Eur Respir J 1997; 10: 695–698
DOI: 10.1183/09031936.97.10030695

European Respiratory Journal
ISSN 0903 - 1936

Cardiovascular consequences of fibreoptic bronchoscopy

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Cardiovascular consequences of fibreoptic bronchoscopy. L. Davies, R. Mister, D.P.S. Spence, P.M.A. Calverley, J.E. Earis, M.G. Pearson. ©ERS Journals Ltd 1997.
ABSTRACT: Fibreoptic bronchoscopy (FOB) is now commonly performed, and the number of elderly patients undergoing the procedure is increasing. Problems with oxygenation during FOB are well-recognised, but there are few data about its cardiovascular effects.

Forty five patients (median age 65 yrs) undergoing elective FOB were studied prospectively. Patients were connected to a 12-lead computerized electrocardiographic recorder, a finger plethysmographic blood pressure (FPBP) monitor and pulse oximeter. Forty three patients were sedated with fentanyl and droperidol, and all were given 5 mL 2.5% cocaine intratracheally and xylocaine spray to the pharynx.

Mean sphygmomanometric cuff blood pressure was raised initially (167/88 mmHg). Mean blood pressure recorded by FPBP rose on intratracheal injection (178/96 mmHg) and remained high throughout the procedure. Mean (SD) initial cardiac frequency was 93 (5.1) beats·min^{-1} and rose to 134 (7.5) beats·min^{-1} during the procedure. Four of the 45 patients showed unexpected ST segment depression of >1 mm for >1 min, and a further three developed bundle branch block. These seven patients had significantly greater tachycardia (152 *vs* 131 beats·min^{-1}) and higher blood pressure (238/131 *vs* 207/109 mmHg). They were older (72 *vs* 61 yrs), had smoked more (63 *vs* 39 pack-years), but had similar lung function and similar changes in oxygen saturation. Oxygen desaturation occurred in 19 patients and this was associated with poor lung function (69 *vs* 84% predicted forced expiratory volume in one second), but was independent of the cardiovascular changes.

Significant cardiovascular changes occur during fibreoptic bronchoscopy, with evidence of cardiac strain in 21% of patients over the age of 60 yrs.
Eur Respir J 1997; 10: 695–698.

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Keywords: Cardiovascular
fibreoptic bronchoscopy

Received: May 30 1996
Accepted after revision October 24 1996

Fibreoptic bronchoscopy (FOB) under local anaesthesia is a widely performed and generally safe procedure, major and minor complications occurring with a frequency of 0.5 and 0.8% respectively, [1]. Hypoxia is a relatively common complication, which may predispose to other problems, including cardiac dysrrythmias [2]. Current guidelines recommend monitoring of arterial oxygen saturation (S_{a,O_2}), with supplementary oxygen if the S_{a,O_2} falls to ≤90% [3]. We were aware of cardiac dysrrythmias occurring in spite of S_{a,O_2} monitoring and its correction, and hypothesized that cardiac disease could be responsible, especially as most FOB patients are elderly smokers. The purpose of this study was to investigate the cardiovascular consequences of FOB, to determine whether they were confined to patients with a previous history of cardiac disease, and whether they could be predicted and observed by routine screening and monitoring methods.

Methods

To test this hypothesis, we monitored the 12-lead electrocardiograph (ECG) and noninvasive blood pressure before and during FOB, and compared these data to the information recordable from presently recommended monitoring procedures. An unselected group of 45 patients (26 males and 19 females) referred for elective bronchoscopy was studied. Median age was 65 years (range 17–81 yrs), mean forced expiratory volume in one second (FEV_1) 78 (range 28–122) % predicted, and mean smoking duration 43 (range 0–155) pack-yrs. Indications for bronchoscopy were as follows: haemoptysis 50%; shadowing on chest radiograph 32%; and unresolving cough or breathlessness 18%. At the time of FOB, there were four lifelong nonsmokers and 21 ex-smokers. All gave written, informed consent to the study, which was approved by the Hospital Ethics Committee. Prothrombin time, haemoglobin and electrolytes were measured and any abnormality corrected prior to the procedure. Resting ECG and spirometry (and arterial blood gas tensions if FEV_1 was <1 L) were recorded. Cuff blood pressure was recorded in the clinic and on arrival in the endoscopy suite.

Patients were premedicated with 0.6 mg intramuscular atropine 20 min before the bronchoscopy. The procedure was performed, in the supine position, by one of two experienced operators. Intravenous sedation, using 5 mg droperidol and 0.1 mg fentanyl, was applied. The dose was halved in those patients with poor lung function, and was omitted in three cases. Analgesia to the pharynx was provided by topical 4% lignocaine spray. Analgesia to the larynx and tracheobronchial tree was by transcricoid injection of 5 mL 2.5% cocaine. Bronchial washings and biopsies were performed as clinically indicated. The duration of each bronchoscopy was recorded.

Oxygen saturation was monitored with a Criticare 504 (Criticare Systems, Milwaukee, USA) pulse oximeter, using a finger probe on the left hand. Blood pressure was monitored continuously, by means of a finger plethysmographic blood pressure (FPBP) monitor (Finapresinger plethysmograph, Ohmeda, Hatfield, UK) on the right hand, which was placed in a relaxed but constant position over the xiphisternum. In six patients, initial values of FPBP were calibrated against values from a sphygmomanometer cuff on the left arm. The ECG was monitored with a 12-lead ECG computerized exercise testing system (Marquette Case 12; Marquette Hellige UK Ltd, Kettering, UK), recording both the rate and ST segment change. ST segment depression of >1 mm for a minimum of 60 s was considered abnormal.

Supplementary oxygen, *via* a nasal cannula at 4 $L \cdot min^{-1}$, was added during the procedure in patients in whom the S_{a,O_2} fell to 90% for at least 10 s. Statistical comparisons were performed with nonparametric techniques using Wilcoxon or Kruskal Wallis methods *via* the Microstat 1 package. A p-value of less than 0.05 was considered significant.

Results

At the start of the procedure, all patients were in sinus rhythm and no resting ECG showed evidence of acute ischaemia. The FOB was completed satisfactorily in all 45 patients. Median duration of the procedure from insertion to removal of the bronchoscope was 15.2 (range 5.2–29.4) min. Nineteen patients required supplementary oxygen to maintain their S_{a,O_2} above 90%. Supplementary oxygen was needed more frequently in patients with an FEV_1 <66% pred, but arterial oxygen desaturation was not related to age, nor to initial S_{a,O_2} (table 1).

In six patients, FPBP readings were correlated with cuff readings. Preprocedure FPBP readings were lower than cuff readings (152 (44)/76 (19) *versus* 173 (30)/105 (17) mmHg). In these six patients, mean systolic FPBPs remained 20 mmHg lower than mean cuff blood pressures throughout the procedure. Differences were consistent over a series of readings in each patient, always in the same direction, and reflect the expected hydrostatic differences due to the finger positioning.

Initial cuff blood pressure readings on arrival at the bronchoscopy suite were greater than clinic readings in all patients (mean 167/88 *vs* 138/79 mmHg; paired Wilcoxon p<0.001). There was a small, but nonsignificant, decrease in mean FPBP after sedation, followed by a significant (p<0.002) increase after intratracheal cocaine injection. This increase was maintained throughout the procedure. Figure 1 shows the mean systolic blood pressures (SBP) measured by FPBP at different stages of the FOB. Diastolic blood pressure (DBP) followed a similar course, so the changes seen were not in pulse pressure but in mean blood pressure. Mean maximum blood pressure occurred following intratracheal cocaine injection until 3 min after bronchoscope insertion and was (SD) 212 (35)/113 (28) mmHg.

Seven patients developed significant electrocardiographic changes during FOB. Figure 2 shows the same data for patients with ECG changes *versus* the rest of the group. Increases in SBP in these seven patients were significantly higher (p<0.02) and remained significantly higher for 9 min after intubation. Four patients developed ST segment depression, two in the inferior leads, one in the anterior, and one in the lateral leads. Two further patients developed right bundle branch block, and one a left bundle branch block. Only one of these seven patients had a history of ischaemic heart disease, having had an inferior myocardial infarction 3 yrs

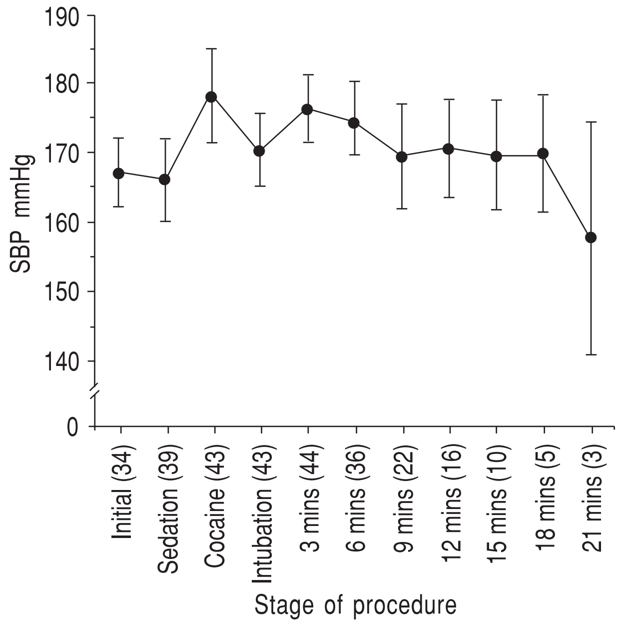

Fig. 1. – Systolic blood pressure (SBP) measured by finger plethysmograph of patients during fibreoptic bronchoscopy related to different stages of the procedure. Values are presented as mean±SEM. The number of patients continuing at each stage is shown in parentheses along the abscissa.

Table 1. – Patient characteristics related to percentage predicted FEV_1

Patient characteristic	FEV_1 25–65.9% pred (n=13)	FEV_1 66–89.9% pred (n=18)	FEV_1 90–122% pred (n=12)	p-value
Age yrs #	62 (15)	61 (17)	61 (14)	NS
Initial S_{a,O_2} %#	96 (2)	96 (3)	96 (2)	NS
Requiring supplementary oxygen$ n‡	8 (62)	8 (40)	3 (25)	<0.005
Smoking pack-years#	58 (44)	38 (17)	33 (18)	NS

#: values are presented as mean, and SD in parenthesis; ‡: absolute number, and percentage in parenthesis. #: poorer lung function associated with greater chance of requiring supplemental oxygen; Chi squared=10.67. FEV_1: forced expiratory volume in one second; S_{a,O_2}: arterial oxygen saturation; NS: not significant; % pred: percentage of predicted value.

previously with inferior Q waves on the resting ECG, and one had frequent (1 in 6) ventricular premature beats on the resting ECG. All of the other patients had normal resting ECGs. None was taking cardiac medication nor complained of chest pain during or after broncho-scopy. The physicians performing the bronchoscopies were unaware of these changes, all of which resolved spontaneously before leaving the bronchoscopy suite.

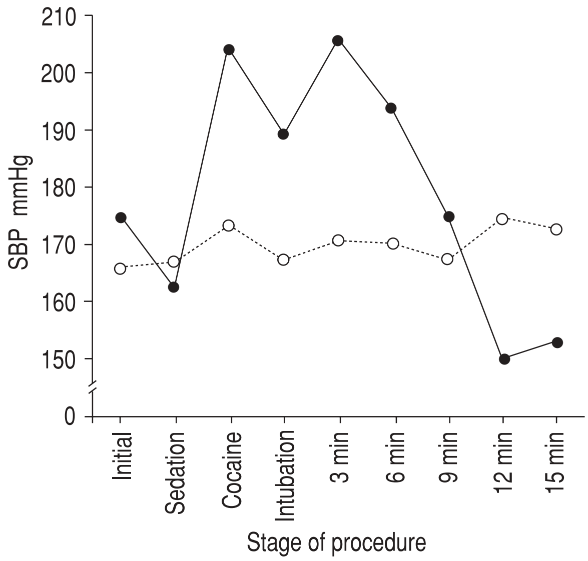

Fig. 2. – Mean systolic blood pressure (SBP) measured by finger plethysmograph in patients who did (—●—) and did not (·····○·····) develop electrocardiographic (ECG) changes during fibreoptic bronchoscopy (FOB).

Table 2. – Characteristics of patients with and without ECH changes

Patient characteristic	Patients with ECG changes (n=7)	Patients without ECG changes (n=38)	p-value
Age yrs	72 (5)	61 (15)	<0.05
Smoking pack-years	63 (41)	39 (23)	<0.001
Initial f_C bpm	106 (13)	91 (17)	<0.001
Maximum f_C bpm	152 (19)	131 (25)	<0.02
FEV1 % pred	78 (12)	78 (24)	NS
Initial S_{a,O_2} %	96 (1)	96 (3)	NS
Median duration of FOB min	15.5	14.6	NS

Values are presented as mean, and SD in parenthesis. ECG: electrocardiographic; bpm: beats·min^{-1}; f_C: cardiac frequency; FEV1: forced expiratory volume in one second; S_{a,O_2}: arterial oxygen saturation; % pred: percentage of predicted value; FOB: fibreoptic bronchoscopy; NS: nonsignificant.

Patients developing ECG changes were older and reached significantly higher maximum cardiac frequencies than those who did not (table 2). There was no correlation between percentage predicted FEV1 or baseline S_{a,O_2} and changes in blood pressure, nor the chance of developing significant ECG changes. As coronary heart disease is more common in the elderly, the patients were divided into three cohorts with respect to age. Table 3 shows mean (SD) lung function, S_{a,O_2}, blood pressure, pack-years smoked, and number of patients with ECG changes in each group. The requirements for supplementary oxygen were similar in each cohort. No patients aged under 60 yrs, three aged between 61–70 yrs, and four aged over 70 yrs developed changes.

Discussion

Fibreoptic bronchoscopy differs from other endoscopic procedures performed under local anaesthesia as it may induce hypoxaemia, and to be successful requires the abolition of protective upper airway reflexes. Problems of periprocedural hypoxaemia can now be identified early and treated with supplementary oxygen, but our data suggest that cardiovascular stress and, especially, hypertension is common and can contribute to potentially important cardiac changes in a group of patients who are older and already have cardiac risk factors.

The age, sex, FEV1 and indications for bronchoscopy of the patients in this study are similar to those in previous reports, and the present results are likely to be representative. The FPBP reliably follows changes in intra-arterial pressure [4]. The absolute values recorded may underestimate "true" blood pressure because the hand from which the recording was made was rested in a comfortable position over the xiphisternum. However, calibration in six patients with conventional mercury sphygmomanometer readings showed that the mean FPBP results were not different from the mean of simultaneously measured cuff pressure, and that changes in one form of blood pressure measurement always followed the other, albeit at an offset caused by the hydrostatic differences.

Hypoxia has been a recognized complication both of transoral and transnasal FOB for at least 20 yrs [5, 6], and dysrryhthmias have also frequently been described [7]. In a study of 70 patients, SHRADER and LAKSHMINARAYAN

Table 3. – Characteristics of patient related to age

Patient characteristic	Age 17–60 yrs (n=11)	Age 61–70 yrs (n=20)	Age 71–80 yrs (n=14)
FEV1# % pred #	74 (23)	84 (24)	72 (20)
Smoking pack-yrs #	24 (15)	40 (19)	64 (34)
Initial S_{a,O_2} %#	96 (4)	96 (2)	96 (2)
Requiring supplementary O_2 n#	4 (36)	10 (50)	5 (36)
Initial SBP mmHg#	173 (26)	168 (31)	161 (32)
Initial DBP mmHg#	89 (25)	89 (30)	85 (18)
Significant ECG changes n‡	0 (0)	3 (15)	4 (29)

#: values are presented as mean, and SD in parenthesis. ‡: absolute number, and percentage in parenthesis. SBP: systolic blood pressure; DBP: diastolic blood pressure. For further definitions see legend to table 2.

[8] reported that hypoxaemia (arterial oxygen tension (P_{a,O_2}) <8 kPa (less than 60 mmHg)) at the end of the procedure correlated significantly with the development of new major arrhythmias, but the abnormalities observed in the present study occurred in spite of correction of hypoxaemia.

In these patients, cuff blood pressure was higher immediately before endoscopy than at the clinic, probably reflecting the patients' anxiety about the procedure and its outcome. However, in spite of intravenous sedation, further consistent and significant rises both in SBP and DBP were seen from the time when the intratracheal cocaine was administered until the end of the endoscopy, these changes rapidly resolving thereafter. The magnitude of change could not be predicted from the resting FEV1, baseline S_{a,O_2}, ECG or cuff blood pressure at the onset of the procedure. In most patients, there were no ECG abnormalities observed during these hypertensive episodes but multichannel recordings did show that 21% of patients over 60 yrs of age developed potentially serious, albeit transient, cardiac ischaemic events/rhythm disturbances. Reliance on a single channel ECG recording would not identify these changes, as they occurred across different leads in different patients.

Cardiac ischaemia may be expected to occur during FOB in patients with known pre-existing coronary artery disease, and this has been documented [9]. However, in 6 of the 7 (86%) patients developing cardiac stress in this study, there was no history of ischaemic heart disease, and in 5 of the 7 (71%) resting ECGs were normal. Although mean cardiac frequency on arrival at endoscopy and maximum mean cardiac frequency reached during bronchoscopy were significantly higher in the group of patients who developed ECG changes, it was not possible to define a resting cardiac frequency at which ECG changes were likely to occur. Therefore, routine prebronchoscopy assessment is relatively insensitive in predicting which patients would develop cardiac strain, although no problems were noted in younger patients (aged less than 60 yrs).

The cause of these unexpected ECG abnormalities is unclear. Cocaine is a powerful topical anaesthetic, with an onset of action within 5 min of administration and a duration of effect of approximately 30 min. It is still widely used in ear, nose and throat (ENT) practice for topical anaesthesia in the nose, and is employed by 15% of UK bronchoscopists [10]. It is believed to be less traumatic than other methods of providing anaesthesia, causes less cough, and is preferred both by patient and bronchoscopist [11]. However, cocaine inhibits noradrenaline reuptake, and is a powerful vasoconstrictor drug when given systemically. It is possible that some of the cocaine administered intratracheally causes the systemic vasoconstriction. However, none of our patients exhibited any central effects that could be attributed to cocaine, nor was there obvious skin-blanching. Its powerful local vasoconstrictor action is likely to limit absorption. An alternative explanation is stimulation of irritant receptors in the central airways by the intratracheal injection and subsequent passage of the endoscope. These receptors have marked vasopressor effects, which may not be completely blocked by the topical anaesthesia that reduces cough nor by pretreatment with atropine in the doses used. The rise in arterial pressure appears to be the most likely cause of the observed ECG abnormalities, since the older patients in whom these occurred were also the ones in whom the greatest changes in arterial pressures were recorded.

Passage of the bronchoscope through the larynx is known to increase cardiac frequency and blood pressure [12], but the present data suggest that this effect is sustained throughout the procedure. This study indicates that fibreoptic bronchoscopy should not be undertaken lightly in elderly patients. There is a role for the noninvasive measurement of blood pressure during fibreoptic bronchoscopy in these patients, who may well be at risk of large increases in blood pressure with consequent cardiac ischaemia. These changes need not be treated during the procedure, as blood pressure rapidly returns to normal once the bronchoscope is withdrawn. Further studies are needed to determine whether these observations are generally applicable or only relevant to the specific technique used in our unit.

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