Gas Exchange During Microsurgery of the Larynx Using Foley Catheter Insufflation Technique

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Summary

The technique of insufflating anesthetic gases via oro-tracheal Rusch type Foley catheter with spontaneous ventilation for micro-surgery of the larynx is described. Fifteen unselected patients were used to assess the adequacy of gas exchange with this technique. Arterial blood gas analysis was carrrid out 5 minutes and 25 minutes after induction of anesthesia. The results at 25 minutes indicate adequate gas exchange. There was a significant increase in the PaO_2 at 25 minutes but the decrease in $PaCO_2$ at 25 minutes was insignificant. The technique also provided very satisfactory conditions for surgery with only minimal risk of gross tracheal soiling. No dysrhythmias were encountered and there was hemodynamic stability in all cases.

Introduction

Anesthesia for microsurgery of the larynx is a challenge to the anesthesiologist since it involves the ultimate in sharing the airway with the surgeon. Anesthetic requirements for the provision of safe anesthesia and optimal conditions for surgery include :–

a) Establishing a clear airway and maintaining adequate gas exchange,

b) Protection of the lower airway from soiling,

c) Ensuring a clear view of the larynx at all times,

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d) Complete or partial immobility of the vocal cords,

e) Provision of adequate space in the larynx for surgical instrumentation.

Several techniques are currently available for achieving the above objectives, each however, with its own advantages and disadvantages. The use of various types of catheters is gradually becoming popular.[2] Nasotracheal simplastic type Foley catheter was employed with IPPV by R.B. Lewis in 1977.[4] He reported the technique to be satisfactory in clinical practice.

To our knowledge there is no study that reports on the state of gas exchange during the use of Rusch type oro-tracheal Foley catheter with spontaneous ventilation for microsurgery of the larynx. The aim of this study is to assess the adequacy of gas exchange with this technique.

Material and Methods

Fifteen ASA 1 patients of both sexes, varying in age from 17 to 48 years were included in this study (Table I).

TABLE I.

AGES, SEXES, DIAGNOSES AND PROCEDURES PERFORMED ON 15 PATIENTS

Patient Number	Age (Yrs.)	Sex	Diagnosis	Procedure Performed
1.	20	M	Laryngeal Polyp.	Polypectomy
2.	17	F	Hoarseness	Microlaryngoscopy (ML)
3.	30	F	Hoarseness	Polypectomy
4.	35	M	Laryngeal Polyp.	Polypectomy
5.	37	M	Hoarseness	ML and Biopsy
6.	40	M	Vocal Cord Nodule	Excision of Nodule
7.	35	F	Laryngeal Nodule	Excision of Nodule
8.	35	M	Edema of Ary-Epiglottic Folds	Laryngoscopy & Biopsy
9.	21	M	Hoarseness	ML and Biopsy
10.	20	F	Hoarseness	ML and Biopsy
11.	29	M	Edema of Ary-Epiglottic Folds	ML and Biopsy
12.	24	F	Vocal Cord Nodule	Excision of Nodule
13.	48	M	Hoarseness	ML and Biopsy
14.	34	M	Hoarseness	ML and Biopsy
15.	40	M	Vocal Cord Polyps	Polypectomy

Premedication was with oral Diazepam (0.15 mg/kg), given 2 hours before operation. Modified Allen's test was carried out prior to induction and all patients were induced in the operating room with Thiopentone sodium (4–5 mg/kg). Anesthesia was maintained with N_2O: O_2 6:4 L/min and Halothane (1–4%) using Mapleson A circuit. Laryngoscopy was carried out when anesthesia was deep and the larynx and upper trachea sprayed with 5 mls. of 4% Lignocaine. After further 2–3 minutes of anesthesia, size FG 12 Rusch type Foley catheter was inserted into the trachea midway between the larynx and the carina. The catheter was secured at the left angle of the mouth and connected to the anesthetic machine via a plastic oxygen delivery tube. Guedel airway was kept in the mouth to assist the exit of expired gases prior to the insertion of the surgeon's laryngoscope.

The inspired concentration of halothane was kept between 1–2% during the procedure. Intravenous supplementation with thiopentone, 50–75 mg, was used if patient moved or coughed. The ECG was continuously monitored and blood pressure was displayed/recorded with Datascope Acutorr 1 at 2–5 minute intervals.

Arterial blood samples were taken from the radial artery 3–5 (5) minutes and again 20–25 (25) minutes after the induction of anesthesia.

At the end of the procedure, the patient was placed on the side, sucked out gently and the Foley catheter removed. Nurses in the recovery room recorded the time interval between the end of anesthesia and the return of the cough reflex and also the "waking time" — i.e. time until patient first responded to command. The surgeons were requested to comment on a) the exposure provided by the technique, b) cord mobility, c) anesthesia as a whole and d) to give any other relevant comments.

Wilcoxon Matched Paris Signed Ranks Test was used in the analysis of the blood gas results.

Discussion

This study revealed that the $PaCO_2$ results at 25 minutes were within normal limits in 12 of the 15 cases (Table II). This contracts with the low $PaCO_2$ results usually associated with techniques employing IPPV[3] or jet ventilation[5,6]. The $PaCO_2$ at 25 minutes was slightly elevated in the remaining 3 cases but was above 50 mmHg in only one patient (54 mmHg). The $PaCO_2$ values at 5 minutes were generally higher than at 25 minutes. The difference exceeded 5 mmHg in 6 cases and was lower at 5 minutes than at 25 minutes in one case. Statistical analysis did not reveal any significance in these differences ($p > 0.05$).

The PaO_2 was generally higher at 25 minutes than at 5 minutes. In 9 cases, the difference exceeded 10 mmHg. One patient had lower PaO_2 at 25 minutes than at 5 minutes. Even though the number involved in this study is small, the difference in the PaO_2 at 5 and 25 minutes is statistically significant ($p > 0.01$).

The increase in the PaO_2 at 25 minutes and the tendency for the $PaCO_2$ to decrease at 25 minutes implies better gas exchange at 25 minutes. The reduction in the anatomical — apparatus dead space by intra-tracheal insufflation and improved ventilation from the lighter level of anesthesia during the procedure, may account for this finding.

Even though the same FIO_2 (0.4) was used in all cases, there was a wide variation in the PaO_2 results obtained from different patients. Varying degrees of air entertainment by the different patients as well as other individual patient factors may be responsible for this finding.

The surgeon's use of Sthorz's laryngostat on the sternum did not adversely affect the gas exchange or circulatory stability as suggested by L. Agosti.[1]

For the patient's convenience, the 5 minute arterial samples were used as the baseline rather than an awake sample. This also makes it easier to compare the PaO_2 results at 5 and 25 minutes. Microlaryngeal operations in our hospital usually last under 30 minutes. We did not therefore consider it necessary to carry out another blood gas analysis after the 25 minute sample.

Bradycardia, dysrhythmias and/or hypotension are sometimes associated with the use of high inspired concentration of halothane. We did not encounter any of the above in our series and there was remarkable hemodynamic stability in all cases.

Even though atropine was not used at any stage in our study, oral secretions were minimal.

Soiling of the trachea was not a problem. This is in agreement with Young,[1] who reported similar findings from the use of plastic catheters. They suggested that this may be partly due to the maintenance of a slightly positive pressure in the airway by the insufflated gases and to the preservation of the carinal reflex.

Early recovery of protective laryngeal reflexes after surgery on the larynx is essential even though much coughing can contribute to edema.[2]

TABLE II.

THE pH, $PaCO_2$ and PaC_2 RESULTS

Patient Number	Time (min)	pH	$PaCO_2$ (mmHg)	PaO_3 (mmHg)
1.	5	7.34	49.0	129
	20	7.37	43.0	152
2.	5	7.32	42.6	168
	20	7.31	41.7	176
3.	5	7.35	43.0	135
	20	7.39	40.0	145
4.	5	7.31	54.0	142
	20	7.38	44.0	140
5.	5	7.33	50.0	108
	20	7.36	44.0	124
6.	5	7.34	43.0	120
	20	7.40	39.0	128
7.	5	7.30	53.0	121
	20	7.48	35.0	125
8.	5	7.29	53.0	100
	20	7.30	48.0	150
9.	5	7.39	43.0	106
	20	7.39	44.0	121
10.	5	7.39	45.0	170
	20	7.35	41.0	150
11.	5	7.40	45.0	107
	20	7.33	54.0	151
12.	5	7.33	47.0	149
	20	7.30	47.0	156
13.	5	7.31	46.0	83
	20	7.32	45.0	126
14.	5	7.32	53.0	140
	20	7.39	42.0	144
15.	5	7.23	51.0	80
	20	7.36	50.0	108

Ten patients regained the cough reflex within 10 minutes of the end of anesthesia and all 15 patients did so within 20 minutes. The "waking time" in 13 cases was under 15 minutes (Table III). Excessive coughing was not seen in any patient.

TABLE III.

DURATION OF PROCEDURES, FIRST COUGH TIME AND WAKING TIMES

Patient Number	Duration of Procedure (min)	First Cough Time (min)	"Waking Time" (min)
1.	30	3	5
2.	25	5	6
3.	30	8	12
4.	30	10	14
5.	40	5	8
6.	50	5	8
7.	45	5	3
8.	30	5	7
9.	25	20	25
10.	32	5	6
11.	25	12	15
12.	60	15	18
13.	30	5	10
14.	35	11	12
15.	45	12	12

Since no neuromuscular blocking agents were employed in our study, post-operative muscle pains from succinylcholine was not encountered. The inhalational technique employed ensured adequate jaw relaxation, avoided the problem of awareness and reduced the total number of drugs involved in the anesthesia. Despite spontaneous ventilation, the vocal cords in 12 of the patients were reported as immobile by the surgeons. There was minimal movement in the remaining 3 patients.

The use of polyvinyl chloride (PVC) suction catheters via the naso-tracheal route for microsurgery of the larynx has been reported.[7,2] The Rusch type Foley catheter is softer than the PVC catheters and hence may not be easy to use naso-tracheally. This softness has the advantage of reducing the chance of trauma to the larynx and tracheal mucosa. Oro-tracheally, the Foley catheter can be inadvertently compressed by the surgeon's laryngoscope.

Such a case was encountered during our study but was easily detected and rectified because of the distinct loud hiss from the pressure relief valve on the Boyle anesthetic machine.

The back pressure also causes the catheter assembly to disconnect from the outlet of the anesthetic machine.

The Foley catheter technique shares the following disadvantages with other catheter techniques :– a) the surgeon invariably inhales expired anesthetic gases and there is theatre pollution since no satisfactory scavenging method exists for the technique. Decreasing the concentration of inhalational agent and using intravenous supplementation to maintain adequate level of anesthesia has been suggested;[1] b) the catheter technique may not be suitable for patients at risk from regurgitation since airway protection is not perfect.

The advantages of the Foley catheter technique outweigh the disadvantages. It is readily available, cheap and easy to use. It offers excellent exposure of the surgical field, leaves ample room for surgical instrumentation and facilitates examination of the posterior commisure. Once the patient is stabilized, the procedure can be carried on for long periods without further drug administration. It has the added advantage that IPPV can be instituted if necessary.[4]

Conclusion

The Foley catheter technique with spontaneous ventilation fulfils most of the anesthetic requirements for providing optimal conditions for microsurgery of the larynx. In our hands, the technique ensured hemodynamic stability and in particular, ensured adequate gas exchange during the procedure.

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