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Use of Ultrasonography vs Clinical Assessment to Confirm Endotracheal Tube Placement by Emergency Physicians

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ABSTRACT

Airway management skills are indispensable for an emergency physician. Unrecognized airway accidents such as oesophageal intubation tend to occur more in emergency room, where it is reported as 6%-16%. Various studies have compared methods used for distinguishing between endotracheal and oesophageal placement of the tube. The aim of this study is to assess the diagnostic accuracy and timeliness of ultrasonography by static method only for identification of Endo tracheal tube (ET Tube) placement in trachea in an emergency setting vs existing clinical methods. This prospective study was carried out in the emergency room from March 2020 till end of October 2022. The ultrasonography was performed 120 emergency patients only after the intubation had been completed i.e. static phase. A linear probe was used over neck to identify the predefined signs of ET intubation. Residents who perform ultrasound examination fill a form after assessment of each patient. It was found that Tracheal Intubation-USG Sensitivity was 99.1, Specificity was 91.7, Positive Predictive Value: 99.1, Negative Predictive Value was 91.7 and Accuracy was 98.3%. Ultrasonography can be used as an adjunct tool to verify the ETT position by Emergency Physicians which can be performed easily after a briefing or short-course training. This study demonstrates that US imaging has a high diagnostic accuracy to immediately confirm proper ETT placement post-intubation in an emergency setup. Therefore, it seems that ultrasonography using static technique only is a proper screening tool in determining endotracheal tube placement.

KEY WORDS: Endotracheal intubation, emergency, ultrasonography, USG Sensitivity

INTRODUCTION

Airway management skills are indispensable for an emergency physician. Unrecognized airway accidents such as oesophageal intubation tend to occur more in emergency room, where it is reported as 6%-16%.

Various studies have compared methods used for distinguishing between endotracheal and oesophageal placement of the tube. Visual confirmation during laryngoscopy, expansion of the chest wall during ventilation, 5 point auscultation, capnography, chest xray are modalities currently used in practice. These techniques vary in their degree of accuracy.

The Advanced Cardiac Life Support (ACLS) 2015 guidelines has recommend continuous waveform capnography in addition to clinical assessment as the most reliable method of confirming and monitoring correct placement of an endotracheal tube (ETT). In 1989, in a study, Vaghadia et al. came to a conclusion that end-tidal carbon dioxide (ETCO2) is most accurate for identifying oesophageal intubation. Capnography has also been found to be the best method for quick assessment of tube position. Capnography is considered as the gold standard, but it has numerous limitations. Waveform capnography works on the principle of detection of exhaled carbon dioxide. This is only possible when there is a sufficient pulmonary blood flow. In conditions where pulmonary blood flow is inadequate such as massive pulmonary embolism and cardiac arrest, capnography is unreliable.

Capnography is freely available in operation theatres but not in many emergency departments (EDs) including at the location where this study was conducted. Ultrasound, on the contrary, is emerging in most EDs as it is used in point of care imaging for trauma as well for guided invasive interventions. Ultrasound machine is portable, non-invasive, and the images are easily reproducible. Various studies have shown that ultrasound is a potential method to confirm proper ETT placement.

Establishing a secure airway in a critically ill patient is a primary step during resuscitation. According to the 2015 Advanced Cardiac Life Support (ACLS) guidelines, adequate support of ventilation along with airway protection during resuscitation is essential. Proper endotracheal tube intubation provides definitive airway control. Nevertheless, unrecognized endotracheal tube misplacement such as in oesophagus can lead to significant mortality and morbidity, and is more likely to occur during emergency scenarios. The reported incidence of oesophageal intubation was around 6–16% during emergency intubation. Thus, early detection of accidental oesophageal intubation is a primary focus during resuscitation. Many traditional and clinical methods can be employed to confirm endotracheal tube placement, for e.g. direct visualization of the vocal cords with laryngoscope observation of chest movement with ventilation, and 5 point auscultation of chest and upper abdomen along with radiological examinations such as chest X ray. Each of these methods has limitations, that affects its reliability in an emergency setting.

Several studies have provided promising results of the use of ultrasound for the confirmation of endotracheal tube placement in cadaveric models and in patients in well-controlled environments. Two recent studies showed up to 100% of sensitivity and specificity of tracheal ultrasound for endotracheal tube placement confirmation in live humans under a well-controlled operating room setting. To this date, few studies have been conducted in emergency settings, so that validation of this potentially useful technique in emergent situations is urgently needed.

Moreover, all studies in recent times employed both dynamic followed by static methods together, Dynamic method is visualising the signs of intubation during intubation and static method is post intubation a study by Abbasi et al in 2014 in Iran employed both dynamic followed by static method. The sensitivity, specificity, positive predictive value, and negative predictive value of the dynamic technique for determining correct endotracheal intubation were 98.1% [95% confidence interval (CI), 88.8–99.9%], 100% (95% CI, 51.6–100%), 100% (95% CI, 91.5–100%), and 85.7% (95% CI, 42–99.2%), respectively. Using the static technique, all testing characteristics listed were surprisingly 100%. Prompting a thought of a possibility of an observational bias where the results of dynamic method might actually affect the static technique and also a 100 % sensitivity, specificity positive and negative predictive value of the static technique persuaded the author to use a static technique only study for ultra-sonographic identification of the et tube placement against the clinical evaluation.

AIMS AND OBJECTIVE:

The aim of this study is to assess the diagnostic accuracy and timeliness of ultrasonography by static method only for identification of Endo tracheal tube (ET Tube) placement in trachea in an emergency setting vs. existing clinical methods.

To study sensitivity, specificity and accuracy of static method of ultrasonography to confirm ET Intubation.

MATERIALS AND METHODS:

Study design

The author conducted a prospective observational study in patients attended the Emergency Department of Narayana Superspeciality Hospital with the help of 4 emergency residents between March 2020 to March 2022. Narayana Superspeciality Hospital is a super-specialty hospital that provides every medical and surgical type of patient care and treat which is inclusive of critical care and emergency services. The hospital has a capacity of 220 beds, of which 21 are in emergency room. Narayana Superspeciality Hospital Emergency department is also an academy for emergency residents, nursing staff and EM technicians which see more than 15,000 patients annually.

***Study population*:**

Sample Size

A group of 4 emergency residents were involved in conducting the study in a total of 120 patients.

Inclusion Criteria

Every patient who was between the age of 18 to 80 years of age of all gender requiring endotracheal intubation by oral route by direct laryngoscopy, both emergency or elective intubation were eligible candidate for the study provided they did not have one of the following exclusion criteria.

Exclusion Criteria

Patients will be excluded if:

- Patients had obvious neck mass or deformity
- Injury over the neck
- More than 3 minutes have passed since the endotracheal intubation

METHODOLOGY

A group of 4 willing emergency residents comprising all three years took part in the study six groups comprising of 4 emergency residents each were declared just to mirror their emergency rotation group. Each resident underwent a prior hands on training of use of ultrasound to identify the basic structures of the neck including trachea oesophagus, carotids, thyroid ,and jugular veins by our consultant and a detailed explanation of single and double tract signs . Every member of a group was asked to be involved in four intubations and evaluating four different cases of intubation using ultrasonography against one intubation from each of the other member of the same group. The intubator clinically confirmed the intubation using direct visualization of et tube passing the vocal cord, 5 point auscultation which involves listening to the breath sound in the upper and lower chests bilaterally and over epigastrium with each artificial breath given, and pulse oximetry suggestive of adequate oxygenation. ET CO2 was not used in this study. Ultrasound was used in static manner only where an attempt was made to understand the presence between single track sign (suggestive of endotracheal intubation) or double track sign (suggestive of esophageal intubation). Most importantly, the ultrasound assessment was initiated within 3 minutes of the endo-tracheal intubation to prevent bias. The EM residents were asked to fill up a form in pairs after seeing a patient.

STATISTICAL ANALYSIS

For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS (version 24.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Two-sample t-tests for a difference in mean involved independent samples or unpaired samples. Paired t-tests were a form of blocking and had greater power than unpaired tests. A chi-squared test (χ2 test) was any statistical hypothesis test wherein the sampling distribution of the test statistic is a chi-squared distribution when the null hypothesis is true. Without other qualification, 'chi-squared test' often is used as short for Pearson's chi-squared test. Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate.

Explicit expressions that can be used to carry out various *t*-tests are given below. In each case, the formula for a test statistic that either exactly follows or closely approximates a *t*-distribution under the null hypothesis is given. Also, the appropriate degrees of freedom are given in each case. Each of these statistics can be used to carry out either a one-tailed test or a two-tailed test.

Once a *t* value is determined, a *p*-value can be found using a table of values from Student's t-distribution. If the calculated *p*-value is below the threshold chosen for statistical significance (usually the 0.10, the 0.05, or 0.01 level), then the null hypothesis is rejected in favour of the alternative hypothesis.

p-value ≤0.05 was considered for statistically significant.

RESULT AND ANALYSIS

Table: Distribution of age

Age in years	Frequency	Percent
≤30	15	12.5%
31 to 40	10	8.3%
41 to 50	8	6.7%
51 to 60	17	14.2%
61 to 70	33	27.5%
71 to 80	37	30.8%
Total	120	100.0%

15(12.5%) patients had ≤30 years of age, 10(8.3%) patients had 31-40 years of age, 8(6.7%) patients had 41-50 years of age, 17(14.2%) patients had 51-60 years of age, 33(27.5%) patients had 61-70 years of age and 37(30%) patients had 71-80 years of age.

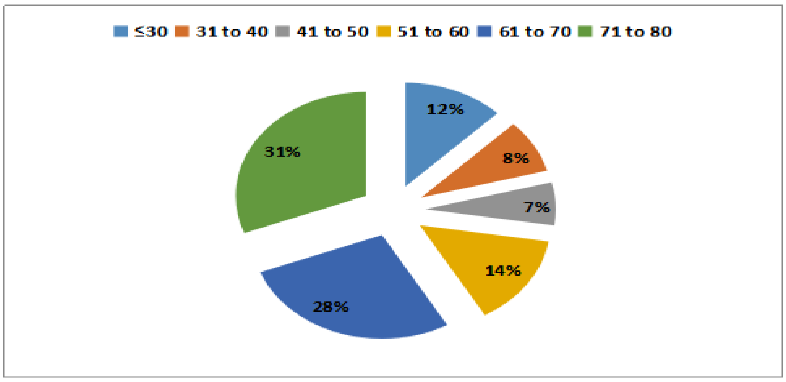


Table 1: Distribution of mean Age in years

	Number	Mean	SD	Minimum	Maximum	Median
Age	120	58.3667	17.1846	21.0000	80.0000	65.0000

The mean age (mean ±s.d.) of the patients was 58.3667 ± 17.1846 years.

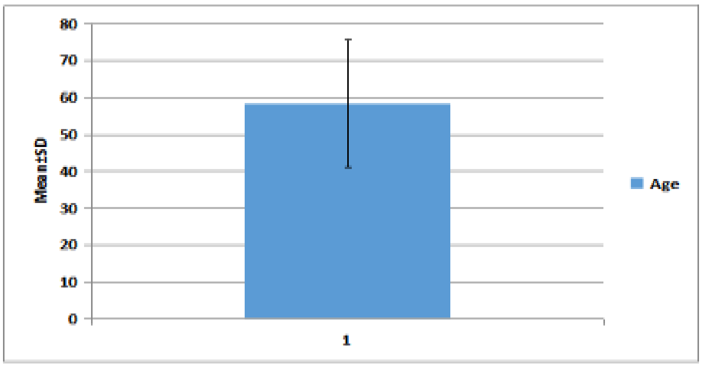


Table 2: Distribution of Sex

Sex	Frequency	Percent
Female	48	40.0%
Male	72	60.0%
Total	120	100.0%

48(40.0%) patients had female and 72(60.0%) patients had male.

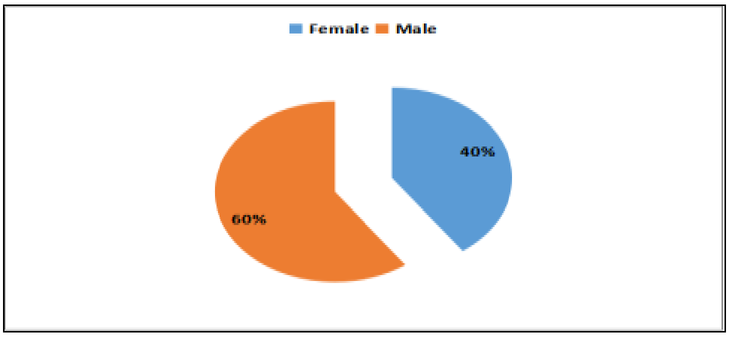


Table 3: Distribution of Intubation

Intubation	Frequency	Percent
Tracheal Intubation	108	90.0%
Oesophageal Intubation	12	10.0%
Total	120	100.0%

108(90.0%) patients had tracheal intubation and 12(10.0%) patients had oesophageal intubation.

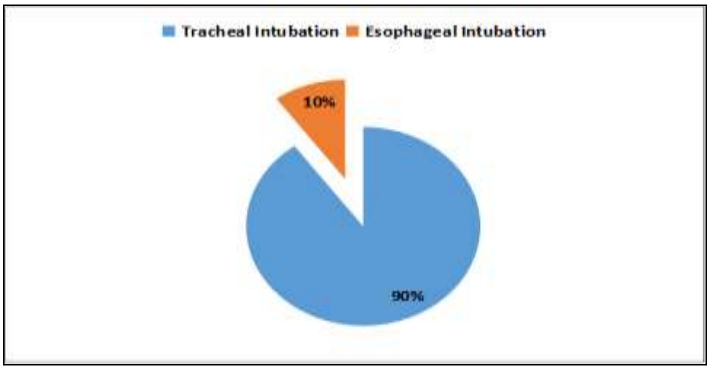


Table 4: Distribution of Intubation indication

Intubation indication	Frequency	Percent
Cardiac arrest	21	17.5%
Cardiovascular disease	28	23.3%
Central nerve system disease	21	17.5%
Pulmonary disease	24	20.0%
Trauma	19	15.8%
Other	7	5.8%
Total	120	100.0%

21(17.5%) patients had cardiac arrest, 28(23.3%) patients had cardiovascular disease, 21(17.5%) patients had central nerve system disease, 24(20.0%) patients had central nerve system disease, 19(15.8%) patients had trauma and 7(5.8%) patients had other intubation indication.

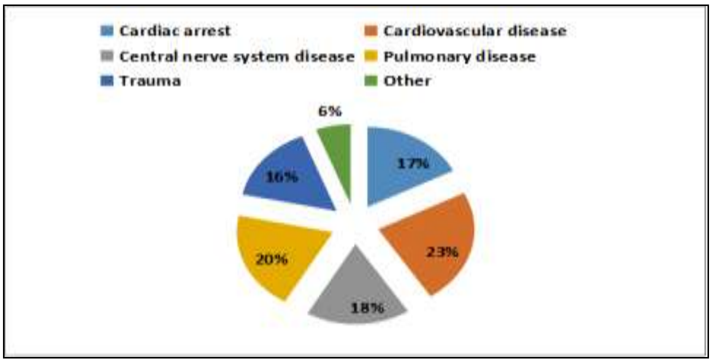


Table 5: Distribution of BMI

BMI group	Frequency	Percent
Normal	81	67.5%
Overweight	22	18.3%
Obese grade I	17	14.2%
Total	120	100.0%

81(67.5%) patients had normal BMI, 22(18.3%) patients had overweight and 17(14.2%) patients had obese grade I.

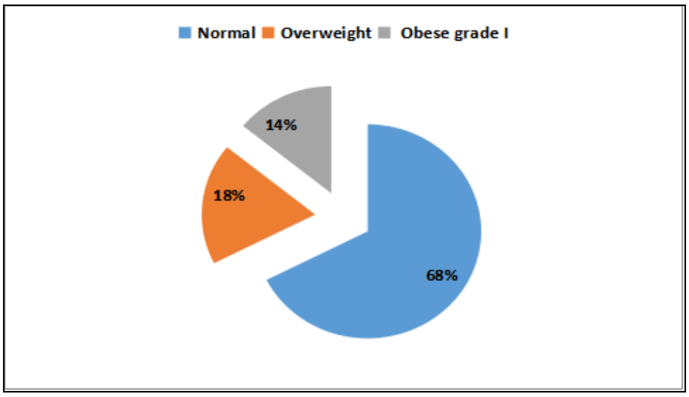


Table 6: Distribution of mean BMI

	Number	Mean	SD	Minimum	Maximum	Median
BMI	120	24.8242	3.4519	20.0000	34.6000	23.5000

The mean BMI (mean ±s.d.) of the patients was 24.8242± 3.4519 kg/m^2.

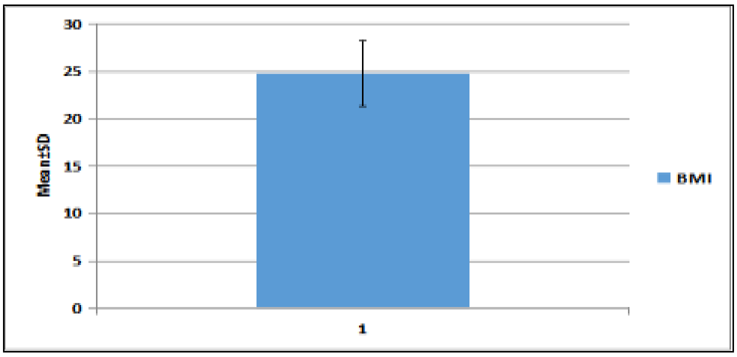


Table 7: Distribution of USG Finding

USG Finding	Frequency	Percent
Tracheal Intubation	108	90.0%
Oesophageal Intubation	12	10.0%
Total	120	100.0%

108(90.0%) patients had tracheal intubation and 12(10.0%) patients had oesophageal intubation.

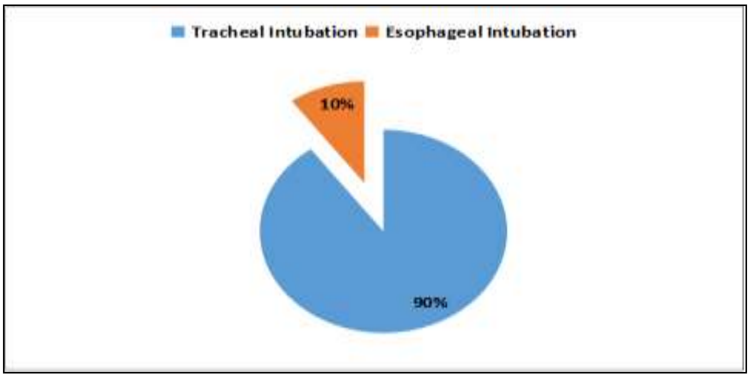


Table 8: Distribution of Emergency and elective

Emergency and elective	Frequency	Percent
Elective	9	7.5%
Emergency	111	92.5%
Total	120	100.0%

9(7.5%) patients had elective and 111(92.5%) patients had emergency.

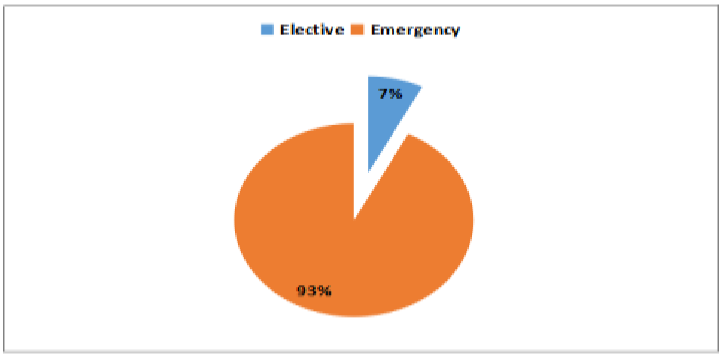


Table 9: Distribution of mean Intubation time in minute

	Number	Mean	SD	Minimum	Maximum	Median
Intubation time in minute	120	5.1333	2.0780	2.0000	15.0000	5.0000

The mean intubation time (mean ±s.d.) of the patients was 5.1333 ± 2.0780 minutes.

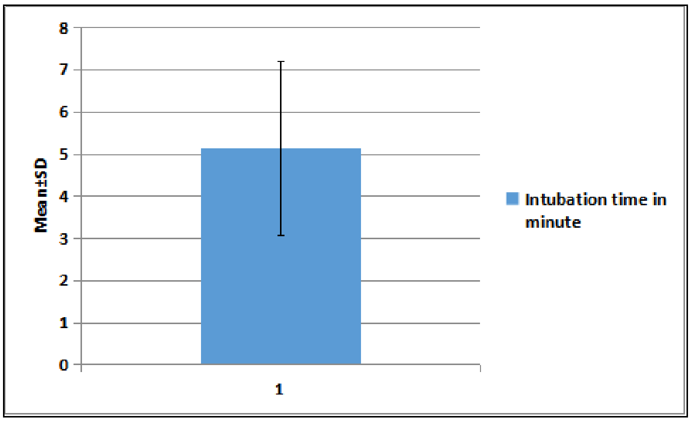


Table 10: Association of age in years group: Intubation

INTUBATION			
Age in years group	**Tracheal Intubation**	**Esophageal Intubation**	**TOTAL**
≤30	15	0	15
Row %	100.0	0.0	100.0
Col %	13.9	0.0	12.5
31-40	9	1	10
Row %	90.0	10.0	100.0
Col %	8.3	8.3	8.3
41-50	8	0	8
Row %	100.0	0.0	100.0
Col %	7.4	0.0	6.7
51-60	16	1	17
Row %	94.1	5.9	100.0
Col %	14.8	8.3	14.2
61-70	31	2	33
Row %	93.9	6.1	100.0
Col %	28.7	16.7	27.5
71-80	29	8	37
Row %	78.4	21.6	100.0
Col %	26.9	66.7	30.8
TOTAL	108	12	120
Row %	90.0	10.0	100.0
Col %	100.0	100.0	100.0

Chi-square value: 8.9974; p-value:0.1092

In tracheal intubation, 15(13.9%) patients had ≤30 years of age, 9(8.3%) patients had 31-40 years of age, 8(7.4%) patients had 41-50 years of age, 16(14.8%) patients had 51-60 years of age, 31(28.7%) patients had 61-70 years of age and 29(26.9%) patients had 71-80 years of age. In oesophageal intubation, 1(8.3%) patient had 31-40 years of age, 1(8.3%) patient had 51-60 years of age, 2(16.7%) patients had 61-70 years of age and 8(66.7%) patients had 71-80 years of age. Association of age in years group vs. Intubation was not statistically significant (p=0.1092).

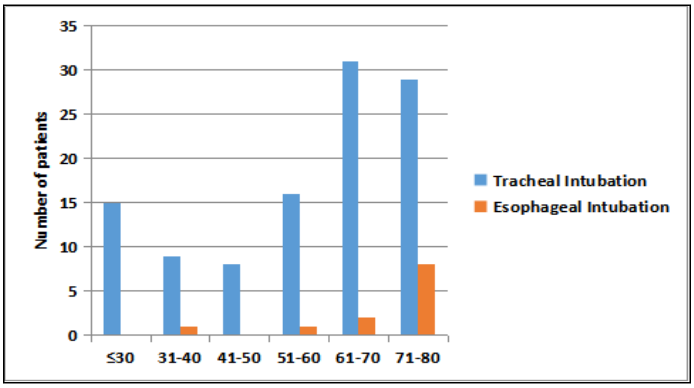


Table 11: Distribution of mean Age in years: Intubation

		Number	Mean	SD	Minimum	Maximum	Median	p-value
Age	Tracheal Intubation	108	57.3981	17.4447	21.0000	80.0000	65.0000	0.0637
	Oesophageal Intubation	12	67.0833	11.9351	35.0000	77.0000	71.0000	

In tracheal intubation, the mean age (mean ±s.d.) of the patients was 57.3981 ± 17.4447. In oesophageal intubation, the mean age (mean ±s.d.) of the patients was 67.0833 ± 11.9351. Distribution of mean age vs. intubation was not statistically significant (p=0.0637).

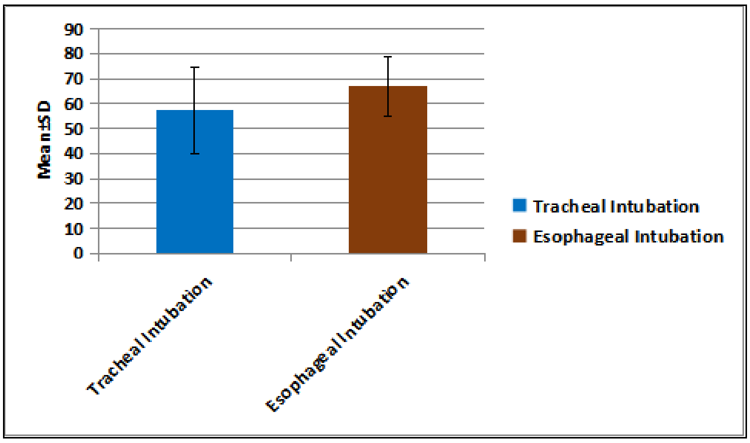


Table 12: Association of Sex: Intubation

INTUBATION			
Sex	**Tracheal Intubation**	**Esophageal Intubation**	**TOTAL**
Female	41	7	48
Row %	85.4	14.6	100.0
Col %	38.0	58.3	40.0
Male	67	5	72
Row %	93.1	6.9	100.0
Col %	62.0	41.7	60.0
TOTAL	108	12	120
Row %	90.0	10.0	100.0
Col %	100.0	100.0	100.0

Chi-square value: 1.8673; p-value:0.171787

In tracheal intubation, 41(38.0%) patients had female and 67(62.0%) patients had male. In oesophageal intubation, 7(58.3%) patients had female and 5(41.7%) patients had male. Association of sex vs. Intubation was not statistically significant (p=0.171787).

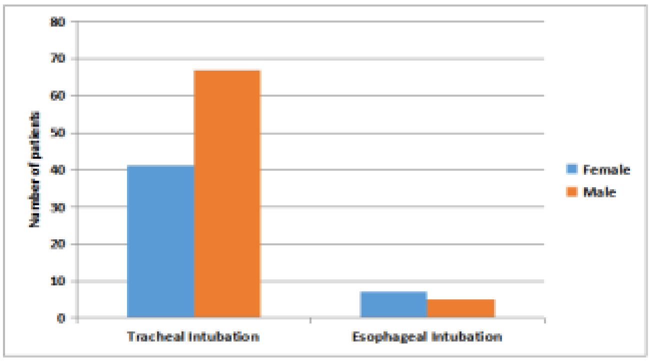


Table 13: Association of BMI group vs Intubation

INTUBATION			
BMI group	**Tracheal Intubation**	**Esophageal Intubation**	**TOTAL**
Normal Row % Col %	81 100.0 75.0	0 0.0 0.0	81 100.0 67.5
Overweight Row % Col %	22 100.0 20.4	0 0.0 0.0	22 100.0 18.3
Obese Grade I Row % Col %	5 29.4 4.6	12 70.6 100.0	17 100.0 14.2
TOTAL Row % Col %	108 90.0 100.0	12 10.0 100.0	120 100.0 100.0

Chi-square value: 80.7843; p-value:<0.0001

In tracheal intubation, 81(75.0%) patients had normal BMI, 22(20.4%) patients had overweight and 5(4.6%) patients had obese grade I.In esophageal intubation, 12(100.0%) patients had obese grade I.Association of BMI vs. Intubation was statistically significant (p<0.0001).

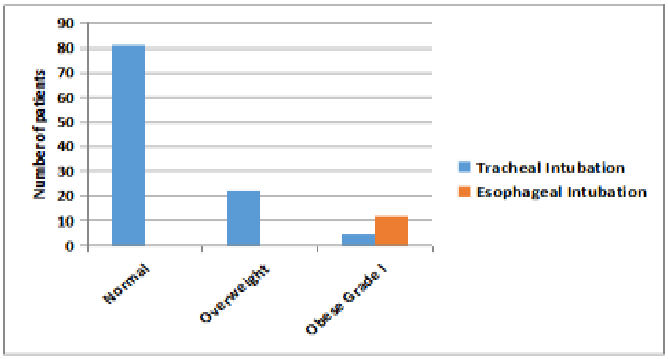


Table 14: Distribution of mean BMI: Intubation

		Number	Mean	SD	Minimum	Maximum	Median	p-value
BMI	Tracheal Intubation	108	23.9972	2.4937	20.0000	34.1000	23.5000	<0.0001
	Esophageal Intubation	12	32.2667	1.1276	31.0000	34.6000	32.0000	

In tracheal intubation, the mean BMI (mean ±s.d.) of the patients was 23.9972 ± 2.4937 kg/m^2. In esophageal intubation, the mean BMI (mean ±s.d.) of the patients was 32.2667 ± 1.1276 kg/m^2.Distribution of mean BMI vs. intubation was statistically significant (p<0.0001).

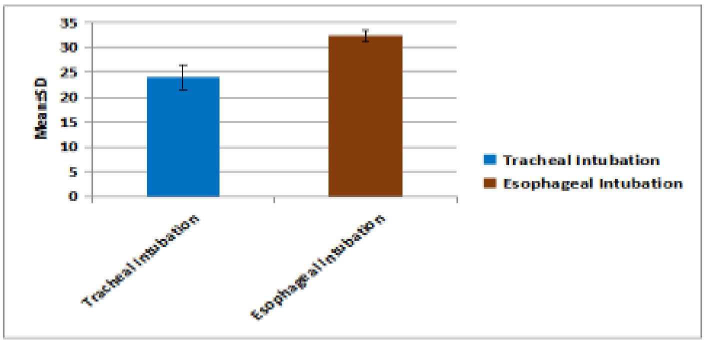


Table 15: Association of Intubation indication: Intubation

INTUBATION			
Intubation indication	**Tracheal Intubation**	**Oesophageal Intubation**	**TOTAL**
Cardiac arrest Row % Col %	19 90.5 17.6	2 9.5 16.7	21 100.0 17.5
Cardiovascular disease Row % Col %	27 96.4 25.0	1 3.6 8.3	28 100.0 23.3
Central nerve system disease Row % Col %	20 95.2 18.5	1 4.8 8.3	21 100.0 17.5
Other Row % Col %	6 85.7 5.6	1 14.3 8.3	7 100.0 5.8
Pulmonary disease Row % Col %	18 75.0 16.7	6 25.0 50.0	24 100.0 20.0
Trauma Row % Col %	18 94.7 16.7	1 5.3 8.3	19 100.0 15.8
TOTAL Row % Col %	108 90.0 100.0	12 10.0 100.0	120 100.0 100.0

Chi-square value: 8.5478; p-value:0.1285

In tracheal intubation, 19(17.6%) patients had cardiac arrest, 27(25.0%) patients had cardiovascular disease, 20(18.5%) patients had central nerve system disease, 6(5.6%) patients had other intubation indication, 18(16.7%) patients had pulmonary disease and 18(16.7%) patients had trauma.In esophageal intubation, 2(16.7%) patients had cardiac arrest, 1(8.3%) patient had cardiovascular disease, 1(8.3%) patient had central nerve system disease, 1(8.3%) patient had other intubation indication, 6(50.0%) patients had pulmonary disease and 1(8.3%) patient had trauma. Association of intubation indication vs. Intubation was not statistically significant (p=0.1285).

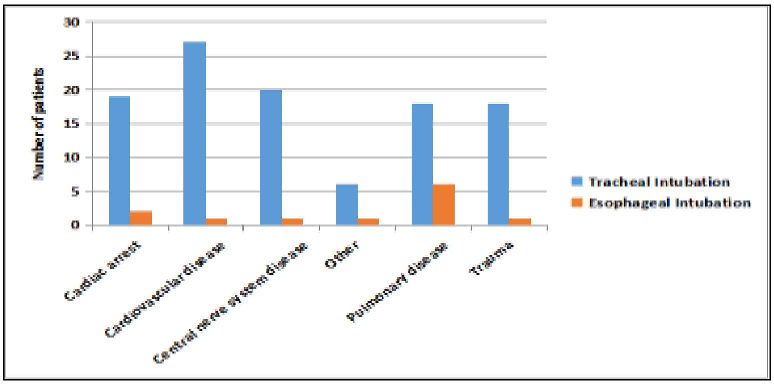


Table 16: Association of USG Finding: clinical finding Intubation

INTUBATION CLINICAL			
USG Finding	**Tracheal Intubation**	**Oesophageal Intubation**	**TOTAL**
Tracheal Intubation-USG Row % Col %	107 99.1 99.1	1 0.9 8.3	108 100.0 90.0
Oesophageal Intubation-USG Row % Col %	1 8.3 0.9	11 91.7 91.7	12 100.0 10.0
TOTAL Row % Col %	108 90.0 100.0	12 10.0 100.0	120 100.0 100.0

Sensitivity:99.1
Specificity: 91.7
Positive Predictive Value: 99.1
Negative Predictive Value: 91.7
Accuracy: 98.3% (TP+TN/Total) X100
Chi-square value: 98.8066; p-value:<0.0001

In tracheal intubation, 107(99.1%) patients had Tracheal Intubation-USG and 1(0.9%) patient had Oesophageal Intubation-USG. In oesophageal intubation, 1(8.3%) patient had Tracheal Intubation-USG and 11(91.7%) patients had Oesophageal Intubation-USG. Association of USG finding vs. Intubation was statistically significant (p<0.0001).

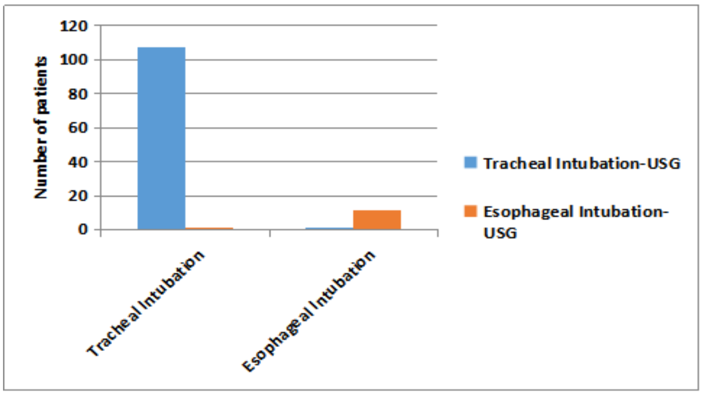


Table 17: Distribution of true positive, true negative, false positive and false negative

	Frequency	Percentage
TRUE POSITIVE	107	89.2%
TRUE NEGATIVE	11	9.2%
FALSE POSITIVE	1	0.8%
FALSE NEGATIVE	1	0.8%
Total	120	100.0%

107(89.2%) patients had true positive, 11(9.2%) patients had true negative, 1(0.8%) patient had false positive and 1(0.8%) patient had false negative.

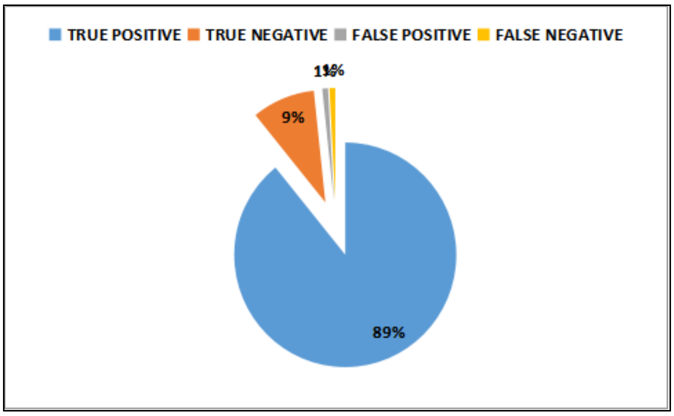


Table 18: Association of Emergency and elective: Intubation

INTUBATION			
Emergency and elective	**Tracheal Intubation**	**Oesophageal Intubation**	**TOTAL**
Elective	7	2	9
Row %	77.8	22.2	100.0
Col %	6.5	16.7	7.5
Emergency	101	10	111
Row %	91.0	9.0	100.0
Col %	93.5	83.3	92.5
TOTAL	108	12	120
Row %	90.0	10.0	100.0
Col %	100.0	100.0	100.0

Chi-square value: 1.6149; p-value:0.203798

In tracheal intubation, 7(6.5%) patients had elective and 101(93.5%) patients had emergency. In oesophageal intubation, 2(16.7%) patients had elective and 10(83.3%) patients had emergency. Association of emergency and elective vs. intubation was not statistically significant (p=0.203798).

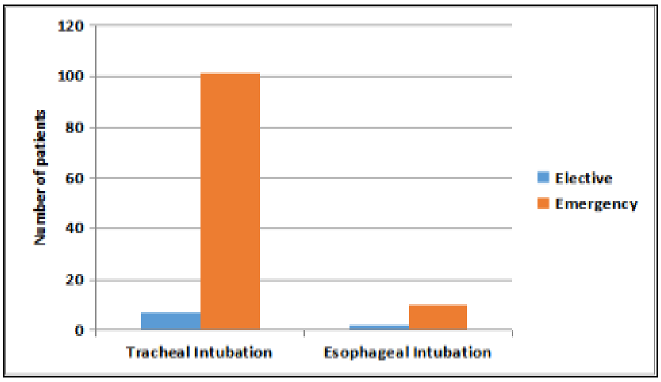
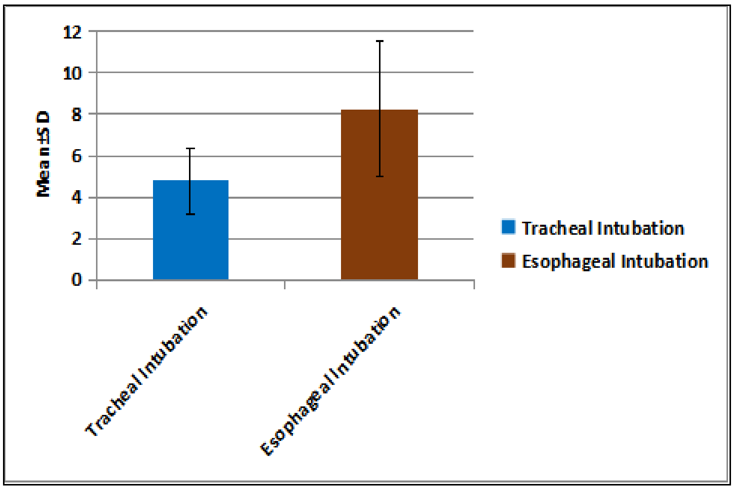


Table 19: Distribution of mean Intubation time in minute: Intubation

		Number	Mean	SD	Minimum	Maximum	Median	p-value
Intubation time in minute	Tracheal Intubation	108	4.7870	1.5829	2.0000	8.0000	5.0000	<0.0001
	Oesophageal Intubation	12	8.2500	3.2509	4.0000	15.0000	8.5000	

In tracheal intubation, the mean intubation time (mean ±s.d.) of the patients was 4.7870 ± 1.5829 minutes. In oesophageal intubation, the mean intubation time (mean ±s.d.) of the patients was 8.2500 ± 3.2509 minutes. Distribution of mean intubation times. intubation was statistically significant (p<0.0001).



DISCUSSION

Chou HC et al [68] found that with ages of 24–94 years old were included in the study and the mean age was 67.4 ± 17.6 years.

Moghadam HZ et al (2017) found that 150 patients with the mean age of 58.52 ± 1.73 years were included (56.6% male).

We found that 15(12.5%) patients had ≤30 years of age, 10(8.3%) patients had 31-40 years of age, 8(6.7%) patients had 41-50 years of age, 17(14.2%) patients had 51-60 years of age, 33(27.5%) patients had 61-70 years of age and 37(3.%) patients had 71-80 years of age. The mean age (mean ±s.d.) of the patients was 58.3667 ± 17.1846 years. 48(40.0%) patients had female and 72(60.0%) patients had male.

Chou HC et al [68] found that the mean BMI was 23.1 ± 4.8 kg/m2. Chou HC et al [68] found that the mean intubation time was 193.4 ± 211 sec.

We found that 81(67.5%) patients had normal BMI, 22(18.3%) patients had overweight and 17(14.2%) patients had obese grade I. The mean BMI (mean ±s.d.) of the patients was 24.8242± 3.4519 kg/m^2. The mean intubation time (mean ±s.d.) of the patients was 5.1333 ± 2.0780 minutes.

Patil V et al [69] (2019) found the incidence of oesophageal intubations was 2.0%. Sun JT et al [72](2014) found that 7 (7.3%) had oesophageal intubations. Hosseini JS et al (2013) found that Ultrasound correctly identified 11 out of 12 oesophageal intubations for a sensitivity of 92%, but misidentified one oesophageal intubation as tracheal. Kabil AE et al (2011) found that the four (10%) patients had confirmed oesophageal intubations.

Present study found that according to clinical finding, 108(90.0%) patients had tracheal intubation and 12(10.0%) patients had oesophageal intubation. But in USG finding, 108(90.0%) patients had tracheal intubation and 12(10.0%) patients had oesophageal intubation.

We found that 21(17.5%) patients had cardiac arrest, 28(23.3%) patients had cardiovascular disease, 21(17.5%) patients had central nerve system disease, 24(20.0%) patients had central nerve system disease, 19(15.8%) patients had trauma and 7(5.8%) patients had other intubation indication. 9(7.5%) patients had elective and 111(92.5%) patients had emergency.

We found that in tracheal intubation, the mean age (mean ±s.d.) of the patients was 57.3981±17.4447. In oesophageal intubation, the mean age (mean ±s.d.) of the patients was 67.0833 ± 11.9351. Distribution of mean age vs. intubation was not statistically significant (p=0.0637).

Chou HC et al [68] found that in tracheal intubation, 55(57.9%) patients had male and in oesophageal intubation, 6(35.3%) patients had male.

We found that in tracheal intubation, 41(38.0%) patients had female and 67(62.0%) patients had male. In oesophageal intubation, 7(58.3%) patients had female and 5(41.7%) patients had male. Association of sex vs. Intubation was not statistically significant (p=0.171787).

It was found that in tracheal intubation, 81(75.0%) patients had normal BMI, 22(20.4%) patients had overweight and 5(4.6%) patients had obese grade I. In oesophageal intubation, 12(100.0%) patients had obese grade I. Association of BMI vs. Intubation was statistically significant (p<0.0001). In tracheal intubation, the mean BMI (mean ±s.d.) of the patients was 23.9972 ± 2.4937 kg/m^2. In oesophageal intubation, the mean BMI (mean ±s.d.) of the patients was 32.2667 ± 1.1276 kg/m^2.Distribution of mean BMI vs. intubation was statistically significant (p<0.0001).

Chou HC et al [68] found that in tracheal intubation, 25(26.3%) patients had cardiac arrest, 5(5.3%) patients had cardiovascular disease, 10(10.5%) patients had central nerve system disease, 5(5.3%) patients had other intubation indication, 43(45.3%) patients had pulmonary disease and 7(7.4%) patients had trauma. In oesophageal intubation, 4(23.5%) patients had cardiac arrest, 3(17.6%) patient had central nerve system disease and 10(58.8%) patients had pulmonary disease.

We found that in tracheal intubation, 19(17.6%) patients had cardiac arrest, 27(25.0%) patients had cardiovascular disease, 20(18.5%) patients had central nerve system disease, 6(5.6%) patients had other intubation indication, 18(16.7%) patients had pulmonary disease and 18(16.7%) patients had trauma. In oesophageal intubation, 2(16.7%) patients had cardiac arrest, 1(8.3%) patient had cardiovascular disease, 1(8.3%) patient had central nerve system disease, 1(8.3%) patient had other intubation indication, 6(50.0%) patients had pulmonary disease and 1(8.3%) patient had trauma. Association of intubation indication vs. Intubation was not statistically significant (p=0.1285).

Chou HC et al found that the sensitivity, specificity, positive predictive value, and negative predictive value of the Tracheal rapid ultrasound exam were 98.9%, 94.1%, 98.9% and 94.1%.

Thomas VK et al (2017) found that the sensitivity and specificity of diagnosis using ultrasonography were 97.89% and 100%, respectively. Patil V et al (2019) found the overall sensitivity of airway ultrasound for confirmation of ETT placement was 96% (CI: 0.89–0.99) and specificity was 100%. The PPV was 100% (CI: 0.94–1.00). Khosla R et al (2016) found that the diagnostic accuracy of the ultrasound method in confirming proper endotracheal tube position was 100% (20/20) and that of the standard method 95% (19/20). Sun JT et al(2014) found that the sensitivity, specificity, positive predictive value, and negative predictive value of tracheal ultrasonography were 98.9%, 100%, 100%, and 85.7%, respectively.

Arafa S et al (2018) found that the sensitivity, specificity and accuracy rates of 97%, 71.4% and 95.3%. Lahham S et al (2018) found that the trachea with 96.4% sensitivity and 33.3% specificity. Kabil AE et al (2011) found that the tracheal ultrasound had a diagnostic accuracy of 97.5% in the detection of endotracheal tube site. The sensitivity was 97.2%, while the specificity was 100%. Tracheal ultrasound had a positive predictive value of 100%, while the negative predictive value was 80%.

Moghadam HZ et al [78] (2017) found that Sensitivity, specificity, positive predictive value, negative predictive value, and positive and negative likelihood ratio of tracheal ultrasonography in endotracheal tube confirmation were 96, 98, 78, 6, and 0.2, respectively. The tracheal ultrasonography by trained emergency medicine residents had excellent sensitivity (>90%) and good specificity (80-90) for confirming endotracheal tube placement.

Gosai Jigarkumar B et al (2017) found that the sensitivity and specificity for the detection of proper ETT placement with US were: Sensitivity:98%, Specificity: 100%, Positive Predictive Value: 100%, Negative Predictive Value: 0%.

We found that Sensitivity was 99.1, Specificity was 91.7, Positive Predictive Value: 99.1, Negative Predictive Value was 91.7 and Accuracy was 98.3%.107(89.2%) patients had true positive, 11(9.2%) patients had true negative, 1(0.8%) patient had false positive and 1(0.8%) patient had false negative.

We found that in tracheal intubation, 107(99.1%) patients had Tracheal Intubation-USG and 1(0.9%) patient had Oesophageal Intubation-USG. In oesophageal intubation, 1(8.3%) patient had Tracheal Intubation-USG and 11(91.7%) patients had Oesophageal Intubation-USG. Association of USG finding vs. Intubation was statistically significant ($p<0.0001$). It was found that totally two patients Oesophageal Intubation was missed by USG and clinical examination. Association of emergency and elective vs. intubation was not statistically significant ($p=0.203798$).

Thomas VK et al (2017) found that the time taken to confirm tube placement with ultrasonography was 8.27 ± 1.54 s compared to waveform capnography and clinical methods which were 18.06 ± 2.58 and 20.72 ± 3.21 s, respectively. The time taken by ultrasonography was significantly less. Songarj P et al (2016) found that the average time of US usage (time from turning the US machine on to finishing the confirmation of the ETT position and depth) was149.9 ± 91.7 seconds.

We found that in tracheal intubation, the mean intubation time (mean ±s.d.) of the patients was 4.7870 ± 1.5829 minutes. In oesophageal intubation, the mean intubation time (mean ±s.d.) of the patients was 8.2500 ± 3.2509 minutes. Distribution of mean intubation time vs. intubation was statistically significant ($p<0.0001$).

CONCLUSION

This study demonstrates that US imaging has a high diagnostic accuracy to immediately confirm proper ETT placement post-intubation in an emergency setup.

It was found that Tracheal Intubation-USG Sensitivity was 99.1, Specificity was 91.7, Positive Predictive Value: 99.1, Negative Predictive Value was 91.7 and Accuracy was 98.3%.

Ultrasonography can be used as an adjunct tool to verify the ETT position by Emergency Physicians which can be performed easily after a briefing or short-course training.

Therefore, it seems that ultrasonography using static technique only is a proper screening tool in determining endotracheal tube placement.

Limitation

In spite of every sincere effort my study has lacunae.

The notable short comings of this study are:
1. The sample size was small.
2. The study has been done in a single centre.
3. The study was carried out in a tertiary care hospital, so hospital bias cannot be ruled out.

Trial Registration Details: This study is an observational prospective study did not require any government trial registration.

Declaration by Authors

Ethical Approval: Ethical approval not required because it is an observational study and we did not administer any medicine or did not change any treatment plan during the research.

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Conflict of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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