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Original Article

COMPARATIVE EVALUATION OF SEVOFLURANE AND ISOFLURANE IN FAST TRACK ANAESTHESIA FOR VALVULAR CARDIAC SURGERY: A RANDOMIZED STUDY

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ABSTRACT

Objective: Contemporary valvular cardiac surgery has evolved with the adoption of expedited postoperative recovery, known as fast-tracking. This paradigm shift results from advancements in anaesthetic agents, surgical techniques, and myocardial protection strategies. Fast-track anaesthesia aims to reduce intensive care unit (ICU) stays and overall hospital length of stay (LOS), optimizing resource utilization. Cardioprotective properties of volatile anaesthetic agents, especially in mitigating ischemic myocardial damage, have garnered attention.

Methods: A hospital-based, randomized, comparative study was conducted at the Department of Anaesthesiology, S. M. S Medical College, Jaipur. 70 undergoing valvular heart surgery under general anaesthesia, were randomly assigned to two groups: Group A (Sevoflurane) and Group B (Isoflurane). Inclusion criteria encompassed ASA grade II to IV patients aged 20 to 50 y, with a body weight of 30-65 kg, and willingness to provide written consent. Anaesthesia induction and maintenance involved the administration of Sevoflurane or Isoflurane based on group allocation. Hemodynamic parameters were recorded at various surgical stages.

Results: Heart rate, systolic blood pressure, and cardiac output were statistically insignificant between groups at different surgical stages ($p>0.05$). Intraoperative variables demonstrated no significant differences, except for a transient decrease in systolic blood pressure post-induction in both groups.

Conclusion: The study underscores the comparable efficacy of Sevoflurane and Isoflurane in valvular cardiac surgery, supported by similar hemodynamic profiles. Understanding the nuances of volatile anaesthetic agents is crucial for their optimal clinical application, considering challenges like beta-blocker usage and perioperative hyperglycemia.

Keywords: Fast track anaesthesia, Valvular cardiac surgery, Volatile anesthetic agents, Ischemic preconditioning

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INTRODUCTION

In contemporary valvular cardiac surgery, expedited postoperative recovery, known as fast-tracking, has become standard practice. This advancement is attributable to a combination of factors, including the utilization of anaesthetic agents characterized by shorter durations of action, diminished reliance on narcotics, enhanced surgical methodologies, and heightened myocardial protection strategies [1].

The implementation of fast-track anaesthesia in cardiac surgery has markedly reduced both intensive care unit (ICU) stays and overall hospital length of stay (LOS), concurrently optimizing resource utilization and mitigating costs without compromising patient outcomes. Recent advancements, particularly in *in vitro* investigations and *in vivo* animal experiments, have spotlighted the cardioprotective attributes of volatile (halogenated) anaesthetic agents in mitigating ischemic myocardial damage [2].

These halogenated agents, mimicking the effects of ischemic preconditioning, have demonstrated efficacy in safeguarding the myocardium, as affirmed in patients undergoing coronary artery bypass graft surgery (CABG) with cardiopulmonary bypass (CPB). Given that myocardial infarction remains a critical perioperative concern, the imperative to shield the myocardium from ischemia during cardiac procedures has spurred extensive research, underscoring the pivotal role of anaesthetic management [3].

The concept of ischemic preconditioning, initially elucidated in 1986, reveals an adaptive response to brief sublethal ischaemic episodes, conferring protection against subsequent lethal ischemia. However, its clinical application is hindered by the inherent risk of exacerbating myocardial vulnerability. Consequently, pharmacological preconditioning emerges as a pragmatic alternative, wherein anaesthetic agents play a crucial role [4].

The intricate mechanisms underlying myocardial protection by anaesthetic agents involve processes akin to ischemic preconditioning, prevention of excessive calcium influx, antioxidant effects, and modulation of the neutrophil/platelet-endothelium interface. Signalling cascades integral to anaesthetic preconditioning encompass protein kinase C (PKC), protein tyrosine kinase (PTK), mitogen-activated protein kinases (MAPK), protein kinase-B, mitochondria, and ion channels [5].

While experimental studies underscore the direct cardioprotective effects of volatile anaesthetic agents, their application in clinical settings demands meticulous consideration of concentration and duration, independent of ischemic preconditioning. Challenges, such as beta-blocker usage and perioperative hyperglycemia, may temper the effectiveness of these agents [6].

Optimal utilization of volatile anaesthetics in surgeries involving extracorporeal circulation (ECC) necessitates strategic administration before aorta clamping and during reperfusion. Additionally, postconditioning effects, akin to ischemic postconditioning, highlight the importance of initiating these agents promptly after unclamping to maximize protective effects [7].

MATERIALS AND METHODS

Materials Required: All equipments required for standard vitals monitoring and emergency drugs.

Monitors

- Multipara cardiac monitor

- FloTrac monitor for continuous cardiac output monitoring.

Anaesthesia drugs

Midazolam, Fentanyl, Etomidate, Rocuronium Ondansetron, Atracurium, Neostigmine.

Study drugs

- Sevoflurane
- Isoflurane

Study location

The study was conducted in the Department of Anesthesiology, S. M. S Medical College and attached group of hospitals, Jaipur, with approval from the institutional ethical committee, review board, and written informed consent.

Study design

Hospital-based, randomized, comparative study design.

Sample size

A total of 70 subjects (35 in each group) were calculated for a power of 80%, assuming a difference in mean to be detected at 3 with SD 4.3, as per a seed article.

Randomization done using the chit-in-the-box method. A total of 70 chits will be prepared, each indicating a particular study group.

Inclusion criteria

- ASA grade II to IV
- Patients approval
- Age 20 to 50 y, bodyweight 30-65 kg
- Valvular heart surgery under general anaesthesia
- Same cardiac medications (e. g., Frusamide, beta-blockers)

Exclusion criteria

- Patients refusal
- Chronic illness (Compromised renal or pulmonary status, Blood coagulation disorder, Diabetes mellitus, Obesity)
- Anaemia (Hb<10 g/dl)
- Difficult intubation criteria
- Hypersensitivity to study drugs
- LVEF<40%, Severe cardiac arrhythmias

Pre-anesthetic checkup

Patients will undergo pre-anesthetic checkup, including a detailed medical history, physical examination, and routine investigations.

Patients will be randomly allocated to two groups:

- Group A: Sevoflurane (1 MAC)
- Group B: Isoflurane (1 MAC)

Procedure

1. NBM for 12 h preoperatively.
2. Monitoring devices attached.
3. Central venous and intra-arterial cannulation performed under local anaesthesia.
4. Intravenous Fentanyl (2 mcg/kg) administered, and baseline data recorded.
5. Preoxygenation with 100% oxygen is carried out.
6. Induction is done, and anaesthesia is maintained with Sevoflurane or Isoflurane.
7. Hemodynamic parameters recorded at different stages.
8. After completing surgery, patients are shifted to the ICU.
9. Statistical analysis of data will be conducted, followed by conclusions.

RESULTS

Tables 1, 2, 3, and 4 present the distribution of patients according to age, the comparison of heart rate at various intervals, the comparison of systolic blood pressure (S. B. P.) at various intervals, and the comparison of cardiac output (CO) in both groups, respectively.

Table 1: Distribution of patients according to age in both groups

Patients	Group sevo		Group Iso		P-Value b/w groups
	Mean	SD	Mean	SD	
Age (Years)	37.9	8.6	39.1	9.1	0.5221

The statistical analysis revealed no significant difference in ASA class distribution of patients between the two groups (p value>0.05)

Table 2: Comparison of heart rate at various intervals

Heart rate	Group a-sevoflurane			Group b-isoflurane			P-value b/w groups
	Mean	SD	P-value	Mean	SD	P-value	
Basal Vitals	87.6	19.5		95.7	16.0		0.0625
2 min after induction	90.7	19.0	0.5057	96.5	18.1	0.8341	0.1911
at sternotomy	90.9	15.9	0.4433	98.9	18.9	0.4384	0.0577
at aortic cannulation	91.8	19.9	0.3733	94.1	17.9	0.7046	0.6108
just after CPB	94.9	14.8	0.0834	98.8	14.1	0.3900	0.2607
After protamine	93.8	13.6	0.1257	96.6	11.8	0.7798	0.3670
Just before shifting to ICU	97.0	15.3	0.0275	98.5	11.8	0.3930	0.6439

Above table shows that the heart rate at various surgical steps as mean±SD. It is observed that heart rates were comparable (statistically insignificant, p value>0.05) in both groups.

Table 3: Comparison of S. B. P. AT various intervals

S. B. P.	Group a-sevoflurane			Group b-isoflurane			P- Value
	Mean	SD	P-Value	Mean	SD	P-Value	b/w groups
Basal Vitals	120.4	13.7		117.3	14.3		0.3643
2 min after induction	101.8	16.2	0.0000	104.5	15.5	0.0006	0.4715
at sternotomy	114.4	15.1	0.0860	114.6	15.2	0.4386	0.9560

S. B. P.	Group a-sevoflurane			Group b-isoflurane			P- Value
	Mean	SD	P-Value	Mean	SD	P-Value	b/w groups
at aortic cannulation	95.5	21.2	0.0000	99.0	21.4	0.0001	0.4921
just after CPB	104.1	13.4	0.0000	104.0	13.6	0.0002	0.9577
After protamine	111.6	10.4	0.0035	108.3	9.5	0.0027	0.1714
Just before shifting to ICU	114.6	9.0	0.0409	110.9	9.1	0.0293	0.0959

It is observed that intraoperative S. B. P. were comparable (statistically insignificant, p value>0.05) in both groups, except at 2 min after induction, where S. B. P. shows decrease in both groups from the baseline values; however, values were statistically insignificant (p value>0.05)

Table 4: Comparison of cardiac output in both groups

Cardiac output	Group a-sevoflurane			Group b-isoflurane			P-Value
	Mean	SD	P-value	Mean	SD	P-Value	b/w groups
Basal Vitals	5.3	1.2		5.0	0.6		0.1679
2 min after induction	4.5	0.8	0.0012	4.1	0.7	0.0000	0.0647
at sternotomy	4.9	0.9	0.0982	4.6	0.5	0.0177	0.1797
at aortic cannulation	4.9	1.0	0.1719	4.6	0.5	0.0083	0.0963
just after CPB	6.5	1.8	0.0017	6.0	0.9	0.0000	0.1733
After protamine	6.7	2.3	0.0019	6.0	1.6	0.0005	0.1663
Just before shifting to ICU	5.8	1.6	0.1080	5.5	0.7	0.0027	0.2243

It is observed that intraoperative CO were comparable (statistically insignificant, p value>0.05) in both groups,

DISCUSSION

The contemporary landscape of valvular cardiac surgery has witnessed a paradigm shift with the advent of expedited postoperative recovery, commonly known as fast-tracking. This transformative approach, attributable to a confluence of factors, encompasses the use of anaesthetic agents characterized by shorter durations of action, reduced reliance on narcotics, advanced surgical techniques, and enhanced myocardial protection strategies. The pivotal objective is to streamline patient recovery while concurrently optimizing resource utilization and minimizing costs [8].

Fast-track anaesthesia in cardiac surgery has demonstrated substantial success in reducing both intensive care unit (ICU) stays and overall hospital length of stay (LOS). This achievement is pivotal not only in improving patient outcomes but also in ensuring efficient resource allocation in healthcare settings. Recent advances in *in vitro* investigations and *in vivo* animal experiments have shed light on the cardioprotective properties of volatile (halogenated) anaesthetic agents, particularly in mitigating ischemic myocardial damage [9].

The cardioprotective attributes of these halogenated agents, mirroring the effects of ischemic preconditioning, have been evident in patients undergoing coronary artery bypass graft surgery (CABG) with cardiopulmonary bypass (CPB). Considering the ongoing concern of myocardial infarction in the perioperative period, safeguarding the myocardium from ischemia during cardiac procedures has become a focal point of extensive research, emphasizing the crucial role of anaesthetic management [10].

The concept of ischemic preconditioning, elucidated in 1986, reveals an adaptive response to brief sublethal ischemic episodes, providing protection against subsequent lethal ischemia. However, the clinical application of ischemic preconditioning faces challenges due to the inherent risk of exacerbating myocardial vulnerability. In response, pharmacological preconditioning, where anaesthetic agents play a pivotal role, emerges as a pragmatic alternative [11].

The intricate mechanisms underlying myocardial protection by anaesthetic agents involve processes akin to ischemic preconditioning, prevention of excessive calcium influx, antioxidant effects, and modulation of the neutrophil/platelet-endothelium interface. Signalling cascades integral to anaesthetic preconditioning include protein kinase C (PKC), protein tyrosine kinase (PTK), mitogen-activated protein kinases (MAPK), protein kinase-B, mitochondria, and ion channels [12].

Experimental studies emphasize the direct cardioprotective effects of volatile anaesthetic agents. However, their clinical application demands meticulous consideration of concentration and duration, independent of ischemic preconditioning. Challenges such as beta-blocker usage and perioperative hyperglycemia may temper the effectiveness of these agents [7].

Optimal utilization of volatile anaesthetics in surgeries involving extracorporeal circulation (ECC) necessitates strategic administration before aorta clamping and during reperfusion. Postconditioning effects, analogous to ischemic postconditioning, underscore the importance of initiating these agents promptly after unclamping to maximize protective effects [2, 13].

CONCLUSION

In conclusion, the study adds to the evolving landscape of fast-track anesthesia in valvular cardiac surgery, providing a foundation for continued research and clinical application of volatile anaesthetic agents in optimizing patient outcomes and resource utilization.

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AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

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