Original Article

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Comparison of the Demonstration-Observation-Assistance-Performance Method and the Traditional Teaching Method for Endotracheal Intubation Skill Acquisition on a Simulator in Medical Students: An Educational Interventional Study

Anaesthesia Section

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ABSTRACT

Introduction: Endotracheal Intubation (ETI) is the insertion of a breathing tube into the trachea—a critical, life-saving skill in Cardiopulmonary Resuscitation (CPR), both inside and outside the hospital setting. Medical graduates often lack clinical skills such as ETI due to limited practical experience.

Aim: To compare the methods of Demonstration-Observation-Assistance-Performance (DOAP) and Traditional Teaching (TT) for ETI skill acquisition, memory performance and skill retention in phase 3 part 1 MBBS students.

Materials and Methods: This educational interventional crossover study was conducted at the Department of Anaesthesiology, Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Imphal, Manipur, India from August 2023 to February 2024. The subjects (phase 3 part 1 MBBS students) were enrolled by universal sampling. They were given a pretest comprising Multiple Choice Questions (MCQs) followed by a lecture. Next, a post-test with the same MCQs was administered. Group I (DOAP) and Group II (TT) each comprised 22 students. ETI skills were taught using a simulator and assessed via Objective Structured Clinical Examinations (OSCE1 and OSCE2), with a recall test in between. On day 14, a crossover of the groups was conducted. Descriptive statistics, t-tests and Chi-square tests were used for statistical analysis.

Results: The groups did not differ statistically significantly in terms of age, sex, or the number of attempts for the National Eligibility Entrance Test (NEET). The students' post-test MCQ scores were significantly higher than pretest scores after the lecture (p-value=0.0001). The number of ETI attempts (1.77±0.685 for Group I and 1.82±1.006 for Group II) and intubation duration in seconds (62.50±20.061 for Group I and 59.55±19.576 for Group II) were comparable in OSCE1. In the recall test, Group I (8.77±0.428) and Group II (8.00±1.046) scores differed significantly (p-value=0.003). The number of ETI attempts (1.14±0.351 for Group I and 1.09±0.294 for Group II) and duration of intubations in seconds (65.23±12.626 for GroupI and 56.68±16.556 for Group II) were comparable in OSCE2. ETI attempts in independent groups decreased significantly, while ETI durations were comparable between OSCE1 and OSCE2.

Conclusion: The DOAP and TT methods were equally effective for ETI skill acquisition and retention. However, the DOAP group demonstrated superior memory performance in the recall test.

Keywords: Checklist, Clinical competence, Crossover studies, Feedback, Intratracheal

INTRODUCTION

The ETI is the process of inserting a breathing tube into the trachea. It is a vital life-saving skill within the physician's armamentarium, particularly in emergency scenarios. Failure to secure a patent airway expeditiously can lead to deleterious consequences, including morbidity and mortality [1]. ETI remains the gold standard for airway management and pulmonary protection in acute settings [2]. It is also part of one of the competencies, Advanced Life Support, included in India's National Medical Council undergraduate anaesthesiology curriculum [3].

Despite substantial theoretical knowledge, medical graduates often lack clinical skills due to limited practical experience. Simulation-Based Learning (SBL) has emerged as a pivotal educational intervention that bridges the gap between theory and practice, promoting the application of knowledge in simulated clinical scenarios [4]. SBL provides a safe, non threatening and ethically sound environment to practice and refine procedural skills, preparing future physicians for optimal patient care [4-6].

The introduction of Competency-Based Medical Education (CBME) has led to a surge in the utilisation of the DOAP method to acquire crucial psychomotor skills. Unlike the traditional "see one, do one" teaching method, the DOAP method offers a structured, multiphased learning course in which students observe the teacher demonstrate the procedure, deconstruct the procedure, assist the teacher and finally perform the procedure in a simulated setting or on real patients under supervision or independently [7].

This study presents several novel aspects in examining ETI training methods: it specifically evaluates ETI training within the context of the new CBME curriculum for phase 3 part 1 MBBS students in India during their clinical postings. Unlike the majority of previous studies that typically assessed skill retention after one month [6-13], this study evaluated retention within a shorter timeframe to align with the practical constraints of undergraduate clinical postings. The aim of this study was to compare the efficacy of the DOAP method with the TT method in terms of ETI skill acquisition, memory performance and skill retention in phase 3 part 1 MBBS students during their clinical postings.

MATERIALS AND METHODS

This educational interventional crossover study was conducted at the Department of Anaesthesiology, Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Imphal, Manipur, India from August 2023 to February 2024. Institutional Ethical Committee (IEC) approval was obtained (IEC Letter of Approval Ref. No. Ac/03/IEC/JNIMS/2018). Written informed consent was obtained from all participants.

Inclusion criteria: Two batches of Phase 3 Part 1 MBBS students from the 2020 batch who were posted for two weeks of rotational clinical postings were included as participants in the study.

Exclusion criteria: Students who missed the subsequent evaluations were excluded from the study.

Study Procedure

For this study, an adult manikin with neck extension in a sniffing position and an open mouth was used. The investigators created 19 MCQs and an ETI checklist. The MCQs were based on the lecture session conducted and the checklist was based on the steps of the procedure taught; one mark was awarded for each correct answer. Two assistant professors from the department validated these materials. Training and evaluation took place in a room adjacent to the operation theatre.

To gauge their degree of fundamental ETI knowledge, each participant completed a pretest consisting of prevalidated MCQs on the first day. Following this, the principal investigator conducted an interactive PowerPoint session on ETI, which included a simulated audio-visual demonstration. The students completed a post-test with the same MCQs after the lecture. Participants' age, sex and the number of attempts to pass the NEET were recorded. The number of NEET attempts was noted to ascertain whether it had any effect on skill learning. The principal investigator then divided the participants into interventional Group I (DOAP) and control Group II (TT) using restricted block randomisation with a block size of 4. Initially, 50 students were enrolled for the study, but six students were excluded (dropouts): five missed the recall test and one missed OSCE 2. Each group had three male dropouts. Ultimately, there were 22 participants in each group.

The students were taught in batches of five to eight students per session. In Group I, the teacher taught ETI in four steps on the manikin [7]:

Step 1: The teacher demonstrated the skill at a normal pace, without commentary ("Demonstration").

Step 2: The teacher demonstrated the procedure while describing each procedural substep in detail ("Deconstruction").

Step 3: The teacher performed the procedure for a third time, based on the substeps described to her by the student ("Comprehension").

Step 4: The student performed the complete skill independently ("Performance").

Steps 3 and 4 were performed with a student-teacher ratio of 1:1. If the students deviated from the usual substeps of ETI during these steps, feedback was provided.

In Group II, the teacher demonstrated and described the substeps of ETI on the manikin. Afterward, the students were asked to practice the procedure, and the trainer clarified any uncertainties [7].

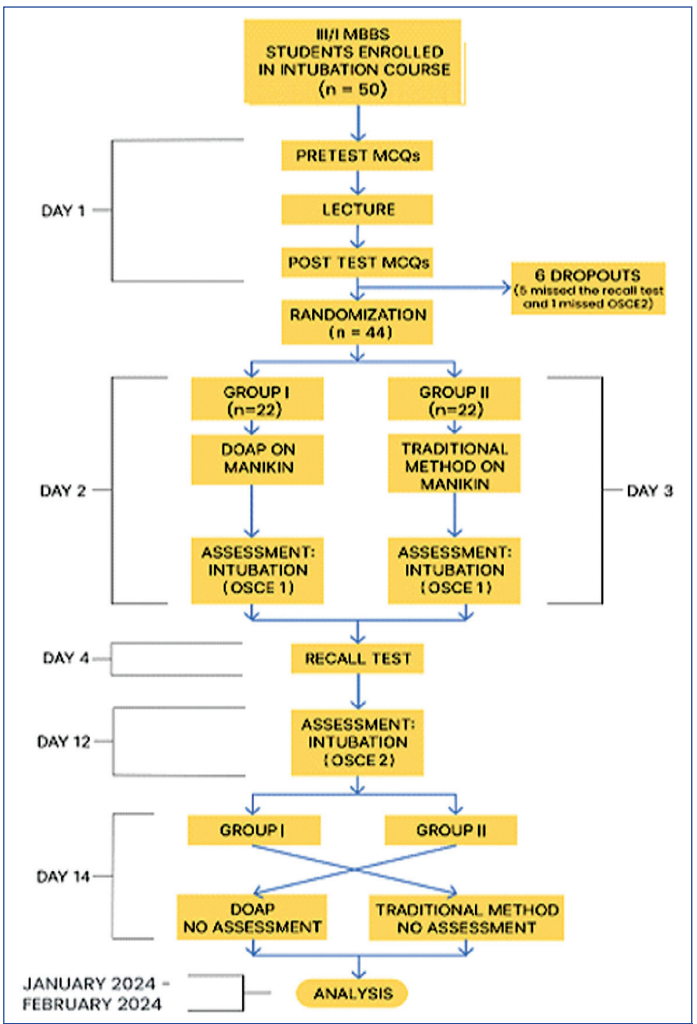
An experienced anaesthesiologist who was blinded to the study evaluated the students using a checklist that recorded the number of successful ETI attempts and the duration of successful intubations during their first performance (skill test to evaluate skill acquisition, i.e., OSCE 1). The duration of intubation was measured from the time of laryngoscopy to effective ventilation of both lungs. A successful intubation was defined as the complete and equal inflation of both lungs of the manikin using an Artificial Manual Breathing Unit (AMBU) bag attached to the endotracheal tube. An unsuccessful procedure was defined by any of the following criteria: (a) a duration of intubation exceeding 120 seconds; (b) oesophageal intubation indicated by gastric inflation; (c) no ventilation or absence of lung inflation; and (d) one-lung ventilation, as indicated by the single lung inflation of the manikin [14]. A Macintosh laryngoscope with a curved blade (size 4) was used for ETI.

If a student in Group I failed the procedure, it was taught again from Step 1. This cycle continued until the student successfully performed it. Likewise, in Group II, the procedure was taught again from the beginning until the student successfully performed it.

On day 4 of the clinical posting, students were given an unanticipated free recall memory performance test, during which they were asked to write down the steps involved in ETI. Active memory retrieval performance was assessed through free recall tests [15]. Marks were awarded based on the ETI checklist; one mark was given for each correctly recalled step. The dependent variables were the number of steps that could be recollected in the correct order and recalled accurately. This test had a time limit of 10 minutes. Procedural steps were considered appropriately recalled, regardless of whether the exact medical terminology was used [15].

On day 12, all participants were again assessed using OSCE 2 (a skill test to evaluate skill retention between the two groups) by an experienced anaesthesiologist who was blinded to the study. The number of attempts and the duration of intubation were recorded. Participants who failed the ETI attempt received feedback and could retry until successful.

A crossover of the study methodology was conducted between the two groups on the final day (day 14) of their posting; however, no assessment or analysis was carried out [Table/Fig-1].



[Table/Fig-1]: Study organisation.

Data collection tool and techniques: The study utilised a comprehensive set of teaching and assessment tools. An LCD

projector and a laptop were used to deliver teaching materials and audio-visual demonstrations during the lecture. Knowledge assessment was conducted using 19 prevalidated MCQs. For skill training and assessment, the following were employed: an ETI checklist, manikin, AMBU bag, endotracheal tube (size 7), 10 mL syringe, and a Macintosh laryngoscope with a curved blade (size 4). Memory performance was measured using a standardised recall test proforma.

STATISTICAL ANALYSIS

The data collected were entered into an Excel sheet, converted into an Statistical Package for the Social Sciences (SPSS) data sheet, and analysed using SPSS Statistics for Windows (version 20.0). Descriptive statistics (frequency, percentages, mean, standard deviation, etc.) and inferential statistics (Student's t-tests, paired t-tests, etc.) were utilised to make inferences on discrete and continuous variables. The Chi-square test was employed to compare the association between categorical variables; a p-value of <0.05 was considered significant.

RESULTS

No statistically significant differences were observed between the two groups in terms of age, sex or NEET attempts [Table/Fig-2,3].

Variable	Mean±SD		Mean difference (95% CI)	t-value	p-value
Scores (n=44)	Pretest scores	6.75±1.966	-7.750 (-8.315 to -7.185)	-27.686	0.0001
	Post-test scores	14.50±2.070			
Age	Group I (n=22)	22.68±1.211	-0.636 (-1.373 to 0.100)	-1.744	0.089
	Group II (n=22)	23.32±1.211			
Recall test scores	Group I (n=22)	8.77±0.428	0.772 (0.286 to 1.259)	3.205	0.003
	Group II (n=22)	8.00±1.046			

[Table/Fig-2]: Comparison of all participants' pretest and post-test scores, age, and of recall test scores after OSCE1 between the two groups.

Variable	Category	Group I N (%)	Group II N (%)	p-value
Sex	Male	06 (54.5)	05 (45.5)	0.728
	Female	16 (48.5)	17 (51.5)	
NEET attempts	1	03 (75)	01 (25)	0.134
	2	11 (68.8)	05 (31.2)	
	3	07 (35.0)	13 (65.0)	
	4	01 (25.0)	03 (75.0)	

[Table/Fig-3]: Comparison of sex and number of NEET attempts between the two groups.
Chi-square test was used

Effectiveness of Training

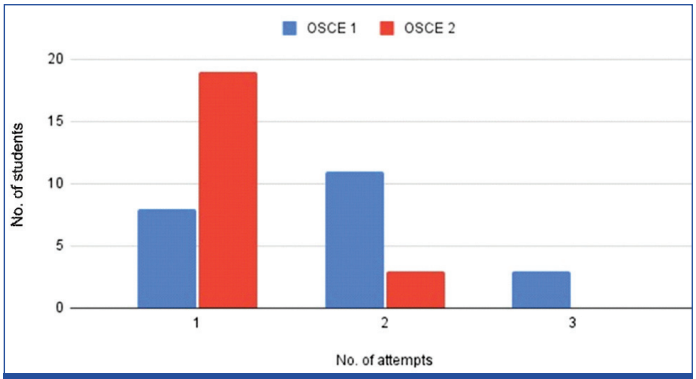
MCQ scores (knowledge test): The knowledge scores for the pre-test and post-test were highly significantly [Table/Fig-2].

Skill test (OSCE 1): Intubation attempts ranged from one to five [Table/Fig-4,5]. However, no statistically significant difference was found between Group I and Group II [Table/Fig-6]. The duration, in seconds, for successful ETI did not differ between the two groups [Table/Fig-7].

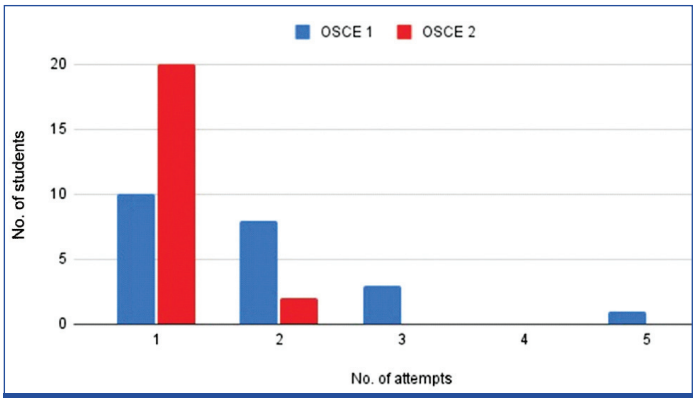
Recall test (memory performance test): In the recall test, Group I significantly outperformed Group II [Table/Fig-2].

Skill Retention Test

Skill test (OSCE2): The number of successful intubation attempts made by Group I and Group II did not differ significantly [Table/Fig-6]. The duration, in seconds, for successful intubation in Group I and Group II was comparable [Table/Fig-7].



[Table/Fig-4]: Comparison of the number of successful ETI attempts among Group I participants according to OSCE1 and OSCE2.



[Table/Fig-5]: Comparison of the number of attempts for successful ETI among Group II participants according to OSCE1 and OSCE2.

Comparison of OSCE1 and OSCE2 (to evaluate skill retention among independent groups): The number of successful ETI attempts between OSCE 1 and OSCE 2 showed a significant difference among Group I participants [Table/Fig-8]. Similarly, a significant difference was found among Group II participants [Table/Fig-8]. Both groups significantly improved from OSCE 1 to OSCE 2, with most students intubating on their first attempt [Table/Fig-4,5]. The duration of successful intubation among Group I participants between OSCE 1 and OSCE 2 was comparable [Table/Fig-9]. Similarly, among Group II participants, comparable results were revealed between OSCE 1 and OSCE 2 [Table/Fig-9].

DISCUSSION

The post-test MCQ scores revealed that students' baseline knowledge of ETI improved significantly following the lecture session. Present study yielded a 100% success rate overall, with only one student requiring five attempts for successful intubation in OSCE 1. The intubation attempts and duration of intubation were comparable between the two groups in OSCE 1. In the recall test, the DOAP group outperformed the TT group. Their documentation of ETI steps, including the use of medical terminology and language, was notably clearer and more precise compared to the TT group. The intubation attempts significantly declined in OSCE2 (skill retention test), limiting the attempts to only two (three students in Group I and two students in Group II). However, the results were comparable between the two groups in terms of the number of ETI attempts and the duration of intubation. Additionally, the skill retention test (comparison between OSCE1 and OSCE2) demonstrated a significant improvement in intubation attempts across the independent groups, while the durations remained comparable between them.

Jasper's simulation-based study showed that 45 medical students achieved a 100% ETI success rate after five attempts [14]. Another simulation study by Reyes EP et al., found that the maximum number of attempts for successful ETI by medical students was three. They also observed that the time required to complete a successful ETI decreased with each subsequent attempt [16].

Group	No. of attempts, Mean±SD		Mean difference (95%CI)		t-value		p-value	
	OSCE 1	OSCE 2	OSCE 1	OSCE 2	OSCE 1	OSCE 2	OSCE 1	OSCE 2
Group I (n=22)	1.77±0.685	1.14±0.351	-0.45 (-0.569 to 0.478)	0.45 (-0.152 to 0.243)	-0.0175	0.465	0.862	0.644
Group II (n=22)	1.82±1.006	1.09±0.294						

[Table/Fig-6]: Comparison of the number of successful ETI attempts between the two groups in OSCE1 and OSCE 2.

Group	Duration of successful intubation (seconds), Mean±SD		Mean difference (95% CI)		t-value		p-value	
	OSCE1	OSCE 2	OSCE 1	OSCE 2	OSCE 1	OSCE 2	OSCE 1	OSCE 2
Group I (n=22)	62.50±20.061	65.23±12.626	2.955 (-9.105 to 15.015)	4.439 (-0.413 to 17.523)	0.494	1.925	0.624	0.061
Group II (n=22)	59.55±19.576	56.68±16.556						

[Table/Fig-7]: Comparison of duration for successful ETI in seconds between the two groups in OSCE1 and OSCE 2.

Variable	Mean±SD		Mean difference between OSCE1 and OSCE2 attempts (95%CI)		t-value		p-value	
	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
OSCE1 (n=22)	1.77±0.685	1.82±1.006	0.636 (0.261 to 1.012)	0.727 (0.291 to 0.164)	3.521	3.634	0.002	0.002
OSCE2 (n=22)	1.14±0.351	1.09±0.294						

[Table/Fig-8]: Comparison of the number of successful ETI attempts among Group I and Group II participants according to OSCE1 and OSCE2.

Variable	Mean±SD in seconds		Mean difference Duration of intubation in OSCE1 and OSCE2 (95%CI)		t-value		p-value	
	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
Duration of successful intubations in OSCE1 (n=22)	62.50±20.061	59.55±19.576	-2.727 (-10.252 to 4.797)	2.864 (-6.547 to 12.274)	-0.752	0.633	0.459	0.534
Duration of successful intubations in OSCE2 (n=22)	65.23±12.626	56.68±16.557						

[Table/Fig-9]: Comparison of the duration of successful intubations in seconds among Group I and Group II participants according to OSCE1 and OSCE2.

However, the number of attempts in the operating room for patients ranged from 15 to 17 times to achieve a 76.8%-90% success rate [17,18]. Therefore, the number of intubation attempts was higher when the procedure was performed on real patients. Authors believe that the complementary use of a human simulator (manikin) in training enabled the students to acquire the skill quickly, resulting in fewer ETI attempts in this study [4,19-21].

Orde S et al., reported that the mean Laryngeal Mask Airway (LMA) insertion time at acquisition was 39.7 seconds for the 2-stage and 34.7 seconds for the 4-stage groups (p-value >0.05), and successful ventilation within 30 seconds occurred in 41.67% of the 2-stage group and 48.33% of the 4-stage group (p-value >0.05) [8]. Greif R et al., also found that participants taught with the 4-stage approach learned the percutaneous needle-puncture cricothyroidotomy as quickly as participants trained with a TT approach [22]. The results of these two studies regarding the procedure's duration are consistent with present study findings.

In their systematic review and meta-analysis, Giacomino K et al., concluded that Peyton's teaching approach required significantly less time to perform the procedure post-acquisition [7]. However, in present study, authors could not establish the superiority of DOAP over the traditional method regarding the time needed for successful skill performance. Knowledge provided to the students during the lecture, which included a simulated audio-visual demonstration, also contributed to fewer intubation attempts. Prior studies have also shown that video-assisted learning enhances performance while acquiring new skills [23-25]. Present study aligns with other research that found similar results between the 2-stage and 4-stage training methods for skill acquisition [8,9,22,26].

Nevertheless, present study findings deviate from previous studies that revealed the DOAP group's superior performance in the procedure compared to the TT method [6,15,27-29]. Based on present study findings on skill acquisition, it can be concluded that the students exhibited a deep understanding of the procedure. Furthermore, medical students who might be required to perform ETI in life-threatening situations could learn to do so with relative ease.

Krautter M et al., found that memory performance in the recall test for central venous catheter insertion steps was better with Peyton's standard four-step approach than with a modified version using only demonstrations [15]. Skrzypek A et al., implemented a modified four-step approach to teach the emergency echocardiographic assessment following the Focus-Assessed Transthoracic Echo (FATE) protocol, which significantly aided learners in quickly memorising and mastering a substantial amount of material [30]. Step 3 (comprehension) of the DOAP method is critical in helping students construct a mental image of the procedural steps, even in the absence of active movement. It reflects deeper processing mechanisms that enable trainees to provide instructions to the trainer. Reflection is essential for assimilating new information, as it helps define the problem, develop solutions, and test those solutions through action [31]. This mental correlate of the procedural motions improves the retention of learning materials. Hence, the DOAP method outperformed the TT method in the recall test, and present study findings align with a previous study on memory performance in recall tests [15].

The skill retention tests in earlier studies were mostly conducted after one month of teaching the skill. In contrast, present study evaluated the retention test over a much shorter period, raising questions about the feasibility of retention tests due to the brief duration of the clinical postings of undergraduate students. Orde S et al., also found comparable results in LMA insertion skill retention [8]. Jeanmonod R et al., observed that paediatric bag-valve-mask and ETI performance were comparable across teaching methods for skill acquisition and retention [9]. Other studies also support present findings on skill retention [10,11]. However, the superiority of the DOAP over the TT method could not be established in this study regarding skill retention [6,7,12,13].

Limitation(s)

The study had several limitations, including being a single-centre study with a small sample size and only one manikin available. The recall test was inconsistently timed across groups, and the skill retention test was conducted on day 12 of the clinical clerkships. Present study did not assess knowledge and skill retention over the long term. Further research with a larger sample size to address these constraints and validate the findings are recommended.

CONCLUSION(S)

Present study demonstrated the potential of both DOAP and TT methods in training medical students for ETI. While both approaches were equally effective in skill acquisition and retention, the DOAP method showed superior memory performance in the recall test. The findings underscore the importance of SBL and audio-visual demonstrations in medical education, particularly for critical procedural skills. This study contributes to innovative teaching strategies for enhancing clinical competency among medical students.

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