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Original Research Article

A Randomised Study to Compare the Between-The-Fingers Grip Technique Vs. Conventional Pen-Holding Grip Technique for Holding an Endotracheal Tube During Orotracheal Intubation at SMS Medical College, Jaipur

Ramesh Kumar[1], Rajni Mathur[2], Gopal Bansal[3], Arun Garg[4]

[1]Resident, Department of Anaesthesiology, SMS Medical College, Jaipur, Rajasthan, India
[2]Professor, Department of Anaesthesiology, SMS Medical College, Jaipur, Rajasthan, India
[3]Assistant Professor, Department of Anaesthesiology, SMS Medical College, Jaipur, Rajasthan, India
[4]Assistant Professor, Department of Anaesthesiology, SMS Medical College, Jaipur, Rajasthan, India

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Corresponding Author: Dr. Ramesh Kumar
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Abstract:

Background: Orotracheal intubation is a fundamental procedure during general anaesthesia, and successful tube placement depends on both adequate glottic visualisation and effective handling of the endotracheal tube (ETT). The conventional pen-holding grip is the most widely taught method for holding the ETT during direct laryngoscopy; however, the between-the-fingers grip has been proposed as an alternative that may offer better real-time control of tube curvature and tip direction. Despite growing interest, limited randomised data exist comparing these two techniques in terms of intubation outcomes.

Objective: To compare the between-the-fingers grip technique with the conventional pen-holding grip technique for holding an endotracheal tube during orotracheal intubation, with respect to intubation attempts, BURP (backward, upward, rightward pressure) requirement, intubation time, haemodynamic changes, and complications.

Methods: This prospective, randomised, comparative study was conducted in the Department of Anaesthesiology, SMS Medical College and attached hospitals, Jaipur, after obtaining institutional ethical approval. Three hundred patients aged 18–60 years, ASA physical status I–II, scheduled for elective surgery under general anaesthesia, were randomly allocated to Group M (modified between-the-fingers grip, n = 150) or Group C (conventional pen-holding grip, n = 150) using sealed opaque envelopes. Primary outcomes included first-attempt intubation success rate, BURP requirement, and intubation time. Secondary outcomes included haemodynamic parameters and intubation-related complications.

Results: Demographic and airway characteristics were comparable between the two groups. First-attempt intubation success was 99.3% in Group M and 97.3% in Group C ($p = 0.176$). BURP requirement was significantly lower in Group M than in Group C (0.7% vs. 6.7%; $p = 0.014$). Mean intubation time was significantly shorter in Group M (12.65 ± 4.23 vs. 14.62 ± 4.71 seconds; $p = 0.0002$). Heart rate and mean arterial pressure during tube insertion were comparable between the groups ($p = 0.505$ and $p = 0.717$, respectively). No major intubation-related complications were observed in either group.

Conclusion: Both grip techniques achieved high first-attempt intubation success rates. However, the modified between-the-fingers grip significantly reduced the need for BURP assistance and shortened the intubation time without producing clinically meaningful haemodynamic differences. It may therefore be considered a useful and effective alternative to the conventional pen-holding grip for routine orotracheal intubation.

Keywords: Orotracheal Intubation; Endotracheal Tube Grip Technique; Between-The-Fingers Grip; Pen-Holding Grip; BURP Manoeuvre; Intubation Time; Direct Laryngoscopy; Randomised Study.

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Introduction

Airway management is a fundamental and critical responsibility in the practice of anaesthesiology and is essential for ensuring patient safety during surgical procedures performed under general anaesthesia. The ability to establish, maintain, and protect a patent airway underpins virtually every anaesthetic technique, and orotracheal intubation remains the gold standard for securing the airway in the majority of operative cases. Successful endotracheal intubation ensures adequate

oxygenation and ventilation throughout the surgical procedure, protects the tracheobronchial tree from aspiration, and facilitates controlled delivery of anaesthetic gases and agents.

Orotracheal intubation, though routinely performed, is a technically demanding procedure that requires the coordinated execution of several sequential steps: appropriate patient positioning, laryngoscope insertion, adequate visualisation of the glottic structures, and precise advancement of the endotracheal tube (ETT) through the vocal cords into the trachea. While much attention in the anaesthesia literature has been directed towards laryngoscope design, blade geometry, patient positioning, and methods to improve glottic visualisation, comparatively less emphasis has been placed on the technique by which the anaesthesiologist holds and manipulates the ETT during the critical moment of tube advancement.

It is well recognised that obtaining a satisfactory glottic view during laryngoscopy does not, by itself, guarantee easy or atraumatic passage of the endotracheal tube. Difficulty may be encountered while directing the tube tip towards the glottic opening, particularly in patients with anterior laryngeal anatomy, suboptimal visualisation grades, or subtle airway variations that are not readily apparent on preoperative assessment. Uncontrolled, forceful, or misdirected advancement of the ETT can result in airway trauma, including mucosal injury, arytenoid dislocation, vocal cord damage, and oesophageal intubation, all of which may lead to significant patient morbidity.

The conventional pen-holding grip, in which the ETT is grasped between the thumb and the index finger in a manner analogous to holding a pen, is the most widely practised and commonly taught method for ETT handling during direct laryngoscopy. This grip provides adequate control for tube insertion in the majority of cases. However, it restricts the operator's ability to dynamically alter the curvature or trajectory of the tube tip during advancement, potentially leading to difficulty in aligning the tube with the glottic opening in challenging intubation scenarios.

The between-the-fingers grip, introduced by Tewari in 2001, offers an alternative approach to ETT handling. In this technique, the ETT is held between the index and middle fingers, which allows the operator to apply gentle, controlled pressure to modify the curvature of the tube in real time during advancement towards the glottic opening. This capacity for dynamic adjustment of tube trajectory has been proposed to improve the accuracy and smoothness of tube insertion, reduce the need for external laryngeal manipulation such as the BURP (backward, upward, rightward pressure) manoeuvre, and decrease the time required for successful intubation.

Despite the potential advantages of the between-the-fingers grip, the clinical evidence comparing it with the conventional pen-holding technique remains limited. Only a few randomised studies have examined this comparison, and further data are needed to support or refute any advantage of one technique over the other in routine clinical practice. Differences may exist between the two grips with respect to the number of intubation attempts required, the frequency of BURP requirement, the time needed for successful tube placement, and the haemodynamic response to intubation. Understanding these differences has the potential to refine teaching practices and improve the efficiency and safety of routine orotracheal intubation.

The present study was therefore designed to compare the modified between-the-fingers grip technique with the conventional pen-holding grip technique for holding the endotracheal tube during orotracheal intubation in patients undergoing elective surgery under general anaesthesia. The primary outcomes assessed were first-attempt intubation success, BURP requirement, and intubation time. Secondary outcomes included haemodynamic changes during intubation and the incidence of intubation-related complications.

Materials and Methods

Study Design and Setting: This was a prospective, randomised, single-centre, parallel-group, comparative study conducted in the Department of Anaesthesiology and Critical Care, Sawai Man Singh (SMS) Medical College and attached group of hospitals, Jaipur, Rajasthan, India. The study was initiated after obtaining approval from the Institutional Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from all participants prior to enrolment.

Sample Size Calculation: The sample size was calculated based on the primary outcome variable (BURP requirement) using a 95% confidence level ($\alpha = 0.05$) and 80% statistical power ($\beta = 0.20$). Accounting for an anticipated difference between the two groups and a potential dropout rate, a total sample size of 300 patients (150 in each group) was determined to be adequate for the study.

Participants

Inclusion Criteria: Patients aged 18 to 60 years of either sex, with American Society of Anesthesiologists (ASA) physical status classification I or II, scheduled for elective surgical procedures requiring general anaesthesia with

orotracheal intubation, were eligible for inclusion in the study.

Exclusion Criteria: Patients with an anticipated difficult airway (Mallampati class III or IV, limited mouth opening, restricted neck mobility, or history of difficult intubation), cervical spine disease or instability, upper-airway abnormalities (tumours, trauma, infection, or oedema), body mass index (BMI) greater than 35 kg/m², and those at an increased risk of aspiration (full stomach, pregnancy, gastroparesis) were excluded from the study. Patients with significant cardiovascular or respiratory comorbidities that could independently affect haemodynamic parameters, and those who refused to provide written informed consent, were also excluded.

Randomisation and Group Allocation: A total of 300 eligible patients were randomly allocated in a 1:1 ratio to one of two groups using a computer-generated random number sequence. Group allocation was concealed using sequentially numbered, sealed, opaque envelopes, which were opened immediately before the induction of anaesthesia. Group M (n = 150) underwent orotracheal intubation using the modified between-the-fingers grip technique, while Group C (n = 150) underwent orotracheal intubation using the conventional pen-holding grip technique.

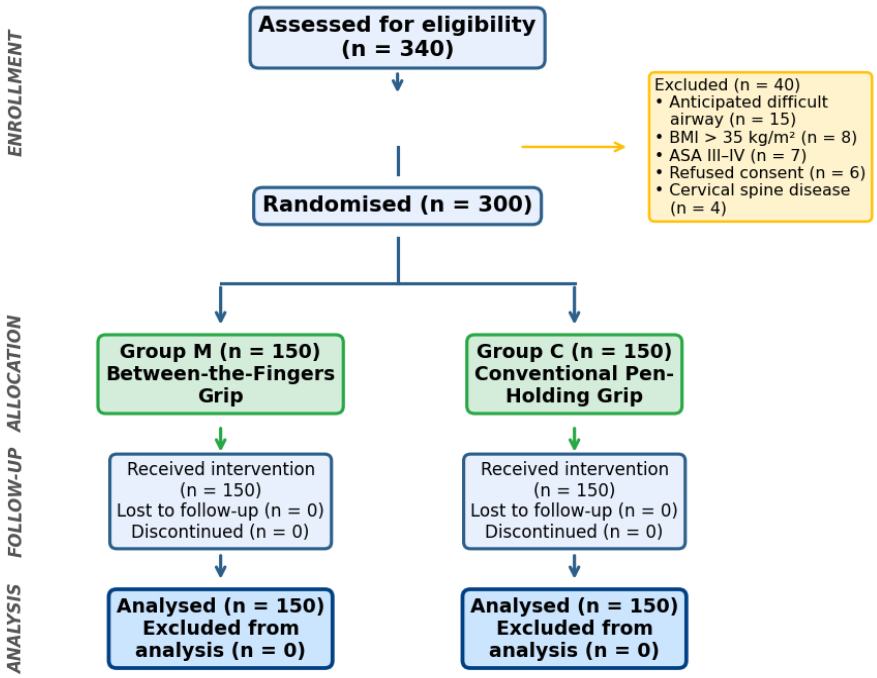

Figure 1: CONSORT flow diagram showing patient enrolment, allocation, follow-up, and analysis

Preoperative Assessment and Preparation: All patients underwent a standardised preoperative assessment, which included a detailed history, general physical examination, systemic examination, and focused airway evaluation. The airway assessment comprised the Mallampati classification, measurement of thyromental distance, assessment of mouth opening, evaluation of neck mobility, and assessment of dentition. Routine preoperative investigations, including complete blood count, blood group and typing, blood glucose, renal function tests, chest radiograph, and electrocardiogram, were performed as per institutional protocol.

Standard monitoring was established prior to the induction of anaesthesia, including electrocardiography (ECG), non-invasive blood pressure (NIBP), pulse oximetry (SpO_2), and end-tidal carbon dioxide ($EtCO_2$) monitoring. An intravenous line was secured, and all patients were premedicated and preoxygenated as per the standardised anaesthetic protocol of the institution.

Anaesthetic Technique: General anaesthesia was induced with a standardised technique, including administration of intravenous induction agents and a neuromuscular blocking agent to facilitate endotracheal intubation. After adequate neuromuscular blockade was confirmed, direct laryngoscopy was performed using a Macintosh laryngoscope blade of appropriate size, with the patient in the sniffing position. The laryngoscopic view was graded according to the Cormack–Lehane classification.

Intubation Technique and Group-Specific Procedure: In Group M, the endotracheal tube was

held between the index and middle fingers (the modified between-the-fingers grip). This grip allowed the operator to control the curvature and trajectory of the tube during advancement towards the glottic opening by applying gentle pressure with the fingers. The tube was advanced under direct vision through the vocal cords into the trachea.

In Group C, the endotracheal tube was held between the thumb and index finger in the conventional pen-holding grip, analogous to holding a writing instrument. The tube was advanced towards the glottic opening in the standard manner. All intubations in both groups were performed by a single experienced anaesthesiologist to minimise inter-operator variability.

If the glottic view was suboptimal, the BURP (backward, upward, rightward pressure) manoeuvre was applied by an assistant as required. The requirement for BURP was documented. Intubation was defined as the point at which the endotracheal tube was advanced through the vocal cords and its cuff was placed beyond the glottic opening. Confirmation of correct tube placement was performed by auscultation of bilateral equal air entry and capnographic confirmation of end-tidal carbon dioxide ($EtCO_2$).

Outcome Measures

Primary Outcomes: (1) First-attempt intubation success rate; (2) Requirement for BURP manoeuvre; (3) Intubation time — defined as the interval from the moment the endotracheal tube tip passed the incisors to the appearance of the first capnographic waveform ($EtCO_2$), recorded by a trained technician using a digital stopwatch.

Secondary Outcomes: (1) Haemodynamic parameters — heart rate (HR) and mean arterial pressure (MAP) at baseline (before induction), during tube insertion, and at the first $EtCO_2$ reading; (2) Intubation-related complications — including lip or mucosal trauma, dental injury, sore throat, and oesophageal intubation.

Statistical Analysis: Data were entered into a Microsoft Excel spreadsheet and analysed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation (SD) and compared between the groups using the independent samples t-test (for normally distributed data) or the Mann–Whitney U test (for non-normally distributed data). Categorical variables were expressed as frequency and percentage (%) and compared using the chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 300 patients were enrolled in the study and analysed, with 150 patients in each group. No patients were lost to follow-up or excluded from the analysis after randomisation.

Baseline Demographic and Airway Characteristics: The demographic and anthropometric characteristics of the two groups are presented in Table 1. The mean age was 38.77 ± 12.77 years in Group M and 38.23 ± 11.77 years in Group C (p = 0.704). The male-to-female ratio was identical in both groups (48.7% vs. 51.3%). Mean BMI was 24.71 ± 4.76 kg/m² in Group M and 24.86 ± 4.68 kg/m² in Group C (p = 0.786). Mallampati grade distribution (p = 0.053) and Cormack–Lehane grading (p = 0.318) were comparable between the groups. Preoperative airway assessment revealed that all patients in both groups had adequate mouth opening, adequate neck movement, thyromental distance greater than 6 cm, and adequate dentition (100% in each group). These findings confirm that the randomisation achieved well-balanced groups with comparable baseline characteristics.

Table 1: Baseline demographic and airway characteristics of the study groups

Characteristic	Group M (n = 150)	Group C (n = 150)	p-value
Age (years), mean ± SD	38.77 ± 12.77	38.23 ± 11.77	0.704
Sex, male/female, n (%)	73 (48.7) / 77 (51.3)	73 (48.7) / 77 (51.3)	1.000
BMI (kg/m²), mean ± SD	24.71 ± 4.76	24.86 ± 4.68	0.786
Mallampati grade I / II, n	36 / 111	47 / 94	0.053
C–L grade I / IIa / IIb, n	93 / 43 / 14	105 / 36 / 9	0.318

BMI = body mass index; C–L = Cormack–Lehane; SD = standard deviation

Primary Intubation Outcomes: The primary intubation outcomes are summarised in Table 2. First-attempt intubation was successful in 149 patients (99.3%) in Group M and 146 patients (97.3%) in Group C; the difference was not statistically significant (p = 0.176). A second attempt was required in 1 patient (0.7%) in Group M and 4 patients (2.7%) in Group C. No patient in either group required more than two attempts for successful intubation.

The BURP manoeuvre was required in significantly fewer patients in Group M compared with Group C (1 patient [0.7%] vs. 10 patients [6.7%]; p = 0.014). This indicates that the between-the-fingers grip facilitated better alignment of the ETT with the

glottic opening, reducing the need for external laryngeal manipulation.

Mean intubation time was significantly shorter in Group M compared with Group C (12.65 ± 4.23 seconds vs. 14.62 ± 4.71 seconds; p = 0.0002). The mean difference of approximately 2 seconds, although modest in absolute terms, was consistent and statistically significant, suggesting improved efficiency of tube advancement with the between-the-fingers grip.

Table 2: Comparison of primary intubation outcomes

Outcome	Group M (n = 150)	Group C (n = 150)	p-value
First-attempt success, n (%)	149 (99.3)	146 (97.3)	0.176
Second attempt required, n (%)	1 (0.7)	4 (2.7)	0.176
BURP required, n (%)	1 (0.7)	10 (6.7)	**0.014***
Intubation time (s), mean ± SD	12.65 ± 4.23	14.62 ± 4.71	**0.0002***

BURP = backward, upward, rightward pressure; *statistically significant (p < 0.05)

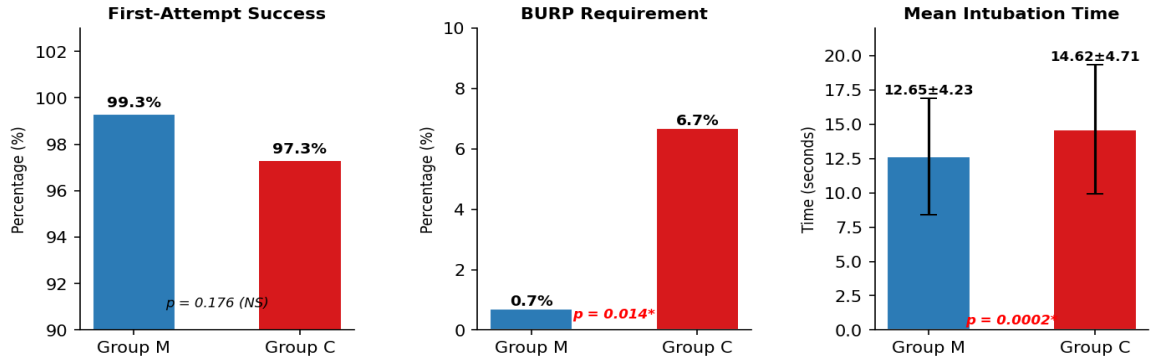

Figure 2: Comparison of primary intubation outcomes between Group M (between-the-fingers grip) and Group C (conventional pen-holding grip). *p < 0.05; NS = not significant.

Haemodynamic Parameters: The haemodynamic parameters at various time points are presented in Table 3. Baseline heart rate was significantly higher in Group M than in Group C (86.11 ± 9.62 vs. 81.84 ± 10.58 bpm; p = 0.0003). However, during tube insertion, heart rate was comparable between the two groups (p = 0.505), indicating that the intubation-related haemodynamic stress response was similar irrespective of the grip technique used. At the first $EtCO_2$ reading, heart rate remained comparable between the groups (p = 0.057).

Baseline MAP was similar in both groups (95.83 ± 7.16 vs. 96.81 ± 8.14 mmHg; p = 0.269). During tube insertion, MAP was also comparable (80.97 ± 8.37 vs. 81.31 ± 7.54 mmHg; p = 0.717). At the first $EtCO_2$ reading, MAP was slightly higher in Group M (88.73 ± 8.16 vs. 86.78 ± 8.24 mmHg; p = 0.041). Although this difference was statistically significant, the absolute difference of approximately 1.95 mmHg is unlikely to be of clinical significance in routine practice.

Table 3: Comparison of haemodynamic parameters at various time points

Parameter	Group M (n = 150)	Group C (n = 150)	p-value
HR – Baseline (bpm)	86.11 ± 9.62	81.84 ± 10.58	**0.0003***
HR – First $EtCO_2$ (bpm)	91.13 ± 9.91	93.29 ± 9.59	0.057
MAP – Baseline (mmHg)	95.83 ± 7.16	96.81 ± 8.14	0.269
MAP – Tube insertion (mmHg)	80.97 ± 8.37	81.31 ± 7.54	0.717
MAP – First $EtCO_2$ (mmHg)	88.73 ± 8.16	86.78 ± 8.24	**0.041***

HR = heart rate; MAP = mean arterial pressure; bpm = beats per minute; $EtCO_2$ = end-tidal carbon dioxide; *p < 0.05

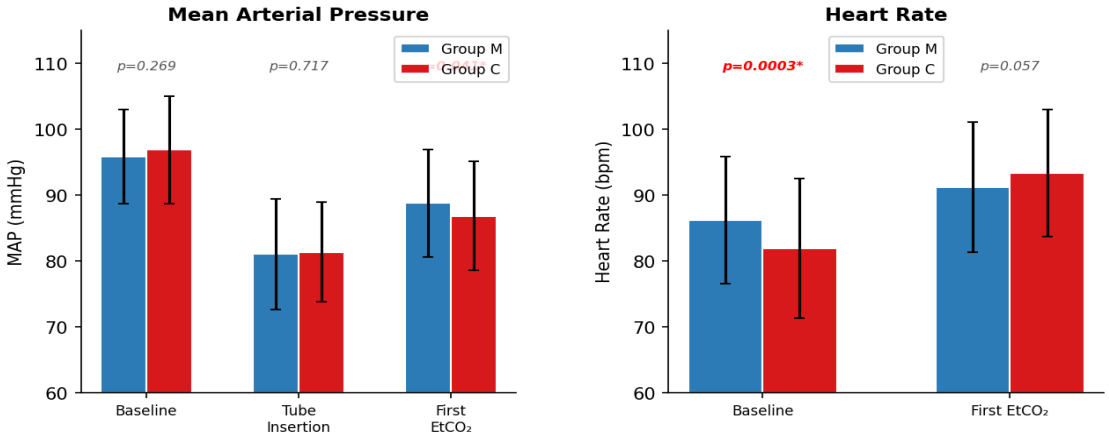

Figure 3: Comparison of haemodynamic parameters (MAP and heart rate) between Group M and Group C at baseline, tube insertion, and first $EtCO_2$ reading. *p < 0.05.

Discussion

The present prospective, randomised study compared the modified between-the-fingers grip technique with the conventional pen-holding grip technique for holding the endotracheal tube during orotracheal intubation in 300 patients undergoing elective surgery under general anaesthesia at SMS Medical College, Jaipur. The groups were well matched for demographic, anthropometric, and airway characteristics, ensuring a valid comparison. Both techniques achieved high first-attempt intubation success rates; however, the modified between-the-fingers grip demonstrated significant advantages in terms of reduced BURP requirement and shorter intubation time.

First-Attempt Intubation Success: First-attempt intubation was successful in 99.3% of patients in Group M and 97.3% in Group C. Although the success rate was numerically higher with the between-the-fingers grip, the difference did not reach statistical significance ($p = 0.176$). This finding indicates that both grip techniques are highly effective for achieving successful orotracheal intubation. These results are consistent with those reported by Thakur et al., who found first-attempt success rates of 99.3% and 97.2% with the modified and conventional grips, respectively, in their randomised controlled trial. Similarly, Tailor et al. observed equivalent first-attempt success rates with both techniques. The consistently high success rates across studies reflect the fact that, in patients with normal airway anatomy, the grip technique is one of several factors contributing to successful intubation, and the overall technique of laryngoscopy and tube advancement is more important than the grip alone.

BURP Requirement: The requirement for the BURP manoeuvre was significantly lower with the modified between-the-fingers grip than with the conventional pen-holding grip (0.7% vs. 6.7%; $p = 0.014$). This finding is clinically meaningful, as the BURP manoeuvre requires an additional assistant and may cause patient discomfort or trauma if applied forcefully. This result closely agrees with the findings of Thakur et al., who reported BURP requirements of 0.75% and 6.99% with the modified and conventional grips, respectively. Tailor et al. also reported a significantly lower BURP requirement with the modified grip (4.0% vs. 24.0%), although the absolute proportions in their study were higher than in the present study, possibly reflecting differences in study populations and operator experience.

The reduced BURP requirement with the between-the-fingers grip can be attributed to the biomechanical advantage of this technique. Holding the ETT between the index and middle fingers allows the operator to apply controlled pressure to modify the curvature of the tube in real time during advancement. This permits more accurate alignment of the tube tip with the glottic opening, thereby reducing the need for external laryngeal manipulation to improve the trajectory of the tube. In contrast, the conventional pen-holding grip provides a relatively fixed tube curvature and trajectory, which may require compensatory external assistance (BURP) when the tube does not align optimally with the glottis.

Intubation Time: Mean intubation time was significantly shorter in Group M than in Group C (12.65 ± 4.23 vs. 14.62 ± 4.71 seconds; $p = 0.0002$). The mean difference of approximately 2 seconds, although modest in absolute terms, was statistically significant and may be clinically relevant in certain situations, such as rapid sequence intubation, emergency airway management, or patients with limited oxygen reserves. A shorter intubation time reduces the duration of apnoea and the risk of desaturation, particularly in patients with compromised respiratory function.

These findings are consistent with previous reports. Thakur et al. observed mean intubation times of 12.7 ± 5.1 seconds and 16.5 ± 7.1 seconds with the

modified and conventional grips, respectively. Tailor et al. also reported significantly shorter intubation times with the modified grip. The consistently shorter intubation time across studies suggests that the between-the-fingers grip facilitates smoother and more efficient tube advancement, possibly because the operator can dynamically adjust the tube trajectory without pausing to reposition or apply external manoeuvres.

Haemodynamic Response: Heart rate and MAP during tube insertion were comparable between the two groups, indicating that the haemodynamic stress response to intubation was not significantly influenced by the grip technique used. Baseline heart rate was significantly higher in Group M (86.11 ± 9.62 vs. 81.84 ± 10.58 bpm; $p = 0.0003$), which is likely a chance finding related to randomisation rather than an effect of the intervention. At the first $EtCO_2$ reading, MAP was slightly higher in Group M (88.73 ± 8.16 vs. 86.78 ± 8.24 mmHg; $p = 0.041$), but the absolute difference of 1.95 mmHg is unlikely to be of clinical relevance in routine anaesthetic practice. Overall, these findings are consistent with those of Thakur et al. and Tailor et al., who reported comparable haemodynamic responses with both grip techniques.

Clinical Implications: The findings of the present study have several important clinical implications. The between-the-fingers grip may be considered as a useful alternative to the conventional pen-holding grip, particularly in situations where optimal glottic alignment is challenging or where external laryngeal manipulation is undesirable. The reduced BURP requirement with the between-the-fingers grip makes it especially relevant in resource-limited settings where an additional assistant may not always be immediately available. Moreover, the shorter intubation time may be advantageous in emergency intubation scenarios, rapid sequence induction, and in patients with limited apnoeic tolerance. Incorporating training in the between-the-fingers grip into anaesthesia residency curricula and simulation-based education programmes may broaden the repertoire of intubation skills available to trainee anaesthesiologists.

Strengths and Limitations: The strengths of the present study include its randomised design, adequate sample size (300 patients), performance of all intubations by a single anaesthesiologist to minimise inter-operator variability, and objective measurement of intubation time by a trained technician. The study evaluated multiple relevant outcomes, including intubation attempts, BURP requirement, intubation time, haemodynamic parameters, and complications.

However, the study has certain limitations that should be acknowledged. First, it was conducted at a single centre, which may limit the generalisability of the findings to other settings. Second, the study included only patients with ASA I–II status and excluded those with anticipated difficult airways; therefore, the results may not be directly applicable to patients with difficult airway anatomy. Third, the operator was not blinded to the group allocation (given the nature of the intervention), which introduces the possibility of performance bias, although the objective nature of the outcome measurements (time, BURP requirement) mitigates this concern. Fourth, the study assessed short-term intubation outcomes and did not evaluate long-term sequelae such as post-extubation airway complications or prolonged sore throat. Finally, the study was limited to direct laryngoscopy and may not be generalisable to intubation performed with video laryngoscopes or other airway devices.

Conclusion

Both the modified between-the-fingers grip and the conventional pen-holding grip achieved high and comparable first-attempt intubation success rates in patients undergoing elective surgery under general anaesthesia. However, the modified between-the-fingers grip significantly reduced the requirement for BURP assistance (0.7% vs. 6.7%; $p = 0.014$) and shortened the mean intubation time (12.65 ± 4.23 vs. 14.62 ± 4.71 seconds; $p = 0.0002$) without producing clinically meaningful haemodynamic differences during tube insertion. The between-the-fingers grip may therefore be considered a useful, effective, and practical alternative to the conventional pen-holding grip for routine orotracheal intubation. Its incorporation into anaesthesia training programmes and clinical practice may improve the efficiency and safety of airway management.

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