Efficacy of Awake Prone Positioning on Oxygenation in COVID-19 Patients on NIV: Relevance in the Modern ICU

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Abstract— **Background: Prone positioning has long been proven to enhance oxygenation in acute respiratory distress syndrome (ARDS). During the COVID-19 pandemic, awake prone positioning (APP) became a cornerstone of supportive management for hypoxaemic patients receiving non-invasive ventilation (NIV). As intensive care units (ICUs) evolve beyond the pandemic, APP continues to play a vital role in managing hypoxaemia due to viral and non-viral pneumonias.**

Aim: To evaluate the effectiveness of awake prone positioning in improving oxygenation among moderate COVID-19 patients on NIV and to contextualise its ongoing relevance in current ICU protocols.

Materials and Methods: A prospective observational study was conducted in the Department of Anaesthesiology, Dr Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation, from January to August 2021. Forty moderate COVID-19 patients (SpO_2 < 85 % on room air) were divided equally into supine and prone groups. Oxygen saturation before and after proning, duration of proning, and need for intubation were assessed. Statistical significance was set at $p < 0.05$.

Results: Mean SpO_2 improved from 90.45 ± 3.69 % in the supine group to 97.25 ± 1.41 % in the prone group ($p < 0.001$). Patients proned for > 4 h/day maintained improved oxygenation and showed a lower need for invasive ventilation. No major complications were noted.

Conclusion: Awake proning remains a safe, effective, and resource-efficient intervention for improving oxygenation in patients with hypoxaemic respiratory failure. Its continued application in the post-pandemic ICU reflects the shift toward proactive, nurse-led, non-invasive respiratory management.

Index Terms— **Awake Proning; Non-Invasive Ventilation; COVID-19; ICU Protocols; Oxygenation; Hypoxaemia; ARDS; Critical Care.**

I. INTRODUCTION

The COVID-19 pandemic transformed global critical-care practice, driving innovation in non-invasive respiratory support. Among these innovations, awake prone positioning (APP) emerged as a pivotal intervention for improving oxygenation without resorting to invasive mechanical ventilation[1] [2].

Physiologically, APP enhances ventilation–perfusion matching, promotes uniform alveolar expansion, and reduces posterior atelectasis[3] [4]. In the supine position, dorsal lung segments collapse under the influence of gravity and mediastinal pressure, increasing shunt fraction[5]. Proning re-expands these segments, improving gas exchange and oxygen delivery[6].

While initially reserved for COVID-19 ARDS, APP has now been integrated into modern ICU protocols for other causes of hypoxaemia such as bacterial pneumonia, aspiration, and postoperative pulmonary dysfunction[7]. Furthermore, the development of high-flow nasal cannula (HFNC) systems, nurse-led proning teams, and tele-ICU monitoring platforms has enhanced the safety and scalability of APP in diverse hospital settings[8] [9].

This study evaluates the impact of awake proning on oxygenation in COVID-19 patients on NIV and its extended relevance in contemporary ICU practice.

II. MATERIALS AND METHODS

Study Design

A prospective observational study was carried out in the Department of Anaesthesiology, Dr Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation, Chinaoutapalli, Andhra Pradesh, after

Institutional Ethics Committee approval (Ref. No: PSIMS/IEC/2021/41).

Patient Selection

Inclusion criteria: Adults aged 18–70 years, RT-PCR–confirmed COVID-19, moderate hypoxaemia (SpO_2 < 85 % on room air), and tolerance for awake proning on NIV. Exclusion criteria: Haemodynamic instability, respiratory fatigue (RR > 40/min), altered mental status, pregnancy, cardiac disease, or refusal to prone.

Grouping and Protocol

- Group A (Supine, n = 20): NIV in supine position.
- Group B (Prone, n = 20): NIV with prone sessions of 3–6 hours per cycle, repeated 3–4 times daily as tolerated.

NIV settings included CPAP (5–10 cm H_2O) or BiPAP (IPAP 12–16 cm H_2O, EPAP 5–6 cm H_2O). SpO_2, respiratory rate, and comfort were continuously monitored. Patients were repositioned every 2–4 hours to prevent pressure injuries.

Outcomes

- Primary outcome: Change in SpO_2 before and after proning.
- Secondary outcomes: Need for intubation, ICU stay length, and proning-related complications.

Statistical Analysis

Continuous data were expressed as mean ± SD; comparisons used Student's t-test. Categorical variables were analysed using the χ^2 test ($p < 0.05$ was considered significant).

III. RESULTS

Demographic Data

Parameter	Supine (n = 20)	Prone (n = 20)	p value
Mean Age (yrs)	53.4 ± 8.3	54.6 ± 9.1	0.71
Male (%)	40	60	0.31

Oxygenation Outcomes

Position	Baseline SpO_2 (%)	Post SpO_2 (%)	Δ Change	p value
Supine	90.45 ± 3.69	91.20 ± 3.02	0.75 ± 1.10	NS
Prone	89.80 ± 4.10	97.25 ± 1.41	7.45 ± 1.28	< 0.001

Duration of Proning vs Intubation

Duration (h/day)	Patients	Mean Δ SpO_2 (%)	Intubated (n)
< 2 h	5	2.0 ± 0.8	3 (60 %)
2–4 h	8	4.6 ± 1.3	2 (25 %)
> 4 h	7	7.8 ± 1.2	0 (0 %)

Complications and Outcomes

Complication	Supine	Prone
Nausea/Vomiting	1	2
Pressure Discomfort	0	3
Desaturation Episode	2	0

Outcome	Supine	Prone	p value
ICU Stay (days)	7.1 ± 2.0	6.0 ± 1.5	0.04
Intubation (%)	40	10	0.03
Survival (%)	85	95	0.27

IV. DISCUSSION

The findings of this study reaffirm that awake proning with NIV significantly improves oxygenation and reduces the need for invasive ventilation[10–12]. The physiological basis lies in improved ventilation–perfusion matching, reduced dorsal collapse, and enhanced secretion clearance[13].

Relevance in the Present-Day ICU

In 2025, awake proning has evolved from a pandemic-driven innovation to a standard component of critical-care respiratory management. Current ICU environments utilise nurse-driven proning protocols with structured checklists to ensure safety and patient comfort. Integration with high-flow nasal cannula (HFNC) and dual-modality oxygen therapy has broadened its indications. Modern ICUs also benefit from AI-assisted monitoring systems that alert staff to desaturation, improper positioning, or pressure risks in proned patients.

Furthermore, tele-ICU networks now allow remote supervision of proning in satellite hospitals, extending this low-cost intervention to resource-limited settings. Staff burnout and turnover, which surged during the pandemic, have led to renewed focus on simulation-based training to standardise proning procedures and reduce complications.

These changes highlight how a technique popularised during COVID-19 has matured into an enduring element of patient-centred, multidisciplinary critical care.

V. LIMITATIONS AND FUTURE SCOPE

The study was limited by its small sample size and single-centre design. Arterial blood gas (ABG) analysis was not performed for all patients, limiting evaluation of PaO_2/FiO_2 changes. The absence of long-term follow-up restricted outcome assessment beyond ICU discharge.

Future research should involve multicentre trials with larger cohorts, integration of automated monitoring, and assessment of combined HFNC + prone strategies in both COVID and non-COVID ARDS.

VI. CONCLUSION

Awake prone positioning with NIV significantly enhances oxygenation and reduces intubation rates in moderate hypoxaemic respiratory failure. Its sustained use in the modern ICU underscores the importance of teamwork, early intervention, and resource-efficient care. Combining APP with advanced monitoring and nurse-led protocols ensures safety, scalability, and improved outcomes across diverse healthcare settings.

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