

## MANUAL JET VENTILATION V. HIGH FREQUENCY JET VENTILATION DURING LASER RESECTION OF TRACHEO-BRONCHIAL STENOSIS

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### SUMMARY

Manual jet ventilation (20 b.p.m.) and high frequency jet ventilation (300 b.p.m.) were compared during laser resection of tracheo-bronchial stenosis under general anaesthesia. Both methods provided similar blood-gas tensions at the 10th min of surgery in patients with tracheal stenosis. In patients with bronchial stenosis high frequency jet ventilation resulted in modest hypercarbia and manual jet ventilation appeared to be the preferred method in these particular patients.

Although high frequency jet ventilation has been used experimentally (Klain and Smith, 1977; Smith, Klain and Babinski, 1980) and clinically (Babinski, Smith and Klain, 1980; Borg, Ericksson and Sjöstrand, 1980; Smith et al., 1981; Carlon et al., 1981) in different situations, no assessment has been made of its role in patients with severe stenosis of the trachea or of a main bronchus. Two previous articles (Toty et al., 1981; Vourc'h, Tannières and Personne, 1980) have described our clinical results using the Nd Yag laser for the photoresection of tracheo-bronchial lesions. The purpose of the present study was to assess, during this procedure, the use of manual jet ventilation (JV) and high frequency jet ventilation (HFJV) and to compare these from two points of view: gas exchange and operating conditions. Previously it was shown that, during bronchoscopy, HFJV at a rate of 300 b.p.m. achieved satisfactory gas exchange and improved operating conditions (Vourc'h et al.; 1983).

### PATIENTS AND METHODS

#### Patients

Forty patients with severe airway stenosis were studied during laser photoresection. The method of ventilation was HFJV (300 b.p.m.) in the first group of 20 patients and manual JV (20 b.p.m.) in the second group.

Twenty-three patients presented with tracheal stenosis (13 in the HFJV group, 10 in the JV group) and 17 with stenosis of a main bronchus (seven in the HFJV group, 10 in the JV group).

#### Methods

Anaesthesia and bronchoscopic technique were as described previously (Vourc'h et al., 1983). The tip of the bronchoscope was kept just above the stenosis, either in the trachea or in a main bronchus. In this latter instance, ventilation of the contralateral lung was provided through side vents (Jardine, Harrison and Healy, 1975).

#### Statistical analysis

Results were expressed as the mean  $\pm$  standard deviation. Statistical analysis used Student's *t* test for comparison between the two groups of patients; A probability of  $P < 0.05$  was regarded as statistically significant.

### RESULTS

The results are summarized in table I. Blood-gas tensions were similar in the two groups before anaesthesia; 10 min following the beginning of surgery  $P_{aO_2}$  did not differ but  $P_{aCO_2}$  was greater in the HFJV group ( $5.43 \pm 1.76$  kPa) than in the JV group ( $4.34 \pm 0.9$  kPa) ( $P < 0.02$ ).

Comparison between the two types of ventilation in patients with tracheal stenosis showed no difference (table II), but there was an obvious difference in patients with stenosis of a main bronchus (table III),  $P_{aCO_2}$  reaching  $5.87 \pm 1.61$  kPa during HFJV and decreasing to  $4.24 \pm 0.69$  kPa during JV ( $P < 0.02$ ). From the endoscopist's point of view HFJV was preferable because it induced less movement of the tracheo-bronchial tree.

### DISCUSSION

Laser surgery is the only method which can improve respiratory function and provide temporary or permanent relief of tracheo-bronchial stenosis follow-

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TABLE I. Comparison between JV and HFJV; patients with tracheal and bronchial stenosis. (\*P &lt; 0.02)

	Manual jet ventilation (20 patients)		High frequency jet ventilation (20 patients)	
	PaO <sub>2</sub> (kPa)	PaCO <sub>2</sub> (kPa)	PaO <sub>2</sub> (kPa)	PaCO <sub>2</sub> (kPa)
Before operation	8.94 ± 1.54	4.83 ± 0.68	9.80 ± 1.5	4.80 ± 0.59
During operation (10 min)	16.86 ± 5.20	4.34 ± 0.9*	14.94 ± 6.6	5.43 ± 1.76*

TABLE II. Comparison between JV and HFJV; patients with tracheal stenosis

	Manual jet ventilation (10 patients)		High frequency jet ventilation (13 patients)	
	PaO <sub>2</sub> (kPa)	PaCO <sub>2</sub> (kPa)	PaO <sub>2</sub> (kPa)	PaCO <sub>2</sub> (kPa)
Before operation	9.00 ± 1.56	4.79 ± 0.56	10.29 ± 1.58	4.87 ± 0.69
During operation (10 min)	18.14 ± 5.37	4.44 ± 1.10	17.38 ± 6.50	5.19 ± 1.84

TABLE III. Comparison between JV and HFJV; patients with stenosis of main bronchus. (\*P &lt; 0.02)

	Manual jet ventilation (10 patients)		High frequency jet ventilation (7 patients)	
	PaO <sub>2</sub> (kPa)	PaCO <sub>2</sub> (kPa)	PaO <sub>2</sub> (kPa)	PaCO <sub>2</sub> (kPa)
Before operation	8.86 ± 1.61	4.88 ± 0.81	8.90 ± 0.76	4.70 ± 0.28
During operation (10 min)	15.57 ± 4.93	4.24 ± 0.69*	10.36 ± 3.98	5.87 ± 1.61*

ing a brief surgical procedure. The need for ventilatory support depends on the endoscopist's technique and although some prefer a fiberoptic instrument (Dumon et al., 1982), our group prefers the use of a rigid bronchoscope since this increases the quality of vision, permits easy cleaning of the optics, adequate suction of blood or secretions and makes the removal of large fragments of tissue easier. The use of a rigid bronchoscope makes general anaesthesia and controlled ventilation essential in most patients. Ventilation was previously achieved by using manual jet ventilation (Sanders, 1967) which was found satisfactory clinically. However, the high pressure

of injected gases induced marked movements of the tracheo-bronchial wall and spread blood and secretions. These side-effects could be minimized using high frequency ventilation.

Analysis of our results is not simple: alveolar ventilation depends on the quality of ventilation and on the result of surgical treatment of the stenosis. However, it is clear that HFJV induced increases in PaCO<sub>2</sub> especially in patients with stenosis of a main bronchus. In these patients, the tip of the bronchoscope was located in a main bronchus, and Keszler and Klain (1982) demonstrated the importance of the position of the jet injector for HFJV. Although

in this study manual JV provided ventilation of the opposite lung through the side vents (Jardine, Harrison and Healy, 1975), because of the high pressure of injected gas, this probably did not occur with the low pressure provided by HFJV.

We recommend, therefore, manual jet ventilation when the tip of the bronchoscope is located in a main bronchus and HFJV when it is located in the trachea. Furthermore, the rate of HFJV can be kept less than 300 b.p.m. if this does not hamper the endoscopist, since it provides better gas exchange.

Another advantage of HFJV is that, at the end of the procedure, when the suxamethonium infusion is discontinued, the patient's spontaneous respiration returns progressively, and the bronchoscope can be removed, without any need for manual ventilation using a face-mask.

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COMPARAISON ENTRE JET-VENTILATION  
A HAUTE FREQUENCE ET JET-VENTILATION  
MANUELLE AU COURS DE LA  
RESECTION AU LASER DE  
STENOSES TRACHEO-BRONCHIQUES

## RESUME

La jet-ventilation manuelle et la jet-ventilation à haute fréquence ont été comparées au cours de la résection au laser de sténoses trachéo-bronchiques sous anesthésie générale. Les deux techniques ont permis d'obtenir des pressions de gaz du sang similaires à la 10<sup>e</sup> min de chirurgie chez des sujets porteurs de sténoses trachéales. Chez les sujets porteurs de sténoses bronchiques, la jet-ventilation à haute fréquence entraînait une hypercapnie modérée et la jet-ventilation manuelle apparaissait comme la technique de choix.

MANUELLE DRUCKVENTILATION UND  
HOCHFREQUENZ-DRUCKVENTILATION  
WÄHREND LASERRESEKTION  
TRACHEOBRONCHIALER STENOSEN

## ZUSAMMENFASSUNG

Während Laserresektion tracheobronchialer Stenosen in Allgemeinnarkose wurden manuelle Druckventilation (20 Atemstöße min<sup>-1</sup>) und Hochfrequenz-Druckventilation (300 Atemstöße min<sup>-1</sup>) miteinander verglichen. Bei Patienten mit Trachealstenosen ergaben sich bei beiden Methoden 10 Minuten nach Operationsbeginn ähnliche Blutgasspannungen. Bei Patienten mit Bronchialstenosen führte die Hochfrequenz-Druckventilation zu einer leichten Hypercarbie. Manuelle Druckbeatmung schien bei dieser Patientengruppe die günstigere Methode zu sein.

VENTILACION A CHORRO MANUAL CONTRA  
VENTILACION A CHORRO DE ALTA  
FRECUENCIA DURANTE UNA RESECCION CON  
LASER DE LA ESTENOSIS  
TRAQUEO-BRONQUIAL

## SUMARIO

Se comparó la ventilación a chorro manual (20 b.p.m.) y la ventilación a chorro de alta frecuencia (300 b.p.m.) durante una resección con laser de la estenosis traqueo-bronquial bajo anestesia general. Ambos métodos produjeron tensiones sangre-gas similares al 10 mo minuto de la cirugía en pacientes con estenosis traqueal. En pacientes con estenosis bronquial, la ventilación a chorro de alta frecuencia ocasionó hipercarbía moderada y la ventilación a chorro manual pareció ser el método preferido en estos pacientes particulares.