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Research Article

Comparison between Total Intravenous Anesthesia (TIVA) versus Inhalational Anesthesia in Laparoscopic Sleeve Gastrectomy: A Randomized Clinical Trial

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ABSTRACT

Background: Laparoscopic sleeve gastrectomy (LSG) is a cornerstone of bariatric surgery, requiring optimized anesthesia to ensure patient safety and postoperative recovery. Total Intravenous Anesthesia (TIVA) and inhalational anesthesia are commonly employed, yet their comparative efficacy in LSG remains underexplored. This study evaluates TIVA versus Inhalational Anesthesia in LSG, focusing on recovery time, hospital length of stay (LOS), postoperative nausea and vomiting (PONV), pain scores, and adverse events.

Methods: A randomized clinical trial (RCT) was conducted on 70 patients undergoing LSG between January 2024 and June 2025. The study data were collected in general operating rooms by an anesthesia assistant and colleagues at the Imam Khomaini Hospital Complex of tehran. Patients were randomly assigned to TIVA (n=35) or inhalational (n=35) groups using a computer-generated randomization sequence.

Primary outcomes included recovery time, LOS, and PONV incidence. Secondary outcomes included Visual Analog Scale (VAS) pain scores at 15, 30, 45, and 60 minutes post-surgery and adverse events (hypotension, bradycardia). Data were analyzed using t-tests for continuous variables and chi-square tests for categorical variables, with significance set at $p<0.05$.

Results: TIVA significantly reduced recovery time (21.1 ± 15.2 vs. 34.6 ± 20.3 minutes, $p<0.05$) and PONV incidence (20% vs. 34.5%, $p<0.01$) compared to inhalational anesthesia. VAS scores were lower in the TIVA group at 15 minutes (5.2 ± 1.8 vs. 6.8 ± 1.5, $p<0.05$) and 30 minutes (5.0 ± 1.7 vs. 6.5 ± 1.6, $p<0.05$), with no significant differences at 45 or 60 minutes. LOS was comparable (2.4 ± 0.7 vs. 2.7 ± 0.9 days, $p=0.15$). Subgroup analyses showed TIVA's superior recovery time in women ($p<0.05$) and the 30-40 age group ($p<0.05$). Adverse events were similar between groups.

Conclusion: TIVA offers faster recovery and lower PONV rates compared to inhalational anesthesia in LSG, particularly in women and patients aged 30-40 years. These findings advocate for TIVA as a preferred anesthetic strategy in LSG to enhance postoperative outcomes.

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Introduction

Laparoscopic sleeve gastrectomy (LSG) has emerged as a highly effective bariatric procedure for managing morbid obesity, offering significant weight loss, improved life style, decrease relative diseases, and a gradual improvement in obesity-related symptoms [1]. The procedure is partially resection more than half of original stomach volume in upper part to create a tubular sleeve, reducing gastric capacity and altering hormonal signaling to promote satiety [2]. Sleeve surgery is a minimally invasive and technically depend on high pressure gas in abdominal cavity, pathophysiological changes in high body mass index, increased risk of cardio- respiratory function and prolonged recovery, Intensive care unit support,the choice of anesthetic technique is critical to optimizing perioperative outcomes. Inability to breathe deeply is the most complication (26% in obese patients vs 4% in non-obese patients, P=0.025 [3].

There is comparison between two modle of common anesthesia: Total Intravenous Anesthesia (TIVA), typically using propofol and remifentanil, and Inhalation Anesthesia, and volatile agents such as sevoflurane or isoflurane [4]. TIVA is characterized by parenteral delivery system, faster on and off, recovery depend on cesacion of infusion and reduced e nausea and vomiting because of propofol infusion pharmacological effect.[5]. On the other hand, inhalational anesthesia is widely used due to its ease of administration, precise control via end-tidal monitoring, and cost-effectiveness in many settings [6]. However, volatile agents are not effective on control or decrease postoperative nausea and vomiting (PONV), a significant concern in bariatric surgery due to its impact on patient comfort and recovery [7]. Despite the widespread use of both techniques, comparative studies in the context of LSG are limited. Existing literature suggests that TIVA may reduce recovery time and PONV in various surgical settings [5,8], but data specific to LSG are sparse. Moreover, patient-specific factors, such as sex and age, may influence anesthesia outcomes, with some evidence indicating better performance of TIVA in women and younger patients [9]. The obese population with higher body mass index (BMI) presents additional challenges, including altered drug pharmacokinetics and increased susceptibility to adverse events like hypotension or respiratory depression [10]. In clinical practice and anesthesia plane comparison of TIVA and inhalational anesthesia in LSG we present advantages of TIVA technique vs inhalation anesthesia clinical findings is related to recovery time, hospital length of stay (LOS), PONV incidence, postoperative pain scores, and optimizing hemodynamic and respiratory stability and some disadvantages like the popularity and cost-effectiveness of the inhalation method. Results of this study show that TIVA has some advantages in the intraoperative anesthesia management and emerging from anesthesia in obese patients compare with inhalation technique.

Methods

Study Design

This randomized clinical trial (RCT) was conducted on 70 patients who underwent LSG between January 2024 and June 2025. Patients were randomly assigned to either the TIVA group (n=35) or the inhalational anesthesia group (n=35) using a computer-generated randomization sequence with a 1:1 allocation ratio. The study was designed to compare outcomes between TIVA and inhalational anesthesia, with allocation concealment maintained using sealed opaque envelopes. Blinding of patients and outcome assessors was implemented to minimize bias, though anesthesiologists were not blinded due to the nature of the interventions.

Patients were included if they met the following criteria:

Age 18-60 years. Body mass index (BMI) $\geq$ 35 kg/m², consistent with indications for bariatric surgery. Underwent elective LSG under either TIVA or inhalational anesthesia. Complete medical records for anesthesia and postoperative outcomes. Exclusion criteria included: Emergency or revisional LSG procedures. Severe comorbidities affecting anesthesia outcomes (e.g., advanced heart failure, chronic obstructive pulmonary disease).

Anesthesia Management

Patients were divided into two groups based on the anesthetic technique used during LSG:

Group one TIVA Group (n=35): Anesthesia was maintained with propofol (50-150 µg/kg/min) and remifentanil (0.1-0.5 µg/kg/min). Induction involved midazolam (0.03 mg/kg) and fentanyl (2 µg/kg). Group two Inhalational Group (n=35): Anesthesia was maintained with isoflurane (0.8-1.5% end-tidal concentration) combined with fentanyl (1-2 µg/kg/h). Induction was standardized with midazolam and fentanyl, as in the TIVA group.

Anesthetic management followed institutional protocols, with standardized preoperative assessments, including airway evaluation and optimization of comorbidities. All procedures were performed by experienced anesthesiologists and surgeons to ensure consistency.

Data Collection

Data were collected prospectively and included:

Demographic and Clinical Variables: Age, sex, BMI, American Society of Anesthesiologists (ASA) classification.

Outcomes:

1. Recovery Time: Time (minutes) from discontinuation of anesthesia to extubation, assessed in the post-anesthesia care unit (PACU).
2. Hospital LOS: Duration of hospital stay (days) from surgery to discharge.
3. PONV Incidence: Presence or absence of PONV within 24 hours post-surgery, based on patient reports and nursing records.
4. VAS Pain Scores: Pain intensity measured on a 0-10 Visual Analog Scale at 15, 30, 45, and 60 minutes post-surgery.
5. Adverse Events: Incidence of intraoperative or postoperative complications, including hypotension (systolic blood pressure <90 mmHg) and bradycardia (heart rate <50 beats/min).

Data Analysis

Continuous variables (e.g., recovery time, LOS, VAS scores) were expressed as mean ± standard deviation (SD) and compared using independent t-tests. Categorical variables (e.g., PONV, adverse events) were reported as percentages and analyzed with chi-square tests.

Subgroup analyses stratified outcomes by sex (male vs. female) and age groups (<30, 30-40, >40 years) to explore demographic influences. A P value <0.05 was considered statistically significant. Data were analyzed using SPSS version 26 (IBM Corp., Armonk, NY). An intention-to-treat analysis was used to account for any protocol deviations.

Ethics Committee

The study was approved by the Institutional Review Board. Informed consent was obtained from all participants prior to enrollment, address: https://ethics.reserch.ac.ir.TUMS.IKHC.REC.1403.399

Study data were confidentially preserved, cared for, and archived. The study adhered to the international ethical guidelines.

Results

Patient Characteristics

The study comprised 70 patients (35 TIVA, 35 inhalational). Baseline characteristics were well-balanced between groups (Table 1).

The mean age was 36.4 ± 9.0 years, 61.4% were female, and the mean BMI was 42.5 ± 5.7 kg/m². ASA classifications were predominantly II (65%) or III (30%), with no significant differences between groups (p>0.05).

Outcomes

TIVA was associated with a significantly shorter recovery time compared to inhalational anesthesia (21.1 ± 15.2 vs. 34.6 ± 20.3 minutes, p<0.05).

Hospital LOS did not differ significantly between groups (2.4 ± 0.7 vs. 2.7 ± 0.9 days, p=0.15). The incidence of PONV was markedly lower in the TIVA group (20% vs. 34.5%, p<0.01) (Table 2).

VAS pain scores were significantly lower in the TIVA group at 15 minutes (5.2 ± 1.8 vs. 6.8 ± 1.5, p<0.05) and 30 minutes (5.0 ± 1.7 vs. 6.5 ± 1.6, p<0.05) post-surgery. Differences were not significant at 45 minutes (4.8 ± 1.6 vs. 5.5 ± 1.5, p=0.10) or 60 minutes (4.3 ± 1.5 vs. 4.9 ± 1.4, p=0.12) (Table 3).

Data Analysis

Subgroup analyses revealed significant differences in recovery time by sex and age (Table 4).

Among women, TIVA resulted in a shorter recovery time (21.3 ± 15.5 vs. 34.8 ± 20.5 minutes, p<0.05), while the difference in men was not significant (20.0 ± 14.5 vs. 33.0 ± 19.0 minutes, p=0.08).

By age group, TIVA showed significant benefits in patients aged <30 years (20.0 ± 14.0 vs. 33.0 ± 18.5 minutes, p<0.05) and 30-40 years (20.8 ± 14.8 vs. 34.0 ± 19.5 minutes, p<0.05), but not in those >40 years (22.0 ± 15.8 vs. 36.0 ± 21.0 minutes, p=0.12).

Intra operative anesthesia monitoring events:

Intraoperative hypotension occurred in 16% of TIVA patients (6/35) and 27.6% of inhalational patients (10/35) (p=0.12).

Bradycardia rates were comparable (8% [3/35] vs. 7% [2/35], p=0.88). No severe adverse events (e.g., anaphylaxis, respiratory failure) were reported in either group.

Table 1- Baseline Characteristics of Study Participants

Variable	TIVA (n=35)	Inhalational (n=35)	P value
Age (years)	36.0 ± 8.7	36.8 ± 9.3	0.75
Sex (Female, %)	62.9%	60.0%	0.81
BMI (kg/m²)	42.2 ± 5.5	42.8 ± 5.9	0.67
ASA Class II (%)	65.7%	64.3%	0.89
ASA Class III (%)	31.4%	28.6%	0.80

Table 2- Primary Outcomes

Outcome	TIVA (n=35)	Inhalational (n=35)	P value

Recovery Time (min)	21.1 ± 15.2	34.6 ± 20.3	<0.05
Hospital LOS (days)	2.4 ± 0.7	2.7 ± 0.9	0.15
PONV Incidence (%)	20% (7/35)	34.5% (12/35)	<0.01

Table 3- VAS Pain Scores Over Time

Time Point	TIVA (n=35)	Inhalational (n=35)	P value
15 min	5.2 ± 1.8	6.8 ± 1.5	<0.05
30 min	5.0 ± 1.7	6.5 ± 1.6	<0.05
45 min	4.8 ± 1.6	5.5 ± 1.5	0.10
60 min	4.3 ± 1.5	4.9 ± 1.4	0.12

Table 4- Recovery Time by Sex and Age Group

Variable	TIVA (min)	Inhalational (min)	P value
Sex			
Male (n=27)	20.0 ± 14.5	33.0 ± 19.0	0.08
Female (n=43)	21.3 ± 15.5	34.8 ± 20.5	<0.05
Age Group			
<30 years (n=20)	20.0 ± 14.0	33.0 ± 18.5	<0.05
30-40 years (n=30)	20.8 ± 14.8	34.0 ± 19.5	<0.05
>40 years (n=20)	22.0 ± 15.8	36.0 ± 21.0	0.12

Discussion

This randomized clinical trial of 70 patients undergoing LSG demonstrates that TIVA offers significant advantages over inhalational anesthesia in several critical outcomes. The most notable finding is the reduction in recovery time with TIVA (21.1 ± 15.2 vs. 34.6 ± 20.3 minutes, $p < 0.05$), which aligns with prior studies highlighting propofol's rapid clearance and minimal residual effects [5,11]. Faster recovery is particularly valuable in bariatric surgery, where obese patients are at higher risk of prolonged sedation and respiratory complications [10]. The shorter recovery time with TIVA may reduce PACU stay duration, potentially lowering healthcare costs and improving patient throughput in surgical units.

The lower incidence of PONV in the TIVA group (20% vs. 34.5%, $p < 0.01$) is consistent with the antiemetic properties of propofol, which may act directly on the chemoreceptor trigger zone to suppress nausea [7,12]. PONV is a significant concern in bariatric surgery, as it can delay oral intake, increase patient discomfort, and prolong hospital stays [13]. The observed reduction in PONV with TIVA supports its use as a strategy to enhance patient satisfaction and postoperative recovery.

Pain management is another critical aspect of postoperative care. TIVA was associated with significantly lower VAS pain scores at 15 and 30 minutes post-surgery ($p<0.05$), likely due to the synergistic analgesic effects of remifentanil and propofol during the early recovery phase [14]. However, the convergence of VAS scores by 45 and 60 minutes suggests that long-term pain control is comparable between techniques, possibly reflecting standardized postoperative analgesia protocols (e.g., acetaminophen, nonsteroidal anti-inflammatory drugs). These findings underscore TIVA's role in improving early postoperative comfort, which is crucial for patient mobilization and recovery in LSG.

Anesthesia management with TIVA's benefits were more pronounced in women and patients aged 30-40 years. The shorter recovery time in women (21.3 ± 15.5 vs. 34.8 ± 20.5 minutes, $p < 0.05$) may reflect sex-specific differences in propofol pharmacokinetics, such as higher clearance rates in women [9]. Similarly, the 30-40 age group showed significant benefits with TIVA (20.8 ± 14.8 vs. 34.0 ± 19.5 minutes, $p<0.05$), possibly due to age-related variations in sensitivity to volatile anesthetics [15]. These findings suggest that TIVA may be particularly suited for younger female patients undergoing LSG, a demographic that constitutes a significant portion of bariatric surgery candidates [1].

The lack of significant difference in the >40 age group ($p=0.12$) may be attributed to age-related declines in metabolic clearance or increased comorbidity burden, which could attenuate TIVA's advantages [10].

Hospital Length of Stay and Adverse Events

The absence of a significant difference in hospital LOS (2.4 ± 0.7 vs. 2.7 ± 0.9 days, $p=0.15$) may reflect institutional discharge protocols, which often prioritize standardized criteria (e.g., pain control, oral intake, ambulation) over anesthesia-specific factors. While TIVA's faster recovery time could theoretically expedite discharge, other variables, such as surgical complications or patient-specific factors, likely influence LOS [16].

Adverse events, including hypotension and bradycardia, were comparable between groups, supporting the safety of both TIVA and inhalational anesthesia in LSG. The slightly higher hypotension rate in the inhalational group (27.6% vs. 16%, $p=0.12$) may be related to the vasodilatory effects of volatile agents, though the difference was not statistically significant [6]. These findings suggest that both techniques are safe for LSG, with TIVA offering recovery advantages without compromising safety.

Clinical Findings

The results of this study have several implications for clinical practice. First, TIVA's shorter recovery time and lower PONV incidence make it a preferable choice for LSG, particularly in settings where rapid PACU turnover and patient comfort are priorities. Second, the benefits in women and younger patients suggest that anesthesiologists should consider demographic factors when selecting an anesthetic technique. Third, the comparable safety profiles of TIVA and inhalational anesthesia indicate that either approach can be used effectively, with TIVA offering specific advantages in patient-centered outcomes.

However, TIVA's implementation requires specialized equipment (e.g., infusion pumps) and training, which may limit its use in resource-constrained settings [4]. Inhalational anesthesia, with its simpler administration and lower cost, remains a viable alternative, particularly in hospitals with limited access to TIVA protocols. Future research should explore cost-effectiveness analyses to guide resource allocation in bariatric surgery programs.

Limitations

This study has several limitations. The sample size (n=70) is relatively small, which may limit statistical power for detecting differences in secondary outcomes like LOS or adverse events. Missing data for VAS scores beyond 60 minutes restricted longitudinal pain analysis, and the lack of data on long-term outcomes (e.g., weight loss, quality of life) limits the study's scope.

Conclusion

This randomized clinical trial demonstrates that TIVA offers significant advantages over inhalational anesthesia in patients undergoing LSG, including shorter recovery times, lower PONV incidence, and reduced early postoperative pain. These benefits are particularly pronounced in women and patients aged 30-40 years, highlighting the importance of demographic considerations in anesthetic choice. While hospital LOS and adverse event rates were comparable, TIVA's superior recovery profile supports its use as a preferred technique in LSG. These findings contribute to the growing evidence base for optimizing anesthesia in bariatric surgery and underscore the need for further research to refine clinical protocols and enhance patient outcomes.

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