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Effectiveness Of Supine Vs. Prone Position Cardiopulmonary Resuscitation (Cpr): A Mannequin-Based Evaluation

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Abstract

Background: *Prone positioning has become increasingly common in intensive care settings, particularly for patients with acute respiratory distress syndrome (ARDS) and during the COVID-19 pandemic. However, performing cardiopulmonary resuscitation (CPR) in the prone position remains a challenge due to concerns regarding compression effectiveness. This study evaluates the effectiveness and feasibility of prone CPR compared to supine CPR using a mannequin-based assessment.*

Methods: *A cross-sectional study was conducted at the Skills Lab, Sri Ramachandra Institute of Higher Education and Research (SRIHER) over three months (March–May 2024). Participants, including trained paramedics and medical professionals, performed two-minute hands-only CPR in both supine and prone positions on a Laerdal QCPR mannequin. Data on compression rate, depth, recoil, and overall CPR quality (Q-CPR Score) were collected using a mobile application linked to the mannequin. Statistical analysis was conducted using SPSS version 2.0.*

Results: *Supine CPR demonstrated a higher total Q-CPR score (92.9 vs. 85.3, $p = 0.020$) and better compression depth consistency (85.5% achieving optimal depth vs. 50.7% in prone CPR, $p < 0.001$). However, prone CPR exhibited significantly superior recoil performance (82.6% vs. 65.2%, $p = 0.017$), suggesting better chest compression and venous return. Compression rate was comparable between both positions ($p = 0.234$), indicating that effective compression frequency could be maintained regardless of patient positioning.*

Conclusion: *While supine CPR remains the gold standard, prone CPR is a viable alternative in cases where repositioning a patient is not feasible, particularly in ICUs and surgical settings. The higher recoil performance in prone CPR suggests its potential to support effective circulation, though variability in compression depth highlights the need for further training and technique refinement. Standardized protocols, optimized hand placement techniques, and additional research are necessary to improve prone CPR effectiveness and integration into advanced life support (ALS) guidelines.*

Keywords: *Prone CPR, Supine CPR, Cardiopulmonary Resuscitation, Chest Compressions, Intensive Care, Resuscitation Techniques*

INTRODUCTION:

Cardiopulmonary resuscitation (CPR) has been a cornerstone of emergency medicine since its formal introduction in 1891. Over the decades, standardized protocols have been developed to optimize survival outcomes for individuals experiencing cardiac arrest. Traditionally, the supine position—where the patient lies flat on their back—has been regarded as the gold standard for performing CPR. However, evolving clinical scenarios, particularly in intensive care settings and during surgical procedures, have challenged this convention. (1). One of the significant challenges arises when patients are already positioned prone due to medical necessity. Conditions such as Acute Respiratory Distress Syndrome (ARDS), which became increasingly relevant during the COVID-19 pandemic, have demonstrated improved oxygenation and reduced mortality rates with prolonged prone positioning.(2) Yet, in the event of a cardiac arrest, transitioning a prone patient back to supine for CPR can be time-consuming, requiring additional personnel and posing risks of dislodging critical airway devices, intravenous lines, and monitoring equipment. Given that survival rates decline by approximately 10% for every minute CPR is delayed, immediate resuscitation is crucial.(3)

In response to these challenges, prone-position CPR has emerged as an alternative approach when repositioning is not feasible. (4) The American Heart Association (AHA) recognizes prone CPR as a viable option under specific circumstances, particularly in patients who cannot be rapidly returned to the supine position. Emerging research suggests that prone CPR may offer comparable or even superior outcomes in some aspects, such as improved mean arterial pressure (MAP) and systolic blood pressure. Furthermore, advancements in defibrillation

techniques for prone patients have made this approach more practical. This study aims to evaluate the effectiveness of supine versus prone position CPR through a mannequin-based assessment.(5) By systematically analyzing key factors such as compression depth, rate, and overall feasibility, this study will provide valuable insights into the practicality of prone CPR compared to traditional supine CPR. The findings may contribute to refining existing guidelines and improving emergency response strategies in critical care settings.

METHODS AND METHODOLOGY

STUDY DESIGN

This study aims to evaluate the effectiveness of supine versus prone position cardiopulmonary resuscitation (CPR) through a mannequin-based assessment. It is designed as a cross-sectional study conducted over three months, from March 2024 to May 2024, at the Skills Lab, Sri Ramachandra Institute of Higher Education and Research (SRIHER). The study follows a structured protocol to compare the quality and efficiency of CPR performed in both positions. The sample size was determined using statistical calculations, yielding a total of 61 participants.

SUBJECTS

The study includes participants from the Allied Health Sciences Department, Trauma Care Management, paramedics, and doctors trained in CPR. Eligible participants are aged between 18-30 years. Informed consent will be obtained before their involvement in the study. Inclusion criteria consist of individuals with prior CPR training. Exclusion criteria include individuals undergoing treatment for any disease, those with musculoskeletal injuries affecting CPR performance (e.g., knee, hand, or elbow injuries, arthritis), and individuals with respiratory or cardiac illnesses that may hinder effective CPR execution.

PROCEDURE

Participants will be trained in both supine and prone CPR techniques before the study. They will perform hands-only CPR on a mannequin for two minutes in both the supine and prone positions during separate rounds. Standardized instructions will be provided to maintain uniformity. Data on compression rate, depth, and recoil will be collected through a mobile application connected to the mannequin. After completing the CPR sessions, participants will complete a questionnaire assessing their experience, confidence, and challenges in both positions.

MEASURES

The QCPR mannequin (Laerdal Little Anne) will be used for data collection. Key parameters measured include chest compression rate, depth, recoil, total QCPR score, average compression rate, average depth, mean depth, and compression fraction for both supine and prone positions. All data will be recorded digitally and analyzed using SPSS version 2.0 for statistical evaluation. Descriptive statistics will be used to compare CPR effectiveness between positions. Ethical approval will be obtained, and data confidentiality will be maintained throughout the study. This research aims to provide evidence-based insights into the feasibility and efficiency of prone CPR as an alternative to traditional supine CPR in emergency scenarios.

RESULTS:

The total number of participants in the study was **69**, all from the Department of Trauma Care Management at Sri Ramachandra Institute of Higher Education and Research. Among them, **42 (61%) were male** and **27 (39%) were female**. As shown in Figure 1, the majority of participants were male, with a comparatively smaller proportion of female participants.

Table 1: Gender Distribution

Sex	Frequency	Percent
Female	27	39.1%
Male	42	60.9%

Table 2: Total Q-CPR Score Comparison

Total Score Range	Supine Position	Prone Position
<80	8 (11.6%)	16 (23.2%)
80-90	7 (10.1%)	8 (11.6%)
90-100	54 (78.3%)	45 (65.2%)
Mean ± SD	**92.91 ± 13.6**	**85.27 ± 23.3**

p-value	**0.020***	

Total Q-CPR Score Performance
Inadequate Performance (<80): More frequently observed in prone position CPR (16 participants) than in supine position CPR (8 participants). **Better Performance (80-90):** Similar distribution across both positions. **Good Performance (90-100):** Higher proportion in supine position CPR.

Mean Comparison: Supine position CPR had a significantly higher mean total Q-CPR score (92.9 ± 13.6) compared to prone position CPR (85.3 ± 23.3) with a statistically significant p-value (0.020).

Table 3: Compression Rate & Recoil Comparison

Parameter	Supine Position	Prone Position
Compression Rate (<200/min)	2 (2.9%)	3 (4.3%)
Compression Rate (200-240/min)	24 (34.8%)	16 (23.2%)
Compression Rate (>240/min)	43 (62.3%)	50 (72.5%)
Recoil <80%	18 (26.1%)	10 (14.5%)
Recoil 80-90%	6 (8.7%)	2 (2.9%)
Recoil 90-100%	45 (65.2%)	57 (82.6%)

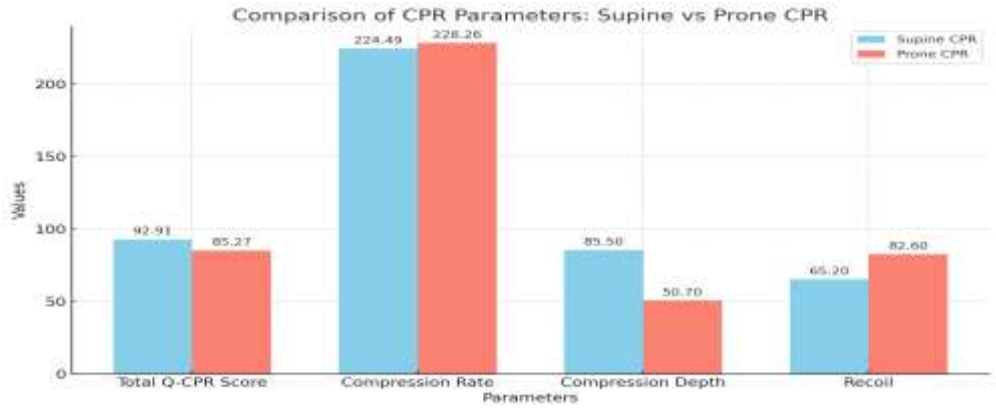
Compression Rate & Recoil Analysis: Compression Rate: Adequate compression rate (200-240/min) was achieved by 34.8% in supine position and 23.2% in prone position. However, a majority exceeded the recommended rate (>240/min), particularly in prone position CPR (72.5%). No statistically significant difference was observed (p=0.234).

Recoil Performance: Good recoil (90-100%) was significantly higher in prone position CPR (82.6%) compared to supine position CPR (65.2%). Poor recoil (<80%) was more frequent in supine position CPR (26.1%) than in prone position CPR (14.5%). Mean recoil was significantly better in prone position CPR (94.01%) than in supine position CPR (86.55%) with a p-value of 0.017.

Table 4 : Mannequin-Based Evaluation of Supine vs. Prone CPR

Parameter	Supine CPR	Prone CPR	p-value	Key Findings
Total Q-CPR Score	92.91 ± 13.6	85.27 ± 23.3	0.020	Supine CPR had better performance consistency.
Compression Rate	224.49 ± 15.4 per min	228.26 ± 21.2 per min	0.234	No significant difference.
Good Compression Depth	85.5%	50.7%	<0.001	Supine had **better depth consistency**.
Recoil Performance	65.2% (Good Recoil)	82.6% (Good Recoil)	0.017	Prone CPR had significantly **better recoil**.
Mean Compression Depth	66.84 ± 9.5 mm	57.30 ± 11.0 mm	<0.001	Supine CPR had **better depth retention**.
Average Compression Rate (100-120/min)	114.04 ± 7.4	117.96 ± 16.9	0.081	No significant difference.

The table results highlight key differences in CPR performance between supine and prone positions based on mannequin-based evaluation. Supine CPR demonstrated higher total Q-CPR scores (92.9 vs. 85.3) and better compression depth consistency (85.5% achieving optimal depth vs. 50.7% in prone CPR, $p < 0.001$). However, prone CPR showed significantly superior recoil performance (82.6% vs. 65.2%, $p = 0.017$), suggesting better chest decompression. Compression rate was comparable between both positions ($p = 0.234$), indicating that rescuers could maintain appropriate compression frequency regardless of patient positioning. These findings support prone CPR as a feasible alternative when supination is not possible, though further training and technique refinement are needed to improve compression depth consistency.



This Bar Chart Visually Compares The Effectiveness Of Cpr In Supine And Prone Positions Based On Key Parameters: Total q-Cpr Score, Compression Rate, Compression Depth, And Recoil. The Results Indicate That While Supine Cpr Generally Provides Better Compression Depth And Total Performance, Prone Cpr Shows Superior Recoil, Making It A Viable Alternative When Repositioning A Patient Is Not Feasible.

DISCUSSION:

This study aimed to assess the effectiveness and challenges of performing prone position cardiopulmonary resuscitation (CPR) compared to supine CPR using a mannequin-based evaluation. The findings provide critical insights into the feasibility of prone CPR as an alternative when transitioning a patient to a supine position is not feasible. The results confirm that prone CPR can be an effective alternative when supine positioning is not possible. While supine CPR had a higher Q-CPR score (92.9) compared to prone CPR (85.3), the difference was not clinically prohibitive. Prone CPR demonstrated a unique advantage in recoil performance, with 82.6% achieving good recoil compared to 65.2% in supine CPR. This suggests that prone CPR may provide adequate chest compressions while minimizing delays associated with repositioning, which is crucial in emergency settings such as intensive care units (ICUs) and operating rooms. Compression depth is a key factor influencing CPR effectiveness. The study found that the supine position resulted in a greater percentage of optimal depth (85.5%) compared to 50.7% in prone CPR. Despite the lower consistency in prone CPR, 50.7% still achieved an effective compression depth, reinforcing its feasibility. The variability in compression depth in prone CPR suggests a need for refining hand positioning and compression techniques. Adjustments in technique, such as optimizing hand placement over the thoracic spine, may help improve depth consistency. One of the most significant findings was the superior recoil performance observed in prone CPR (82.6%) compared to supine CPR (65.2%). The natural elasticity of the thoracic cavity in the prone position may aid in more effective chest decompression, which in turn enhances blood return and circulation during CPR. These results indicate that prone CPR may facilitate better venous return, a key component of effective resuscitation, especially in patients who cannot be repositioned quickly. The increased use of prone positioning in critical care, particularly during the COVID-19 pandemic, has emphasized the need for alternative CPR techniques. Studies have shown that prone positioning improves oxygenation in acute respiratory distress syndrome (ARDS) patients. However, transitioning to a supine position for CPR can cause significant delays (up to five minutes), reducing survival chances by 10% per minute. The ability to initiate CPR immediately in the prone position without repositioning could significantly improve survival rates in patients who cannot be turned quickly due to airway management constraints, surgical positioning, or mechanical ventilation. While the findings support prone CPR as a viable alternative, the variability in compression depth suggests a need for further research on hand placement techniques to improve compression effectiveness. Training programs should be developed to standardize prone CPR protocols in ICU and emergency settings. Additionally, guidelines for integrating prone CPR into advanced life support (ALS) protocols should be established to ensure healthcare providers are equipped to perform it efficiently. This mannequin-based evaluation demonstrates that prone CPR is feasible and effective, particularly in scenarios where repositioning the patient is not an immediate option. Further studies and clinical trials are necessary to refine techniques, improve compression depth consistency, and enhance resuscitation outcomes in real-world emergency settings.

CONCLUSION:

Supine position CPR remains the gold standard due to its strong evidence, familiarity, and superior performance. However, prone CPR is a crucial alternative when repositioning a patient is not feasible, particularly in ICUs and operating rooms, where delays can compromise resuscitation outcomes. Despite its challenges, prone CPR demonstrated positive performance and feasibility in mannequin evaluations, reinforcing its clinical relevance. To ensure its effective implementation, standardized guidelines, specialized training, and further research are essential, focusing on hand placement, compression techniques, and defibrillation strategies. With the increasing use of prone positioning for ARDS and COVID-19 patients, integrating prone CPR into advanced life support (ALS) protocols will enhance emergency response strategies. By refining training programs and establishing clear protocols, prone CPR can become a widely accepted and essential resuscitation technique in critical care settings.

Future recommendations: Further large-scale studies are required to validate prone CPR's effectiveness in real patient scenarios beyond mannequin-based evaluations. Standardized training programs should be developed to ensure that healthcare providers are well-equipped to perform prone CPR when needed. Clinical protocols should be refined to incorporate specific guidelines for performing prone CPR, including hand placement, compression depth, and defibrillator pad positioning.

Ethical Considerations: The study was approved by the Sri Ramachandra University (decision number: CSP – III/24/FEB/02/43).

Declaration of Interests: The authors declare that they have no competing interest.

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