THE PHYSIOLOGICAL CONSEQUENCES OF BRONCHOSCOPY: A STUDY OF THE HAEMODYNAMIC CHANGES DURING BRONCHOSCOPY

Das A K¹, Dutta S¹

ABSTRACT

Physiological consequences are inherent to the procedure of bronchoscopy. Sixty patients who underwent bronchoscopy at the Medical College Hospitals, Calcutta, India, were studied to determine the changes that occur during bronchoscopy. Of these twenty were consecutive adult patients who underwent rigid bronchoscopy under general anaesthesia (Group I). Twenty were consecutive adult patients who had flexible bronchoscopy under local anaesthesia (Group II). Ten consecutive paediatric patients underwent rigid bronchoscopy with spontaneous ventilation under General Anaesthesia (Group III) and ten were operated with controlled ventilation (Group IV). Heart Rate, Blood Pressure SpO₂ and ECG were monitored during and upto 60 minutes after the procedure.

Heart Rate changes were minimal in Group I but maximum in Groups II and III. Procedures like suctioning & Bronchoalveolar Lavage (Bal) were associated with fall of SpO₂, SpO₂ was best maintained in the fourth group. Three patients out of forty adults patients had Electrocardiogram (ECG) changes. Significant Mean Arterial Pressure (MAP) rise was seen in adults, but this was not significant in children. General Anaesthesia failed to modify the rise of MAP observed in adults.

Key Words: Bronchoscopy : Physiological consequences : SpO₂, ECG changes, heart rate, Mean arterial pressure.

¹. Manipal College of Medical Sciences, Phulbari, Pokhara, Nepal.

Address for correspondence : Prof. Dr. Anjan K. Das
Department of Surgery
Manipal Teaching Hospital
Post Box No.: 341, Phulbari, Pokhara, Nepal
Tel: 00977-61-24811, 26598, Fax: 00977-61-22160
Email: mth@mos.com.np
INTRODUCTION

Bronchoscopy in adults, children and infant is commonly undertaken for wide varieties of diagnostic & therapeutic indications. With modern instrumentation, light source and anaesthetic techniques this procedure is quite safe. However, the procedure in itself is gross assault on the normal physiological functioning of the airway and haemodynamics and several consequences occur which are inherent in the procedure itself. These include competition for the airway by the bronchoscopist and anesthesiologist, and the effects of frequently performed procedures like suctioning, bronchoalveolar lavage, (BAL) and biopsy. Physiological changes occur during the procedures, a knowledge of which is of important for safe bronchoscopy. Changes in the haemodynamics or of saturation levels that are inherent in the procedure can help to provide insight in order to avoid complications and also to alert us regarding the most vulnerable moments during the procedure. This study was designed to monitor the physiological changes that take place during bronchoscopy in a wide variety of conditions to identify changes that are inherent in me procedures, so that strategies to avoid complications could be devised and implemented.

AIM : This study was undertaken to study the haemodynamic changes occurring during bronchoscopy in adults and children under the following criteria :

a) Changes of blood pressures, oxygen saturation, heart rate and ECG in adults undergoing rigid bronchoscopy under general anaesthesia.

b) Changes of blood pressure, oxygen saturation, heart rate and ECG in adults undergoing flexible bronchoscopy under local anaesthesia.

c) Changes of blood pressure, oxygen saturation, heart rate and ECG in children undergoing rigid bronchoscopy under general anaesthesia using controlled ventilation and spontaneous ventilation.

PATIENT AND METHODS

This study was conducted in the Department of Thoracic and Cardiovascular Surgery, Medical College and Hospital, Calcutta between 01/01/1999 and 31/5/1999. After obtaining informed consent from 40 adults patients and the parents of 20 children who required bronchoscopy, the patient was subjected to bronchoscopy by a single surgeon. The patients were divided onto the following groups (Table I).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Bronchoscope Introduced</th>
<th>Anaesthetic Technique</th>
<th>M : F</th>
<th>Age (Range)</th>
<th>Median Age</th>
<th>Weight (Range)</th>
<th>Mean Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (n=20)</td>
<td>Rigid</td>
<td>GA with controlled ventilation</td>
<td>18:2</td>
<td>21-76 yr.</td>
<td>44 yr.</td>
<td>36-72 kg</td>
<td>56.2 kg</td>
</tr>
<tr>
<td>II (n=20)</td>
<td>Flexible</td>
<td>Local Anaesthesia</td>
<td>18:2</td>
<td>22-82 yr.</td>
<td>47 yr.</td>
<td>35-68.5 kg</td>
<td>57 kg</td>
</tr>
<tr>
<td>III (n=10)</td>
<td>Rigid</td>
<td>GA with Spontaneous ventilation</td>
<td>7:3</td>
<td>6 month - 10 yr.</td>
<td>4.6 yr.</td>
<td>3.6-15 kg</td>
<td>5.7 kg</td>
</tr>
<tr>
<td>IV (n=10)</td>
<td>Rigid</td>
<td>GA with Controlled Ventilation</td>
<td>6:4</td>
<td>3 month - 12 yr.</td>
<td>5.2 yr.</td>
<td>3-16 kg</td>
<td>6.9 kg</td>
</tr>
</tbody>
</table>
Group I: 20 adults patients (F : M = 2 : 18) were bronchosced by a rigid bronchoscope under general anaesthesia.

Group II: 20 adult patients (F : M = 2:18) were bronchosced by a flexible bronchoscope under local anaesthesia.

Group III: 10 children (F : M = 3:7) underwent rigid bronchoscopy under general anaesthesia with spontaneous ventilation.

Group IV: 10 children (F : M = 4:6) underwent rigid bronchoscopy under general anaesthesia with controlled ventilation.

Group I patients were pre-medicated with Diazepam 0.02 mg/kg orally prior to the procedure. The patients were induced with I.V. thiopentone 4 to 5 mg/kg, and atropine 0.02 mg/kg. Muscle relaxation was provided with succinylcholine 1mg/kg I.V. loading dose and 0.5mg/kg increments. The patients were ventilated with oxygen enriched air using a Sander's Jet ventilator at 10 to 15 breaths per minute.

Group II were pre-medicated with Diazepam 0-02 mg/kg orally 1 hour prior to the procedure. The patients were asked to gargle with xylocaine viscous 4% 5 minute before the procedure. Inj. Atropine 0.02 mg/kg was given to reduce the volume of secretions. Subsequently 2ml of 4% xylocaine was injected via the cricothyroid membrane.

Group III patients were pre-medicated with Syrup Diazepam (0.02 mg/kg) 1 hour prior to the procedure in the O.T holding area. They were induced with 2-3% halothane, followed by IV caiylation and I.V. Atropine 0.02 mg/kg. They were maintained with 1 - 2 % halothane and spontaneously ventilated with 02, N20 (40% + 60%) through the side arm of the rigid bronchoscope.

Group IV patients were pre-medicated with Syrup. Diazepam (0.02 mg/kg) 1 hour prior to the procedure in the O.T holding area. They were induced with 2 - 3 % halothane, followed by IV caiylation and injection of I.V. Atropine 0.02 nag/kg. Muscle relaxation was provided with succinylcholine 1mg/kg and 0.5 mg/kg as incremental dose. Controlled ventilation was provided with 02, N20 (40% & 60%) and 0.5% halothane through the side arm of the bronchoscope.

The monitoring of Sao2, H.R., MBP and ECG. (Hewlett Packard, Andover MA. USA) was undertaken at 2 minutes interval during the procedure and at 15 minutes interval upto 1 hour after the conclusion of bronchoscopy.

The indications for which bronchoscopy was undertaken is provided in Table 2. The subjects were not separated as for disease as consecutive patients were allotted randomly to the groups by an observer not related to the study. However both adult and paediatric groups had similar median age, weight (Table III) and pre operative haemodynamic characteristics (Fig 1,2,3)

**Table II: Indications of Bronchoscopy**

**Adults : n = 0**
1. Diagnostic : n=36
   a) Haemoptysis : 20 
   b) Suspicious lung Shadow : 12 
   c) Unexplained Cough with expectorant : 4 
2. Therapeutic : n=4 
   a) Foreign Body : 1 
   b) Postoperative Secretions : 3 

**Children : n = 20** 
1. Diagnostic : n=7 
   a) Unexplained collapse of lobe : 7 
2. Therapeutic : n=13 
   a) Foreign Body : 12 
   b) Postoperative secretions : 1
Table III: Physiological Changes in different groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Heart Rate (beats/min)</th>
<th>Blood Pressure (Mean / mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Operative</td>
<td>Maximum Change</td>
</tr>
<tr>
<td>I</td>
<td>83.8±5.35</td>
<td>**</td>
</tr>
<tr>
<td>II</td>
<td>81.7±4.86</td>
<td>*</td>
</tr>
<tr>
<td>III</td>
<td>120±1.2</td>
<td>**</td>
</tr>
<tr>
<td>IV</td>
<td>128±2.1</td>
<td>**</td>
</tr>
</tbody>
</table>

** = P < 0.01
* = P < 0.05
• = P < 0.05 - GR IV showed an increase of SPO2 during bronchoscopy as compared to a fall in Group I, II and III

RESULT

The data were analysed under the following categories:
- **GR I** - Adults under G.A
- **GR II** - Adults under L.A
- **GR III** - Paediatric patient with Spontaneous Ventilation
- **GR IV** - Paediatric patient with controlled ventilation
The demographic profile was comparable in between Group I & II and Group III & IV (Table I).

**ADULTS UNDER GENERAL ANAESTHESIA : (GROUP I)**

Heart Rate: The mean heart rate was initially 83.8 ± 5.35 beats/min. On insertion of the bronchoscope, there was a significant rise to 107.5 ± 10.75 beats/min (P<0.01). After the scope passed the vocal cords, there was a fall in the heart rate to 97 ± 2.5 beats/min. During removal of the scope the heart rate rose to 105 ± 1.4 beats/min. Heart rate reached pre-insertion values 15 minutes after removal of the bronchoscope.

Blood Pressure: The mean arterial pressure (MAP) followed a pattern similar to the heart rate. The initial MAP was 88.1 ± 6.54 mmHg, which rose significantly to 96.12 ± 4.18 mmHg (P<0.01) on insertion of the bronchoscope. After the scope passed the vocal cords the MAP fell slightly and returned to the pre-insertion levels at 15 minutes after removal of the instrument. The rise of blood pressure was mainly systolic.

\( \text{SPo}_2 \): The initial \( \text{SPo}_2 \) was 96.1 ± 2.38 % which fell significantly during insertion to 92.3± 2.19% (P<0.01) but recovered and was maintained at the pre-insertion value up to the end of the procedure. The \( \text{SPo}_2 \) was very sensitive to all procedures done during bronchoscopy. Suctioning caused a highly significant fall to a mean of 85.5 ± 1.71% (P<0.01) if carried out for more than 1 minute. Injections of saline aliquots during bronchoalveolar lavage (BAL) reduced the mean \( \text{SPo}_2 \) to 86.8 ± 2.1% (P<0.01). In 2 patients with Bronchiectasis who had low initial \( \text{SPo}_2 \) (90% & 89%) the levels fell to 83% & 80% during instrumentation. They needed post operative oxygenation for a period of 2 hours during which the \( \text{SPo}_2 \) returned to normal.

ECG Changes: In 2 patients there was ST depression in lead IE which lasted for more than 60 seconds. These changes began during insertion of the bronchoscope and persisted throughout the procedure. There was complete recovery within 5 minutes of removal of the scope.

**ADULTS UNDER LOCAL ANAESTHESIA (Group II)**

Heart Rate: The heart rose from 81.7 ± 4.86 beats/min to 120± 13.1 beats/min on insertion of the bronchoscope in this group which was statistically significant (P<0.05) when compared to the GR I Patients. However the subsequent course was similar to that of patients undergoing GA. The heart rate returned to the Pre-insertion values 20 minutes after removal of bronchoscope.

Blood Pressure: There was a highly significant rise from 84.6 ± 1.23 mm Hg 93.3 ± 3.73 (P0.01) during insertion in a similar manner to patients undergoing GA. None of the patients in this group had hypertension i.e. BP > 140/90 mm Hg- The changes in this group was not statistically different from those in GR I.

\( \text{SPo}_2 \): The \( \text{SPo}_2 \) at the beginning of the procedure was 97.2 ± 2.51% which fell significantly to 94.1 ± 1.36% (P<0.01%) during insertion. The fall was significantly less than patients undergoing GA. (P0.05). Suctioning and BAL produced significant (P<0.01) fall in \( \text{SPo}_2 \). Interestingly this fall was more (P<0.01) in GR I and GR II.

ECG Changes: I patient had mild ST depression (between l-2mm) and recovered as soon as the scope was withdrawn.

**PAEDIATRIC PATIENTS WITH SPONTANEOUS VENTILATION: (Group III)**

Heart Rate: Initial heart rate of 120±1.2 beats/
min increased significantly to 160± 6.1 beats/min (P0.01) during insertion of the bronchoscope. Thereafter it declined to pre-insertion levels. There was a rise to 146±1.45 beats/min (P0.01) on removal of the scope.

**Blood Pressure** : The blood pressure showed a marked difference from GR I & II. The sharp rise on insertion and removal were absent in this group. The mean pressure rose from 68±2.11 to 77.9± 1.19 during removal of the scope.

**SPO₂** : The SPO₂ declined from a mean of 92.2± 1.5% to 86± 5.3% (P0.05) during insertion of the instrument, which returned to normal within 5 minutes. SPO₂ fell significantly during suctioning and BAL (Table 3 & Fig 1)

**ECG** : No important ECG changes were observed.

**PAEDIATRIC PATIENTS WITH CONTROLLED VENTILATION : (Group IV)**

**Heart Rate** : The pre insertion heart rate was 128±2.1 beats/min which rose to 142± 4.2 beats/min (P0.01) on insertion of the bronchoscope. Heart rate fell to 119 ± 2.3 beats/min after removal of the scope. The changes were similar that seen in GRDI.

**Blood Pressure** : No sharp rises of Blood pressures were seen. The MAP rose from 64.28 ± 1.92 to a maximum of 82.11± 1.86mm Hg which reverted to the baseline on removal.

**SPO₂** : The SPO₂ increased from a mean of 94± 2.3% to 98 + 1.8% (P0.05) on insertion of the bronchoscope. This was probably due to controlled ventilation with a high concentration of oxygen, through the side arm of the bronchoscope. Suctioning and BAL caused a significant fall of SPO₂.

**ECG** : No important changes were observed in ECG.

**DISCUSSION**

Bronchoscopy is a particularly demanding procedure and it involves the invasion of the airway by the operator, which can interfere with oxygenation and delivery of anesthetic agents 3 In addition, the original lung condition that necessitated bronchoscopy may lead to serious hypoxaemia with attendant consequences on the haemodynamics. This has been documented in Western patients but there has been no recent study in South Asia regarding the haemodynamics of patients undergoing bronchoscopy.

This study aimed at understanding the physiological changes, occurring both in adults and the paediatric group, undergoing bronchoscopy and anaesthesia with different techniques. Though pre-medication and I.V. Atropine was common to all groups, anaesthetic techniques were varied to find out the haemodynamic changes with each technique. The important findings in this study are mainly five. First, the rise in heart rate on insertion of the bronchoscope was present in all groups studied. However it was least in GR I and maximum in GR II & III. This fact has been recently documented by Davies and his colleagues.4 The tachycardia may in part be due to apprehension, associated with the procedure, but it was also present in a 3 month old child. Therefore it is a part of cardiovascular responses occurring during bronchoscopy. Though the flexible bronchoscope was used in GrII, this did not prevent me tachycardia which was in fact more than GrI patients who underwent rigid bronchoscopy under GA. Tachycardia may in itself be benign in most cases but, in older patients definite ECG changes were observed, suggesting that they must be monitored very carefully and measures may be taken to reduce tachycardia during insertion of the bronchoscope by using I.V. lignocaine or Esmolol.5 Though the disease process may affect the
haemodynamic consequences - Our study included random allocation of patients to each group. Therefore it was not possible to ascertain the effects of the disease perse in individual groups.

Secondly, the hypertensive patients are a particular cause for concern, especially during insertion and removal of the bronchoscope. GA failed to modify this response. Therefore it is essential for the operator to be as gentle as possible during the maneuver and also use pharmacological agents (Sodium Nitroprusside, Nitroglycerine etc) if necessary. Changes in blood pressure was not significant in the children.

The third finding was that physiological changes followed the same pattern, whether LA or GA was used. GA failed to abolish the cardiovascular stress response during bronchoscopy though the rise of heart rate was significantly less. Therefore, GA may be the better choice in certain patients where the technique of anaesthesia may be tailored according to the Pro-operative haemodynamic status of the patient.

The fourth point to note is the BAL and suctioning were associated with a fall of SPo₂. This was more marked in children, where foreign bodies were removed. Instrumentation for more than 30 seconds caused a significant fall in SPo₂. Thus it is necessary to balance the need for a quiet, relaxed field to grasp the foreign body, with the need to ventilate. This is also true for all patients with low initial SPo₂ and pre-existing lung disease. The patients may require prolonged oxygenation following bronchoscopy.

Finally, it is imperative to note that children undergoing controlled ventilation, had less physiological disturbance in terms of SPo₂ and heart rate. Thus unless the child has serious airway obstruction prior to bronchoscopy, it would be prudent to use controlled, rather than spontaneous ventilation. Moreover, the post operative recovery was faster in GR IV than GR III, where halothane had been used in higher concentration in order to maintain anaesthesia.

CONCLUSION

Physiological changes are an inevitable part of bronchoscopy. It occurs in both flexible and rigid bronchoscopy, in adults and children, and with the use of general or local anaesthesia. This study has demonstrated that cardiovascular changes are inevitable, though most marked in adults who are hypertensive or ischaemic. Measures are necessary to minimize the changes in this group of patients. It is also clear that there is a marked drop in SP02 during procedures like suctioning, bronchoalveolar lavage and foreign body removal. This was most evident in paediatric patients with spontaneous ventilation. Careful monitoring is essential to note changes that occur during the procedure and several measures have been suggested that can decrease the changes that take place and make the procedure as safe as possible.

REFERENCES