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Selective intubation with endotracheal tube introducer in difficult airway: A randomized, prospective, cross-over study

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Abstract:

BACKGROUND: Selective lung intubation is a life-saving procedure in emergency departments. While various equipment can be used in selective lung intubation, most of this equipment is not readily available; therefore, single-lumen endotracheal intubations are performed for rapid interventions.

MATERIALS AND METHODS: This study was designed as a randomized, prospective, cross-over study using the 90° rotation technique for selective intubation on a manikin model with and without endotracheal tube introducer (ETI) in difficult airway settings. Forty-six emergency physicians were included in the study. The primary outcome was evaluating time to selective intubations, and secondary outcomes were first and second attempt success rates and the self-perceived difficulty level of each method according to the participants.

RESULTS: The mean time to the first successful endotracheal intubation was significantly longer for both right selective and left selective intubations with ETI utilization than without ([39.71 ± 9.83 vs. 21.86 ± 5.94 s], [$P < 0.001$]), ([42.2 ± 10.81 vs. 26.23 ± 7.97 s], [$P < 0.001$], respectively). The first-pass success rate did not differ for right selective intubation with or without an ETI (45/46 [97.8%] and 45/46 [97.8%], respectively). However, the first-pass success rate for left selective intubation was significantly higher with ETI as compared to without an ETI (30/46 [65.2%] and 13/46 [28.3%], respectively) ($P < 0.001$).

CONCLUSIONS: While the success rates of right selective intubation were the same, the left selective intubation success rates with ETI are higher than the styletted endotracheal tube, which can be strong evidence for this method's applicability in practice. Expanding the use of ETI and increasing the experience of the practitioners can contribute to further success.

Keywords:

Difficult airway, elastic bougie, intubation technique, selective intubation

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Introduction

Selective lung intubation is a life-saving procedure and has an integral part in critical airway procedures.[1] Double-lumen endotracheal tubes, endobronchial blockers, or single-lumen tubes are used in selective lung intubation. Although various equipment can be used in selective lung intubation, they are not readily available in most emergency departments (EDs). In addition, single-lumen endotracheal tubes' insertion may be more comfortable in patients with difficult airway features than double-lumen endotracheal tubes.[2,3] Alternative methods should be available for selective intubation when rapid interventions are needed.

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Box-ED Section

What is already known on the study topic?

- Various equipment can be used in selective lung intubation but most of this equipment is not readily available in most emergency departments
- Endotracheal tube introducers (ETIs) can be used for selective intubation to increase success rates and are easily available.

What is the conflict on the issue? Has its importance for readers?

- The role of ETI with selective intubation, especially with difficult airway settings, remains uncertain
- The correct technique and equipment may increase selective intubation success rates, and ETI is easily available adjunct equipment.

How is this study structured?

- This was a single-center, randomized, prospective, cross-over study, including 46 emergency physicians performing a total of 186 selective intubation attempts.

What does this study tell us?

- There was no difference in right selective intubation success rates with or without ETI
- However, the success rates of left selective intubation with ETI are higher than without
- Expanding the utilization of ETI can contribute to further success in selective intubation.

Endotracheal tube introducers (ETIs) are effective, inexpensive, easy-to-use, and accessible airway devices in the airway management. Furthermore, ETIs can improve first-pass success in poor laryngeal appearance and difficult airway conditions. While there are several studies on bougie use in ED, there are insufficient data on patients requiring selective intubation, and no data were presented with difficult airway to our knowledge.

This study aimed utilization of ETI in selective lung intubation with difficult airway using the 90° rotation technique.

Materials and Methods

Study design and setting

This study was designed as a randomized, prospective, and cross-over study. Kocaeli Derince Training and Research Hospital local ethics comittee approved the study (approval date: 12.09.2019, approval no: 2919/81). Forty-six emergency physicians (12 emergency medicine specialist and 34 emergency residents) were given 10 h of theoretical and 5 h of practical training on advanced airway management within 2 days in "The Advanced Airway Course of Emergency Medicine Association of Turkey" before the study and participants also had instructions of how to perform selective intubation with the styletted endotracheal tube (sET) using the 90° rotation technique, ETI utilization, and selective lung intubation by an experienced airway trainer before their intubation attempts. Then, the participants were allowed to practice on the manikin both with sET and ETI.

Operators intubated the manikin using the following intubation methods in randomized order: (1) right selective intubation with sET, (2) left selective intubation with sET, (3) right selective intubation with ETI, and (4) left selective intubation with ETI. Therefore, each participant performed four airway interventions. If participants were unsuccessful in their first attempt, they have tried a second time and if that attempt was also unsuccessful, the intervention has been recorded as failed.

The selective intubation technique used was after the vocal cords were passed, practitioners were asked to perform the procedure by rotating ETI or sET, 90° clockwise for right selective lung intubation, and 90° counterclockwise for left selective lung intubation. Written consent was obtained from participants, and a camera was placed in the resuscitation room where the model was placed, showing the manikin and the participant on the same screen. Timer was initiated after handling of the laryngoscope and was concluded by confirming the successful intubation (aeration of the selective lung with bag valve mask).

After obtaining written consent, the participants' attempts were randomized using the permutation method using the randomization document created on September 03, 2019 from "www.randomization.com." An equal number of cards were created for each participant, including the order and method they would intubate. Regardless of which method they started randomly, the participants were asked to try again with the same method in unsuccessful attempts. Between every attempt mannikin's airway was checked by the study team if difficult airway was presented in the same way.

The primary outcome was measuring and comparing selection intubation times while secondary outcomes were the participants' first attempt success rates, number of interventions, and ETI experiences. After all attempts concluded, the participants were asked to evaluate the intervention methods' difficulty levels as 1 – very easy, 2 – easy, 3 – medium, 4 – difficult, and 5 – very difficult according to the Likert scale.

Life/form® Deluxe Crisis™ Mannequin Torso adult-type manikin was used in the study. The manikin's tongue

inflated with 20 cc air (recommendation of the product manual) to provide difficult airway conditions (Cormack–Lehane grade 3). Intubation equipment used for the study also included Macintosh laryngoscope (size 3), VBM Medizintechnik ETI (15 Fr 65 cm), 7.5 mm endotracheal tube, 10 fr stylet, 10 cc injector for cuff inflation, bag valve mask, and lubricant gel.

Data analysis

Statistical analysis was performed by using IBM SPSS version 20.0 (IBM Corp., Armonk, NY, USA) package program. The normal distribution compatibility test was evaluated with the Kolmogorov–Smirnov Test. Numerical variables with normal distribution were given as mean ± standard deviation; numerical variables without normal distribution were given as median (25^{th}–75^{th} percentile); and categorical variables as frequency (%). The groups' difference was tested with the Mann–Whitney U-test for the numerical variables that did not have a normal distribution, and the Yates Chi-square and Monte Carlo Chi-square test for categorical variables. $P < 0.05$ was considered statistically significant. The sample size, alpha 0.05, beta 0.95, and the difference between the groups was considered significant for 5 s and was calculated as 46 with the "G Power" program.

Results

Forty-six emergency physicians participated in the study. First-pass success rate did not differ for right selective intubation with or without an ETI (45/46 [97.8%] and 45/46 [97.8%], respectively), but the first-pass success rate for left selective intubation was significantly higher with ETI compared to without an ETI (30/46 [65.2%] and 13/46 [28.3%], respectively) ($P < 0.001$). The first attempt success rates for selective endotracheal intubation are summarized in Table 1.

All the participants successfully completed the second attempt of right selective intubation with and without an ETI (1/1 [100%] and 1/1 [100%], respectively) but for left selective intubation, success rates for the second attempt with and without an ETI were lower (8/16 [50%] and 3/33 [9.1%], respectively) ($P = 0.003$).

The mean time to the first successful endotracheal intubation was significantly longer for both right selective and left selective intubations with ETI utilization than without ([39.71 ± 9.83 vs. 21.86 ± 5.94 s], [$P < 0.001$]), ([42.2 ± 10.81 vs. 26.23 ± 7.97 s], [$P < 0.001$], respectively). The mean times to the first successful selective endotracheal intubation are summarized in Table 2.

Thirteen participants had previous clinical experience with an ETI (used ETI for at least one patient intubation in their clinical practice) (13/46). Participants' success rates did not significantly differ with or without experience with ETI. The first success rates for right selective intubation with and without ETI experience were 13/13, 32/33, respectively ($P = 0.717$). First success rates for left selective intubation with and without ETI were 10/13 and 20/33, respectively ($P = 0.245$).

The difficulty of left selective endotracheal intubation was perceived as difficult/very difficult without ETI using 31/46 (67%) in the Likert scale compared to right selective endotracheal intubation ETI use as easy/easiest 45/46 (98%). Likert scale ratings of right and left selective endotracheal intubation using an ETI, were reported as easy/easiest, 41/46 (87%), and 27/46 (49%), respectively.

Discussion

Although selective intubation is rarely needed in EDs, it can be a life-saving procedure when necessary. The utilization of auxiliary airway equipment such as ETIs can facilitate the intubation process with better success rates. ETI increases first pass success in emergency intubation, especially in patients with difficult airway.[1,4,5] Patients requiring selective intubation potentially have difficult airway conditions in the emergency room; therefore, it is important to research and apply methods that might improve success. For this reason, we conducted our work on a model with a difficult airway feature. ETIs provide steerable, thin, and curved tips, and with the addition of a 90° rotation technique, the procedure's success rate increased, especially in left selective intubation. Some authors have investigated selective lung intubation effectiveness in fresh cadaveric studies and real patients.[6-9] However, there are limited data in the literature on this subject. Since patients who need selective intubation might have a difficult airway, our study provides data with difficult airway conditions on selective intubation, which was never presented, to our knowledge.

Selective intubation success rates may vary depending on which the main bronchus it is performed for; the right main bronchus has a vertical and wider shape; therefore, right selective lung intubations have higher success rates (90%–100%) and shorter times in many studies.[6-9] Furthermore, success rates in the right selective lung intubation might improve with ETI. A prospective, randomized, fresh cadaver study demonstrated increased success rates with ETI in the right selective intubation.[6] Furthermore, in a randomized controlled study comparing ETI's first pass success and sET, the success rates were 96% and 82%, respectively.[1] In our study, the success rate with the right selective sET method was found to be 97.8%, even though it was a difficult airway model. In addition, the participants who

Table 1: First attempt success rates of the participants

	Right selective intubation (%)	Left selective intubation (%)
With ETI	45/46 (97.8)	30/46 (65.2)
Without ETI	45/46 (97.8)	13/46 (28.3)
P	1	<0.001

ETI=Endotracheal tube introducers

Table 2: The mean times to first successful selective ıntubations

	Right selective intubation (s)	Left selective intubation (s)	*P*
With ETI	39.71±9.83	42.2±10.81	0.327
Without ETI	21.86±5.94	26.23±7.97	0.055
P	<0.001	<0.001	

ETI=Endotracheal tube introducers

did not succeed in their first attempts were successful in their second attempts for right selective intubation in our study.

Success rates in the literature are relatively lower for left selective intubation.[6-9] However, the success rate of up to 100% has been reported using ETI.[6] Our study's success rates were 65.2% and 28.3%, respectively, with ETI and sET in left selective intubation. This difference can be explained by the restrictive effect of difficult airway settings. These results may improve further with the use of video-assisted intubation devices that increase visualization.

Although it is known that the use of ETI extends the intubation period, there are data with difficult airway settings, intubation times can be reduced.[10,11] In addition, a rigor for first-pass success might be more important than intubation times when the difficult airway is present.

In our study, the Likert Scale was used to standardize and evaluate each method's difficulty perceived by the participants.[12] The participants' self-perceived assessment with or without ETI was ("difficult" or "very difficult") with 5.5% and 33.7%, respectively. The participants reported that ETI's intubation was easier than without, even though the majority had no previous ETI experience.

Thirteen (28.3%) participants had used ETI in their clinical practice before the study. In addition, the first success rates for right selective intubation with and without ETI experience were 13/13 and 32/33, respectively (P = 0.717). Therefore, the participant's clinical ETI experience did not affect their success rates as they are similar to those without prior experience.

Limitations

This study had several limitations. Our study was concluded with a manikin; therefore, it was difficult to imitate certain factors frequently encountered while securing the airway, such as blood, stomach content, or sputum. Consequently, we used only lingual manipulation to achieve standardization in our study. The occurrence of other difficult airway factors might affect the first-pass success as well as intubation time. In addition, using different types of ETI might result in different times and success rates.

This was a simulation study. The crowded and stressful working environment will affect the success rate; therefore, our study might not reflect real lifetime success rates. However, this study presents a baseline first-pass success rates and intubation time for selective intubation with ETI which was not presented before.

Finally, this study reports the findings of a single-center; therefore, results cannot be generalized.

Conclusions

Although this technique was the first-time method by most participants, the success rates of left selective intubation with ETI are higher than the conventional method, which can be strong evidence for this method's applicability in practice. Expanding the use of ETI and increasing the experience of the practitioners can contribute to further success.

Author contributions statement

HÖ: Writing-Reviewing, Conceptualization, Data Curation, EŞ: Writing-Reviewing-Editing, Formal Analysis, OK: Methodology, Data Curation, EA: Data Curation, Investigation HCH: Conceptualization, Methodology, Writing-Original draft preparation.

All authors have also revised the material critically for important intellectual content and approved the final version to be submitted.

Ethical approval

Kocaeli Derince Training and Research Hospital local ethics comittee approved the study (approval date: 12.09.2019, approval no: 2919/81).

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Conflicts of interest

None Declared.

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