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Original Article

Comparison Effects of Postural Drainage and Positive Expiratory Pressure Technique in Community Acquired Pneumonia

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ABSTRACT

Background: Community-acquired pneumonia (CAP) is a major health concern worldwide, leading to substantial hospitalization and morbidity. Physiotherapy interventions like postural drainage and positive expiratory pressure (PEP) are commonly used in managing CAP, but their relative effectiveness in improving respiratory parameters is not fully understood.

Objective: The study aimed to compare the effects of postural drainage and PEP techniques on respiratory parameters, specifically pH values and alveolar-arterial oxygen tension, in patients with CAP.

Methods: In this randomized clinical trial, 46 patients with mild to moderate CAP were divided into two groups: postural drainage (n=23) and PEP technique (n=23). Data collection occurred pre- and post-intervention in each session, with analysis conducted using SPSS version 23. The Shapiro-Wilk test determined data normality, leading to the use of the Mann-Whitney U test for non-parametric data.

Results: Improvements in oxygen saturation were observed in both groups. However, other arterial blood gas parameters, including pH and alveolar-arterial oxygen tension, showed no significant changes post-intervention. Specifically, pH values for the postural drainage group had mean ranks of 21.13, 22.04, 24.74, and 20.70 across sessions, while the PEP technique group showed mean ranks of 25.87, 24.96, 22.26, and 26.30, with p-values ranging from 0.152 to 0.525. Similarly, alveolar-arterial oxygen tension comparisons yielded p-values between 0.056 and 0.231.

Conclusion: Both postural drainage and PEP techniques effectively improved oxygen saturation in CAP patients, but they did not significantly impact other respiratory parameters. This suggests their utility in specific areas of respiratory management in CAP, with limitations in broader pulmonary function improvement.

Keywords: Community-acquired pneumonia, Postural drainage, Positive expiratory pressure, Respiratory parameters, Randomized clinical trial.

INTRODUCTION

Community-acquired pneumonia (CAP) represents a significant public health concern, being a primary contributor to global mortality and morbidity (1). Defined as an acute infection of the lung parenchyma, CAP's etiology includes various viruses, bacteria, and fungi (2). Distinct from Hospital-acquired (HAP), Healthcare-associated (HCAP), and Ventilator-associated pneumonia (VAP), CAP is characterized by its acquisition outside hospital settings (3). HAP manifests as a lung parenchyma infection occurring 48 hours post-hospital admission (4), VAP is associated with mechanical ventilation (5), and HCAP is contracted in lower-standard healthcare facilities like dialysis units (6).

The pathogenesis of pneumonia involves invasion of the lower respiratory tract by pathogens such as gram-negative bacilli, Streptococcus pneumoniae, and Haemophilus influenzae, primarily through aspiration of secretions (7). While micro-aspirations of these pathogens occur routinely in healthy individuals, leading to a low risk of pneumonia progression (8), the likelihood of developing pneumonia is contingent upon factors such as the bacterial inoculum's pathogenicity, volume and frequency of aspirate, and the host's immune response (9). Comorbidities like alcoholism, diabetes, and malnutrition can exacerbate the risk by enhancing

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oropharyngeal colonization with virulent organisms, impairing host immune responses through deficiencies in immunoglobulin, salivary fibronectin, and complement, all crucial in preventing bacterial surface binding (10, 11).

CAP's substantial role in morbidity and mortality is underscored by McLaughlin et al. (12), highlighting a significantly higher hospitalization rate for pneumonia in individuals over 65 compared to younger populations. In 2017, influenza and pneumonia combined accounted for 46,200 deaths, with an estimated hospitalization cost for CAP at approximately 55,000 USD, contributing to an annual financial burden of around 110 billion USD (13). The risk factors for pneumonia, including age and comorbidities like respiratory diseases (e.g., COPD, bronchiectasis), cardiovascular, and renal diseases, escalate the likelihood of CAP (1, 14). Additionally, conditions like epilepsy, stroke, and dementia, associated with aspiration issues, also elevate the risk (15). Lifestyle factors such as tobacco and alcohol use, recent use of corticosteroids, antibiotics, and existing structural lung diseases increase the susceptibility to gram-negative bacterial pneumonia (16, 17).

Given the prevalence of CAP and its associated healthcare burdens, this randomized control trial aims to evaluate the efficacy of postural drainage versus positive expiratory pressure techniques in managing CAP. This investigation seeks to contribute substantially to the existing body of knowledge regarding physical therapy interventions for CAP, offering insights into optimal management strategies.

The rationale for this study stems from the need to optimize physical therapy interventions in the management of Community-Acquired Pneumonia (CAP), a condition with significant global health implications. Given the diverse pathophysiological mechanisms and varying responses to treatment in CAP patients, especially considering factors like age and comorbidity profiles, it is imperative to investigate and compare the effectiveness of different therapeutic strategies. Postural drainage and positive expiratory pressure techniques represent two prevalent methods in respiratory physiotherapy, yet there is a lack of consensus on their comparative efficacy in enhancing mucociliary clearance, improving oxygenation, and reducing hospital stay in CAP patients. Therefore, this study aims to provide empirical evidence on the effectiveness of these techniques, potentially guiding clinicians in selecting the most appropriate intervention for CAP management, thereby improving patient outcomes and potentially reducing healthcare costs associated with prolonged hospitalization and treatment.

MATERIAL AND METHODS

In this Randomized Clinical Trial (RCT), registered under the clinical trial number NCT05356494, data collection was undertaken at Services Hospital, Lahore from April to June, with the study concluding within six months post-synopsis approval. The sample comprised 46 patients, equally divided into two groups, determined using the AROSOFT online sample size calculator to detect significant differences between two means (18). The non-probability convenient sampling technique facilitated data collection, with participants randomly assigned to groups using the coin method.

Inclusion criteria encompassed patients diagnosed with community-acquired pneumonia by physicians, hospitalized for less than 48 hours, exhibiting mild to moderate cases (19, 20), and aged between 40 to 70 years (21), irrespective of gender. Exclusion criteria included individuals with genetic disorders such as cystic fibrosis, a recent history of surgery, or any cardiac issues.

The primary outcome measures were arterial blood gases (ABGs), assessing oxygen saturation, pH, pCO2, pO2, HCO3, and the arterial oxygen to fraction of inspired oxygen ratio (PaO2 / FiO2) (22). ABGs are instrumental in measuring these parameters, with hypoxemia indicated by lower values and higher values signifying adequate oxygenation. Additionally, the alveolar-arterial oxygen tension difference (A-a) PO2 was calculated using the formula PAO2 – PaO2 (23).

Before the specific treatments, all participants underwent baseline treatment involving diaphragmatic breathing and inspiratory exercises, consisting of maximum inspiration and an inspiratory pause. This baseline treatment entailed three sets of each exercise, each with ten repetitions and a one-minute rest between sets (23).

Group A, the postural drainage group, received postural drainage subsequent to the baseline treatment. This process lasted for 10 minutes, with patient positioning tailored according to the specific lung segment and lobe requiring drainage, as confirmed by X-ray and auscultation (24).

Group B underwent the positive expiratory pressure technique using the Acapella PEP device, following the baseline treatment. The protocol involved the patients performing the technique for three cycles per session, ensuring proper posture to facilitate air movement. Each cycle included taking a deep breath, holding it for 2 to 3 seconds, using the mouthpiece to exhale steadily for 4 to 6 seconds, and concluding with huffing and coughing to expel mucus (25). Pre- and post-treatment evaluations of oxygen saturation, arterial oxygen to fraction of inspired oxygen ratio, and alveolar-arterial oxygen tension difference were conducted after every session via ABG analysis.

For the data analysis procedure in this study, data collected pre- and post-intervention across all sessions were analyzed using SPSS version 23. The normality of the data was initially assessed using the Shapiro-Wilk test to determine the appropriateness of

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parametric or non-parametric statistical tests. Given the non-normal distribution of the data, the Mann-Whitney U test, a non-parametric test, was employed to evaluate the significance of differences between the postural drainage and positive expiratory pressure (PEP) technique groups. This analytical approach ensured a robust and appropriate statistical evaluation of the treatment outcomes in this randomized clinical trial.

RESULTS

The bar graph provides a detailed comparison between the Postural Drainage Group and the PEP Technique Group across various demographic factors. In the gender category, the Postural Drainage Group consists of 12 males and 11 females, while the PEP Technique Group includes 10 males and 13 females. For age, the Postural Drainage Group has an average age of 52.21 years with a standard deviation of 13.6, whereas the PEP Technique Group averages at 56.60 years with a standard deviation of 15.9. Regarding Body Mass Index (BMI), the Postural Drainage Group shows an average BMI of 28.21 with a standard deviation of 3.6, in contrast to the PEP Technique Group's average BMI of 26.60 and a standard deviation of 5.9. These values, represented by blue bars for the Postural Drainage Group and green bars for the PEP Technique Group, clearly illustrate the differences and similarities between the two groups across gender, age, and BMI categories.

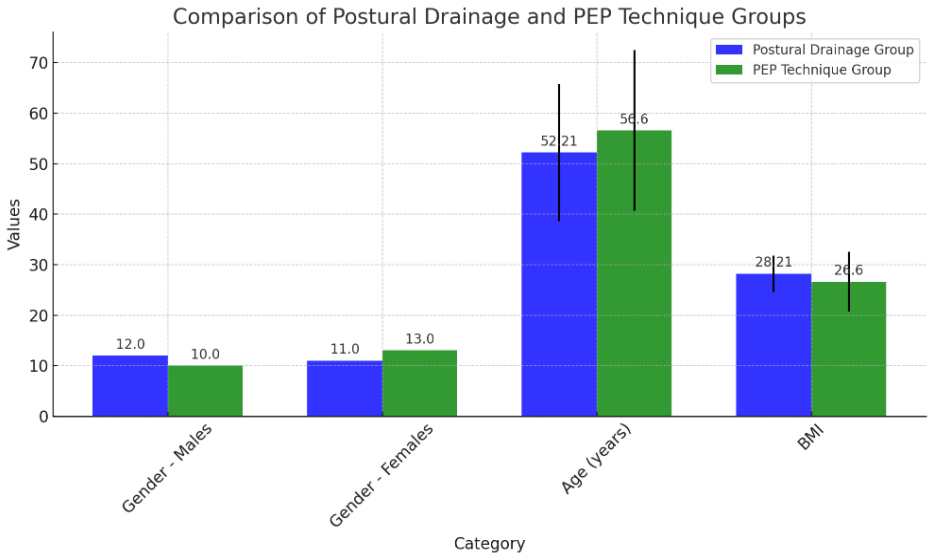

Figure 1 Comparative Demographics

Table 1 presents the comparison of pH values between the postural drainage and PEP technique groups across four different sessions (PHa, PHb, PHc, PHd). For the postural drainage group, the mean ranks in these sessions were 21.13, 22.04, 24.74, and 20.70 respectively, with corresponding sum of ranks being 486.00, 507.00, 569.00, and 476.00. In contrast, the PEP technique group demonstrated mean ranks of 25.87, 24.96, 22.26, and 26.30, with sum of ranks at 595.00, 574.00, 512.00, and 605.00 for the same sessions. The p-values for these comparisons were 0.226, 0.455, 0.525, and 0.152 respectively, indicating no significant differences between the groups in terms of pH values, as none of the p-values were below the 0.05 threshold for statistical significance.

Table 1: Comparison of pH Values Between Postural Drainage and PEP Technique Groups

Group	N	Mean Rank	Sum of Ranks	p-value
PHa- Postural Drainage	23	21.13	486.00	0.226
PHa- PEP Technique	23	25.87	595.00	
PHb- Postural Drainage	23	22.04	507.00	0.455
PHb- PEP Technique	23	24.96	574.00	
PHc- Postural Drainage	23	24.74	569.00	0.525
PHc- PEP Technique	23	22.26	512.00	
PHd- Postural Drainage	23	20.70	476.00	0.152
PHd- PEP Technique	23	26.30	605.00	
p < 0.05 indicates a significant difference.				

In Table 2, the comparison of Alveolar-Arterial Oxygen Tension (PAO2pao2) between the postural drainage and PEP technique groups is illustrated over four sessions (PAO2pao2a, PAO2pao2b, PAO2pao2c, PAO2pao2d). The postural drainage group had mean ranks of 20.96, 21.04, 19.72, and 21.13 with sum of ranks at 482.00, 484.00, 453.50, and 486.00 across these sessions. The PEP technique

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group displayed mean ranks of 26.04, 25.96, 27.28, and 25.87, and their sum of ranks were 599.00, 597.00, 627.50, and 595.00 respectively.

Table 2: Comparison of Alveolar-Arterial Oxygen Tension Between Postural Drainage and PEP Technique Groups

Group	N	Mean Rank	Sum of Ranks	p-value
PAO2pao2a- Postural Drainage	23	20.96	482.00	0.199
PAO2pao2a- PEP Technique	23	26.04	599.00	
PAO2pao2b- Postural Drainage	23	21.04	484.00	0.214
PAO2pao2b- PEP Technique	23	25.96	597.00	
PAO2pao2c- Postural Drainage	23	19.72	453.50	0.056
PAO2pao2c- PEP Technique	23	27.28	627.50	
PAO2pao2d- Postural Drainage	23	21.13	486.00	0.231
PAO2pao2d- PEP Technique	23	25.87	595.00	
$p < 0.05$ indicates a significant difference.				

The p-values were calculated as 0.199, 0.214, 0.056, and 0.231. These values suggest that there were no statistically significant differences in Alveolar-Arterial Oxygen Tension between the two groups, as all p-values exceeded the 0.05 significance level.

DISCUSSION

Community-acquired pneumonia (CAP) is a prevalent diagnosis, contributing significantly to mortality and hospitalization rates, and often leading to various pulmonary complications. Physiotherapy plays a pivotal role in mitigating these complications, employing techniques like postural drainage and positive expiratory pressure (PEP) devices to clear airways and enhance oxygenation. This study aimed to compare the effectiveness of these two techniques in improving respiratory parameters in CAP patients.

A study by Masood Alam et al. (2020) explored similar territory, comparing the effects of incentive spirometry and acapella on arterial blood gases post-coronary artery bypass graft surgery (26). Their findings revealed slight improvements in PaO2 and Pco2, suggesting both techniques were equally effective in that patient group (27). While the results align with the current study in terms of oxygen saturation improvement, it's noteworthy that other arterial blood gas (ABG) parameters in CAP patients did not exhibit significant enhancement following either technique. This contrast underscores that in CAP, these techniques may primarily augment oxygen saturation, but not necessarily other ABG parameters.

Diana Pozuelo-Carrascosa et al. (2018) conducted a systematic review, examining the impact of physiotherapy techniques, including postural drainage and manual hyperinflation, on intubated patients with ventilator-associated pneumonia (28). The review, encompassing five trials, concluded that a multimodal physiotherapy approach could reduce mortality rates and prevent further pulmonary complications by improving respiratory parameters and oxygen saturation. This finding is partly consistent with the present study, suggesting an improvement in oxygen saturation and bicarbonate levels, yet indicating no significant superiority of one technique over the other.

Contrastingly, Jiali Sun et al. (2021) investigated the efficacy of PEP devices in pediatric pneumonia patients, comparing acapella with postural drainage (29). Their randomized control trial reported more pronounced improvements in the acapella group in terms of airway clearance and sputum reduction, a divergence from the current study's findings. This discrepancy highlights differences in the experimental design and perhaps the distinct responses in pediatric versus adult populations with pneumonia.

CONCLUSION

The current study concludes that both postural drainage and PEP techniques are effective in enhancing oxygen saturation in CAP patients, demonstrating statistically significant differences in this particular parameter. However, it's important to note that other respiratory parameters did not show a similar level of improvement. This underscores the need for a nuanced understanding of physiotherapy's role in CAP management, emphasizing the efficacy of these techniques in specific aspects of respiratory function but acknowledging their limitations in broader pulmonary rehabilitation.

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