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IMPACT OF MECHANICAL PERCUSSOR ON REOPENING COLLAPSED LUNG IN FEMALE DIAGNOSED WITH LABIAL TEAR IN CRITICAL CARE UNIT- A CASE REPORT

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ABSTRACT

Background: *Rapid advancements in physiotherapy within critical care have led to the implementation of mechanical devices that support airway clearance while minimizing therapist fatigue and patient discomfort. Mechanical percussors provide controlled, consistent chest wall oscillations and may be particularly beneficial for patients who cannot tolerate manual percussion. Evidence remains limited regarding their use in patients experiencing severe pain, such as those with labial tears.*

Case Presentation: *This case report describes a 75-year-old female with diabetes, hypertension, prior breast cancer surgery, and an acute labial tear who was admitted to the ICU with fever, swelling, and generalized weakness. During her stay, she developed secretion retention and progressive respiratory deterioration leading to left lung collapse. Laboratory findings revealed elevated and deranged lab values, metabolic acidosis, hypoxemia, and left lung collapsed on imaging. Manual chest physiotherapy, including huffing, coughing, counter-stretches, and deep breathing, was not much effective due to pain and poor tolerance.*

Intervention: *To avoid worsening pelvic and thoracic pain, a mechanical percussor was applied in the left lung postural drainage position at 20–30 Hz, three times daily. This intervention was selected based on evidence supporting its safety, controlled frequency, and improved comfort compared to manual techniques.*

Results: *Significant improvement was observed after four days of mechanical percussion. SPO_2 increased from 88% (on 4 L oxygen) to 96%, respiratory rate normalized from rapid shallow breathing to 18 breaths per minute, and breath sounds returned in the left lung. Arterial oxygenation improved markedly (PaO_2 from 56 to 106 mmHg). Chest X-ray demonstrated restored aeration, and dyspnea reduced from mMRC grade 4 to grade 1. The intervention was well tolerated and did not provoke pain or hemodynamic instability.*

Conclusion: *Mechanical percussion effectively reopened a collapsed lung in a critically ill patient with a labial tear who was unable to tolerate manual percussions. The device facilitated secretion mobilization, improved lung expansion, and reduced dyspnea, offering a safe and patient-friendly alternative to traditional chest physiotherapy. These findings support the integration of mechanical percussors in ICU physiotherapy practice and highlight the need for future large-scale studies and randomized controlled trials.*

Keywords: *Mechanical Percussor, Labial Tear, Collapsed Lung, Critical Care Unit*

INTRODUCTION

We are living in 21st century and the world is advancing so fast, gone were the days when medical treatment and interventions were just confined and bounded with time consuming methods, medications, and diagnostic findings (Browning et al., 2024). Now within just a single click and analysis, medical professional can easily understand and get access to the diagnosis, treatment, assessment plan of the patient (Kothinti et al.,2024). One such area where there has been tremendous advancement is the critical care unit (Halpern et al., 2023). Critical Care Unit is the specialized area designed for providing treatment to the patients who are highly dependent on oxygen and ventilator support followed by under observation monitoring (Bellani et al., 2021). In critical care unit not just doctors and nurses works but healthcare professionals such as consultants, nurses, doctors, respiratory therapist, physical therapist, speech therapist, occupational therapist, and many more all together collaborate and innovate to bring better outcomes for the patient care (Alanazi et al., 2024). Physical therapy is one such domain in which physical therapist works together from preventing muscle atrophy to promoting early weaning of patient from ventilator support (Wu et al.,2023). With advancement and innovation physical therapy has also been advancing, previously physical therapy was just related to limb and chest physical therapy but now it has evolved with advancement and various mechanical devices has replaced the role of manual physical therapy such as High frequency chest wall oscillator; that works mechanically with the support of Jacket in providing positive pressure and vibrates patient's lungs leading to airway clearance ; another innovative advancement is the intermittent pneumatic compression commonly known as Vena Flow; it works in pumping venous return and lead to prevention of deep venous thrombosis in critical care unit by inflation and deflation of sleeves (Bruner et al.,2024 ; Kim et al.,2024). Similarly machines like cycle ergometry has lessen and reduced physical workload and burnout of physical therapist by minimizing repetitive strains and musculoskeletal complications associated with prolong manual limb physical therapy especially in obese and prolong bed bounded patients needing passive range of motion; now with single click of the button of cycle ergometry patient can engaged in passive and active assisted range of motion leading to prevention of deconditioning and critical care neuropathy and polyneuropathy (O'Grady et al.,2024).

One of the innovative approach of respiratory chest physiotherapy is Mechanical percussor, that currently stands out as most innovative tool in managing respiratory complications and reduction of atelectasis in patients admitted in critical care unit (Hue et al.,2022). Gone are the days when physical therapists standing at patient bed side continuously performing manual percussion by hand through cupping method and uncertain whether equal and effective pressure was being implemented or not , a practice that frequently leads to physical fatigue and professional burnout (Nevin et al., 2025)This mechanical percussor is designed in such way that it has various frequency such as 20 to 50 hertz which can be implemented as per the need and demand of the patient. Like if the patient is in critical care unit, administering 20 to 30 hz pressure is sufficient enough to reduce chances of vitally instabilities (Pan et al.,2025). This machine is designed as non invasive modality, it is operated by generating rhythmic oscillations and vibrations that are transmitted to chest wall which in return loses the secretions and leads to reduction of atelectasis and lung collapse (Younes et al., 2022).

One study conducted by Ahmed et al., 2024 published in Egyptian journal analyzed that mechanical percussor was found to be effective in promoting drainage of secretions, improving lung compliance and promoting pulmonary toileting highlighting that adopting mechanical percussor most frequently than manual method can lead to great consistent results, reducing therapist efforts and patient comfort too. Various studies compared the manual percussions with

mechanical percussor and analyzed that mechanical percussor was more comfortable for patient and physical therapist and with maintained consistent mechanical energy led to mobilization to secretions, improved lung compliance and atelactsis especially for patients with pain, tear, obesity, and surgical wounds where manual percussions can be painful (Shahood et al., 2022).

Labial tear is one condition in which due to tear and laceration of labia, patient faces pain, difficulty in sitting and bleeding (Gommesen et al., 2024). Due to fear that pain may increase, patient avoids coughing, and clearance of secretions and if severe and admitted in critical care unit, prolong supine and sustained position without out of bed mobilization leads to reduced chest expansion and excessive secretions causing mucous plugging and ventilation perfusion mismatch which in return leads to lung collapse and once lung is collapsed, here comes the role of physical therapist to innovate and rehabilitate the patient (Pearson et al., 2022). Patient here already has pain, heightened fear of movement, implementing manual percussions can be challenging as this intervention can be painful too making it difficulty to promote effective airway clearance (Baker et al., 2025). So this case report aims to evaluate the impact of mechanical percussor in reopening collapsed lung in patient with labial tear.

Case Presentation

75 year old female, known case of Diabetes and Hypertension, with history of cancer of breast 8 years back, underwent surgery that is radical mastectomy 8 years ago married with 1 kid, up and about admitted with fever, valvular swelling, and generalized weakness. According to the attendant the patient was up and about at home then suddenly developed valvular swelling 5 days back that increased with time in size and pain.

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Laboratory Workup

Table 1: Lab workup and Findings

Parameter	18/10/25	17/10/25	16/10/25	15/10/25	14/10/25
Hb/PCV (Hemoglobin / Packed Cell Volume)	19 / 49	19.4	18.2	13.3	15.4 / 46
TLC (Total Leukocyte Count $\times 10^9$/L)	59.85	62	5.7	81.4	31.02
Platelets ($\times 10^9$/L)	192	192	800	264	196
PT/INR (Prothrombin Time / International Normalized Ratio)	19.7 / -	-	-	-	-
APTT (sec) (Activated Partial Thromboplastin Time)	-	80.1	74.1 / 88.8	66.0	-
Urea / Creatinine	-	-	142 / 3.1	-	58 / 0.6
Na^+ / K^+ (Sodium / Potassium mmol/L)	129 / 4.1	129 / 4.2	105 / 4.6	110 / 4.6	114 / 4.4
Cl^- / Na^+ (Chloride / Sodium)	89 / 123	89 / 123	105 / 111	110 / 114	106 / 114
HCO_3^- (Bicarbonate mmol/L)	3.8	2.9	3.3	3.4	-
Ca / Corr. Ca (Calcium / Corrected Calcium mg/dL)	9.7 / 9.8	-	-	-	-
Mg (mg/dL) (Magnesium mg/dL)	-	-	-	1.69	-
Phosphate (mg/dL)	-	-	1.62	-	-
Bilirubin (mg/dL)	0.92	-	-	-	-
SGPT (Serum Glutamic Pyruvic Transaminase U/L)	20	-	-	-	-

SGOT (U/L) (Serum Glutamic Oxaloacetic Transaminase U/L)	23	-	-	-	-
ALP (Alkaline Phosphatase U/L)	159	-	-	-	-
Troponin I	-	-	-	-	0.13
CRP (C-Reactive Protein mg/L)	31.8	5.31	-	-	-
LDH (Lactate Dehydrogenase U/L)	511	-	-	-	-
Blood C/S	-	-	sent	-ve	-
Tracheal C/S	-	-	sent	-ve	-
Urine C/S	-	-	NG	-	-
PRO BNP (Pro-Brain Natriuretic Peptide)	-	sent	-	-	-
MRSA (Methicillin-Resistant Staphylococcus aureus)	-	-	-	-	Positive
Urine D/R	Nitrite -ve, Glucose +, Ketones +, Pus cells 1–2, Proteins 1.5	-	-	-	-

The lab results showed that patient was fighting initially with strong infection and stress when arrived in the ICU. Initially WBC, CRP and LDH were high indicating inflammation. Had low sodium and bicarbonate showing body was in metabolic acidosis leading to poor breath and contributing to lung collapsed. Kidney parameters were deranged initially followed by abnormal slightly blood clotting test. Over time, with critical care management and physical therapy lab started to improved showed in table.

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Echocardiography Findings

Table 2: Echocardiography Findings

Consideration	Findings
Left Ventricular Size	Normal
Left systolic function	Normal, ejection fraction; 55%
Reversal of mitral inflow	Diastolic dysfunction grade 1
Right ventricular systolic function	Normal, TAPSE 20mm
Mitral Regurgitation	Mild
Tricupsid regurgitation	Moderate
Pulmonary Artery Systolic Pressure	40 mm HG
Septal Hypertrophy	Yes

Here findings suggest that diastolic dysfunction is of grade 1 combined with tricuspid regurgitation and mitral regurgitation, showing heart relaxes slowly and causing breathlessness although ejection fraction is normal. This can be the reason that labral tear patient developed shortness of breath leading to collapsed lung.

Imaging Findings

REQ # :
REC # :

Chest:
B/L mild pleural effusion c̄ subsegmental atelectasis.

Abd:
Liver] (N)
GB]
CBD – only visualized at porta hepatis d/t gases.
PV – (N)
Pancreas – P/V d/t gases.
Spleen – (N)
R.K 10.2cm / 1.2cm] Both kidneys are echogenic.
L.K 10.1cm / 1.2cm] W/R urea/creat correlation.

Reported by

Note: Final report will be issued after review of consultant.
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Figure 1: Ultrasound CT Chest and Abdomen Report

The ultrasound shows **bilateral mild pleural effusion**, which can compress the lower lung segments and contribute to **subsegmental atelectasis**, explaining reduced air entry, shallow breathing, or mild hypoxia if present. These small pockets of collapsed lung tissue often occur when fluid limits lung expansion, especially in elderly or bedridden patients. Additionally, echogenic kidneys suggesting chronic kidney disease may lead to fluid overload, further worsening pleural effusion and increasing the risk of atelectasis. Together, these findings correlate well with early lung collapse due to small effusions.

RADIOMETER ABL800 FLEX

ABL835 PATIENT REPORT — Syringe - S 195uL — 08:16 PM Sample # 43122 — 10/17/2025

Identifications

Patient ID	HOU5
Patient Last Name	5
Patient First Name	5
Sample type	Not specified
T	37.0 °C

Parameter	Value	Unit	Range
Blood Gas Values			
pH	7.400		[-]
pCO_2	37.1	mmHg	[-]
pO_2	56.5	mmHg	[-]
Oximetry Values			
ctHb	15.5	g/dL	[-]
sO_2	91.3	%	[-]
FO_2Hb	89.7	%	[-]
FCOHb	0.5	%	[-]
FHHb	8.6	%	[-]
FMetHb	1.2	%	[-]
Electrolyte Values			
cK^+	3.5	mmol/L	[-]
cNa^+	135	mmol/L	[-]
cCa^{2+}	1.05	mmol/L	[-]
cCl^-	114	mmol/L	[-]
Metabolite Values			
cGlu	6.8	mmol/L	[-]
cLac	2.8	mmol/L	[-]
ctBil	20	µmol/L	[-]
Temperature Corrected Values			
pH(T)	7.400		
$pCO_2(T)$	37.1	mmHg	
$pO_2(T)$	56.5	mmHg	
Oxygen Status			
ctO_2c	19.5	Vol%	
$p50c$	29.07	mmHg	
Acid Base Status			
cBase(Ecf)c	-1.6	mmol/L	
$cHCO_3^-(P,st)c$	23.1	mmol/L	

Notes
c Calculated value(s)

Figure 2: Arterial Blood Gases

On the day when patient developed lung collapsed, the ABG shows **hypoxemia (low pO_2 and low sO_2)** while CO_2 remains normal. This is **typical of atelectasis,** where collapse of lung segments reduces oxygen exchange but does not impair CO_2 removal initially. The normal pH and normal CO_2 indicate the patient was **not in respiratory failure**, but had **oxygenation impairment** due to the collapsed lung areas and pleural effusion.

Intervention

After staying for 10 days in intensive care unit, patient start developing retention of secretions , at first nebulizing agents were provided, followed by active chest physical therapy including huffing and coughing techniques, counter stretches and deep breathing exercises which were painful, leading to improvement in oxygenation, still chest was not fully expanded and audible crackles were present. The findings of Xray showed left lung collapsed.

Here physical therapist decision based on evidence based practice was important as when lung gets collapsed the most important treatment is postural drainage and percussions, but giving percussions to the patient already having pain and history of breast cancer can itself be a risk. So to avoid pain and lead to better outcomes, physical therapist implemented Mechanical Percussion, set on 20 to

30 hz thrice daily in left lung postural drainage position.

Pre Intervention

Initially, the patient presented with 88% spo2 on 4 litre facemask, and rapid shallow breathing pattern, along with absent lung sounds at left lung, arterial blood gases analyzed severe hypoxemia and patient reported severe dyspnea of grade 4 on the Modified Medical Research Council (mMRC) Dyspnea. All these findings collectively indicated severe ventilation perfusion mismatch, reduced gaseous exchange, and pulmonary function requiring respiratory physical therapy considering pain parameter too.

Table 2 : Pre Intervention findings

Parameter	Pre-Assessment
Spo2	88%
Respiratory Rate	28, rapid shallow
Breath sound	Absent
Chest x-ray	Left lung collapsed
ABGS-PA02	56
MmRc	4

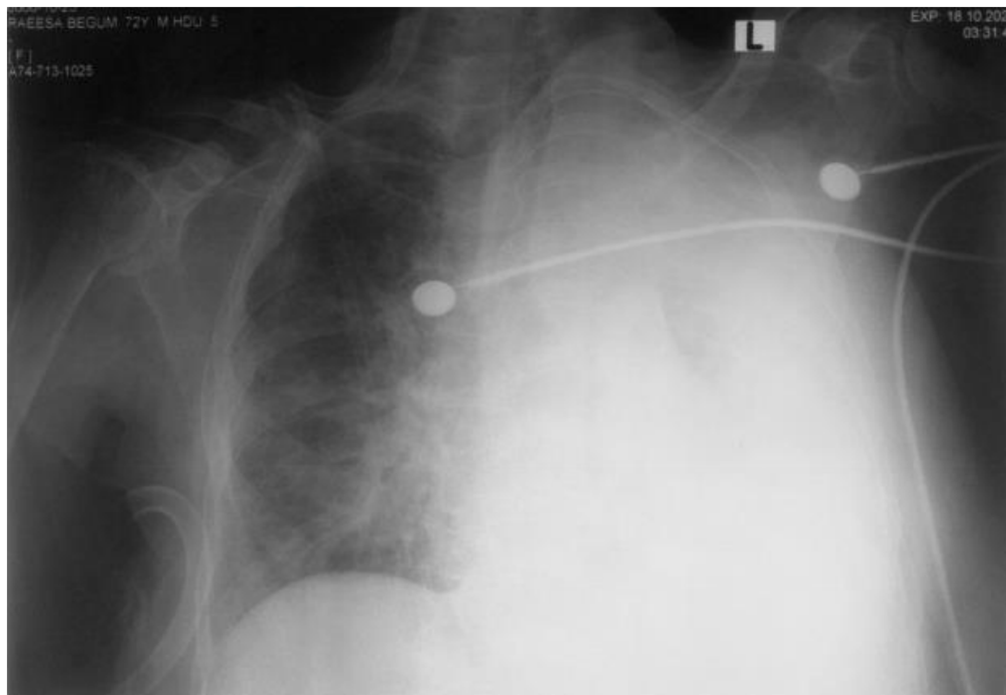

Figure 3: Pre Intervention Chest Xray

Post Intervention

After four days of mechanical percussor, when assessed patient showed significant improvement in terms of oxygen, respiratory rate, chest expansion and hypoxemia along with functionally patient reported minimal breathlessness corresponding to grade 1 on mMrc dyspnea scale. These findings analyzed that using mechanical percussor combined with postural drainage can be effective method not only in lung expansion, secretion clearance and pulmonary toileting but

also reduces the pain associated with manual percussions making it comfortable and feasible to perform by physical therapist.

Figure 4: Application of Mechanical Percussor in Left Lung Postural Drainage Position

Table 3: Post Intervention findings (Day 4 of Mechanical Percussor)

Parameter	Pre-Assessment
Spo2	96%
Respiratory Rate	18, regular not shallow
Breath sound	Present
Chest x-ray	Improved lung aeration
ABGS-PA02	106
MmRc	1

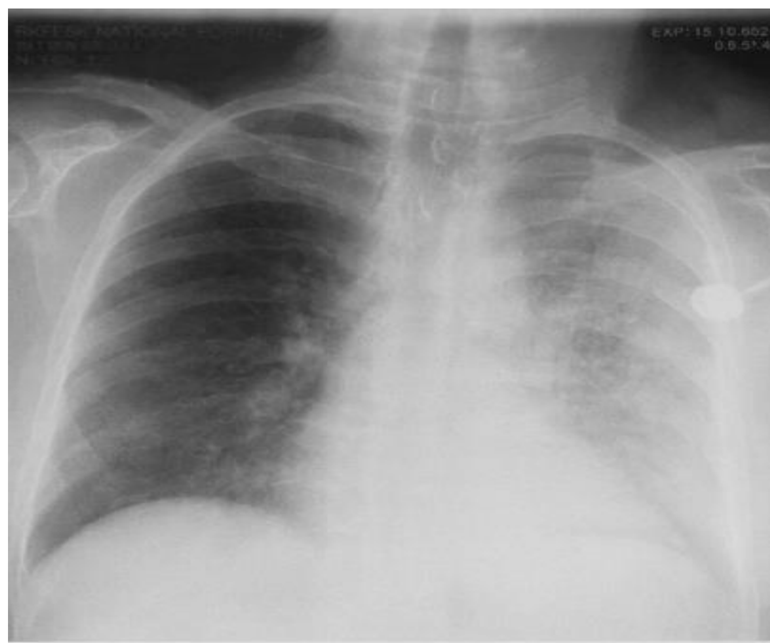

Figure 5: Post Intervention Chest Xray

Discussion

This study aims to overcome the gap between conventional and advanced chest physiotherapy. In our study we preferred mechanical percussor over manual percussion because it turned out to be effective, less painful, didn't increase pelvic abdominal pressure, was vitally stable , with controlled frequency, amplitude and safer to use on post-surgery patients.

Previous literature highlights a study conducted by Cheatham et al., 2021 which analyzed that the device named Hyperice mechanical percussor turned out to be effective in prevention of injury (25%) and post treatment efficiency was found to be (42.8%) in sports athletes and the reason for its usage was myofascial treatment. On contrary the study conducted by Ali et al., 2025 highlighted the importance of mechanical percussor in children, the target population was children diagnosed with pneumonia and the results showed that the mechanical percussor turned out to be effective in improving hemodynamics including heart rate, respiratory rate and reduction of pain. Similarly another study compared mechanical percussor with manual percussion in cystic fibrosis patients and the results showed that the manual percussion was preferred over the mechanical percussor in such patients. Another study conducted by Lin YP et al., 2017 related to high frequency chest wall oscillation and traditional chest physical therapy in icu patients showed that the patients treated with high frequency chest wall oscillation reported significantly higher level of comfort during chest physiotherapy. In addition, the study by Clinkscale Darnetta et al., 2012, compared mechanical percussor with other chest physical therapy in intubated and non intubated adults showed similar result. However,the mechanical percussor was associated with better comfort score and was associated with more rapid resolution of lobar atelectasis.

This case report highlights the efficacy of mechanical percussor in labial tear patient and it was highlighted that previously the patient's left lung was fully collapsed, with shrinked alveoli and decreased air entry. Patient was unable to expectorate the sputum and despite continuous efforts of providing manual percussions, the end results were not effective. So mechanical precursor was implemented for period of seven days. The results showed that after seven days of treatment the patient was able to expectorate sputum, air entry was improved and lung expansion was achieved.It can be concluded that mechanical percussor turned out to be effective in improving the collapsed lung with labial tear.

Other than this, physical therapist working in ICUs are occupied with many patients requiring physical efforts and work therefore adding such interventions which that can work mechanically yet innovatively can be a great help for physical therapists as it can help in achieving efficient results, reducing burnout, and reeducation of cumulative trauma disorders such as carpal tunnel syndrome, tendonitis, and de qeurvain syndrome. So adding importance of mechanical percussor and other mechanical devices vest therapy, acapella, exsufflator, insufflator and many others in the health policies and guidelines of health care practitioners can lead to not just better outcome but also be effective of wellbeing of physiotherapists. Future studies such as cross sectional studies need to be done on mechanical percussor to understand the knowledge, barriers and attitude of physical therapist towards it.

Conclusion

This case report provided evidence that a mechanical percussor is a safe, effective and well tolerated intervention by the patients and was helpful in reopening a collapsed lung of a critically ill patient with labial tear where manual percussions were not tolerated. The intervention successfully mobilized secretions, restored lung aeration and reduced dyspnea without increasing pain and compromising hemodynamic stability. More researches are recommended especially randomized controlled trials and reviews to further explore the long term benefits of mechanical percussor in various settings.

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