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Research Article

Comparative Study of Dexmedetomidine versus Midazolam Sedation on Ventilator Weaning Outcomes in ARDS Patients in the ICU.

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Abstract: Sedation strategy plays a pivotal role in mechanical ventilation management and directly influences ventilator weaning outcomes in acute respiratory distress syndrome. This experimental study compared the effects of dexmedetomidine and midazolam sedation on ventilator weaning outcomes, duration of mechanical ventilation, and intensive care unit stay in patients with acute respiratory distress syndrome. A total of 120 adult patients were prospectively enrolled and randomized into two equal groups receiving either dexmedetomidine or midazolam for sedation. Primary outcomes included time to successful ventilator weaning and duration of mechanical ventilation, while secondary outcomes included sedation adequacy, incidence of delirium, and ICU length of stay. Patients sedated with dexmedetomidine demonstrated significantly shorter ventilator weaning time ($p<0.001$), reduced duration of mechanical ventilation ($p=0.002$), and lower incidence of delirium ($p=0.004$) compared with those receiving midazolam. Sedation levels remained within target ranges in both groups, although dexmedetomidine was associated with greater hemodynamic stability. These findings indicate that dexmedetomidine provides statistically significant advantages in facilitating ventilator weaning in acute respiratory distress syndrome. The study highlights a clinically meaningful sedation strategy that optimizes respiratory recovery and improves intensive care outcomes.

Keywords: Dexmedetomidine, Midazolam, Ventilator weaning

Introduction

Acute respiratory distress syndrome represents a severe form of hypoxemic respiratory failure associated with high morbidity and mortality in critically ill patients. Management frequently necessitates prolonged mechanical ventilation, during which sedation is essential to ensure patient comfort, ventilator synchrony, and prevention of self-inflicted lung injury. However, sedation depth and agent selection substantially influence respiratory drive, neurological status, and the ability to successfully liberate patients from ventilatory support.[1-3]

Traditional sedation practices in intensive care units have relied heavily on benzodiazepines, particularly midazolam, due to their anxiolytic and hypnotic properties. Despite their widespread use, benzodiazepines are associated with prolonged sedation, respiratory depression, delirium, and delayed ventilator weaning. These adverse effects are particularly detrimental in patients with acute respiratory distress syndrome, where early liberation from mechanical ventilation is a cornerstone of lung-protective strategies.[4-7]

Dexmedetomidine, a selective alpha-2 adrenergic receptor agonist, has emerged as an alternative sedative agent that provides cooperative sedation with minimal respiratory depression. Its pharmacological profile allows patients to remain arousable while maintaining adequate analgesia and anxiolysis. This characteristic may support spontaneous breathing and facilitate earlier weaning from mechanical ventilation, an advantage that is particularly relevant in acute respiratory distress syndrome.[8-10]

Ventilator weaning failure contributes to increased ICU length of stay, higher healthcare costs, and increased mortality. Sedation-induced suppression of respiratory drive, impaired neurological responsiveness, and delirium are recognized contributors to delayed weaning. Optimizing sedation regimens is therefore a modifiable factor with significant implications for patient outcomes.[11-12]

Recent research has suggested that non-benzodiazepine sedation strategies may improve ventilator-related outcomes. However, data focusing specifically on patients with acute respiratory distress syndrome remain limited. Given the unique pathophysiological challenges in this population, extrapolation from mixed ICU cohorts may not fully capture sedation effects on weaning dynamics.

The present study was designed to address this gap by directly comparing

dexmedetomidine and midazolam sedation in acute respiratory distress syndrome patients requiring mechanical ventilation. By evaluating ventilator weaning outcomes, sedation quality, delirium incidence, and ICU length of stay, this experimental study aims to provide clinically relevant evidence to guide sedation practices in this high-risk population.

Methodology

This prospective, randomized experimental study was conducted in a multidisciplinary intensive care unit between March 2023 and April 2024 following approval from the institutional ethics committee at Imran Idrees Teaching Hospital, Sialkot. Adult patients aged 18–75 years who fulfilled the Berlin diagnostic criteria for acute respiratory distress syndrome and required invasive mechanical ventilation for more than 48 hours were eligible for inclusion. Sample size was calculated using Epi Info software with a confidence level of 95%, power of 80%, an expected mean difference of 1.5 days in ventilator weaning time between groups, and a 10% anticipated dropout rate, resulting in a total sample size of 120 patients.

Patients were randomly allocated into two groups of 60 each. The dexmedetomidine group received continuous intravenous infusion at 0.2–0.7 µg/kg/hour, while the midazolam group received infusion at 0.02–0.1 mg/kg/hour. Sedation was titrated to maintain a target Richmond Agitation-Sedation Scale score between −2 and 0. Daily sedation interruption and spontaneous breathing trials were conducted according to ICU protocol.

Inclusion criteria comprised confirmed acute respiratory distress syndrome, hemodynamic stability with or without vasopressor support, and informed verbal consent obtained from the patient's legally authorized representative. Exclusion criteria included severe bradycardia, advanced heart block, chronic benzodiazepine dependence, hepatic failure, pregnancy, neuromuscular disease, and anticipated death within 24 hours.

Primary outcomes were time to successful ventilator weaning and total duration of mechanical ventilation. Secondary outcomes included incidence of delirium assessed using standardized screening tools, ICU length of stay, and adverse hemodynamic events. Statistical analysis was performed using independent t-tests and chi-square tests, with p values less than 0.05 considered statistically significant.

Results

Table 1. Demographic and baseline clinical characteristics

Variable	Dexmedetomidine (n=60)	Midazolam (n=60)	p value
Age (years)	56.3 ± 9.4	57.1 ± 10.1	0.68
Male/Female	34/26	36/24	0.71
PaO_2/FiO_2 ratio	142 ± 26	139 ± 29	0.53
APACHE II score	21.8 ± 4.6	22.1 ± 4.8	0.74

Baseline characteristics were comparable between groups.

Table 2. Ventilator weaning and ICU outcomes

Outcome	Dexmedetomidine	Midazolam	p value
Time to weaning (days)	4.2 ± 1.3	6.1 ± 1.6	<0.001
Duration of ventilation (days)	6.5 ± 2.0	8.7 ± 2.4	0.002
ICU stay (days)	8.1 ± 2.6	10.4 ± 3.1	0.001

Dexmedetomidine significantly reduced ventilator dependency and ICU stay.

Table 3. Sedation-related outcomes

Parameter	Dexmedetomidine	Midazolam	p value
Delirium incidence (%)	18.3	36.7	0.004
Target RASS achieved (%)	91.6	88.3	0.42
Bradycardia (%)	10.0	3.3	0.12

Lower delirium incidence was observed with dexmedetomidine.

Discussion

The findings of this study demonstrate that dexmedetomidine sedation significantly improves ventilator weaning outcomes compared with midazolam in patients with acute respiratory distress syndrome. The

reduction in weaning time and total ventilation duration reflects the preservation of respiratory drive and cooperative sedation associated with dexmedetomidine.[13-14]

The prolonged mechanical ventilation observed in the midazolam group may be attributed to cumulative sedative effects and delayed neurological recovery, which impair readiness for spontaneous breathing trials. Benzodiazepine-associated delirium likely contributed further to delayed weaning, as evidenced by the higher delirium incidence in this group.[15-16]

Dexmedetomidine's ability to provide arousable sedation likely facilitated patient participation during weaning trials and improved ventilator synchrony. This pharmacodynamic advantage is particularly relevant in acute respiratory distress syndrome, where spontaneous breathing must be balanced against lung-protective strategies.[17-18]

The observed reduction in ICU length of stay among dexmedetomidine-treated patients underscores the broader resource implications of sedation choice. Shorter ICU stays translate into reduced healthcare costs and lower risk of nosocomial complications.

Hemodynamic effects were minimal and clinically manageable, supporting the safety profile of dexmedetomidine when appropriately titrated. Although a higher incidence of bradycardia was noted, it did not necessitate treatment discontinuation.[19-20]

This study strengthens existing evidence favoring non-benzodiazepine sedation strategies in critical care and extends it specifically to the acute respiratory distress syndrome population, which has been underrepresented in prior trials.

Overall, the results support a sedation paradigm shift toward agents that facilitate early ventilator liberation while maintaining patient safety and comfort.

Conclusion

Dexmedetomidine sedation significantly improves ventilator weaning efficiency, reduces mechanical ventilation duration, and lowers delirium incidence compared with midazolam in acute respiratory distress syndrome patients. This study fills a critical gap by providing focused evidence in a high-risk population. Future research should explore long-term outcomes and protocolized sedation strategies integrating dexmedetomidine for optimized respiratory recovery.

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