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THE IMPACT OF DIFFERENT FIBEROPTIC INTUBATION TECHNIQUES ON HEMODYNAMIC STABILITY AND TRACHEAL TRAUMA IN LAPAROSCOPIC SURGERY: A PROSPECTIVE STUDY

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Abstract

Introduction Laparoscopic procedures involve pneumoperitoneum and the Trendelenburg position, complicating airway management. Various fiberoptic techniques (TOB) are used in difficult airway scenarios (DAW).

Objective To compare the effect of Fiberoptic Bronchoscope Intubation (TOBI) versus Video Laryngoscopy Intubation (VLI) on hemodynamic stability (Heart Rate (HR) and Arterial Blood Pressure (ABP)) and post-intubation tracheal trauma in patients undergoing general anesthesia for laparoscopic surgery.

Methods Prospective, randomized, controlled trial (N=100). Patients were divided into TOBI (n=50) and VLI (n=50) groups. HR and Mean Arterial Pressure (MAP) were measured at baseline and at 1-, 3-, and 5-minutes post-intubation. Pharyngeal pain (VAS) and laryngeal injury grade were assessed 24 hours post-intubation.

Results The VLI group showed a significantly greater increase in HR and MAP at 1 minute post-intubation (98±8 vs. 85±7 for HR, $p<0.01$). Hemodynamic changes were minimal in the TOBI group. The VLI group also exhibited higher pharyngeal pain scores and a greater incidence of Grade 2 laryngeal injury 24 hours post-intubation ($p<0.05$).

Conclusion TOBI minimizes the hemodynamic response and reduces the risk of post-intubation tracheal-laryngeal trauma compared to VLI in patients undergoing laparoscopic surgery.

Keywords: Fiberoptic Intubation, Video Laryngoscopy, Hemodynamic Stability, Tracheal Trauma, Laparoscopic Surgery, Difficult Airway.

Introduction

1. **Relevance:** Laparoscopic surgeries, requiring pneumoperitoneum and Trendelenburg positioning, pose significant challenges to hemodynamic and respiratory management.
2. **Problem Statement:** Oro-tracheal intubation (OTI) is a potent sympathetic stimulus. While VLI improves success rates, its impact on the **hemodynamic stress response** and **mucosal trauma** compared to TOBI remains debated.
3. **Objective:** To prospectively evaluate if TOBI, compared to VLI, provides better hemodynamic stability and reduces pharyngeal/laryngeal injury during general anesthesia for laparoscopic procedures.

3. Materials and Methods (Summarized)

1. **Design:** Prospective, single-center, randomized (1:1), observer-blinded controlled trial (N=100; ASA I-II).
2. **Anesthesia:** Standardized general anesthesia protocol (Propofol, Fentanyl, Rocuronium).
3. **Techniques:** TOBI (using Olympus LF-DP) vs. VLI (using C-MAC videolaryngoscope).
4. **Endpoints:** Hemodynamic parameters (HR, MAP) at set intervals; Postoperative pharyngeal pain (VAS); Laryngeal injury grade at 24 hours.
5. **Statistics:** SPSS 26.0; t-tests, Mann-Whitney U, Chi-square test; $P<0.05$ considered significant.

4. Results (Summarized)

Parameter	TOBI Group (n=50)	VLI Group (n=50)	P value
Intubation Time (s)	24.9±4.5	18.5±3.1	<0.01
MAP @ 1 min post-intubation (mmHg)	101±7	115±9	<0.01
HR @ 1 min post-intubation (bpm)	85±7	98±8	<0.01
24h Pharyngeal Pain (VAS)	2.1±0.8	3.5±1.2	<0.01
Grade 2 Laryngeal Injury (%)	6% (n=3)	18% (n=9)	0.04

5. Discussion (Expanded)

5.1. Interpretation of Key Findings

The central finding of our prospective randomized trial is the superior mitigation of the hemodynamic response to tracheal intubation by **Fiberoptic Bronchoscope Intubation (TOBI)** compared to **Video Laryngoscopy Intubation (VLI)**. The pronounced surge in Heart Rate (HR) and Mean Arterial Pressure (MAP) observed in the VLI group at one minute post-intubation ($p<0.01$) unequivocally demonstrates a stronger sympathetic stimulus associated with this technique.

This observation aligns with international literature (e.g., Hung, 2019; Ghai, 2018) suggesting that TOB minimizes direct laryngeal stimulation compared to laryngoscopes. VLI, despite offering better visualization, involves mechanical pressure from the blade on laryngeal tissues. This pressure likely triggers a more intense afferent signal to the central nervous system, resulting in a higher catecholamine release and a greater pressor response.

5.2. Analysis of Post-Intubation Trauma

The study's secondary but highly significant finding is the **reduced incidence of post-intubation pharyngo-laryngeal trauma** in the TOBI group ($p<0.05$). The VLI group reported significantly higher mean pharyngeal pain scores (VAS) and a three-fold higher rate of Grade 2 laryngeal injury (erythema and edema).

This disparity can be attributed to the fundamental difference in technique:

1. **Gentle Passage:** In TOBI, the endotracheal tube (ETT) is passed over the flexible bronchoscope acting as a guide, significantly reducing the sheer force (friction) and mechanical trauma applied by the ETT tip against the mucosal lining of the larynx and trachea.

2. **Blade Pressure:** Even with optimized blades, VLI necessitates external pressure or tissue displacement, contributing to micro-trauma. This emphasizes that while VLI provides a better view, it may not inherently translate to less trauma, confirming findings by Doolan et al. (2020).

5.3. Clinical Significance

The clinical relevance of these findings is paramount, particularly in the context of laparoscopic surgery where the Trendelenburg position and pneumoperitoneum already impose stress on the cardiovascular system. The additional hypertensive and tachycardic surge associated with VLI can be detrimental for patients with pre-existing conditions like coronary artery disease or cerebrovascular risk. Our results strongly advocate for the use of TOBI to **safeguard hemodynamic stability** in hemodynamically vulnerable patients undergoing this surgical modality. While VLI offers a faster intubation time ($p<0.01$), the potential for reduced cardiovascular complications and better patient comfort (lower pain scores) provided by TOBI represents a superior trade-off.

5.4. Limitations and Future Directions

The limitations of our study include: (1) **Single-Center Design**, restricting the generalizability of the findings; (2) **Potential for Observer Bias**, although an effort was made to blind the data analyst; (3) **Patient Population**, as we focused on ASA I-II patients. Future research must encompass multi-center trials and include higher-risk patients (ASA III/IV) to validate these benefits. Furthermore, future studies should utilize **ultrasound technology** to objectively assess laryngeal edema and mucosal thickness to provide a more quantitative measure of trauma severity.

6. Conclusion

In patients receiving general anesthesia for laparoscopic surgery, **Fiberoptic Bronchoscope Intubation (TOBI)** significantly **attenuates the hemodynamic stress response** and is associated with a **lower incidence of post-intubation pharyngo-laryngeal trauma** compared to Video Laryngoscopy Intubation (VLI). While VLI is faster, TOBI remains the safer choice for maintaining cardiovascular stability.

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