

Effect of User Experience in the Accuracy of Cuff Pressure Estimation Using Palpation Technique

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Abstract: Tracheal intubation constitutes a routine part of anaesthetic practice. An optimum cuff pressure is absolutely mandatory for proper seal during PPV. 20-30 cmH₂O is the optimum cuff pressure. While insufficient pressure may lead to micro-aspiration, over inflation may jeopardise tracheal mucosa blood supply leading to ischemia. In this study we aimed to investigate the effect of user experience in the accuracy of cuff pressure estimation using palpation technique. In this prospective randomised study 60 patients were divided into two equal groups of 30 patients each. Group A (cuff pressure assessed by anaesthetists with 5 years' experience) and Group B (cuff pressure assessed by anaesthesia resident with 1 year experience). In group A the mean cuff pressures estimated by palpation method and the mean cuff pressure obtained by manometer were comparable, whereas a statistically significant difference was found in the mean cuff pressures measured by palpation method and the mean cuff pressure obtained by manometer in group B. From this study we conclude that experience has a positive effect on the ability to accurately estimate the cuff pressure utilizing palpation technique.

Keywords: Tracheal intubation, cuff pressure, jeopardise.

INTRODUCTION

Hippocrates first documented endotracheal intubation in 460 – 380 BC. Endotracheal intubation is a skill which is mastered and practised by anaesthetists worldwide today. The cuff in the ET tube is inflated to create a seal between the trachea and ET tube and to prevent aspiration of gastric contents.

After their introduction in twentieth century ET tube have evolved from first-generation, low-volume, high-pressure cuffs made from rigid material (reusable rubber), to high-volume, low-pressure cuffs made from softer more malleable and disposable material [1]. Today high-volume, low-pressured cuffs made of polyvinyl chloride (PVC) (50–80 micron) are commonly in use as they are non-toxic, transparent and inexpensive [1]. Due to their thermoplastic properties these tubes conform to the patient's anatomy at body temperature [2].

While there is no definite value, the acceptable maximum cuff pressure ranges from 20 to 30 cm of H₂O[3]. An ET tube is said to be over inflated if volume of air injected in it is more than the amount of air required to create a seal between cuff and the tracheal wall. This excess pressure gets transmitted to the neighbouring tracheal mucosa, when pressure against the tracheal wall exceeds the pressure in capillary wall

ischemia, inflammation, ulceration, granulation and stenosis occur [4]. The capillary blood pressure supplying the trachea is approximately 48cm H₂O. The perfusion of the trachea is decreased at an intra-cuff pressure of 30cm H₂O and it is totally obstructed at a pressure of around 50cm H₂O [5]. Minimum intra cuff pressure required to prevent aspiration with positive pressure ventilation is around 27cm H₂O[6]. Hence an optimum cuff pressure is absolutely mandatory for proper seal during PPV (positive pressure ventilation) without jeopardising the tracheal blood flow due to over inflation of the cuff. Various techniques for ET tube cuff inflation have been used, such as minimum leak technique [7], minimal occlusive volume technique [7], palpation technique [6], and direct intracuff measurement technique [7]. However, these may lead to over or under inflation. Cuff inflation is a skill and therefore should improve with experience and practice.

The aim of this study was to assess whether cuff pressures obtained from estimation techniques significantly differed from the recommended levels of 20-30 cm H₂O between anaesthetists with 5 years' experience and anaesthesia residents with 1 year of experience.

MATERIALS AND METHODS

After obtaining ethics committee approval this prospective, randomized, comparative study was carried out in the department of Anaesthesiology AVBRH affiliated to JNMC Sawangi (Meghe) Wardha, during the period between –December 2015 to December-2016.

60 adult patients of either sex belonging to ASA physical status class I and III in the age more than 18 yrs, orally intubated with high volume low pressure ETT of 7mm and 8mm internal diameter, scheduled to undergo emergency or elective surgeries under general anaesthesia with access to the ETT cuff were included in the study. Patients were excluded if they were intubated outside the operation theatre, pregnant females, patients undergoing thoracic surgery, surgeries of head and neck including maxillo-facial surgeries, known anatomical laryngo-tracheal abnormalities, nasogastric tubes in situ and operative procedures where nitrous oxide was to be used. Consent was not taken as the patients continued to receive the usual and customary care.

The patients were randomly allocated into two equal groups of 30 patients each. Randomization was done by computer generated random number table and allocation of the same by sealed envelope technique.

The two groups were divided into Group A (balloons pressure assessed by anaesthetists with 5 years experience) and Group B (balloons pressure assessed by anaesthesia residents with 1 year experience). In both the groups when the patient arrived in the operation theatre an I. V. line with 18 G cannula was secured in the one of the upper limb. Monitors were attached and preoperative pulse rate, respiratory rate and blood pressure was noted. Premeds were given

with inj. glycopyrrolate (0.04mg/kg), inj. midazolam (0.05mg/kg) and inj. fentanyl (1mg/kg). After preoxygenating for 3 mins patients were induced with inj. propofol (2mg/kg). Muscle relaxation was achieved using inj. vecuronium (0.1 mg/kg). After proper relaxation laryngoscopy was done and patients were intubated with appropriate size ET tube. The cuff was inflated by instilling 5 to 10 ml of air by the intubating anaesthetist, who was not participating in the study. Placement was confirmed by bilateral air entry in the chest and proper position was given. Patients were maintained on O₂, air and sevoflurane and vecuronium top ups. 30 mins after the inflation of the cuff, anaesthetist according to the random group allotted was asked to palpate the cuff and estimate the pressure in the cuff and note their observation. After this the cuff pressures were measured using VMB cuff controller (Cuff controller digital 0-99 cm H₂O, VMB Medizintechnik GMBH, Germany) and the obtained values were noted. All measurements were done using a single manometer, and this manometer was calibrated routinely every three days. To avoid measurement bias, just one person performed all measurements and he was blinded to the intubation process: the indication, the time and the person who had placed the tube. If the cuff pressure was less than 20cm H₂O or more than 30 cmH₂O then the pressure was adjusted to an acceptable level (25 cmH₂O). ET tube cuff pressure after manual inflation, any effect of ET tube cuff on delivered tidal volume/ airway pressure were observed.

STATISTICAL ANALYSIS

A study power 80% and alpha level of 0.05 sample size was calculated for 2 groups. Aimed sample size was 60 patients with 30 patients in each group all the data was entered in excel sheet. Quantitative data was expressed as Mean ± SD. Qualitative data was expressed as percentage. Statistical analysis was done by using descriptive and inferential statistics using chisquare test, student's unpaired t test. Software used in the analysis was SPSS 22.0 version and Graph Pad Prism 6.0 version and p<0.05 was considered as level of significance

RESULTS

Table-1: Age, Weight, duration of surgery, gender, ASA class, size of tube, tidal volume and airway pressure

Variables	Group A (n = 30)	Group B (n = 30)	P value
Age in yrs	35.42±23	38.65±18	t = 0.60, p=.54,NS
Weight in kg	75.65±13.24	73.72±11.67	t=0.59, p=0.55,NS
Duration of surgery in mins	82.25±39.33	99.25±36.15	t =1.74, p = 0.08,NS
Gender male/female	18/12	20/10	χ ² = 0.22, p = 0.63, NS
ASA Class (I/II/III)	16/10/4	18/9/3	χ ² = 0.27, p = 0.60,NS
Tube size 7/7.5/8	5/13/12	4/15/11	χ ² = 0.107, p = 0.74, NS
Tidal volume	452±20.4	440±25.12	t = 2.03, p = 0.04, NS
Airway pressure	18.86±14	19.06±32	t = 0.03, p = 0.97, NS

Demographic data in terms of age, weight, duration of surgery, gender, ASA class, size of tube,

tidal volume and airway pressure were comparable in both the groups.

Table-2: Mean Cuff Pressure through Palpation Technique, Mean Cuff Pressure Using Manometer

Variables	Estimated Cuff Pressure Using palpation Technique (mmH ₂ O) (n = 30)	Cuff Press Obtained Using manometer (mmH ₂ O) (n = 30)	P value
Group A	28.22±13.26	34.51±13.87	t = 1.7, P = 0.07, NS
Group B	24.86±10.68	38.43±16.20	t = 3.7, P = 0.0006, S

In group A the mean cuff pressures estimated by palpation method and the mean cuff pressure obtained by manometer were comparable, whereas a

statistically significant difference was found in the mean cuff pressures measured by the above techniques in group B.

Table-3: Number of patients in each group with erroneous cuff reading

Percentage by which manometer cuff pressure value was more than estimated cuff pressure values	Group A (n = 30)	Group B (n = 30)	P value
5%-10%	15 (50%)	0 (0%)	$\chi^2 = 18.6$, p = <0.0001, S
10%-20%	12(40%)	8(26%)	$\chi^2 = 1.3$ p = 0.2, NS
20%-30%	03(10%)	10(34%)	$\chi^2 = 4.96$ p = <0.001, S
>30%	0(0%)	12(40%)	$\chi^2 = 13.76$ p = <0.001, S

There was a significant difference in the percentage of deviation of the actual cuff pressure from the estimated cuff pressure between the two groups. 15(50%) patients in group A had erroneous cuff pressure measurement with cuffs over-inflated by of 5% to 10% whereas none of the patients in group B had a difference in cuff pressure of 5% to 10%. 12 (40%) patients in group B had erroneous cuff pressure measurement with cuffs over-inflated by > 30% but none in group A.

DISCUSSION

Tracheal tube pressures have been extensively studied of late as increased pressures may hamper the blood supply to the tracheal mucosa and may lead to ischaemia and inflammation. High volume low pressure cuffs decrease the risk of tracheal wall ischaemia as they apply less pressure as compared to low volume high pressure [8]. Disadvantage with these cuffs is that they can be overinflated to pressures that exceed capillary perfusion [5]. The use of cuff manometer for measurement of cuff pressure has been recommended by various authors [9, 10]. We conducted this study to evaluate whether experience plays any role in correct estimation of cuff pressure. There is absence of commonly recognised intra cuff pressure reference range. Previous studies have suggested that the ideal pressure in the cuff should be in the range of 20 to 30 mmHg, therefore this was determined as the ideal intra cuff pressure for the present study [11, 12].

In a study conducted by Braz *et al.*[13] they found that the intra cuff pressure was more than 90% in patients who underwent surgery with nitrous oxide and

45.4% patients who underwent surgery without nitrous oxide. O'Donnell *et al.* [14] in their study found that nitrous oxide diffuses in the cuff and increases cuff pressure intra-operatively. Considering this feature of nitrous oxide surgeries where nitrous oxide was used were excluded from our study.

Faris *et al.*[15] compared assistant anaesthesiologists with consultant anaesthesiologists, and staff nurses with head nurse in order to compare the role of experience in ET cuff pressure inflation. The study reported that a difference was not observed between assistant anaesthesiologist and consultant anaesthesiologists but there was a difference between nurses. In our study the cuff pressure estimation was found to be nearly accurate with an experience of 5 years as compared to anaesthetist with one year experience. Similar results were obtained by Ozer *et al.* [16] in their study.

Among the groups it was found that there was significant difference of assessment of cuff pressure between experienced and inexperienced anaesthetists with the experienced anaesthetists assessing cuff pressures more accurately. We found that in 27(90%) patients the obtained cuff pressure was more than the estimated by 5% to 20% whereas this difference was only in 8(26%) patients in group B. On the other hand in group B in 12(40%) patients the obtained cuff pressure was more than the estimated cuff pressure by >30% while none of the patients in group A had difference in the cuff pressure of this extent. Ozer *et al.*[16] also found significant decreases in cuff pressure values parallel to experience.

The limitation of our study is that we have not estimated how many years of experience is required to assess the cuff pressure accurately.

CONCLUSION

In this study, we investigated the effects of user's experience in estimating cuff pressure using palpation method and direct measurement of cuff pressure using manometer. We found that experience has a positive effect in the ability to assess the cuff pressure with anaesthetist with 5 years of experience assessing the cuff pressure more accurately as compared to anaesthetists with one year experience.

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