

Comparison of Modified between-the-Fingers Grip and Conventional Pen-holding Grip for Endotracheal Tube Handling during Orotracheal Intubation: A Randomised Clinical Trial

RICHA TAILOR¹, JIGISHA MEHTA², SARA MARY THOMAS³

ABSTRACT

Introduction: Correct handling of the Endotracheal Tube (ETT) is essential for successful tracheal intubation. The “between-the-fingers grip” allows real-time manipulation of ETT curvature during insertion, potentially improving alignment with the laryngeal inlet compared to conventional pen-holding grip.

Aim: To compare the efficacy of between-the-fingers grip with conventional pen-holding grip for endotracheal intubation regarding first-pass success rates, requirement for Backward Upward Rightward Pressure (BURP) manoeuvre, and procedural efficiency.

Materials and Methods: The randomised single centre clinical study was conducted at a tertiary care academic hospital from September 2024 to February 2025. One hundred adult patients (18-60 years) undergoing elective surgery under general anaesthesia were randomised to group C (conventional pen-holding grip, n=50) and group M (modified between-the-fingers grip, n=50). A single experienced anaesthesiologist performed all intubations using direct laryngoscopy. Parameters studied included first-pass success rate, BURP requirement, intubation

time, and haemodynamic changes (heart rate, mean arterial pressure). Data were analysed using Statistical package for Social Sciences (SPSS) version 23. Categorical variables were compared using Fisher’s-exact test, continuous variables using independent t-tests. Statistical significance was set at $p<0.05$.

Results: Demographic characteristics were similar with mean age 32.6 ± 9.8 vs 30.9 ± 8.2 years, 50% vs 48% males, and comparable airway assessments between group C and group M respectively. First-attempt intubation success was equivalent between groups (98.0% vs 98.0%, $p>0.05$). BURP requirement was significantly reduced in the modified grip group (4.0% vs 24.0%, $p<0.001$), representing 20% absolute risk reduction. Mean intubation time was shorter with modified grip (12.7 ± 5.1 vs 16.5 ± 7.1 seconds, $p<0.01$). Haemodynamic parameters remained stable and comparable between the groups.

Conclusion: The between-the-fingers grip demonstrates equivalent first-pass success to conventional technique while significantly reducing BURP requirements by 20% and intubation time by 23%. This technique offers clinical advantages particularly when skilled assistance is limited.

Keywords: Backward upward rightward pressure manoeuvre, General anaesthesia, Grip technique, Laryngoscopy

INTRODUCTION

Airway management remains the cornerstone of anaesthetic practice, with successful endotracheal intubation being fundamental to patient safety during general anaesthesia [1,2]. The technique of holding the ETT during laryngoscopy has received limited scientific attention despite its potential impact on intubation success [3]. While various aspects of intubation technique have been extensively studied, including laryngoscope blade selection, patient positioning, and pharmacological optimisation, the method of ETT handling remains relatively unexplored in the contemporary literature. Traditional teaching emphasises the pen-holding grip for ETT manipulation during direct laryngoscopy [4]. However, this conventional approach provides limited dynamic control over tube tip positioning as it approaches the glottic opening. First-pass intubation success has become increasingly important as a quality indicator, with studies demonstrating that complications and mortality escalate with increasing numbers of procedural attempts [5,6]. A recent study has shown that multiple intubation attempts are associated with significantly increased odds of adverse events, with odds ratios ranging from 4.4 to 13.9 for complications with attempts 2-5+ compared to first-pass success [7].

The BURP manoeuvre, originally described by Knill RL in 1993, has become a standard technique for improving glottic visualisation during difficult laryngoscopy [8]. However, this manoeuvre

requires skilled assistance and introduces coordination delays that may not always be available, particularly in emergency situations [9]. Recent studies have shown BURP requirements ranging from 6-24% of cases, depending on patient population and technique employed [10,11]. The need for external laryngeal manipulation requires an additional trained assistant and increase overall procedural complexity. In 2001, Tewari P described an alternative “between-the-fingers” grip that allows real-time manipulation of ETT curvature during insertion, potentially improving alignment with the laryngeal inlet [12]. This grip gives a biomechanical advantage by enabling the anaesthetist to guide the tube’s trajectory dynamically during advancement, helping accommodate anatomical variations and decreasing reliance on external assistance [13].

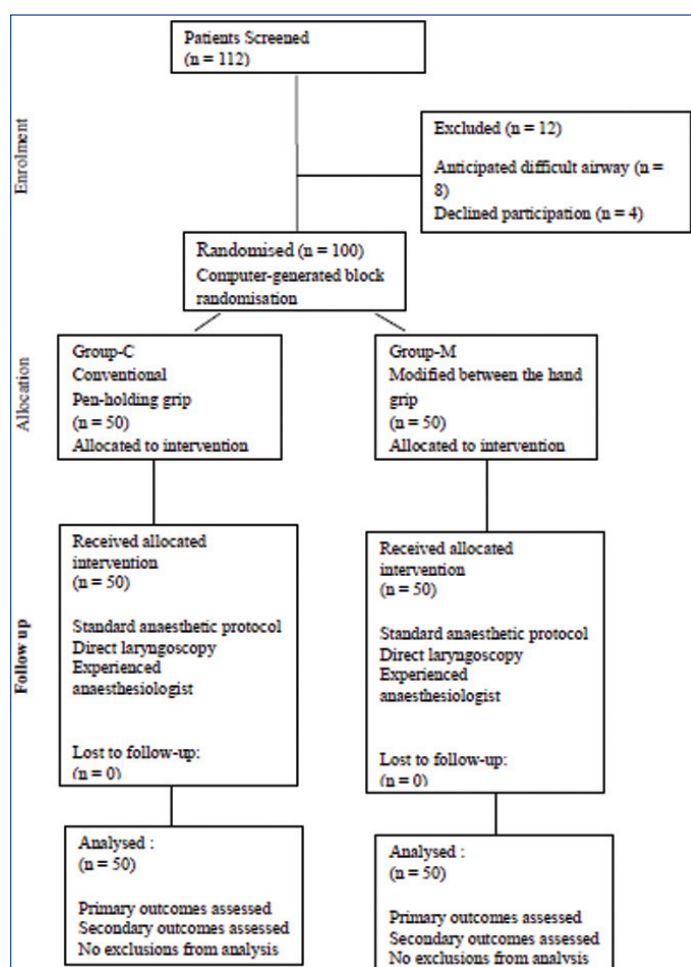
Despite these theoretical advantages, limited high-quality evidence exists comparing the clinical efficacy of different ETT handling techniques [13]. Only a few randomised trials have examined tube handling methods, with most research focusing on laryngoscope types rather than ETT manipulation techniques [14]. Furthermore, existing studies [15-18] have primarily focused on novice operators or simulation environments which limit their generalisability to clinical practice. The present study addresses this lacuna by providing a rigorous comparison of these techniques in a clinical setting with standardised outcome measures. The present study aimed to compare the efficacy of the between-the-fingers grip with the

conventional pen-holding grip for endotracheal intubation regarding first-pass success rates, requirement for BURP manoeuvre, and procedural efficiency.

MATERIALS AND METHODS

The present randomised single-blinded clinical trial was conducted at Department of Anaesthesiology, Dhiraj Hospital, Smt. Bhikhibhen Kanjibhai Shah Medical Institute and Research Centre, Sumandeep Vidyapeeth Deemed to be University, Piparia, Vadodara, Gujarat, India from September 2024 to February 2025.

Sample size calculation: Sample size was calculated based on pilot data showing 24% BURP requirement with conventional grip and anticipated 4% with modified grip. Using the formula for comparing two proportions: $n = \frac{Z\alpha\sqrt{2p(1-p)} + Z\beta\sqrt{p_1(1-p_1) + p_2(1-p_2)}}{(p_1 - p_2)^2}$, where $p_1 = 0.24$, $p_2 = 0.04$, $p = (p_1 + p_2)/2 = 0.14$, $Z\alpha = 1.96$ (for $\alpha = 0.05$), and $Z\beta = 0.84$ (for 80% power), the calculated sample size was 45 per group. We enrolled 50 patients per group to account for potential dropouts [19]. An overview of the study participants is depicted in the consort flow diagram [Table/Fig-1]. The study received Institutional Ethics Committee approval (IEC: SVIEC/ON/MEDI/RP/August/24/3) on 5th August 2024. Written informed consent was obtained from all the participants.



[Table/Fig-1]: CONSORT flow diagram.

Inclusion and Exclusion criteria: The inclusion criteria for the study comprised adults aged 18 to 60 years with an American Society of Anaesthesiologists (ASA) physical status of I to III, scheduled for elective surgery under general anaesthesia requiring endotracheal intubation, with Mallampati grades 1 to 3, and a body mass index between 18.5 and 35 kg/m². The exclusion criteria included anticipated difficult airway (defined as Mallampati grade 4, limited mouth opening less than 3 cm, or thyromental distance under 6 cm), previous documented difficult intubation, head and neck pathology, cervical spine instability,

haemodynamic instability, emergency surgery, contraindications to atracurium (such as allergic history or neuromuscular disorders), and pregnancy.

A total of 112 patients were screened, with 100 meeting inclusion criteria and completing the study. Twelve patients were excluded (8 for anticipated difficult airway, 4 declined participation).

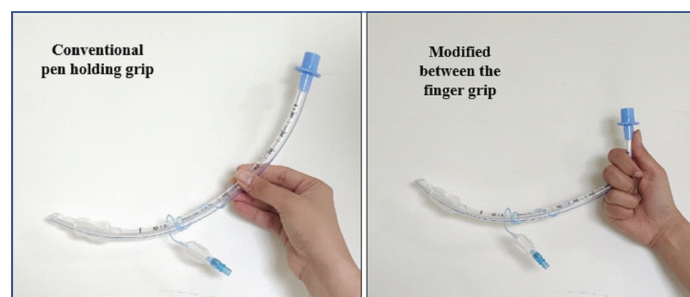
Study Procedure

Patients underwent standardised preanaesthetic evaluation including detailed history, physical examination, airway assessment, and routine investigations. Patients were kept nil per mouth for six hours for solids and two hours for clear liquids as per ASA fasting guidelines [20]. On arrival in the operating room, standard ASA monitoring was established including electrocardiography, non-invasive blood pressure, and pulse oximetry.

Intravenous access was secured using an 18-gauge cannula (standard for surgical patients to allow rapid fluid administration if needed). Ringer's lactate solution was initiated at 2 ml/kg/hr as it provides physiological electrolyte composition and is the preferred crystalloid for perioperative fluid therapy [21]. Preoxygenation was performed using face mask with 100% oxygen at 6 L/min for three minutes to achieve adequate denitrogenation [22]. Premedication included injection glycopyrrolate 0.2 mg i.v., ondansetron 4 mg i.v., midazolam 1 mg i.v. and tramadol 100 mg i.v.

Anaesthesia was induced with propofol 2-2.5 mg/kg i.v. titrated to loss of verbal response. Following induction, mask ventilation was initiated with tidal volume 8 mL/kg, respiratory rate 12/min, and Positive End-Expiratory Pressure (PEEP) 5 cm H₂O to maintain functional residual capacity [23]. Neuromuscular blockade was achieved with atracurium 0.5 mg/kg i.v. After three minutes of mask ventilation, laryngoscopy was performed by a single experienced anaesthesiologist.

Patients were randomised to group C (conventional pen-holding grip, n=50) and group M (modified between-the-fingers grip, n=50) using computer-generated randomisation with sealed opaque envelopes opened immediately before intubation [Table/Fig-2]. The anaesthesiologist performing intubation was not blinded due to the nature of intervention, but the participant patients were blinded to group allocation.



[Table/Fig-2]: Conventional pen holding and modified between-the-fingers grips.

Outcome measures: Primary outcomes included number of intubation attempts (first-pass success) and requirement for BURP manoeuvre. Secondary outcomes included time to successful intubation (laryngoscope insertion to first EtCO₂ waveform) and haemodynamic parameters (heart rate, mean arterial pressure).

If intubation required >3 attempts, stylet/bougie use, or change of operator, cases were excluded from the study. However, no case required exclusion for the same in the present study. Following successful intubation, anaesthesia was maintained with isoflurane and intermittent atracurium doses. At surgery completion, neuromuscular blockade was reversed using neostigmine 0.05 mg/kg with glycopyrrolate 0.01 mg/kg after return of train-of-four response. Extubation was performed after meeting standard criteria including sustained head lift >5 seconds and tidal volume >5 mL/kg.

STATISTICAL ANALYSIS

Data analysis was performed using SPSS version 23.0 (IBM Corp., USA). Normality was assessed using Shapiro-Wilk test. Continuous variables were expressed as mean±standard deviation and compared using independent t-tests. Categorical variables were expressed as frequency (percentage) and compared using Fisher's-exact test. The p-value<0.05 was considered statistically significant.

RESULTS

One hundred patients completed the study protocol with equal distribution between groups (n=50 each). Demographic characteristics were comparable between groups [Table/Fig-3].

Parameter	Group C (n=50)	Group M (n=50)	p-value
Age (years)	32.6±9.8	30.9±8.2	0.34
Male gender	25 (50.0%)	24 (48.0%)	0.84
BMI (kg/m²)	23.4±2.1	23.5±2.3	0.81
ASA Grade I	30 (60%)	31 (62%)	0.84
ASA Grade II	18 (36%)	18 (36%)	1.00
ASA Grade III	2 (4%)	1 (2%)	0.56
Mallampati Grade 1	28 (56%)	29 (58%)	0.84
Mallampati Grade 2	19 (38%)	19 (38%)	1.00
Mallampati Grade 3	3 (6%)	2 (4%)	0.65
Cormack-Lehane Grade 1	25 (50%)	26 (52%)	0.84
Cormack-Lehane Grade 2a	17 (34%)	17 (34%)	1.00
Cormack-Lehane Grade 2b	6 (12%)	5 (10%)	0.75
Cormack-Lehane Grade 3a	2 (4%)	2 (4%)	1.00

[Table/Fig-3]: Demographic and baseline characteristics.
Test used: Fisher's-exact test for categorical variables, independent t-test for continuous variables p<0.05 statistically significant, p<0.001* statistically highly significant**

Both groups achieved identical first-attempt intubation success rates of 98% (49/50 patients each, p>0.99). The modified grip group demonstrated significantly lower BURP requirement compared to conventional grip {2/50 (4%) vs 12/50 (24%), p=0.004}, representing an absolute risk reduction of 20% (95% CI: 7.8%-32.2%) [Table/Fig-4].

Mean intubation time was significantly shorter in the modified grip group (12.7±5.1 vs 16.5±7.1 seconds, p=0.003), representing a 23% reduction. The time measurements by Cormack-Lehane grade represent subgroup analyses of the overall intubation time. Subgroup analysis showed this time advantage was consistent across Cormack-Lehane grades 1-2a (11.8±4.2 vs 14.9±5.8 seconds) and grades 2b-3a (15.1±5.9 vs 20.3±7.8 seconds) [Table/Fig-4].

Parameter	Group C (n=50)	Group M (n=50)	p-value	Effect size
First-attempt success	49 (98.0%)	49 (98.0%)	>0.99	-
BURP requirement	12 (24.0%)	2 (4.0%)	0.004**	ARR: 20%
Intubation time (seconds)	16.5±7.1	12.7±5.1	0.003*	Mean difference: 3.8s (23% reduction)
Time by CL grade 1-2a	14.9±5.8	11.8±4.2	0.008*	-
Time by CL grade 2b-3a	20.3±7.8	15.1±5.9	0.04*	-

[Table/Fig-4]: Primary and secondary outcomes.
p<0.05 statistically significant, p<0.001* statistically highly significant**, ARR: Absolute risk reduction

Heart rate and mean arterial pressure changes during intubation were comparable between groups with no clinically significant differences, indicating haemodynamic stability with both techniques [Table/Fig-5].

Parameter	Conventional (n=50)	Modified (n=50)	p-value
Baseline HR (bpm)	85.6±18.2	87.4±19.1	0.62
Peak HR during intubation	98.3±21.5	102.1±22.3	0.35
Baseline MAP (mmHg)	96.8±17.9	99.2±18.5	0.49
Peak MAP during intubation	108.7±20.4	111.3±21.1	0.52

[Table/Fig-5]: Haemodynamic parameters.
HR: Heart rate; MAP: Mean arterial pressure; bpm: beats per minute.
All comparisons performed using independent t-test

DISCUSSION

The present study demonstrated that the between-the-fingers grip is as effective as the conventional pen-holding grip for achieving first-pass intubation success while providing significant advantages in reducing external laryngeal manipulation requirements and procedural time. The 98% first-attempt success rate in both groups exceeds traditional benchmarks reported in emergency medicine literature. In the study by April MD et al., Brown CA et al., and Kim C et al., [7,24,25], first-pass success rates typically range from 85-90%, highlighting the favourable results achieved with both techniques in our controlled setting.

The most striking finding was the 20% absolute reduction in BURP requirement with the modified grip (24% vs 4%). This finding contrasts with Thakur S et al., who reported lower baseline BURP requirements of 6.99% in their 276-patient study [13]. The higher BURP requirement in the present study's conventional group may reflect stringent criteria for optimal glottic visualisation and the inclusion of Cormack-Lehane grade 2b-3a patients. The superior performance of the modified grip in reducing BURP requirement aligns with the biomechanical advantages described in the original technique [11]. The between-the-fingers grip allows real-time manipulation of ETT curvature, enabling dynamic alignment with the glottic opening under direct visualisation. The clinical significance of reducing BURP requirement extends beyond mere convenience. External laryngeal manipulation requires coordinated teamwork, introduces potential for cervical spine movement in trauma patients, and may interfere with surgical field preparation [26]. In resource-limited settings or emergency situations where skilled assistance is unavailable, techniques that minimise dependence on external manipulation become particularly valuable [27].

Recent studies have questioned the universal benefit of BURP Yu T et al., found that BURP manoeuvre effectively reduced difficult laryngoscopies from 21.1% to 6.1% but noted that difficult intubation rates paradoxically increased from 12.4% to 41.9% when BURP was applied [10]. This paradox may result from anatomical distortion caused by external pressure, highlighting the advantage of techniques that achieve optimal alignment through tube manipulation alone [28].

The 3.8-second reduction in intubation time (16.5±7.1 vs 12.7±5.1 seconds) represents a clinically meaningful 23% improvement in procedural efficiency. This time reduction, while modest in absolute terms, becomes significant in critical situations where rapid airway control is essential. Studies have shown that each 10-second delay in intubation increases the risk of hypoxemia by 12% in critically ill patients [29]. The absolute intubation times observed are consistent with established benchmarks for safe airway management, where guidelines recommend completion within 30-60 seconds [30,31]. Finding that intubation time advantages persisted across different Cormack-Lehane grades suggests the technique's benefit is not limited to easy airways. The proportionally greater time savings in grade 2b-3a patients (5.2 vs 3.1 seconds)

indicates the modified grip may be particularly advantageous in challenging laryngoscopic views. In the study by Wang YM et al., mean intubation times of 34.4 ± 12.6 seconds were reported in experienced hands, considerably longer than the present study's findings [32]. This difference may reflect variations in measurement methodology, with the present study measuring specifically from tube insertion to first EtCO₂ upstroke rather than total procedure time.

The comparable haemodynamic responses between groups during intubation suggest that the modified grip technique does not introduce additional physiological stress. Both groups demonstrated expected increases in heart rate and mean arterial pressure during laryngoscopy, consistent with normal sympathetic responses to airway manipulation [33,34]. The absence of significant haemodynamic differences indicates that the modified technique's learning curve does not compromise patient safety.

Limitation(s)

The present single-centre study involved only elective patients with anticipated normal airways. Results may not generalise to emergency intubations or patients with difficult airway anatomy. The single experienced operator design, while reducing variability, may limit generalisability across different skill levels. Future multi-centre trials should evaluate the technique across varying operator experience levels and clinical contexts. The higher-than-expected BURP requirement in the conventional group warrants further investigation. Additionally, we did not assess long-term outcomes such as sore throat or dental trauma, which may differ between techniques. The convergent evidence supports the clinical utility of the between-the-fingers grip as a valuable technique in airway management education and practice. The 20% absolute reduction in BURP requirement represents a clinically significant advantage, particularly in settings with limited skilled assistance. Integration of this technique into airway management curricula could enhance trainees' technical repertoire and improve patient outcomes. Future research should investigate the technique's performance in emergency settings and across different levels of operator experience.

CONCLUSION(S)

The present randomised clinical trial demonstrates that the between-the-fingers grip for ETT handling achieves equivalent first-pass intubation success to the conventional pen-holding grip while providing significant clinical advantages. The technique reduces BURP requirement by 20% absolute (83% relative reduction) and decreases intubation time by 23%, benefits that persist across different laryngoscopic grades. These findings support adopting the modified grip as a primary technique in airway management, particularly in settings where external assistance is limited or when rapid intubation is critical. The biomechanical advantages of dynamic tube control make this technique a valuable addition to the anaesthesiologist's armamentarium. Future research should explore its utility in emergency airway management and evaluate learning curves across different training levels.

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PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Anaesthesiology, Smt. Bhikhiben Kanjibhai Shah Medical Institute and Research Centre, Sumandeep Vidyapeeth (Deemed to be University), Piparia, Vadodara, Gujarat, India.
2. Associate Professor, Department of Anaesthesiology, Smt. Bhikhiben Kanjibhai Shah Medical Institute and Research Centre, Sumandeep Vidyapeeth (Deemed to be University), Piparia, Vadodara, Gujarat, India.
3. Professor and Head, Department of Anaesthesiology, Smt. Bhikhiben Kanjibhai Shah Medical Institute and Research Centre, Sumandeep Vidyapeeth (Deemed to be University), Piparia, Vadodara, Gujarat, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Richa Tailor,
B 364, Taksh Aura, Near L ant T Knowledge city, Ankhol,
Vadodara, Gujarat, India.
E-mail: richa.tailor@gmail.com

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