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Original Article

Impact of manual diaphragmatic release technique on diaphragmatic excursion post partial pancreaticoduodenectomy

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Abstract

Purpose: To detect the impact of manual diaphragmatic release technique on diaphragmatic excursion post partial pancreaticoduodenectomy.

Materials and Methods: A total of 60 participants who are from 35 to 55 years old, undergone partial pancreaticoduodenectomy. The individuals were randomized into two groups the experimental group(n=30), were administered a manual diaphragmatic release technique with traditional physiotherapy program while the control group(n=30), were administered traditional physiotherapy program. The treatment interventions were administered 3 sessions per week one hour per session for a duration of four weeks. The diaphragmatic excursion was assessed by ultrasonography which were taken both before and after a four-week period of interventions.

Results: following 4 weeks of treatment, both groups exhibited a statistically substantial difference in diaphragmatic excursion on the right and left sides compared with pretreatment. No statistically significant difference was seen between the two groups before the treatment ($p > 0.05$). A statistically significant difference was found between groups A and B after treatment in terms of axillary as well as clavicular diaphragmatic excursion on the right as well as left sides ($p < 0.01$).

Conclusion: Adding manual diaphragmatic release technique to complete traditional physiotherapy program may have a greater efficacy on improving diaphragmatic excursion for patients post pancreaticoduodenectomy.

Keywords: Manual diaphragmatic release technique; Diaphragmatic excursion; Ultrasonography; Partial Pancreaticoduodenectomy.

Introduction:

Whipple procedure, sometimes called a partial pancreaticoduodenectomy, is an invasive surgical treatment that involves removing the pancreatic head, duodenum, gallbladder, as well as bile duct **(1).**

Chronic pancreatitis can be effectively treated with Whipple surgery, which usually involves the management of pain and exocrine insufficiency. The main justification for having surgical intervention in the treatment of chronic pancreatitis was the presence of intractable abdominal pain **(2).** Patients of blunt abdominal injuries who have suffered damage to the duodenum as well as pancreas may be candidate for Whipple procedure. Accidents involving a lap belt have been the only known cause of this pattern of injuries in extremely rare instances. When a common bile duct is damaged, the pancreas leaks, the duodenum is transectioned, or there is bleeding surrounding the pancreas as well as duodenum as a consequence of abdominal trauma, a partial pancreaticoduodenectomy may be performed **(3).**

Many complications may happen to patients after whipple procedure which is usually open surgery that uses a large opening and more blood loss, more complications and a slow recovery time **(4).**

Post-operative pulmonary complications (PPCs) are the most common cause of postoperative morbidity along with mortality in whipple procedures such as pneumonia which may decrease diaphragmatic excursion and affect chest mobility. A reduction in diaphragm movement, a compromised central nervous system, alterations in the ventilation-perfusion ratio, diminished cough efficiency, increased respiratory rate, as well as diminished lung volumes as well as capacities are some of the major abnormalities that lead to PPCs **(5).**

Patient movement and respiratory mechanics are affected by anesthesia, surgical trauma, and postoperative circumstances (including incisions, drains, as well as catheters) **(6).**

An indirect method for lengthening tightened diaphragmatic muscle fibers and facilitating stronger, more effective contractions is the manual diaphragmatic release technique (MDRT). Both healthy people and patients recovering from partial pancreaticoduodenectomy have benefited from the MDRT's ability to increase thoracic mobility and lung function within the framework of osteopathic medicine as well as manual therapy practices **(7).**

This study was conducted to examine the impacts of MDRT upon diaphragmatic excursion among patients experiencing PPCs post pancreaticoduodenectomy.

Materials and Methods:

Study design

The study design was a parallel, pre- and post-test, single-blind randomized controlled experiment conducted between December 2022 to June 2023. Before the beginning of the study, ethical approval was given from Cairo university faculty physical therapy's ethical committee (No. P.T.REC/012/004389).

Sample size calculation

This statistical analysis was conducted utilizing G*POWER (version 3.1.9.2; Franz Faul, Universität Kiel, Germany) [F tests-MANOVA: Repeated measures, within-between interaction]; we determined the a priori sample size. The effect size was set at 0.74, and we conducted an 80% power analysis with a two-sided 5% significant level. Thus, 60 patients were included for the overall sample size, which was later revised upwards to 70 patients after a 15% increase to account for patients who dropped out between randomization and the conclusion of the treatment.

Randomization

Each patient was randomly assigned to one of two equivalent groups. The envelope mode was used to carry out the randomization processes. Patients who consented to take part in the trial were given one of two cards: one that included only conventional treatment and one that included MDRT. The physiotherapist was requested to choose one envelope at random after the envelopes were sealed. Patients were placed in the appropriate group based on the card they chose. During the 1st week of randomization, the treatment was started according to the determined dates.

Participants

In all, sixty patients participated in the study. Subjects were selected at randomly from the National Liver Institute Hospital at Egypt's Menoufia University.

Before they could be enrolled in the study, individuals were screened to determine if they were eligible. Participants were then asked to sign a document indicating their informed consent before they could be registered.

Male and female patients from 35 to 55 years old who had medically regulated postoperative pain following a partial pancreaticoduodenectomy were eligible to participate in this study. All patients included in the trial were required to provide informed consent, and a thorough medical history was taken, including details about symptoms before and after surgery.

Mechanical ventilation, pleural effusion, collapsed lungs, intolerance of incisional pain, cardiac disease, psychological difficulties, neurological disorders, and alcohol addiction were all reasons for participant exclusion from the trial.

Out of the initial recruitment of 70 patients screened for eligibility, 60 patients were randomized into one of the two intervention groups, Notably, there were no reported side effects associated with the intervention **(Figure 1).**

Outcome measures

Data was collected through individual interviews and physical assessment Measurement were done for all patients in experimental group (A) and control group(B). Diaphragmatic excursion by ultrasonography was estimated initially while starting the study before and after 4 weeks of treatment. The outcome measure was Diaphragmatic excursion.

Intervention

Group A (the experimental group) was given MDRT in addition to conventional treatment (breathing exercises, vibration, percussion) for 4 weeks, 3 times a week one hour per session. While Group B (the control group) was given conventional treatment only for 4 weeks, 3 times a week one hour per session. The diaphragmatic excursion was assessed by ultrasonography respectively after 4 weeks.

The therapist produced manual contact upon the base of the costal cartilages of the 7th to 10th ribs using the pisiform, hypothenar, as well as the last 3 fingers while the patient lay supine. As the patient inhaled deeply, the therapist carefully pulled in a cephalad manner to coordinate with the patient's rib elevation motion. As you breathe out, the therapist will bring their hands closer to your inner costal margin. As the patient took deeper breaths, the therapist worked to establish traction and gradually increase the depth of contact. The technique was executed in two sets of ten deep breaths, separated by one minute.

By releasing any air that may be held in the lungs and allowing more air to enter the lungs through inhalation, deep breathing can alleviate shortness of breath. The client might have a sense of relaxation and equilibrium as a result. When the patient stands or sits, he lets his chest expand by drawing his elbows back a little. patients were instructed to take a deep breath from his nose, hold his breath to five, he gently lets his breath pass through his nose.

The percussion was conducted with a powerful and constant beat. Make sure that every beat sounds hollow. Since the majority of the motion occurs at the wrist while the arm is relaxed, playing percussion seems to be easier. Properly cupped hands should not feel any pain or sting from percussion. To avoid injuring the kidneys in the lower part of the back, the spleen on the right, as well as the liver on the left, it is very important to avoid clapping over the vertebral column, sternum, stomach, lower ribs, or back.

A method called vibration helps the mucus to enter the larger airways by gently shaking it. The caregiver tightens the shoulder and arm muscles to produce a gentle shaking action while placing a firm touch on the chest wall across the area of the lung that is being drained. The caregiver then lightly presses on the part that is vibrating. Another option for the caregiver is to put one hand overlapping the other and compress the top and bottom hands together to make them vibrate. It is the flattened hand that vibrates, not the cupped hand. The goal is to exhale as slowly and completely as possible.

Statistical analysis

The age comparison among the groups was done using an independent t-test. To compare the gender distribution among the groups, a chi-squared test was used. We used the Shapiro-Wilk test to make sure the data was normally distributed. The homogeneity of variances among groups was tested using Levene's test. When comparing groups on axillary as well as clavicular diaphragmatic excursion, we used an independent t-test. When comparing groups on before and after treatment measures, we used independent t-test. All statistical tests were set to have a significance level of $p < 0.05$. Our entire statistical analysis was carried out using SPSS version 25 for Windows, which is developed and maintained by IBM SPSS in Chicago, IL, USA.

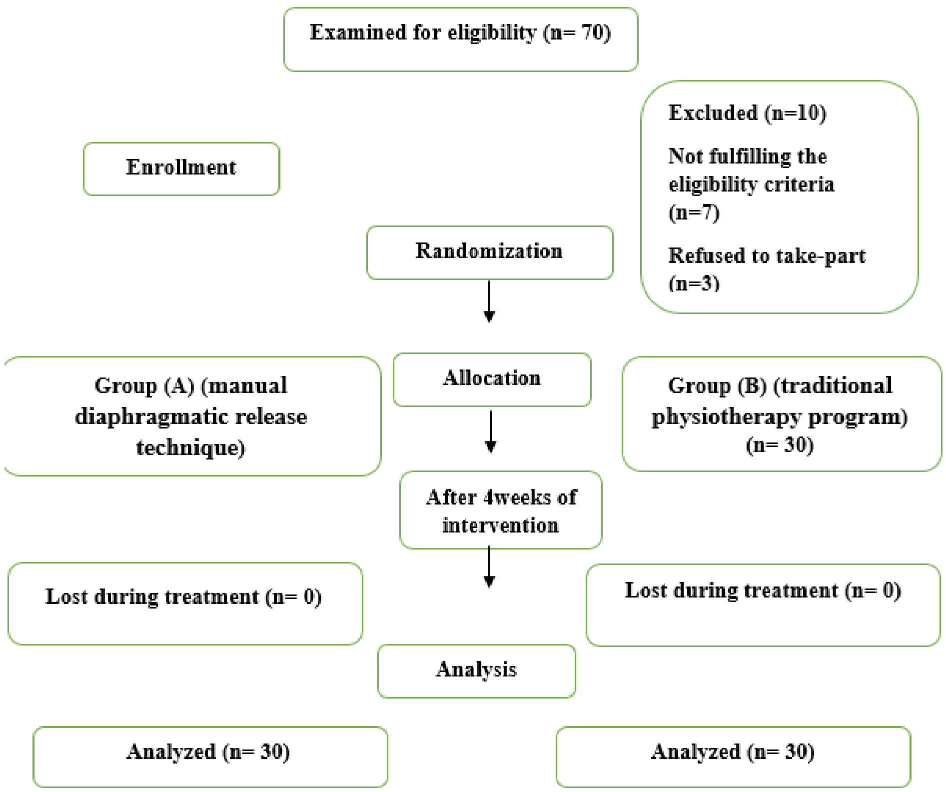

Figure 1. Flow diagram presenting the progression of patients at for every stage of the clinical trial

Results:

Participants characteristics

The participants characteristics in groups A and B are shown in **Table 1.** When comparing the groups according to age and sex, no statistically significant difference was found ($p > 0.05$).

Table 1. Comparison of participants characteristics among group A and B:

	Group A	Group B	p-value
	Mean ± SD	Mean ± SD	
Age (years)	44.13 ± 6.02	43.77 ± 6.19	0.82
Sex			
Females	9 (30%)	10 (33%)	0.78
Males	21 (70%)	20 (67%)	

Effect of treatment on midaxillary and midclavicular diaphragmatic excursion:

Within group comparison:

For both Group A and Group B, the difference between before and after treatment midaxillary as well as midclavicular diaphragmatic excursion was statistically significant ($p > 0.001$). Group A had a 20% change and a 17.10% change in right as well as left midaxillary diaphragmatic excursion, respectively, whereas group B had a 6.53% change and a 5.70 percentage change. In group A, the percentage change in right as well as left midclavicular diaphragmatic excursion was 20.88% and 21.01%, respectively. In group B, the corresponding percentage changes were 9.56% and 10.59%. **(Table 2,3) (Figure 2,3).**

Between groups comparison:

Prior to treatment, there was no statistically significant difference among the groups ($p > 0.05$). A statistically significant difference was found between groups A and B after treatment in terms of midaxillary as well as midclavicular diaphragmatic excursion on the right and left sides ($p < 0.01$) **(Table 2,3) (Figure 2,3).**

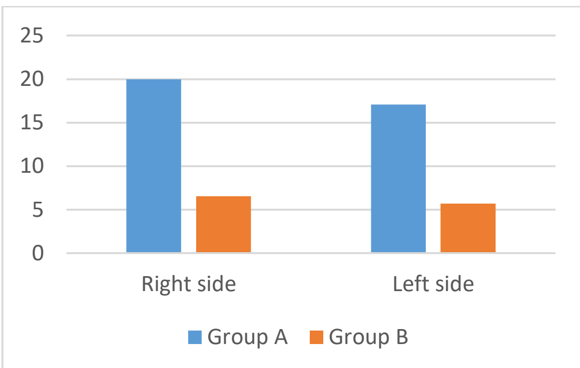

Figure 2. Diaphragmatic excursion at midaxillary level

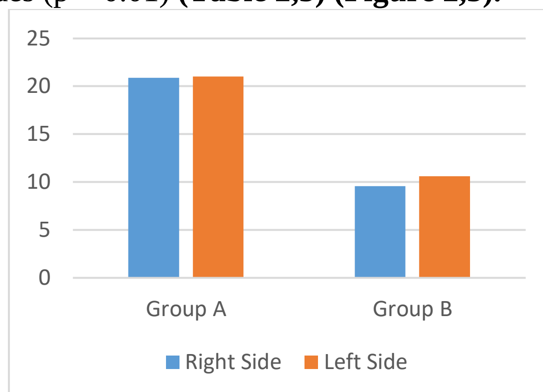

Figure 3. Mean midclavicular diaphragmatic excursion pre and post treatment of group A and B at clavicular level

Table 2. Mean midaxillary diaphragmatic excursion pre and post treatment of group A and B:

Diaphragmatic excursion at midaxillary level (cm)	Group A	Group B			
	Mean ± SD	Mean ± SD	MD	t- value	p value
Right side					
Pre treatment	2.55 ± 0.39	2.45 ± 0.38	0.1	1.49	0.34*
Post treatment	3.06 ± 0.38	2.61 ± 0.31	0.45	5.07	0.001†
MD	-0.51	-0.16			
% of change	20	6.53			
	-11.22	-4.38			
	p = 0.001†	**p = 0.001†**			
Left side					
Pre treatment	2.69 ± 0.45	2.63 ± 0.41	0.06	-1.28	0.58*
Post treatment	3.15 ± 0.41	2.78 ± 0.35	0.37	3.75	0.001†
MD	-0.46	-0.15			
% of change	17.10	5.70			
	-12.05	-4.78			
	p = 0.001†	**p = 0.001†**			

SD, standard deviation; MD, mean difference; p-value, probability value, (*) No significant differences, (†) significant difference.

Table 3. Mean midclavicular diaphragmatic excursion pre and post treatment of group A and B:

Diaphragmatic excursion at midclavicular level (cm)	Group A	Group B			
	Mean ± SD	Mean ± SD	MD	t- value	p value
Right side					
Pre treatment	2.49 ± 0.42	2.51 ± 0.41	-0.02	-0.18	0.85*
Post treatment	3.01 ± 0.41	2.75 ± 0.39	0.26	2.53	0.01†
MD	-0.52	-0.24			
% of change	20.88	9.56			
	-16.21	-6.33			
	p = 0.001†	**p = 0.001†**			
Left side					
Pre treatment	2.57 ± 0.39	2.55 ± 0.49	0.02	0.17	0.87*
Post treatment	3.11 ± 0.40	2.82 ± 0.37	0.29	2.93	0.005†
MD	-0.54	-0.27			
% of change	21.01	10.59			
	-11.63	-6.52			
	p = 0.001†	**p = 0.001†**			

SD, standard deviation; MD, mean difference; p-value, probability value, (*) No significant differences, (†) significant difference.

Discussion:

One of the key components in the development of postoperative pulmonary dysfunction is compromised diaphragmatic function following abdominal surgery. Following major abdominal surgery, patients often experience postoperative pulmonary complications (PPCs), which can lead to serious health problems and expensive healthcare costs **(8).**

SO, this study was designed to assess the impact of MDRT on diaphragmatic excursion post partial pancreaticoduodenectomy. The result of this trial showed that manual diaphragmatic release technique in combination with traditional methods for 4 weeks have significant positive effects on diaphragmatic excursion.

The therapeutic impacts of MDRT on improving diaphragmatic excursion are suggested it could be because of stretching the fibers of the diaphragm, which makes the chest wall more mobile **(9).**

Research has shown that the MDRT has beneficial effects on the respiratory muscles by increasing their flexibility in addition to the chest cavity's length-tension ratio. Proprioception and the flexibility of nearby fibers can both be enhanced with this method. It applies gentle pressure to a targeted location, which releases tension in the soft tissues by stimulating the nervous system via the Golgi tendon organs **(10).**

The findings of this study are in line with earlier research **(9,11,10);** for example, **Rocha et al. (9)** observed an increase in diaphragm mobility in stable chronic obstructive pulmonary disease patients after administering the Manual Diaphragm Release Technique**.** Improved forced vital capacity (FVC), forced expiratory volume (FEV1), and 6 MWT11 were observed after using the MDRT and Redoming of the Diaphragm techniques, according to research by Abdaleel Ashraf AM et al. Maximum expiratory pressure, all cirtometry coefficients, as well as thoracic cavity mobility were all improved by the "diaphragm lift" and double diaphragm, according to research by **Braga DKAP et al. (10).**

The findings of this study match with those of **OBAYA et al. (12)** demonstrating that myofascial release of the intercostal muscles as well as diaphragm can enhance vital capacity along with diaphragmatic excursion in patients experiencing post-operative pleural effusion. This, in turn, reduces the possibility of pulmonary complications and improves quality of life.

Also, when doing laparoscopic abdominal procedures, Namratha found that positive end expiratory pressure (PEEP) helped maintain diaphragmatic excursion. The results showed that diaphragmatic excursion and dynamic compliance were both enhanced by the pulmonary recruitment technique **(13).**

Elnaggar et al. (14) found that traditional respiratory retraining, the thoracic lymphatic pump approach, or MDRT, all administered over the course of 12 therapy sessions, effectively reduced asthma symptoms in children. Diaphragmatic release was the method of choice for improving forced vital capacity (FVC), forced expiratory volume (FEV1), diaphragmatic mobility, as well as P(A-a) oxygen saturation (O2) in the overall study.

Moreover, **ELIMY et al. (15)** has demonstrated that the addition of MDRT to the inspiratory muscle training (IMT) reduces hypertension individuals' post-COVID-19 syndrome symptoms over the long term, indicating that MDRT may be useful for treating patients experiencing post-acute COVID-19 complications.

Authors' contributions

KM analyzed and interpreted the patient data regarding the manual diaphragmatic release technique and the partial pancreaticoduodenectomy. MM performed the statistical analysis and was a major contributor to writing the manuscript. All authors read and approved the final manuscript.

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Conflicts of Interest: The authors declare that they have no competing interests.

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