Using Smartphone Application iLarynx to Teach Novices to Perform Fiber Optic Intubation

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Key Words: *fiber optic intubation, training, iLarynx, smartphone application.*

Summary. *The aim of the study was to investigate whether the fiber optic intubation learning process is more efficient when the app is being used.*

Methods. It was a randomised, controlled, single-blinded trial. Medical students (n=54) were taught about fiber optic intubation in a theoretical lecture, after which they were divided into two groups: G1 – iLarynx training (n=28), and G2 – no additional training (n=26). G1 was instructed to use the iLarynx app for a month. After a month, students' skills were tested with the help of moulages. The duration of the task fulfilment was assessed. The data of subjective performances were analysed using Mann-Whitney one-way analysis of variance. The rate of intubation failure was analysed by the Pearson chi-square test. Permission of the Bioethics Centre of the Lithuanian University of Health Sciences No. BEC-MF-536 was obtained.

Results. There was no significant difference in the duration of intubation between the groups (G1 56.46±17.825 s, G2 58.04±29.26 s, P=0.634). Then, 27 students (50.0%, n=54) who had previous experience with endotracheal intubation were divided between the groups (G1 – 13 students, G2 – 14 students, P=0.768). G1 used the iLarynx app from 1 to 10 times a week with the median of 3 times a week. G1 students used the app significantly more often if they had previous endotracheal intubation experience (P=0.04).

Conclusion. The data show no significant change in the fiber optic intubation learning efficiency. The motivation to practice is greater when a student already has experience in the particular field.

Introduction

The fiber optic intubation (FOI) technique has long been considered the gold standard in the management of predicted difficult airways, and for this reason every anaesthesia practitioner is required to master this complex skill (1, 2). However, studies have shown that ~40% of anaesthesiologists are not proficient in the performance of FOI (3), which is a difficult skill to teach, learn and maintain (4). Learning of novice anaesthesiology residents is often long and takes up to 58 attempts to achieve proficient results in the use of FOI. It is worth mentioning that each individual's learning process may be influenced by multiple factors, such as motivation, aptitude, inherent skills, and enthusiasm on the part of the learner, and experience and enthusiasm generated by the teacher (5). As well as doctors, nursing practitioners could also provide anaesthesiologist-assisted airway management including FOI. There is a wide range of possibilities to combine theoretical and nursing skills using special simulation technologies and applications. Extending medical or nursing educational programmes of anaesthesiology could provide some improvements.

New technologies are increasingly integrated into medical service. Smartphones are able to perform various functions of computer devices and have developed rapidly over the last decade becoming smaller, faster, with improved storage capacity, optical resolution and camera functionality (6). There are various teaching strategies to improve FOI skills to reach the proficiency level. One of these includes simulation-training sessions. In a simulated environment, the trainee has the advantage of concentrating on developing skills with repetitive practice without life threatening consequences. Hence, simulation technologies have become extremely popular (7, 8). In order to assist virtual reality technologies, a virtual reality software application iLarynx has been developed. The app uses built-in accelerometer properties of iPhone or iPad (Apple Inc., Cupertino, CA, USA) that mimics hand movements for the performance of fiber optic skills. The iLarynx software has the advantage of being free of charge and can be easily installed on an iPhone or iPad device, which can be more accessible to potential learners (15).

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Although previous studies have shown how to teach FOI to novices (9, 10) and have given information about the use of simulators to teach FOI (11), particular guidelines of virtual simulator-assisted education, time, attempts and efforts that are necessary to teach a novice to perform FOI successfully or to reach the proficiency level remain unclear. Our aim of the current study was to evaluate the effect of virtual airway simulation using the iLarynx smartphone application of novices performing FOI.

Material and Methods

The study design is a randomised, controlled, single-blind investigation. It was held at the Lithuanian University of Health Sciences. After obtaining the permission of the Bioethics Centre of the Lithuanian University of Health Sciences No. BEC-MF-536 as well as written informed consent, a total of 54 participants were voluntarily enrolled into this study. Based on random selection, the students were divided into two groups: G1 (n=28) which was asked to use the iLarynx app, and G2 (n=26) – a group without additional training. One month before the investigation, all the participants attended a theoretical lecture which described upper airway anatomy as well as the main steps of the successful performance of FOI. After the lecture, G1 students were additionally instructed to use the iLarynx app on a daily basis for the whole month as much as they wanted to develop the necessary FOI skills. After a month of individual practice with iLarynx, G1 and non-trained G2 students skills were tested using a high-fidelity simulation manikin (AirSim Advance; Trucorp Ltd., Belfast, Northern Ireland). Before the final test, each participant had a practical review of fiberscope usage and one trial to attempt FOI. Neither support nor feedback from investigators were given during these trials. The second attempt was considered as final. The duration of the task fulfilment was assessed. The primary outcome was considered as an advance of a fiberscope from the manikin's mouth up to the carina. Failed final attempts were considered as longer than 150 s. All the data were responsibly collected by the team of 2 investigators. To ensure the reliable obtainment of the results, the researchers who helped to perform intubation were not aware of the fact whether the student performing intubation was an app user or a non-app user. Additional data were collected by a questionnaire from each participant including questions on previous intubation experience, time (min) of using the iLarynx app per day and time per week. In conclusion, the study participants were asked to give feedback commenting on advantages and disadvantages of FOI and to give their personal opinion about iLarynx.

Statistical analysis was performed and graphs were generated using IBM SPSS Statistics 20. Data of subjective performances and preferred intubation aid were analysed using the Mann-Whitney U test. The rate of intubation failure was analysed by the Pearson chi-square test. Data are presented as absolute numbers, in percentage, and as mean and standard deviation. A P value <0.05 was considered significant for all analyses (12, 13).

Results

Of 54 students, 53 successfully (<150 s) completed the study. One group of students (n=28) were learning to perform FOI with gained skills of using iLarynx, while the other 26 students were tested as a control group without special preparation. Of all participants, 27 students (50%) previously had endotracheal intubating experience and were divided in each group (G1 – 13 students, G2 – 14 students, χ^2=0.297, P=0.586) (Table 1).

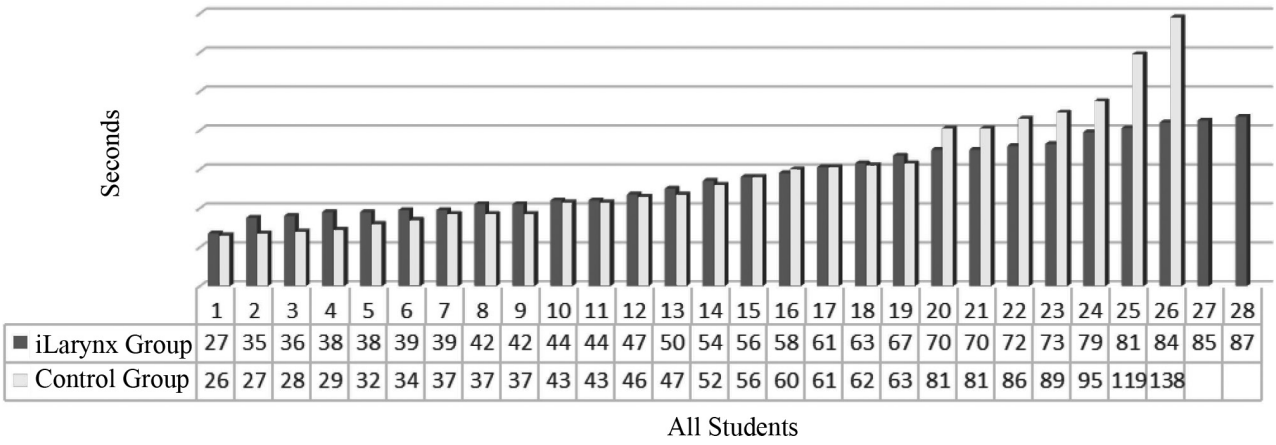
In G1, the intubation time varied from 27 s to 87 s, while in G2 from 26 s to 138 s. There was no significant difference in the intubation time between the groups (G1 56.46±17.825 s, G2 58.04±29.26 s, U=336.5, P=0.634) (Fig. 1).

G1 used the iLarynx app from 1 to 10 times a week with a median value of 3 times a week. Weekly duration of training varied in the iLarynx group from 4 min to 60 min with an average value of 17.43±16.43 min (Fig. 2).

G1 students used the app significantly more often if they had previous endotracheal intubation experience with a laryngoscope compared with students without previous endotracheal intubation experience (U=54.5, P=0.04). However, neither the intubation time (P=0.58) nor the learning time (P=0.34) had a significant influence on students who previously performed endotracheal intubation (Fig. 3).

Table 1. Distribution of Participants

	G1 (iLarynx group)	G2 (Control group)	Total	*P*
Number of participants (%)	28 (52)	26 (48)	54 (100)	–
Successful first intubation (%)	28 of 28 (100)	25 of 26 (96)	53 of 54 (98)	0.295
Previous intubation with laryngoscope experience (%)	13 of 28 (46)	14 of 26 (54)	27 of 54 (50)	0.586



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
iLarynx Group	27	35	36	38	38	39	39	42	42	44	44	47	50	54	56	58	61	63	67	70	70	72	73	79	81	84	85	87
Control Group	26	27	28	29	32	34	37	37	37	43	43	46	47	52	56	60	61	62	63	81	81	86	89	95	119	138		

Fig. 1. Comparison of intubation time between the groups

In the iLarynx group, the intubation time varied from 27 s to 87 s, while in the control group from 26 s to 138 s. There was no significant difference in the intubation time between the groups (G1 56.46±17.825 s, G2 58.04±29.26 s, U=336.5, *P*=0.634).

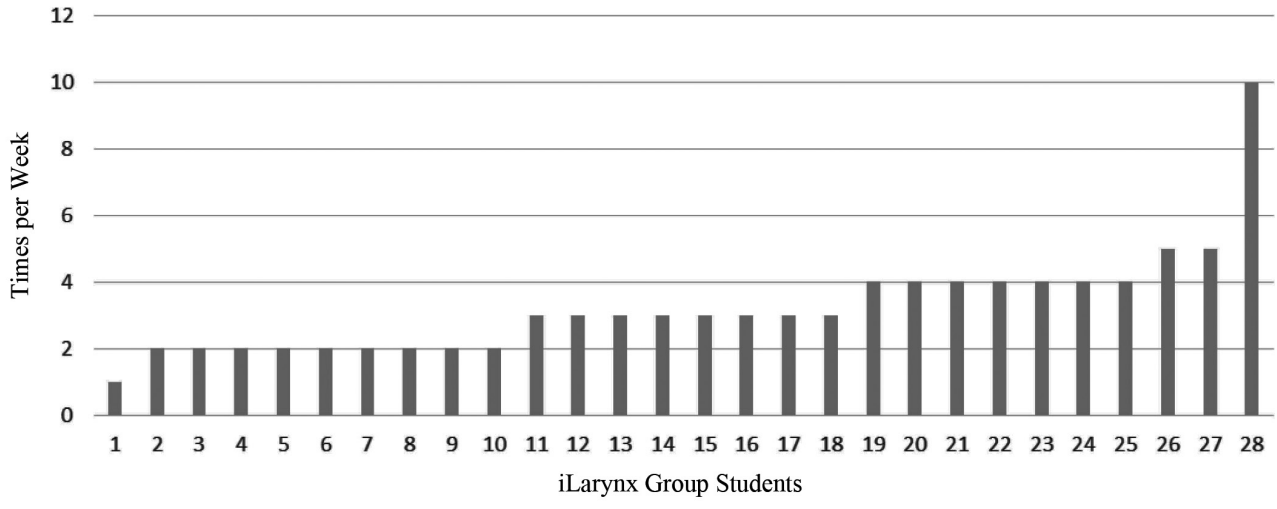


Fig. 2. Times per week when the iLarynx app was used

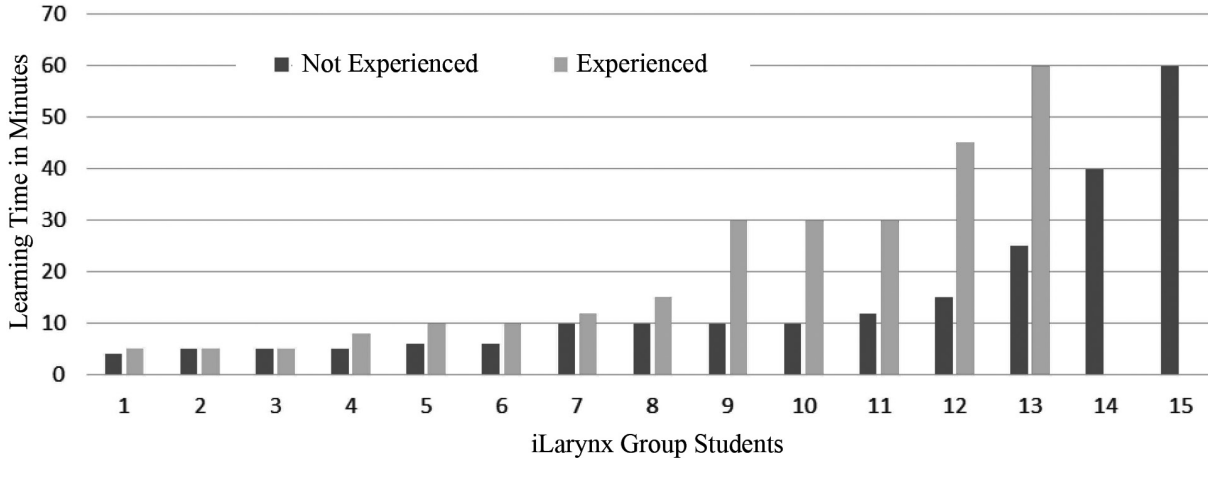


Fig. 3. Learning time in minutes and previous experience of FOI

Discussion

FOI is a clinically important technique in anaesthesiology practice requiring good psychomotor skills as well as manual dexterity. To maintain required competences, regular practice and appropriate training are necessary (14). Our aim of the study was to find out whether the iLarynx app itself could be used as an effective technology for educational purposes. We selected 54 medical students who performed FOI. Each individual's learning process may be influenced by multiple factors, such as motivation, aptitude, inherent skills, enthusiasm, on the part of the learner, and experience and enthusiasm generated by the teacher, although these factors were not a focus of our study (5). This study shows that the iLarynx app could be one of possible learning implements, but the benefits compared with the common manikin intubation technique are negotiable.

Our study showed no significant differences in the intubation time and the learning time between the groups. Previous intubation experience had no significant importance, too. These results are in disagreement with Oliveira et al.'s study (n=20), which demonstrates that virtual airway simulation improves dexterity of novices in performing upper airway endoscopy (15). This might be so, because Oliveira et al. assessed not the momentary one-attempt performance of trainees, but a ten-attempt evaluation with a higher rate of failed turns. Furthermore, the researchers did not evaluate previous students' experience handling an endoscopic device or any physical impairment that could possibly limit their performance, although we did not notice such a tendency in our study either. It is worth mentioning that participants were allowed to practice using the iLarynx app only up to 30 minutes. In comparison with our investigation, a smaller number of participants (n=54 vs n=20) were involved. These propositions could be significant in influencing major differences between the studies.

Considering our results and those of other studies, some questions remain unclear, such as how much time and how many attempts are required to train novice learners to the basic proficiency skill level and how much effort is required to retrain them (16). In our study, we established a weekly average duration of virtual practicing with the iLarynx app ranging from 4 min to 60 min per week with a mean value of 17.53 min, taking into consideration the fact that the motivation of participants differs. According to our results, the average time that a student spent using the app was 3 times per week or about 6 min per 1 specific learning time. Revising Hawkes et al.'s study and their smartphone technology to teach neonatal endotracheal intubation NeoTube application, we found out that the average time spent on the application was 3 min 52 s per learning time, and only 2 min 50 s were spent on the videos and images section. A comparison of our subjective results and Hawkes et al.'s objective results shows that our students spent twice as much time learning FOI with iLarynx than a random NeoTube app user, which suggests that our student's motivation was sufficient to reach significant results (17). An interesting finding of our study is that students used the app significantly more often if they had previous endotracheal intubation experience with a laryngoscope compared with students without previous endotracheal intubation experience, suggesting that experienced trainees are more motivated than random participants. It was also considered which teaching method motivated students more. According to Dalal et al., FOI training should be tailored to the needs of each individual (5).

To assess the iLarynx app and to get feedback about FOI, each participant after intubation performance was asked to assess pros and cons of the app and FOI. The majority of the students confirmed benefits of FOI and its necessity in anaesthesiology practice. The iLarynx app was commonly described as a useful innovation, alleviating the study process and making it more practice-oriented, which is also free of charge; however, students also noticed that the app became boring after several times of use. We speculate that the interface of the iLarynx app could possibly reduce the students' motivation in regular use, as our participants used to spend about 3 times per week learning virtual FOI.

In consistency with our findings, several previous small group studies of FOI training comparing results with a different kind of virtual reality airway simulators have reported controversial results. Our results are in agreement with several previous studies that showed no significant differences between a virtual reality model and control groups (18–21). In contrast, there is some evidence that virtual reality FOI significantly improves intubation performance (9, 22–24). However, most of the studies agree that virtual reality simulation-based teaching, especially smartphone combination with FOI, is an alternative, inexpensive and daily progressing innovative method. Further researches are required to assess the benefits of the iLarynx app as an intubation aid in a clinical scenario for general evaluation of virtual reality tools.

There are several limitations in our study. First, we evaluated the iLarynx app as a personal education programme, but we did not check its real-time possibilities with an iPhone modified bronchoscope, as some other researchers did. Although the FOI technique is used in the management of predicted difficult airways, we evaluated uncomplicated airways, explaining that as independent evaluation of educational app effectiveness, but not FOI teaching. An important limitation in this study was its

design utilising a manikin simulator in a controlled scenario and not patients in a clinical environment. The use of manikins has been suggested in the early evaluation of airway technology, as it eliminates bias generated by different anatomical/clinical conditions (25, 26). On the other hand, if we performed this study in patients, the assessment would face many other limitations, such as different testing conditions, time differences of assessment, etc. (16). Awareness of being under observation could also influence the behaviour of the participants, potentially altering their performance.

Conclusions

The study showed no significant change in the fiber optic intubation learning efficiency. The motivation tends to increase when a student already has experience in a particular field. This might be due to the modest sample and the learning period. Further research is necessary to assess whether the iLarynx app makes the intubation learning process more efficient.

Statement of Conflict of Interest

The authors state no conflict of interest.

Fibrooptinės intubacijos mokymasis išmaniojo telefono programėle *iLarynx*

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Raktažodžiai: fibrooptinė intubacija, mokymasis, *iLarynx*, išmanioji programėlė.

Santrauka. *Tikslas* – nustatyti, ar fibrooptinės intubacijos mokymasis efektyvesnis naudojant išmaniojo telefono programėlę nei jos nenaudojant.

Metodika. Atliktas atsitiktinių imčių viengubai aklas tyrimas (gautas Lietuvos sveikatos mokslų universiteto Bioetikos centro leidimas Nr. BEC-MF-536). Į jį įtraukti 54 medicinos studentai savanoriai, kurie teorinės paskaitos metu buvo apmokyti atlikti fibrooptinę intubaciją. Po apmokymo jie atsitiktiniu būdu padalyti į dvi grupes: G1 – papildomai treniravosi su *iLarynx* programėle (n = 28), G2 – papildomai nesitreniravo (n = 26). G1 grupė naudojosi programėle vieną mėnesį. Jiems buvo nurodyta treniruotis tiek, kad pasijustų išmokę ir užtikrinti savo fibrooptinės intubacijos įgūdžiais. Po mėnesio visų studentų intubavimo įgūdžiai patikrinti naudojant muliažus. Tyrėjai, kurie padėjo atlikti intubaciją, nežinojo, kuriai grupei studentai priklausė. Vertinta procedūros trukmė, ar pavyko intubacija, ar turėta intubacijos laringoskopu patirties. Duomenų analizė atlikta taikant neparametrinį statistinį Mann'o-Whitney'aus U testą ir Pearson'o chi kvadrato testą. Pasirinktas statistinis reikšmingumo lygmuo – $p < 0,05$.

Rezultatai. Intubacijos reikšmė statistiškai reikšmingai nesiskyrė (vidurkis ± standartinis nuokrypis): (G1 56,46 ± 17,825 s, G2 58,04 ± 29,26 s, $p = 0,634$). 27 studentai (50,0 proc., n = 54), kurie turėjo patirties intubuojant laringoskopu, buvo vienodai pasiskirstę tarp grupių (G1 – 13 studentų, G2 – 14 studentų, $p = 0,768$). G1 *iLarynx* programėlę naudojo nuo 1 iki 10 kartų per savaitę, mediana – 3 kartai per savaitę. Studentai, turintys įprastos intubavimo patirties, statistiškai reikšmingai dažniau naudojosi programėle ($p = 0,04$).

Išvados. Fibrooptinės intubacijos mokymasis nebuvo efektyvesnis naudojant išmaniojo telefono programėlę. Motyvacija mokytis buvo didesnė tų, kurie jau turėjo panašios patirties.

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Received 10 February 2016, accepted 15 March 2016