

Methods of endotracheal tube placement in patients undergoing pelviscopic surgery

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SUMMARY

Accidental endobronchial intubation is reported frequently during laparoscopic gynaecological surgery. We performed a prospective randomised study to compare three different methods of endotracheal tube placement in terms of susceptibility of accidental endobronchial intubation in patients undergoing laparoscopic gynaecologic surgery.

The endotracheal tube was positioned by one of three methods: it was secured by palpating at the suprasternal notch while holding the pilot balloon (Group_{Cuff}); by placing the 21 cm mark at the upper incisors (Group_{21cm}); or by placing a guide mark, which was made on the surface of the tube 2 cm above the proximal end of the cuff, at the level of the vocal cords (Group_{VC}). The distance from the tip of endotracheal tube to the carina was measured with the patient in a neutral position (D_{TC0}) and after the formation of pneumoperitoneum in the Trendelenburg position (D_{TC1}).

Eighty-eight patients were enrolled. Pneumoperitoneum and Trendelenburg position caused inward movement of the endotracheal tube toward the carina in 99%. In each group, the mean value of D_{TC1} was significantly shorter than D_{TC0} (Group_{Cuff} 3.0 ± 1.1 vs. 1.7 ± 1.0 , Group_{21cm} 2.5 ± 0.8 vs. 1.1 ± 0.9 , Group_{VC} 3.5 ± 0.7 vs. 2.3 ± 0.8 , D_{TC0} vs. D_{TC1} respectively) (all $P < 0.01$). Accidental endobronchial intubation occurred in 14%, with the lowest frequency in Group_{VC} (2.6 %, $P < 0.01$) and the highest in Group_{21cm}, although this was not significantly ($P = 0.09$) different from Group_{Cuff} (26.7% vs. 10.0%).

The incidence of endobronchial intubation was lowest in Group_{VC} but endobrochial intubation could not be avoided using any of these methods.

Key Words: endotracheal tube, endotracheal intubation, laparoscopic surgery

The use of laparoscopic techniques for gynaecological surgery is increasing. During gynaecological laparoscopic surgery the combination of pneumoperitoneum and the steep Trendelenburg position increases the risk of endobronchial intubation by decreasing the distance between the tip of the endotracheal tube (ETT) and the carina^{1,2}.

After intubation, one of the following manoeuvres can be performed prior to securing the ETT. With the cuff palpation method, the tube is secured after ballottment at the suprasternal notch causes pilot cuff distension³. Second, the ETT can be secured at

a pre-determined depth (21 cm for women and 23 cm for men)^{4,5} and third, a guide mark on the ETT can be placed at the level of vocal cords^{6,7}. All of these methods are reliable, simple and fast, but for patients undergoing laparoscopic gynaecological surgery, which of the above methods may be better for avoiding endobronchial intubation has not been investigated. We performed a randomised clinical trial to compare these three methods for the risk of endobronchial intubation during gynaecological laparoscopic surgery.

METHODS

After obtaining hospital review board's approval and informed consent from patients, 90 female patients scheduled for laparoscopic gynaecological surgery under general anaesthesia were enrolled. Patients of height < 155 cm and with known pulmonary disease or a malformation of the trachea or the bronchus on chest radiography were excluded.

After the induction of anaesthesia and muscle paralysis, intubation was performed with a 7.0 mm inner diameter ETT (Hi-Lo™, Mallinckrodt, Ireland).

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Patients were randomly allocated into one of the three groups by computer-generated random numbers. The ETT was secured by one of the three methods, as follows. In Group_{Cuff}, the tube was secured based on distension of the pilot balloon during repeated gentle finger palpation at the suprasternal notch³. While the ETT was advanced or withdrawn, the ETT cuff was gently pressed at the level of suprasternal notch and, simultaneously, in the other hand a pilot balloon was held to determine maximal distension. The ETT was secured at a depth where maximal balloon distension was felt. In Group_{21cm}, the ETT was secured after the 21 cm mark was placed at the upper incisor teeth. Finally, in Group_{VC}, a guide mark was made on the surface of the ETT 2 cm above the proximal end of the cuff and the ETT secured when the guide mark was placed at the vocal cords.

After the ETT was secured, a second anaesthetist measured the distance between the tip of the ETT and the carina (D_{TC}) using fiberoptic bronchoscopy (Olympus LF-P, Olympus Optical Co., Japan). The bronchoscope was inserted through a special fiberoptic swivel connector (Opti-Port™, Mallinckrodt, Ireland) to allow ventilation during its use. When the fiberoptic bronchoscope reached the carina, the first mark was made on the bronchoscope, after which it was withdrawn and a second mark made when it reached the tip of the ETT. The difference between the two marks was considered the D_{TC} , which was initially measured with the patients in neutral position (D_{TC0}). The patients were then placed in a steep (20° to 25°) Trendelenburg position and pneumoperitoneum created by percutaneous insufflation of carbon dioxide to a pressure limit of 15 mmHg. After 30 minutes, the distance from the tip of ETT to the carina was measured again (D_{TC1}). Before each measurement, the attending anaesthetist assessed the appropriate position of the ETT by observing clinical signs such as symmetric chest movement, bilateral auscultation of the lung fields, inspiratory pressure, peripheral oxygen saturation and capnography. The attending anaesthetist was not informed of the results unless endobronchial intubation had occurred. In this case, the ETT was withdrawn 2 cm after D_{TC} measurement.

Based on previous investigations, the incidence of endobronchial intubation during pelviscopic surgery was assumed to be 27%². We considered an endobronchial intubation rate of less than 10% to be clinically acceptable. A power analysis with β (0.2) and α (0.1) indicated 29 patients in each group were required.

Statistical analysis was performed using SPSS 11.0 for Windows (SPSS, Chicago, U.S.A.). The data are expressed as mean \pm SD or range (min-max). Within each group, the measured D_{TC} were compared across different time points using the Wilcoxon rank sum test. The frequency of endobronchial intubation was compared using the Fisher Irwin test. Statistical significance was considered at $P < 0.05$.

RESULTS

A total of 90 female patients were enrolled. Two patients from Group_{VC} were excluded because the attending anaesthetist was unable to see the vocal cords during intubation, leaving 88 data sets for analysis. The demographic characteristics of the three groups were similar (Table 1). The location of the ETT tip in relation to the carina is shown in Figure 1. Pneumoperitoneum and the Trendelenburg position caused an inward movement of the ETT in 87 patients (99%) and in one patient it remained unchanged. During the study, the ETT migrated into a main stem bronchus in 12 patients (Group_{21cm} n=8; Group_{Cuff} n=3; Group_{VC} n=1). This incidence was not significantly different between Group_{21cm} and Group_{Cuff} (26.7% vs. 10%, $P=0.09$) but it was significantly lower than other groups in Group_{VC} (2.6%, $P < 0.01$). Among the 12 endobronchial intubation events, only seven were recognised by the attending anaesthetist. None of the patients experienced complications related to the endotracheal or endobronchial intubation postoperatively.

TABLE 1
Demographic characteristics of the patients

	Group _{Cuff} n=30	Group _{21cm} n=30	Group _{VC} n=28	Total n=88
Age (years)	46.8 \pm 8.5	45.3 \pm 10.6	46.8 \pm 8.5	46.2 \pm 9.0
Weight (kg)	59.4 \pm 7.2	57.2 \pm 7.0	57.9 \pm 8.5	58.2 \pm 6.8
Height (cm)	161.5 \pm 3.9	162.0 \pm 4.1	162.0 \pm 3.6	161.8 \pm 3.8

There were no significant differences between the groups.

DISCUSSION

Our study shows that neither the cuff palpation method nor the fixation of ETT at a pre-determined depth provide proper positioning of an ETT throughout gynaecological laparoscopic surgery, despite both being popular placement methods. Positioning the ETT by placing a guide mark relative to the vocal cords resulted in a higher frequency of satisfactory positioning, but did not prevent endobronchial intubation during the surgery.

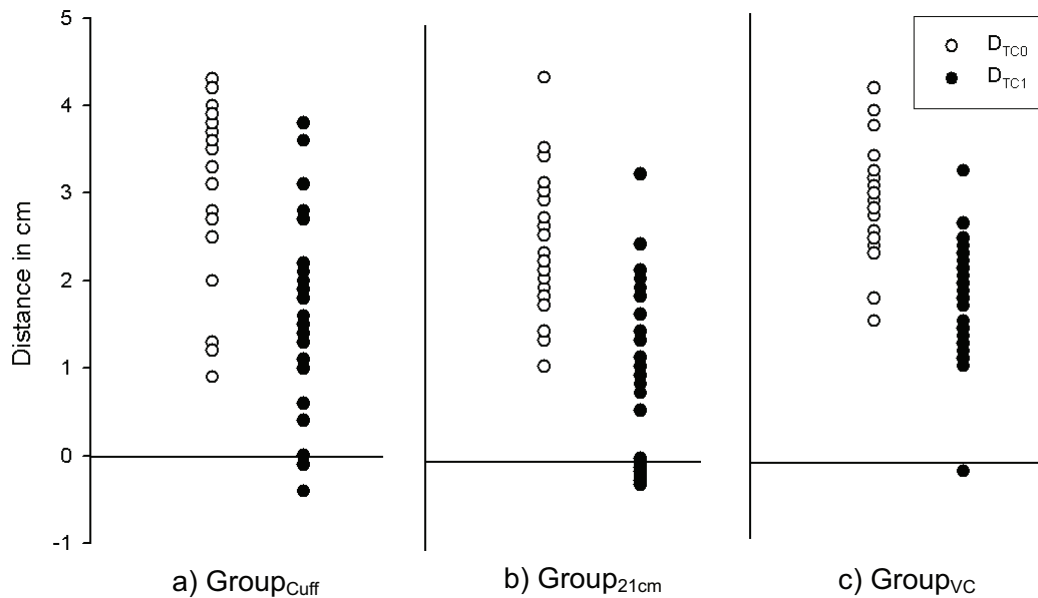


FIGURE 1: The distance between the tip of the endotracheal tube and the carina. a) Group_{Cuff}=endotracheal tube secured after cuff palpation, b) Group_{21cm}=endotracheal tube secured after 21 cm mark placed at upper incisor, c) Group_{VC}=endotracheal tube secured after a guided mark was placed at vocal cord level. D_{TC} =the distance between the endotracheal tube tip and the carina when the patient was in the neutral position (D_{TC0}) or in the Trendelenburg position combined with pneumoperitoneum (D_{TC1}).

In a neutral position, the average D_{TC0} was 3 cm and none of the placement methods led to endobronchial intubation, as reported previously for the cuff palpation method³, 21 cm method^{4,5} and guide mark method^{6,7}. The pneumoperitoneum in combination with the Trendelenburg position resulted in inward movement of the ETT tip to the carina in 99% of the patients and D_{TC1} was shorter than D_{TC0} by 1.4 cm on average and 2.2 cm maximum. Taking into consideration that the minimum values of D_{TC0} were 0.9, 1.1 and 1.9 cm for Group_{Cuff}, Group_{21cm} and Group_{VC} respectively, the margin of safety was insufficient in all groups.

In terms of the frequency of endobronchial intubation, placing a guide mark 2 cm above the proximal end of the cuff ETT at the level of the vocal cords appears to be a better method of the ETT placement than the other methods investigated. However, the guide mark method has its own limitations, because it can only be applied when the vocal cords are clearly visible. Moreover, it might increase the risk of vocal cord injury or paralysis, because the cuff position is closer to the vocal cords in comparison to the other methods. It has been suggested that the upper end of the ETT cuff must be located at least 1.5 cm below the vocal cords to avoid paralysis⁸. During our study, two patients in Group_{VC} had a D_{TC} value greater than 4.5 cm. Because the tracheal length is 11 to 12 cm in women^{1,9,10} and the average distance between the

distal and proximal end of an ETT cuff is 6 cm, a D_{TC} value greater than 4.5 cm indicates that vocal cord paralysis is a possibility.

During our study, only seven (58%) endobronchial intubations were detected by the attending anaesthetist prior to bronchoscopic examination. This is consistent with previous reports that clinical signs are not reliable indicators of endotracheal intubation^{11,12}. We believe the use of fiberoptic bronchoscopy should be considered to confirm ETT position during laparoscopic gynaecological surgery.

A limitation of our study relates to the demographic characteristics of the patients. The study population included only Asian women with a mean height shorter than that of some other populations. Because of their short stature, it is possible that the patients included in this study had a higher risk of endobronchial intubation, although the incidence was similar to that reported by others².

The most important findings from our study were that none of the methods evaluated guaranteed correct ETT positioning throughout the procedure; that only approximately half the endobronchial intubations were detected by clinical signs and that the Group_{VC} method was associated with the lowest incidence of endobronchial intubation (but it may impose a risk of vocal cord paralysis). Confirmation of ETT position with fiberoptic bronchoscopy could be helpful during gynaecological laparoscopic surgery.

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