Section: Miscellaneous

Original Research Article

EMERGENCY DEPARTMENT PROCEDURAL SEDATION FOR ORTHOPEDIC REDUCTIONS: KETAMINE WITH PROPOFOL VERSUS KETAMINE ALONE - A RANDOMIZED CONTROL TRIAL

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ABSTRACT

Background: Procedural sedation is an essential component of emergency orthopedic practice, facilitating painless fracture and joint reductions while ensuring patient comfort and procedural success. Ketamine is widely used because of its analgesic and dissociative properties; however, its use may be associated with prolonged recovery and emergence reactions. Combining ketamine with propofol (ketofol) may improve sedation quality while minimizing adverse effects. This study was designed to compare the efficacy and safety of ketamine-propofol versus ketamine alone for procedural sedation during orthopedic reductions in the emergency department.

Materials and Methods: A total of 68 adult patients requiring procedural sedation for orthopedic reductions. Participants were randomly allocated into two equal groups: Group KP received ketamine (0.5 mg/kg) combined with propofol (0.5 mg/kg), while Group K received ketamine alone (1 mg/kg). Primary outcomes included procedural success and recovery characteristics. Secondary outcomes comprised hemodynamic stability, pain scores, adverse events, and physician and patient satisfaction.

Results: Both groups achieved high procedural success rates. The ketamine–propofol group demonstrated significantly faster onset of sedation (2.6±0.8 vs 3.8±1.0 minutes), shorter recovery time (18.4±4.7 vs 27.8±6.5 minutes), shorter emergency department stay (71.6±14.2 vs 86.9±17.4 minutes), and lower post-procedural pain scores (1.2±0.8 vs 1.8±0.9; $p<0.05$). Emergence reactions were significantly less frequent with ketofol, while hemodynamic parameters and respiratory safety remained comparable between groups. Physician and patient satisfaction scores were significantly higher in the ketofol group.

Conclusion: Ketamine with propofol provides more efficient procedural sedation than ketamine alone by facilitating faster recovery, improved patient comfort, fewer emergence reactions, and greater clinician satisfaction without compromising safety. Ketofol represents an effective and reliable sedation strategy for orthopedic reductions in the emergency department.

Keywords: Procedural sedation, ketamine, propofol, fracture reduction, emergency medicine.

INTRODUCTION

Procedural sedation and analgesia (PSA) are an essential component of modern emergency medicine, allowing clinicians to perform painful diagnostic and therapeutic procedures while ensuring patient comfort, minimizing anxiety, and facilitating successful interventions. Orthopedic reductions, including fracture manipulations and joint dislocations, are among the most frequently

performed emergency procedures requiring effective procedural sedation because they necessitate adequate analgesia, muscle relaxation, and patient immobility. An ideal sedative agent should provide rapid onset of action, effective analgesia, cardiovascular stability, preservation of spontaneous respiration, rapid recovery, and a low incidence of adverse events. Despite significant advances in emergency medicine, the optimal pharmacological regimen for procedural sedation during orthopedic reductions remains an area of ongoing research.[1,2]

Ketamine is one of the most widely used sedative agents in emergency departments owing to its dissociative anesthetic properties, potent analgesic effect, preservation of airway reflexes, minimal respiratory depression, and maintenance of cardiovascular stability through sympathetic stimulation.[3] These pharmacological characteristics make ketamine particularly suitable for trauma patients and orthopedic emergencies. However, ketamine administration may be associated with several adverse effects, including prolonged recovery time, nausea, vomiting, excessive salivation, emergence reactions, hallucinations, and agitation, which can delay patient discharge and reduce overall satisfaction.[3,4]

Propofol is another commonly used sedative-hypnotic agent because of its rapid onset, short duration of action, predictable recovery profile, and antiemetic properties. Nevertheless, propofol lacks intrinsic analgesic activity and may produce dose-dependent hypotension and respiratory depression, particularly when administered in higher doses or as a sole sedative agent.[5] These limitations have encouraged investigators to evaluate combination regimens that capitalize on the complementary pharmacodynamic properties of ketamine and propofol.

The combination of ketamine and propofol, commonly known as ketofol, has emerged as an attractive alternative for procedural sedation. Ketamine counterbalances the hypotensive effects of propofol by stimulating sympathetic activity, whereas propofol attenuates ketamine-induced emergence phenomena and postoperative nausea. Furthermore, combining both drugs allows lower doses of each agent to be administered, potentially improving hemodynamic stability, shortening recovery time, and reducing drug-related adverse effects without compromising analgesic efficacy.[2,6]

Several randomized controlled trials have demonstrated that ketofol provides effective procedural sedation with faster recovery, improved physician satisfaction, and comparable or fewer respiratory complications than ketamine or propofol alone.[2,6,7]

Recent systematic reviews and meta-analyses have further supported the efficacy and safety of ketofol, reporting shorter recovery periods, lower incidence of emergence reactions, and high procedural success rates across various emergency department procedures. However, variability in study populations, dosing regimens, outcome measures, and clinical settings has resulted in inconsistent findings regarding recovery characteristics and adverse event profiles.[7,8] Moreover, evidence from Indian tertiary care emergency departments remains relatively limited, particularly among adult patients undergoing orthopedic reductions.

Therefore, the present randomized controlled trial was undertaken to compare ketamine combined with propofol versus ketamine alone for procedural sedation during orthopedic reductions in the emergency department.

MATERIALS AND METHODS

This prospective, randomized controlled trial was conducted in the Department of Emergency Medicine in collaboration with the Department of Orthopedics at MNR Medical College and Hospital, Sangareddy, Telangana, India from January 2025 to June 2026. The study protocol was approved by the institutional ethics committee. A total of 68 patients presenting to the emergency department with acute orthopedic injuries requiring closed reduction under procedural sedation were screened consecutively for eligibility. Written informed consent was obtained from all participants or legally authorized representatives before enrolment.

Inclusion Criteria: Patients between 18-65 years of age, ASA grade I or II, acute orthopedic injuries requiring closed reduction including shoulder dislocation, elbow dislocation, wrist dislocation, distal radius fractures, forearm fractures, ankle dislocations and ankle fractures requiring manipulation, Glasgow Coma Scale score of 15 and willing to provide informed consent.

Exclusion Criteria: Patients allergic to ketamine and propofol, pregnancy, lactation, ASA grade III or higher, with cardiovascular disease, uncontrolled hypertension, Severe hepatic complications, renal dysfunction, increased intracranial pressure, acute psychosis, severe chronic obstructive pulmonary disease, requirement for immediate operative intervention under general anesthesia and unwilling to participate.

All the study participants (n=68) were randomly divided in to two study groups. Group KP (n=34) cases received intravenous ketamine 0.5 mg/kg, followed by intravenous propofol 0.5 mg/kg. Group K (n=34) cases received intravenous ketamine 1 mg/kg alone administered slowly over 60 seconds, before sedation, all patients underwent complete medical history, physical examination, airway assessment (Modified Mallampati classification), ASA grading, baseline pain assessment using the Visual Analog Scale (VAS), baseline Ramsay Sedation Score, haemodynamic parameters, respiratory rate and oxygen saturation (SpO_2). Intraoperative data were recorded using a structured case record form including additional drug doses, hemodynamic parameters, sedation scores,

procedural success, recovery profile, adverse events and satisfaction scores.

Statistical Analysis: The collected data were extracted into Microsoft Excel sheet and analysed using SPSS v.26.0. Continuous variables were expressed as mean and standard deviation (SD) and compared using the independent Student's t-test. Categorical variables were expressed as frequencies and percentages and compared using the Chi-square test. Repeated hemodynamic measurements were analyzed using repeated measures analysis of variance (RM-ANOVA) with Bonferroni correction for multiple comparisons. Effect sizes were presented as mean differences, risk ratios (RR), or 95% confidence intervals (CI). A $p<0.05$ was considered statistically significant outcome.

RESULTS

Table 1: Demographic and clinical characteristics of study groups (n=68).

Study variable	Group KP (n=34)	Group K (n=34)	p-value
Age (years)	37.8±11.6	39.1±12.2	0.65
Gender			
Male	24 (70.6%)	23 (67.6%)	0.79
Female	10 (29.4%)	11 (32.4%)	
Weight (kg)	68.4±10.2	69.1±9.6	0.77
BMI (kg/m²)	24.7±3.5	25.1±3.2	0.61
ASA status			
Grade - I	23 (67.6%)	22 (64.7%)	0.80
Grade - II	11 (32.4%)	12 (35.3%)	
Type of injury			
Shoulder dislocation	10 (29.4%)	9 (26.4%)	-
Distal radius fracture	7 (20.5%)	8 (23.5%)	
Forearm fracture	5 (14.7%)	6 (17.6%)	
Elbow dislocation	4 (11.7%)	3 (8.8%)	
Ankle fracture or dislocation	6 (17.6%)	5 (14.7%)	
Others	2 (5.8%)	3 (8.8%)	

Table 2: Sedation and procedural characteristics among study groups.

Study variable	Group KP	Group K	p-value
Sedation onset (min)	2.6±0.8	3.8±1.0	0.001
Reduction procedure (min)	7.9±2.1	8.3±2.3	0.45
Recovery time (min)	18.4±4.7	27.8±6.5	0.001
ED stay (min)	71.6±14.2	86.9±17.4	0.001
Additional sedation required	4 (11.8%)	9 (26.5%)	0.12
Procedural success			
Successful reduction	33 (97.1%)	31 (91.2%)	0.30
Failed reduction	1 (2.9%)	3 (8.8%)	

Table 3: Comparison of hemodynamic parameters between study groups.

Parameter	Baseline		End of procedure		p-value
	Group KP	Group K	Group KP	Group K	
Heart rate (beats/min)	88.7 ± 10.8	89.5 ± 9.7	86.3 ± 9.8	90.4 ± 10.6	0.08
SBP (mmHg)	128.3 ± 12.5	127.6 ± 11.9	122.4 ± 11.1	125.8 ± 12.8	0.19
DBP (mmHg)	78.6 ± 8.1	79.2 ± 7.7	75.8 ± 7.2	77.4 ± 7.5	0.31
MAP (mmHg)	95.2 ± 8.6	95.5 ± 7.9	91.3 ± 7.2	92.7 ± 8.0	0.42
SpO_2 (%)	98.4 ± 0.9	98.3 ± 0.8	97.8 ± 1.1	97.4 ± 1.3	0.18

Table 4: Comparison of adverse events between study groups.

Adverse event	Group KP	Group K	p-value
Oxygen desaturation	2 (5.9%)	3 (8.8%)	0.64
Hypotension	1 (2.9%)	-	0.31
Nausea	3 (8.8%)	6 (17.6%)	0.28
Vomiting	1 (2.9%)	4 (11.8%)	0.17
Emergence reaction	1 (2.9%)	7 (20.6%)	0.024
Excessive salivation	2 (5.9%)	4 (11.8%)	0.39
Airway intervention	-	1 (2.9%)	0.31

Table 5: Physician and patient satisfaction

Variable	Group KP	Group K	p-value
Physician satisfaction (1–10)	9.4 ± 0.7	8.6 ± 0.9	0.001
Patient satisfaction (1–10)	9.2 ± 0.8	8.4 ± 1.0	0.001

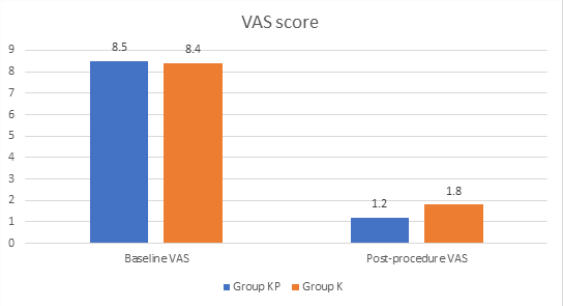

Figure 1: Assessment of pain scores

DISCUSSION

The baseline similarity between the two groups supports the internal comparability of the trial. The observed 97.1% successful reduction rate with ketofol compared with 91.2% with ketamine alone is consistent with earlier clinical experience in which ketofol has produced high procedural success rates. A large prospective adult series involving predominantly orthopedic procedures reported successful completion in approximately 98% of cases using ketofol, demonstrating its suitability for painful emergency procedures.[10] This similarity is clinically relevant because adequate procedural conditions depend not only on analgesia but also on sufficient dissociation, immobility, and tolerance of manipulation.

The reduction in sedation onset time with ketofol may reflect the complementary pharmacodynamic effects of the two agents. Ketamine provides dissociative analgesia, whereas propofol contributes rapid hypnosis. Evidence directly comparing the two regimens is supportive but not entirely uniform. A systematic review and meta-analysis specifically comparing ketamine with ketofol concluded that ketofol was generally safe and more effective for procedural sedation and analgesia, although the included studies were relatively heterogeneous.[8] Therefore, the shorter onset observed in the present dataset should be interpreted as a study specific finding rather than a universally established pharmacological advantage.

Recovery time was another important outcome. The mean recovery time was substantially shorter with ketofol than with ketamine alone. This finding is clinically plausible because the combination may permit lower exposure to ketamine while maintaining adequate procedural conditions. A recent systematic review examining low dose ketamine combined with propofol found that two included studies demonstrated shorter recovery with low dose ketamine combinations, although the authors emphasized considerable heterogeneity and insufficient evidence for a definitive recovery advantage.[11] Özen Karabulut B, Akgün M found that ketamine propofol was associated with favourable patient satisfaction and that propofol containing regimens generally provided efficient recovery characteristics.[12]

The significantly lower frequency of emergence reactions in the ketofol group represents an important finding. Ketamine-associated recovery phenomena can include unpleasant dreams, hallucinations, agitation, and behavioral disturbance. In a multicenter double-blind randomized trial involving adults, ketofol reduced the incidence of unpleasant recovery reactions by approximately 22% compared with ketamine alone and also reduced the need for interventions directed at these reactions.[13] This directly supports the direction of the present findings and provides a stronger clinical rationale for the observed improvement in recovery experience.

Post procedural pain scores were also lower in the ketofol group. Ketamine remains an effective analgesic during painful procedures, but the addition of propofol may improve sedation depth and procedural tolerance without eliminating ketamine's analgesic effect. Importantly, evidence is not uniformly supportive of superiority for every outcome. A systematic review of low dose ketamine or opioids combined with propofol found inconsistent results for analgesic efficacy and concluded that existing evidence was insufficient to establish a clear advantage of low dose ketamine-propofol combinations over opioid propofol regimens.[11] Thus, the lower pain score observed here should be considered an encouraging finding requiring confirmation in adequately powered trials.

Hemodynamic and respiratory outcomes were comparable between groups. This is consistent with contemporary evidence indicating that serious complications during emergency procedural sedation are uncommon when appropriate patient selection, monitoring, and rescue capabilities are available. A recent systematic review and meta-analysis of randomized trials found that respiratory events were more frequent than cardiovascular complications overall, while serious events such as laryngospasm, aspiration, and intubation remained uncommon.[14] The present low frequency of desaturation and airway intervention therefore appears clinically plausible.

The lower incidence of emergence reactions in the ketofol group also translated into higher patient and physician satisfaction. This finding is supported by randomized evidence showing improved provider satisfaction with ketamine-propofol compared with propofol alone.[6] as well as the more recent network meta-analysis demonstrating improved patient satisfaction with ketamine-propofol compared with some alternative sedation strategies.[12] Nevertheless, satisfaction is influenced by multiple factors, including procedural success, pain control, recovery experience, communication, and waiting time, and therefore should not be interpreted solely as a pharmacological effect.

Recent comparative research also illustrates that ketofol is one of several viable combination strategies. A randomized trial comparing ketamine-dexmedetomidine, ketofol, and ketamine alone investigated recovery agitation and other sedation outcomes in adults undergoing painful emergency

procedures.[15] Furthermore, a systematic review and meta-analysis of esketamine-propofol combinations reported reductions in hypotension and bradycardia compared with comparator regimens, although an increased risk of agitation was observed.[16] These findings emphasize that the clinical effect of combination sedation depends on drug selection, dose, patient characteristics, and procedural context rather than simply on combining two agents.

CONCLUSION

Ketamine with propofol and ketamine alone were effective and safe for procedural sedation during orthopedic reductions in the emergency department. However, ketofol provided significant clinical advantages, including faster onset of sedation, shorter recovery time, reduced emergency department stay, lower post-procedural pain scores, fewer emergence reactions, and higher physician and patient satisfaction, while maintaining comparable hemodynamic stability and procedural success. These findings suggest that ketofol is a reliable and efficient sedation regimen for emergency orthopedic procedures and may be preferred over ketamine alone to optimize patient outcomes, procedural efficiency, and overall quality of emergency care.

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