrive, intraventricular hemorrhage (IVH) and periventricular leukomalacia (PVL) with associated neurodevelopmental and audiovisual handicaps **[5]**. Both immaturity and the severity of RDS are limiting factors preventing routine early extubation of all preterm babies. Preventing immaturity is difficult and often this problem is unavoidable. However, there are some evidence-based interventions to reduce the severity of RDS **[6]**. Respiratory Distress Syndrome could be treated medically and by physical therapy modalities. The medical treatment involve: breathing support (oxygen, endotracheal tube), Lines (arterial line, intravenous, umbilical catheters), medicine (bronchodilators, diuretics, sedatives, steroids). Chest physiotherapy (CPT) is used to loose secretions in baby's lungs to keep the airways clear and help the baby to breathe easier **[7]**. The forms of CPT more commonly used during the neonatal period are active CPT (tapping or vibration delivered on the chest) and non-active techniques (e.g. positioning and suction alone) **[8]**. The goal of therapy for patients with RDS is to maintain pH of 7.25-7.4, arterial oxygen tension (PaO2) of 50 – 70 mm Hg and carbon dioxide pressure (PaCO2) of 40 – 65 mm Hg, depending on the neonate's clinical status **[5]**. There are still scarce and conflicting studies in neonatal CPT **[9]**. Information on adverse effects of CPT is not adequate enough in the trials included to gauge safety for practice. In view of this and the lack of clear evidence for benefit, it recommends using this intervention cautiously **[10]**. Previous studies highlighted the beneficial therapeutic effects of interventional procedures of physiotherapy. However, previous investigations reported deleterious effects, suggesting that the handling procedures of interventional therapy in preterm infants result in hemodynamic instability, and therefore it is not indicated **[11]**. However, unlike in children and adults, where the use of CPT has been proven to be beneficial to cardio-respiratory function. It is not recommended in neonatal RDS [12]. Reported complications of CPT include hypoxaemia [13], rib fractures and cerebral injuries [14] and encephaloclastic porencephaly[15].Therefore, this study was conducted to test the hypothesis that a routine CPT program would reduce RDS of mechanically ventilated extremely preterm neonates without incidence of adverse outcomes including rib fracture and cerebral injury when compared with a program of routine positioning and suctioning.

2. Patients and Methods

2.1. Patients

Sixty extremely preterm newborns with gestational age ranged from 26 to 28 weeks were enrolled in this study. They were admitted between January 2012 and April 2013 in the Neonatal Intensive Care Unit (NICU), Al-jahra Hospital, Ministry of Health, Kuwait. After birth, they were treated with exogenous surfactant replacement and citrate caffeine as prophylaxis of apnea of prematurity. They were diagnosed as RDS and were mechanically ventilated with Synchronized Intermittent Mechanical Ventilation (SIMV), with fraction of inspired oxygen (FiO2) <0.6. The most common cause of RDS in the new born is related to insufficient levels of surfactant in lung and most mortalities from RDS occurs within 72 hours after birth **[16]**. Most IVH occur in the first 72 hours after birth **[17]**. So, the chronological age of the selected children was from 4 to 7 days. We considered the following inclusion criteria: birth weight equal or less than 1000 grams; clinical and radiological diagnosis of RDS. The radiological diagnosis (X-ray findings) was based on diffuse reticulogranular infiltrate (ground glass appearance) **[18]**. Clinical diagnosis was established when the newborn presented early respiratory distress (tachypnea, expiratory grunt, nasal flaring, chest retraction and cyanosis), early onset and progressive evolution **[19]**. They had RDS score ≥ 6 according to Downes' score **[20]**. The newborn who had one or more of the following criteria were excluded from the study: newborn with congenital malformations, asphyxia at time of birth, genetic syndromes, neurological disorders or congenital infection with clinical manifestations, seizures, who underwent procedures,or those who had IVH or major cerebral abnormality. Intraventricular hemorrhage was defined according to the classification described by **Tudehope et al**. **[21]** grade 1- IVH subependymal haemorrage, grade 2- IVH filling<50% of the ventricle, grade3-IVH filling>50% of the ventricle and grade 4-IVH with parenchymal involvement. Major cerebral abnormality defined as one or more of the following: cerebral cyst formation (porencephalic cyst, periventricular leukomalacia, Periventricular- intraventricular hemorrhage, hydrocephalus[8].

The patients were assigned randomly into two groups of equal numbers: control group (14 boys, 16 girls) and study group (15 boys, 15 girls). The work was carried out in accordance with the code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. Parents of the newborns signed a consent form prior to participation as well as acceptance of the Ethics Committee of the Ministry was taken.

2.2. Methods

2.2.1. For evaluation

Daily review of the medical records were done. Observation for any signs of RDS, settings of the ventilator, evaluation of posture and muscle tone were conducted pre and post each CPT session for study group and daily for the control group. Evaluation of vital signs, ABG_s, chest X-ray and cranial ultrasound were done for both groups pre treatment, after 2 days (post 1),after 7 days (post 2) Vital signs were measured including heart rate (HR), respiratory rate (RR), systolic arterial pressure (SAP) and diastolic arterial pressure (DAP). Arterial blood gases were including: PaO2, PaCO2, and pH. Chest X-rays were done for follow of RDS and rib fracture which were interpreted by a pediatric radiologist who was blinded to group allocation. Cranial ultrasound scans using a color Doppler unit (Hewlett-Packard Doppler 'IMAGE POINT'), were performed with a 2.2-5 MHz transducer. When there was clinical suspicion of bleeding, additional ultrasound examinations were performed. Both coronal and sagittal sections were obtained through the anterior fontanelles to detect any cranial abnormality including IVH and major cerebral abnormality.

2.2.2. For treatment

Newborns of both groups were mechanically ventilated and controlled medically by neonatologist.

Control group: Newborns of the control group received medical treatment and routine nursery care only. Routine nursery care of the ventilated infants included positioning, endotracheal tube (ETT) care. Routine ETT care was performed 4-6 hourly by instilling 0.25-0.5 ml of normal saline before suctioning by neonatal nurses. After suctioning, the baby was changed and repositioned.

Study group: The newborns in this group received the same medical treatment and routine nursery care given to the control group. In addition, they received a specially designed CPT three times per day in an interval of 4 hours between each session as recommended by **Bertone [22]**. Each treatment spent a maximum of 20 minutes (min.) which was not included preparation, physical examinations, diagnostic imaging when performed and variables measurement. The newborns were treated for 7 consecutive days. Non invasive monitoring of oxygen saturation (SpO2) and HR were maintained and analyzed during the entire CPT. According to **Santos et al. [23]** in cases of SpO2 reduction below 87%, tachycardia or bradycardia (alterations >15% of that predicted for the age), the intervention was interrupted and FiO2 increased by 10% over the baseline level. By stabilizing SpO2 and HR, the child was again ventilated with the initial parameters and intervention is resumed. If the SpO2 and/or HR were not reversed with these actions, physiotherapeutic intervention would be interrupted and appropriate therapeutic measures carried out with data recorded and evaluated. The CPT included the following:

Postural drainage: The patient's chest radiograph was reviewed and chest auscultation was performed prior to CPT to identify areas of particular involvement. Depending on the location of coarse crepitations, presence of secretions and the newborn tolerance, appropriate drainage positions were applied with avoidance of head down position and excessive neck flexion/ extension. According to **Crane [24]** each postural drainage position was applied for 3-5 min. with Lung squeeze technique (LST) and vibration, followed by about 2 min. suctioning or until clear return of the fluid to the tube, according to the patient's tolerance. Every newborn was put in 3-4 positions according to coarse crepitations.

Lung squeeze technique: Each set of lung squeezes consisted of three or four sustained chest compressions lasting for about 5 seconds, followed by a gentle slow "release phase," with the chest wall being completely released **[25, 26].**

The selected drainage positions used in the present study were as follows:

- Anterior segments of right and left upper lobes were drained with the newborn in flat, supine position. Lung squeeze technique followed by vibration were done over the chest directly under clavicles around nipple area, without direct pressure on sternum.
- Right and left lateral basal segments of lower lobes were drained at 30 degrees leaning forward, with LST and vibration over uppermost portions of lower ribs.
- Right and left anterior basal segments of lower lobes were drained at 30 degrees modified trendelenburg, while the newborn was lying on appropriate side with 30 degrees turn backward. LST followed by vibration was done at anterior lower margin of ribs.

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Suctioning and positioning: Nasotracheal and ETT suctioning by instilling 0.25-0.5 ml of normal saline before suctioning was done by neonatal nurses. Positioning of each newborn after CPT was done with advices given to the nurse to change each position every two hours. Each treatment episode should be carried out in a maximum of 2 positions with the particular area of collapse is uppermost**.** However, careful consideration must be taken as to whether the newborn tolerated a position especially when there was contraindication. The positions were used: side-lying, half lying, prone, three quarter prone, with head to the right is useful with persistent right upper lobe collapse.

Statistical analysis

Descriptive statistics were done in the form of mean and standard deviation to summarize patient's characteristics, vital signs and ABG_S. Inferential statistics assessed changes in all measuring variables including: Repeated Measures One-way analysis (ANOVA) was used to compare between the mean values of pre, post 1 and post 2 results for each group. Unpaired t-test was used to show the statistical differences between the two groups (pre, post 1 and 2). The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through SPSS (Statistical Package for Social Sciences) version 20.

3. Results

3.1 characteristics of enrolled newborns

The mean and standard deviation, of the characteristics of enrolled newborns at the beginning of the study including; gestational age (weeks), birth weight (grams), age (days) at enrollment, apgar score at 5 min, are presented in table 1. No significant differences were recorded between the two groups (P>0.05) which revealed that both groups were matched before starting of the study.

Table (1): characteristics of enrolled newborns

Variable	Control group	Study group	t-value	p-value
GA (weeks)	26.8±0.68	26.87±0.64	-0.32	0.75
WB (grams)	830±49.86	837.33±39.36	-1.09	0.29
Age (days)	4.73±0.59	4.67±0.62	0.24	0.82
AS	8.00±1.10	8.20±1.30	0.46	0.65

Data are expressed as mean ∪} SD

GA – gestational age

WB- weight at birth

AS - Apgar score at 5th minute

p. value: level of significance

***3.2* . Vital signs and arterial blood gases**

The collected data from this study represent the statistical analyses of the vital signs including (HR, RR, SAP and DAP) and ABG_S including (pH, PaO_2 and $PaCO_2$).

Results within the groups:

Study group: Repeated Measures ANOVA showed statistically significant differences (P <0.05) when comparing pre and post (1); post (1) and (2); pre and post (2) mean values of all measuring variables. The changes were in the form of increasing in (SAP, DAP, pH, PaO_2) and decreasing in (HR, RR, $PaCO_2$), as presented in table 2

Table (2): Vital signs and arterial blood gases of the study group

Variable	HR (Bpm)	RR (bpm)	SAP (mmHg)	DAP (mmHg)	pH	PaO_2 (mmHg)	$PaCO_2$ (mmHg)
Pre	164.20±1.86	65.80±2.43	51.73±1.83	31.13±2.33	7.09±0.04	50.07±1.88	58.13±1.60
Post (1)	145.67±2.13	56.73±3.28	60.33±1.92	39±1.69	7.19±0.05	59.67±2.41	55.87±2.33
Post (2)	134.87±1.92	48.60±2.35	74.60±2.29	46.73±1.71	7.29±0.04	66.2±3.39	45.07±2.37
MD (pre / post 1)	18.53*	9.07*	-8.60*	-7.87*	-0.10*	-9.60*	2.27*
MD (post 1/post 2)	10.80*	8.13*	-22.87*	-7.73*	-0.11*	-6.53*	10.80*
MD (pre/post 2)	29.33*	17.20*	-14.27*	-15.60*	-0.21*	-16.13*	13.07*

Data are expressed as mean ± SD HR: Heart rate; Bpm- Beat per minute; RR- Respiratory rate;
bpm- breath per minute; SAP- Systolic arterial pressure; mmHg- millimeter mercury;
DBP: Diastolic arterial pressure pH- Hydrogen ion concentration PaO2-arterial oxygen tension
PaCO2- Arterial carbon dioxide tension MD- Mean difference * - Mean difference is significant at p<0.05

Control group: The differences obtained when comparing pre-treatment results to post (1) in RR, SAP, DAP, PaO_2 and $PaCO_2$ variables were statistically non significant (P>0.05) while significant differences in the form of decrease in HR and increase in pH were recorded (P<0.05). Statistically significant changes (P<0.05) were recorded when comparing post (1) and (2); pre and post (2) of all measuring variables. The changes were in the form of increasing in (SAP, DAP, pH, PaO_2) and decreasing in (HR, RR, $PaCO_2$) as presented in table 3

Table (3): Vital signs and arterial blood gases of the control group

Variable	HR (Bpm)	RR (bpm)	SAP (mmHg)	DAP (mmHg)	pH	PaO_2 (mmHg)	$PaCO_2$ (mmHg)
Pre	164.53±1.81	65.40±124	50.40±3.11	30.07±2.05	7.07±0.06	50.76±4.47	59.07±1.87
Post (1)	161.73±1.39	62.60±5.83	51.93±3.96	32.20±2.98	7.10±0.05	51.33±5.29	58.53±1.81

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Post (2)	150.40±0.91	59.1±4.32	66.07±1.87	43.33±1.68	7.15±0.03	53.93±4.38	54.07±1.91
MD (pre / post 1)	2.80*	-2.80	-1.53	-2.13	-.03*	-0.47	0.53
MD (post 1/post 2)	11.33*	-3.50*	15.67*	-13.27*	-.05*	-2.60*	4.47*
MD (pre/post 2)	14.13*	-6.30*	14.13*	-11.13*	-.09*	-3.07*	5*

Data are expressed as mean ± SD HR: Heart rate; Bpm- Beat per minute; RR- Respiratory rate; bpm- breath per minute; SAP- Systolic arterial pressure; mmHg- millimeter mercury;

DBP: Diastolic arterial pressure pH- Hydrogen ion concentration PaO2-arterial oxygen tension

PaCO2- Arterial carbon dioxide tension MD- Mean difference * - Mean difference is significant at p<0.05

Results between the groups:
There were non significant differences between the two groups in all measuring variables before starting the treatment which suggested proper sample subdivision. While after 2 and 7 days, the results showed significant differences in all measuring variables between both groups (P <0.05) in favor of the study group as presented in table 4 and demonstrated in figures 1 to 4.

Table (4): Vital signs and arterial blood gases of both groups

Parameter	Pre		Post (1)		Post (2)		t-value		
	control	study	Control	Study	control	study	Pre	Post(1)	post(2)
HR (Bpm)	164.53±1.81	164.20±1.86	161.73±1.39	145.67±2.13	150.4±0.91	134.87±1.92	-0.62	-29.35*	-32.58*
RR (bpm)	65.4±124	65.8±2.43	62.6±5.83	56.73±3.28	59.1±4.32	48.60±2.35	0.68	-2.86*	-7.07*
SAP (mmHg)	50.40±3.11	51.73±1.83	51.93±3.96	60.33±1.92	66.07±1.87	74.6±2.29	1.56	6.15*	11.21*
DAP (mmHg)	30.07±2.05	31.13±2.33	32.20±2.98	39±1.69	43.33±1.68	46.73±1.71	1.49	7.22*	5.04*
pH	7.07±0.06	7.09±0.04	7.10±0.05	7.19±0.05	7.15±0.03	7.29±0.04	1.82	6.38*	14.60*
PaO_2 (mmHg)	50.76±4.47	50.07±1.88	51.33±5.29	59.67±2.41	53.93±4.38	66.2±3.39	-0.68	5.94*	9.18*
$PaCO_2$ (mmHg)	59.07±1.87	58.13±1.60	58.53±1.81	55.87±2.33	54.07±1.91	45.07±2.37	-1.54	-3.51*	-11.71*

Data are expressed as mean ± SD HR: Heart rate; Bpm- Beat per minute; RR- Respiratory rate; bpm- breath per minute; SAP- Systolic arterial pressure; mmHg- millimeter mercury; DBP: Diastolic arterial pressure pH- Hydrogen ion concentration PaO2-arterial oxygen tension PaCO2- Arterial carbon dioxide tension MD- Mean difference * - significant at p<0.053.

3.3 Adverse outcome measures
Adverse outcome measures including incidence of rib fractures and any cranial abnormality (including IVH and major cerebral abnormality) are presented in table 5. neither rib fractures nor cerebral injuries were recorded in both groups Before starting of the treatment. After 2 days of treatment, one newborn developed IVH-grade 2 and another one developed PVL in the control group while no cases developed any adverse effects in the study group throughout the treatment.

Table (5): Adverse outcome measures for both groups

Parameter	pre		Post (1)		Post (2)	
	Control	Study	Control	Study	Control	Study
IVH- Grade 1	-	-	-	-	-	-
IVH –Grade 2	-	-	1	-	1	-
IVH- Grade 3	-	-	-	-	-	-
IVH –Grade 4	-	-	-	-	-	-
Major cerebral abnormalities	-	-	1	-	1	-
Rib fractures	-	-	-	-	-	-

IVH- Intraventricular hemorrhage. Major cerebral abnormality defined as one or more of the following: cerebrcyst formation (porencephalic cyst, periventricular leukomalacia, Periventricular- intraventricular hemorrhage or encephaloclastic poreencephaly) or hydrocephalus

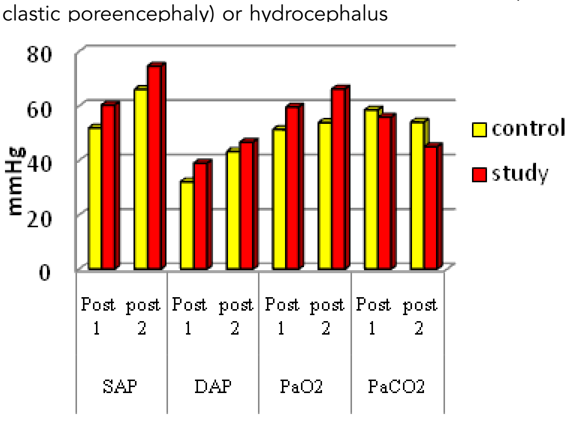

Figure 1.Post-treatment mean values of SAP, DAP, PaO_2 and $PaCO_2$ of both groups

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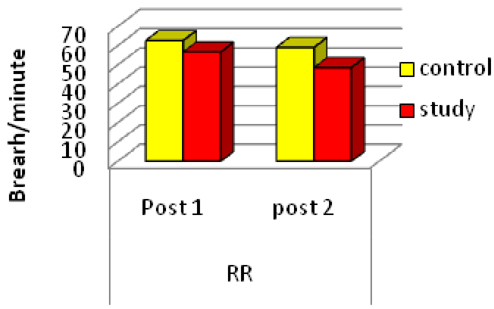

Figure 2. Post-treatment mean values of the repirtory rate of both groups

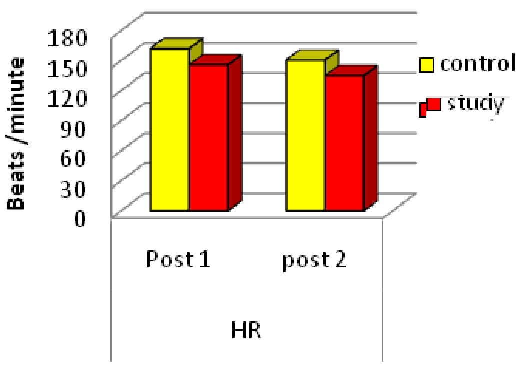

Figure 3. Post-treatment mean values of the heart rate of both groups

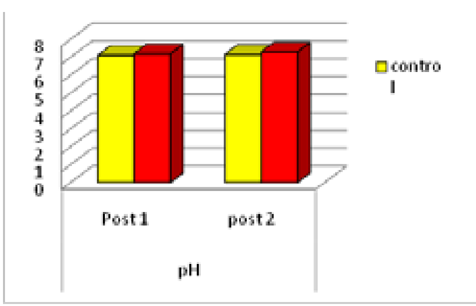

Figure 4.Post-treatment mean values of pH of both groups

4. Discussion

The present study evaluated the effects of the selected CPT on extremely preterm neonates who were mechanically ventilated with RDS. The measuring variables were vital signs, ABG_S and incidence of adverse outcomes including rib fracture and cranial abnormality (IVH and major cerebral abnormality). However, numerous studies evaluated the effects of CPT on preterm with RDS, but to our knowledge, this study is the first controlled randomized one.

comparing between the mean values of vital signs and ABG_S in the starting of the study and after 2 days for the control group showed statistical significant differences (P<0.05) which was in the form of decreasing in HR and increasing in pH and non significant differences regarding to RR, SAP, DAP, $Paco_2$ (P >0.05). While, there were significant differences between the results after 2 and 7 days from starting of the study in all measuring values (P<0.05). These differences were in the form of decreasing in (HR, RR, $PaCO_2$) and increasing in (SAP, DAP, PH, PaO_2)

The improvement recorded in the control group could be attributed to the combined effects of medical treatment and routine suctioning of the neonates. This could be explained by Cleary et al. **[27]** who stated that, an improved oxygenation during SIMV in neonates with RDS, allowed a reduction in ventilation pressure or oxygen exposure in this group of neonates, who were at risk of having complications of ventilation.

RDS, improved gas exchange, lowered ventilatory requirements and decrease the incidence of IVH by using the medications **[28]**. Multiple doses of surfactant results in a greater improvement in ventilation and reduce risk of acute lung injury **[29]**. Lowering of surface tension that allows the alveolus to remain inflated, and permits gas exchange due to administration of surfactant **[17]**. Endotracheal suctioning should be performed regularly in ventilated neonates to remove obstructive secretions **[30]**.

Improvement in all measuring variables was recorded in the study group after 2 and 7 days of treatment. This improvement could be attributed to the combined effects of the designed CPT and the same medical treatment given to the control group. There was decreasing in HR, RR, and PaCO2 and increasing in SBP, DBP, PaO2 and PH. Also, there were significant differences between control and study groups in favor of the study one when comparing the post treatment mean values of all measuring variables.

Our investigation provides evidences that CPT contributes to reduce the hemodynamic instability in newborns with RDS. This comes in agreement with Lacey **[31]** who attributed these results to improvement of oxygenation, improvement in air way resistance and inflating the collapsed or atelectatic lung in patients who received CPT. Abd El-Fattah et al. **[32]** confirmed that, CPThad significant decrease of PaCO2 of neonates after 48 hours. Hough et al. **[33]** reported that, CPT has been used in many neonates around the world to improve airway clearance and treat lung collapse.

Study conducted on ventilated preterm neonates compared LST with conventional percussion and vibration, suggested that LST is more effective in treating atelectasis and can be used to treat signs of uneven distribution of ventilation, bronchial clearance and prevent the development of atelectasis **[25]**.

Physiotherapy procedures provides stability of hemodynamic variables, such as HR, the functional maintenance of newborn cerebral circulation and maintenance of airways with turbulent flow and minimal secretion, which allow a increased permeability and reduced number of intrinsic airway that contribute to increased airway resistance and decrease in gas changes physiological events **[34]**.

Also our finding comes in agreement with the finding of Kole and Metgud **[35]** who concluded that CPT, LST technique and reflex rolling are safe and effective for improving oxygenation in preterm neonates with respiratory problems and can be used in clinical settings.

Our findings are not in agreement with Tudehope and Bagley **[36]** who stated that, several studies have reported transient hypoxemia and changes in physiologic parameters such as heart rate and blood pressure with CPT.

Regarding to the incidence of adverse outcome measures, no rib fractures were observed in both groups after the suggested

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period of treatment (7 days). Also, there were no cerebral injuries recorded in the study group after suggested period of treatment .

This is supported by the findings of Beeby et al. **[37]** who found no evidence that CPT was associated with abnormal neurological outcomes in extremely preterm neonates. Lacey **[31]** reported that, a study of preterm neonates with RDS at Royal prince Alfred Hospital found no association between application of CPT and cerebral ischemic lesions (IVH or PVL) as a complication for CPT treatment of ventilated neonates. Also, Knight et al. **[38]** concluded that, encephaloclastic porencephaly emerged as a problem at a time when the use of CPT had decreased which began to appear because of some other factor.

Our findings are not in agreement with earlier studies by Raval et al. **[39]** who showed that a single randomized trial found an increased incidence of severe IVH in preterm neonates with RDS receiving early active CPT life.

There was one neonate developed IVH-grade 2 and another one developed PVL in the control group after 2 days after beginning of treatment. While no increase in the number of neonates developed cerebral injuries or its severity recorded after 7 days. This could be due to hypotension which continued with these two cases till the third day. This may be explained by Annibale and Hill **[40]** who stated that, IVH is particularly common in infants, especially premature infants or those of very low birth weight. The cause of IVH in premature infants, unlike that in older infants, children or adults, is rarely due to trauma. Instead it is thought to result from changes in perfusion of the delicate cellular structures that are present in the growing brain, which is especially vulnerable to hypoxic ischemic encephalopathy. The lack of blood flow results in cell death and subsequent breakdown of the blood vessel walls, leading to bleeding. Lee et al**. [41]** added that, blood vessels in the germinal matrix next to the ventricles are very fragile and vulnerable to fluctuations in blood flow, which can cause the vessels to rupture and bleed.

5. Conclusion

This study was conducted to evaluate the effect of routine CPT on extremely preterm neonates when compared with a program of routine positioning and suctioning. The neonates had respiratory distress syndrome and were ventilated on non invasive mechanical ventilator. The obtained results showed significant improvement after 2 and 7 days of treatment in vital signs and arterial blood gases of the group received CPT. No adverse effects regarding to the cerebral injuries or rib fractures were recorded in this group while two neonates didn't receive CPT, developed cerebral injuries. Therefore, CPT is a safe and effective line of treatment for extremely preterm mechanically ventilated neonates with respiratory distress syndrome.

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