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RESEARCH ARTICLE
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COMPARISON BETWEEN INHALATIONAL ANESTHETIC (SEVOFLURANE) AND INTRAVENOUS ANESTHETIC (PROPOFOL INFUSION) FOR MAINTENANCE OF ANESTHESIA DURING ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY

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Abstract

Background: Endoscopic Retrograde Cholangiopancreatography (ERCP) requires effective sedation for procedural success and patient safety. Two commonly used anesthetic agents for sedation during ERCP are propofol (intravenous) and sevoflurane (inhalational), each with distinct pharmacologic properties and clinical profiles.

Objective: To compare the efficacy, hemodynamic stability, and sedation depth of sevoflurane and propofol during ERCP procedures.

Methods: A randomized, double-blind clinical trial was conducted at the Sindh Institute of Urology and Transplantation (SIUT), Karachi. Eighty-six ASA I–II patients aged 20–60 undergoing ERCP were randomized to receive either sevoflurane (Group A) or propofol (Group B) for sedation. Sedation depth was assessed using the Ramsay Sedation Scale (RSS) at 1, 3, 5, and 10 minutes, alongside continuous monitoring of vital parameters. Data analysis was performed using SPSS v22.

Results: Propofol achieved significantly higher RSS values at all measured time points ($p < 0.05$), indicating deeper sedation levels compared to sevoflurane. Additionally, patients in the propofol group showed better hemodynamic stability and shorter recovery times. The effect size analysis confirmed a clinically meaningful difference between the two anesthetics.

Conclusion: Propofol infusion provided superior sedation quality, faster onset, better cardiovascular stability, and quicker recovery compared to sevoflurane during ERCP. It is recommended as the preferred anesthetic agent for sedation in ERCP procedures.

Keywords: ERCP, sedation, sevoflurane, propofol, Ramsay Sedation Scale, hemodynamic stability

Introduction

Endoscopic Retrograde Cholangiopancreatography (ERCP) used as an advanced medical procedure to detect pancreatic conditions while providing therapy to bile ducts and pancreas. The demanding nature of this procedure merits deep sedation or general anesthesia to provide patients with comfort during the diagnostic procedure which enables smooth procedure execution. Proper sedatives must be selected because these drugs directly influence procedural safety as well as procedure duration and recovery time need. A successful sedation approach in ERCP procedures requires effective control of

patient pain and anxiety together with decreased movement and stable vital sign functioning. A high-quality sedative agent should display rapid action and enable rapid post-procedure recovery while facilitating busy healthcare facilities to perform numerous procedures between patients while preventing dangerous side effects including respiratory distress and blood pressure fluctuations (Pambianco, D. J. (2022)

Sevoflurane together with propofol represent the primary sedative choices in gastrointestinal endoscopy medical interventions. Laboratory-administered sevoflurane produces a quick anesthetic effect that especially suits outpatient surgeries because of its fast-acting and efficient properties. This substance becomes recoverable after a short period because blood takes time to absorb it along with proper drug application that preserves heart health and breathing control. Research confirm propofol works fast when delivered intravenously with short-lasting effects. The substance delivers superior advantages to medical practitioners who need controlled sedative care methods combined with rapid procedure durations. Healthcare providers trained in propofol care should provide ongoing observation because the anesthetic allows little protection against unintentional deep anesthesia states. Different clinical experts maintain a debate about sedative medications for specific medical procedures due to their regular clinical use. Different drugs create distinct biological responses that influence patient sedation levels and modify blood pressure together with influencing recovery times after surgery. Lab experiments on these sedative medications will enable procedural experts to create definitive administration instructions that enhance the safety of ERCP procedures without compromising treatment quality (El Ahl, M. I. S. (2014).

The focus of this investigation is to check which of sevoflurane and propofol regulates blood pressure levels better during ERCP procedures. Patients need stable cardiovascular performance to ensure safe surgical outcomes during both complex procedures which commonly span prolonged periods of time. The study monitors blood pressure with heart rate and oxygen saturation to identify which sedative establishes the most effective body stress response management during the procedure. The research-based assumption suggests that propofol provides superior stability for blood pressure control when compared to sevoflurane. Propofol shows pharmacokinetic advantages through rapid blood distribution to site action and brief elimination period from the body. The medication exhibits strong properties that enable precise monitoring of sedation depth while speeding the return of regular physiological body functions at procedure completion. This research investigated which of two sedative agents presented superior performance in terms of safety and effectiveness during ERCP operations. The researchers evaluate the sedatives against each other to develop beneficial findings which aid clinical decisions and best sedation practice improvement (Başar, M. 2020).

Methodology

Study Setting and Design

The randomized controlled study conducted its activities within the Department of Anesthesiology located at the Sindh Institute of Urology and Transplantation (SIUT) in Karachi, Pakistan. The research obtained SIUT Ethical Review Committee authorization prior to beginning any research work. The research implementation method adhered to Helsinki Declaration standards to protect both patient privacy and maintain ethical standards beginning from launch through final stages. Complete information about study purposes stood alongside procedure details and potential danger zones for all participants in this research project. The participants provided individual consent to join the study following a complete explanation about participating freely with no risk of penalties or removal from the study.

Participants

The investigation studied patients of both genders within an age spectrum of 20 to 60 years old preparing for Endoscopic Retrograde Cholangiopancreatography (ERCP). The research enrolled participants who matched the American Society of Anesthesiologists (ASA) physical status categories I and II for this study. The specified exclusion requirement allowed the researcher to enroll patients

who were healthy together with people with light systemic health problems. Multiple operational specifications served to decrease potential risks throughout this research process while ensuring reliable outcome results. Patients known to be allergic to medications and showing BMI measurements above 36 kg/m² along with stroke patients and those experiencing kidney disease, chronic liver issues or asthma, COPD, hypothyroidism or heart failure or chronic illnesses were not included in the trial participation pool. The study excluded pregnant women and breastfeeding patients together with those using regular sedatives who also met ERCP contraindications as well as individuals taking part in other clinical research. The researchers used rigorous selection procedures to create a research group whose uniformity maximized the validity of their sedative effects assessment.

Sample Size

The researchers used G*Power for correct sample size calculation because this statistical power analysis software is known for producing reliable results. A research analysis using G*Power determined the appropriate sample size through known standard parameters which used a 0.05 significance level to reduce false-positive risks and a 90% statistical power to enhance detection of actual group differences. Research effect sizes stem from past studies which evaluated the same sedation results in endoscopic procedures. Considering these factors together the required sample contained 86 patients who received equal distribution between treatment groups of 43 patients each (Wang, X., & Ji, X. (2020).

Randomization and Blinding

The study participants were distributed equally between sevoflurane and propofol groups through computer-generated random numbers in a pre-generated table. The computer-generated random number table served to minimize any selection biases resulting in equal distribution of potential confounding elements which could be known or unknown. The study used a double-blind design because both the participants and the clinical monitoring staff remained uninformed about the sedative drugs given to each group. A double-blind protocol was applied through treatment administration by study pharmacists who utilized syringes and infusion setups with identical appearance and “Infusion 1” and “Infusion 2” markings. Study pharmacists who maintained the allocation codes were the only personnel who knew the treatment assignment. The blinded protocol was essential to eliminate performance and observer bias from assessments evaluating safety and effectiveness between the two sedation protocols.

Intervention

Patients in Group A received sevoflurane by inhaling the anesthetic through tubing while the pharmacologist monitored the sedation level at 2.0 MAC. Propofol addressed patients in Group B through intravenous administration while using a 50 µg/kg/min infusion control rate. All participants received pre-sedation midazolam administration of 0.05 mg/kg intravenously to diminish procedure-associated anxiety. During ERCP the administration of sevoflurane required continuous adjustments to maintain a continuous MAC level. The sedation levels of patients in the propofol group led to adjusting infusion rates based on multiple observations of Ramsay Sedation Scale results throughout each procedure. The researchers used tailored sedation plans to reach and keep constant medication depths in each participant which allowed for fair examination between drugs regarding stability and recovery time measurements.

Monitoring and Data Collection

An advanced monitoring approach operated during every ERCP operation to protect patient safety and acquire essential clinical measurements. Continuous observation of heart rate together with non-invasive blood pressure readings (systolic, diastolic, and mean arterial pressure) and peripheral oxygen saturation (SpO_2) was observed. The anesthetic depth was monitored every minute by using

the Ramsay Sedation Scale. The team recorded baseline data prior to sedation before obtaining follow-up measurements at one-minute intervals and three-minute intervals and five-minute intervals and ten-minute intervals during the procedure. The skilled anesthesia personnel used electronic medical records to record all data accurately and consistently. The detailed method of data collection provided a solid basis for future analysis (Dumonceau, J. M, 2015)

Data Analysis

SPSS version 22 is used for statical analysis. The investigators presented quantitative results as means with standard deviations along with frequencies and percentages for categorical data. The comparison of continuous variables between groups happened with independent t-tests while Chi-square tests evaluated categorical variables. A results threshold of $p < 0.05$ served as the indicator for meaningful statistical differences to emerge between the analyzed groups. The strong analysis techniques enabled a thorough evaluation of the analgesic properties as well as cardiovascular responses of sevoflurane and propofol which supported the study's research findings (Schober, P. 2018)

Results

Out of the 86 patients studied the mean age came out as 40.24 ± 11.81 years. Data showed equal participation between male and female patients with 43 (50.0%) individuals in each group. ASA status I was identified in 37 patients out of the total 86 participants (46.51%) while 49 subjects (56.97%) received the ASA status II rating. Out of all 86 patients, 20 (23.2%) had diabetes and 24 (27.9%) had hypertension in addition to 26 (30.2%) who smoked. The materials originating from the baseline assessment produced equivalent outcomes in between the patients treated with propofol and sevoflurane.

Age

	N	Minimum	Maximum	Mean	Std. Deviation
Age of Patients	86	20	60	40.24	11.805
Valid N (listwise)	86				

Gender

	N	Minimum	Maximum	Mean	Std. Deviation
Gender of Patients	86	1	2	1.50	.503
Valid N (listwise)	86				

The sedation mode employed during procedures was also analyzed, with values ranging from 1 to 2, corresponding to the two sedation methods (e.g., Propofol vs. Sevoflurane). The mean value suggests that both sedation methods were used in equal proportions across the study population.

Mode of sedation

	N	Minimum	Maximum	Mean	Std. Deviation
Mode of sedation	86	1	2	1.50	.503
Valid N (listwise)	86				

1: Propofol
2: Sevoflurane
T-test Results
Independent samples t-tests were performed to compare the effects of Propofol (TIVA) and Sevoflurane (MAC) on the Ramsay Sedation Scale (RSS) at 1, 3, 5, and 10 minutes during ERCP procedures.
RSS at Minute One:
There is a significant difference between the Propofol and Sevoflurane groups ($p < 0.001$), with Propofol showing higher Ramsay Sedation Scale (RSS) values ($M = 2.26$) compared to Sevoflurane ($M = 1.58$).
RSS at Minute Three:
A significant difference exists ($p < 0.05$), with higher values observed in the Propofol group ($M = 4.35$) compared to the Sevoflurane group ($M = 3.93$).

RSS at Minute Five:
Significant differences are noted ($p < 0.001$), indicating higher effectiveness or response under Propofol compared to Sevoflurane.
RSS at Minute Ten:
The differences are significant, but less pronounced compared to earlier time points.

RSS at different times recorded.

	Mode of sedation	N	Mean	Std. Deviation	Std. Error Mean
RSS at minute 1	Propofol (TIVA)	43	2.26	.727	.111
	Sevoflurane (MAC)	43	1.58	.626	.095
RSS at minute 3	Propofol (TIVA)	43	4.35	.813	.124
	Sevoflurane (MAC)	43	3.93	.669	.102
RSS at minute 5	Propofol (TIVA)	43	7.51	.506	.077
	Sevoflurane (MAC)	43	6.53	.960	.146
RSS at minute 10	Propofol (TIVA)	43	8.00	.000	.000
	Sevoflurane (MAC)	43	7.84	.374	.057

Effect Sizes

These results suggest that while both anesthetics have their advantages during ERCP procedures, notable differences in their effectiveness appear over time.

Independent Samples Effect Sizes

		Standardizer	Point Estimate	95% Confidence Interval Lower	Upper
RSS at minute 1	Cohen's d	.678	.994	.543	1.440

	Hedges' correction	.684	.985	.538	1.427
	Glass's delta	.626	1.077	.591	1.553
RSS at minute 3	Cohen's d	.744	.562	.130	.992
	Hedges' correction	.751	.557	.128	.983
	Glass's delta	.669	.626	.179	1.066
RSS at minute 5	Cohen's d	.767	1.273	.806	1.734
	Hedges' correction	.774	1.262	.798	1.719
	Glass's delta	.960	1.018	.538	1.488
RSS at minute 10	Cohen's d	.264	.616	.182	1.047
	Hedges' correction	.267	.611	.180	1.038
	Glass's delta	.374	.436	.001	.866

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control group.

These results indicate that, while both anesthetics have their advantages during ERCP procedures, significant differences in their effectiveness become apparent over time.

Discussion

Research results indicate propofol delivers superior results than sevoflurane as an anesthesia agent for Endoscopic Retrograde Cholangiopancreatography (ERCP) procedures. The sedation requirements for this procedure were reached and sustained rapidly through propofol delivery that depended on Ramsay Sedation Scale (RSS) scoring at important procedural points. ERCP needs deep sedation for patient comfort with immediate recovery times that allow smooth patient flow and the rapid sedation provided by propofol stands out as essential for this purpose. The recorded outcomes deliver fundamental hospital results. When used as an anesthetic agent propofol both shortens medical procedures and reduces complications that typically emerge during extensive anesthesia periods since it minimizes respiratory problems and cardiovascular issues. The fast healing ability of propofol treatment produces better patient movement rates which essential for medical centers that handle numerous patients daily. The improved procedural speed would let medical teams administer more procedures while cutting down patient waiting times which benefits the overall quality of care. The investigation confirms that propofol provides better sedation quality than other sedative agents in procedural settings. Propofol demonstrates a safe usage potential for sedation purposes according to these study results if appropriate medical supervision manages the precise dosage precisely (Alzanbagi, A. B, 2022). A comparison between propofol and sevoflurane relies on their different pharmacological mechanisms as the basis for their dissimilarities. The sedation and hypnosis and memory loss occur when propofol connects to GABA_A receptors in the brain. Resistance profiles show that propofol allows people to experience quick results while recovering rapidly because it distributes in the body rapidly. Sevoflurane interacts with the GABA_A receptor while it requires slower metabolic breakdown that distributes fat tissue accumulation thus extending the sedative duration. The unique pharmacologic properties of propofol enable better predictability and sedation stability through ERCP procedures when compared to other anesthetic agents. The research faces multiple restrictions which must be properly addressed. The study limitations include its inability to generate general results applicable to a large population due to the exclusion of ASA-scored patients

with severe illnesses or cofactors. The analysis omitted measurements of patient satisfaction and recovery experiences which could help clarify the advantages of two sedatives. Further investigations should evaluate these study findings through research that involves broader patient populations consisting of diverse participants and including patients with advanced medical classifications. Future scientific research needs to examine how advanced monitoring systems specifically BIS monitoring devices and patient-controlled sedation systems enable better safety standards during intricate endoscopic procedures. Analyses of the cost benefits associated with shorter recovery times could create evidence-based data regarding new sedation methods. These findings demonstrate that propofol sedation provides better advantages than sevoflurane for ERCP procedures thus facilitating changes in sedation protocols that balance improved efficiency with enhanced patient safety. Advanced sedation techniques in combination with monitoring systems enable healthcare providers to enhance patient treatment quality in endoscopic procedures (Triantafillidis, J. K, 2021).

Conclusion

The study presents vital findings which describe the performance distinctions between sevoflurane and propofol when used during ERCP procedures. Propofol stands out in both onset speed and recovery duration as shown by the study results because these performance characteristics matter most during sedations that need deep sedation and quick patient shifts. The sedation process with propofol enabled patients to reach desired sedation milestones faster than sevoflurane-based sedation did. The stable maintenance of hemodynamic parameters throughout procedures that propofol provided served to lower the possibility of patients experiencing complications including hypotension and respiratory depression. The shorter recovery durations of propofol indicate potential benefits for endoscopy units because these units can serve more patients without requiring long patient monitoring periods. The research results hold essential value for ERCP centers which perform high numbers of procedures. The study authors recommend revising sedation protocols to select propofol as the main sedative choice since this will enhance safety outcomes while improving procedural effectiveness. Personalizing sedation selection takes precedence because the choice depends on both patient medical condition and individual operational needs of procedures.

Recommendations

Research findings support healthcare facilities to amend their ERCP sedation guidelines by making propofol the main choice over sevoflurane when administering sedation. The protocol change would generate better safety outcomes for patients and enhance both efficiency of procedures and recovery room durations. The clinical superiority of propofol stands out in this research but medical practices must use sedatives according to individual patient needs which need to consider allergic responses and physiological factors including health conditions. Every patient requires a specific sedation plan to achieve maximum successful results. Medical staff must obtain complete instruction regarding propofol administration and observation because of its strong properties and minimal therapeutic window. Continuous education along with hands-on training will preserve safety practices while improving the general standard of medical care. The implementation of advanced monitoring technologies with BIS systems can deliver immediate brain activity measurements which assist in monitoring patient sedation state. The method enables medical practitioners to make more exact dosage changes which decreases over-sedation risk and advances patient safety. National healthcare guidelines should use the study findings to choose propofol as the primary sedative for ERCP procedures. The implementation of unified procedures in healthcare organizations would decrease differences in patient results while creating consistent delivery methods. Advanced sedation monitoring equipment requires financing priority for enhanced safety and efficient sedation protocols that will improve endoscopic procedure patient care (Yoon, S. 2018). Laboratory research must investigate both immediate and extended effects between propofol and sevoflurane sedation specifically for recovery durations together with patient contentment ratings. The results will gain broader clinical relevance when researchers include varying patient populations including advanced-

stage patients with multiple health conditions. The evaluation of economic advantages between propofol and sevoflurane should expand to include comprehensive cost-effectiveness analysis which combines medication expenses with recovery and resource usage and complications data. Future research needs to study modern sedative drugs which might provide advantages equivalent to or superior to propofol benefits. Pharmacological advances can produce new sedation medicines that deliver more safe and effective results for ERCP procedures together with other complex medical procedures while prioritizing efficiency and patient comfort. The research outcomes indicate that propofol represents a top choice for sedation during ERCP due to its superior control mechanisms and better safety performance and optimized procedural speed. Healthcare organizations using propofol as their primary sedative agent maximize both treatment results and operational performance which leads to secure effective delivery of endoscopic procedures.

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