SUDDEN CARDIORESPIRATORY ARREST FOLLOWING LUNG RESECTION : PULMONARY THROMBOEMBOLISM

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SUMMARY : *Pulmonary resection may be complicated by potentially fatal complication of pulmonary thromboembolism, but it is frequently misdiagnosed owing to its complex presentation.*

In a study of 990 patients undergoing lung resection for bronchogenic carcinoma, eighteen patients (1.8 %) died following sudden cardiorespiratory arrest (SCRA). Fourteen (78%) of these, twelve (86%) male and two (14%) females with a median age of 65 years (range 58-71y) underwent postmortem examination. The primary cause of death identified was pulmonary embolism in 12 (86%) and myocardial infarction in two (14%) patients. Pathologic examination revealed that all patients had severely oedematous lungs. The source of thormbus was within deep leg veins in eight patients (66%), the right pulmonary artery stump in two (17%), wiht no identifiably source to be found in the other two patients although massive embolus was identified in the main pulmonary artery of both.

We conclude that pulmonary embolism is a major cause of early death following pulmonary surgery and its diagnosis should be considered in patients who develop unexpected deterioration of cardiorespiratory status in the postoperative period.

***Key Words :** Thromboembolism Surgery, Postmortem Examination, Lung Cancer.*

INTRODUCTION

Three factors constitute Vichow's triad; 1.venous stasis 2. trauma to vascular endothelium 3.altered coagulability encourage venous thrombosis during and after surgery. Patients at greatset risk of embolic phenomena secondary to thrombosis are those who are above the age of 50 years (8, 9), who have a malignant neoplasm which induces a hypercoagulable state (2, 5, 11), and who are immobile before and after surgery. Satur et al (15) suggested that pulmonary thromboemboli was an under diagnosed complication of pulmonary surgery, an opi-

nion confirmed by Ziomek et al (17) who identified an 19% incidence of thromboembolism following lung resection. They also stressed that this complication affected the older patient being treated for a bronchogenic carcinoma more frequently than younger patients being treated for non-malignant pulmonary conditions.

Diagnosis of pulmonary thromboembolism following resection remains undetermined and often attributed to other causes. This difficulty is particularly extreme in patients who have suffered sudden and severe deterioration in cardiopulmonary func-

tion.

In this report we describe the results of a retrospective study in which the cause of death identified in patients suffering sudden cardiorespiratory arrest was examined and its relationship to risk factors evaluated and diagnostic problems in patients following pulmonary surgery and requirements for prophylaxis discussed.

MATERIAL AND METHOD

Patients who had undergone lung resection for bronchogenic lung carcinoma at the regional cardiothoracic surgery centre between 1980-1994 were reviewed retrospectively. The patients who died due to sudden cardiorespiratory arrest (SCRA) and underwent postmortem examination were included in the study. Two patients were excluded from the study in whom the primary cause of death was described as being myocardial infarction. Possible preoperative risk factors considered were age, sex, preoperative hospital stay and a previous history of thromboembolic disease. The relationship with peri-and postoperative risk factors were evaluated. Parameters studied included type of resection, duration of surgery, postoperative complications, prolonged bed rest, cell type and stage of the tumour, anticoagulation prophylaxis and evidence of postoperative deep venous thrombosis (DVT). The postmortem report of each patient was reviewed and the primary cause of death, source and place of emboli, as well as status of the lung were determined. Chi-square test was used to test the differences between the group in event frequency. Valid statistical significance was accepted under the level of 0.05.

RESULTS

Nine hundred and ninety patients underwent lung resection for non-small cell lung carcinoma between 1980-1993. Fifty eight (5.9 %) of these patients died in the postoperative period with or without a determined cause. Eighteen (31 %) of the latter 58 patients, an incidence of 1.8% of the total study population, died following SCRA in the absence of a predetermined clinical problem. In fifteen cases (79 %) attempts at resuscitation were unsuccessful. Three (21 %) were successfully resuscitated but died on the 6th, 27th and 32nd postoperative days of multiple organ failure.

Postmortem examination was performed in 14 (78 %) of the eighteen patients. Twelve patients in whom the primary cause of death was pulmonary

origin were studied (two patients were excluded in whom the primary cause of death was massive myocardial infarction). They constituted of two (17%) females and 10 (83%) males with a median age of 65 years (range 58-71). The period of hospitalisation immediately prior to surgery was a median 2.6 days (range 1-9). This did not significantly differ from the rest of the patients, p=NS (2.6 vs 2.3 days).

No patient had a history of thromboembolic disease prior to surgery. The treatment of choice was pneumonectomy in eight (67 %) patients (three left and five right) although bilobectomy or lobectomy was carried out in 4 (33 %) patients. Histopathological examination of the resected specimen revealed that three (25 %) patients were stage I, three (25 %) stage II and six (50 %) stage IIIa. Cell type of the tumour was squamous cell carcinoma in 10 (83%) and adenocarcinoma in 2 (17 %) patients. The median onset of SCRA was 39.5 hours with a range 20-160 hours. Diagnosis of pulmonary thromboembolism following collapse was assumed in one patient who underwent emergency embolectomy. The patient however died following this procedure.

Postmortem examination revealed severely oedematous lung tissue in all patients. Fresh large emboli was identified in all twelve patients, which in one case was 40 cm long and extending from the inferior vena cava, though the right atrium and ventricle and into the pulmonary artery. Small organising emboli were found in the smaller branches of the pulmory artery in three (25 %) cases in whom slight dyspnea was observed 2 to 4 days pior to SCRA which had been attributed to poor respiratory funtion and operation. The source of thromboemboli was the deep calf veins in 8 (66.6 %) patients and was in the pulmonary artery stump in two (16.6 %) who underwent right pneumonectomy. In two (16.6 %) patients massive emboli were identified in the main pulmonary artery and its major branches. However, no thrombus was identified in the veins of the legs.

15,000 IU calcium heparin (Calciparine, Sanofi, UK) was administered subcutaneously in three divided doses as prophylaxis in 6 (50 %) patients commencing two hours following surgery. No pharmacological prophylaxis was administered to the other six patients, as a preference of the surgeon. A therapeutic dose of heparin was administered to only two patients in whom deep vein thrombosis

10

was diagnosed on 2nd and 4th postoperative day. These two patients however suffered fatal cardio-respiratory arrest in two and 18 hours following initiation of anticoagulant therapy. Demographic data of the patients are shown in Table 1.

(eight pneumonectomies and four lobectomies) and the primary diagnosis was malignant neoplasm in each case. Morrell and Dunnill (9) showed in their postmortem study that the majority of the cases were 50 years of age or more. This was also de-

Patient No	Sex	Staging	Operation	Onset of SCRA (hrs)	Cell Type	Heparin Phrophylaxis
1	M	IIIa	RP	20	Squamous	Yes
2	M	IIIa	RP	74	Squamous	Yes
3	F	IIIa	RP	24	Adeno	No
4	M	I	RP	38	Squamous	No
5	M	IIIa	RP	160	Squamous	No
6	F	IIIa	LP	115	Squamous	Yes
7	M	II	LP	96	Squamous	Yes
8	M	IIIa	LP	24	Squamous	Yes
9	M	I	RMLL	40	Squamous	Yes
10	M	I	RLL	70	Squamous	No
11	M	II	LLL	38	Adeno	No
12	M	II	RUL	39	Squamous	No

M = Male, F = Female, RP & LP = Right and left pneumonectomy, RMLL = Right middle and upper lobectomy, RLL = Right lover lobectomy, RUL = Right upper lobectomy, LLL = Left lover lobectomy.

Table 1 : Demographic data of the patients.

DISCUSSION

Despite entexsive research into the prevention, diagnosis as well as treatment and risk factors of pulmonary thromboembolism are poorly characterised.

Pulmonary resection for bronchogenic carcinoma provides the most effective form of treatment for this condition. However, the group of patients requiring this therapy commonly possess characteristics which predispose them to the occurence of thromboembolism. These major risk factors include advanced age, trauma such as recent major operation, advanced malignancy such as stage IIIa or IV lung cancer, prolonged duration of surgery and anaesthesia, obesity as well as prolonged postoperative immobilisation (3, 8, 9, 12). Some patients may have additional risk factors such as previous history of DVT, a known hypercoagulable state and heart disease. All patients in this study had one or more major risk factors of thromboembolism expressed above. They possessed a median age of 65 years and had been hospitalized prior to surgery. The patients had also undergone major surgery

monstrated by Gillinov et al (3) and Reis et al (12) in patients undergoing coronary artery by-pass grafting. Satur et al (15) suggest that the incidence of pulmonary embolus may be underestimated and that this failure to diagnose the problem arises from an often confusing presentation. Ziomek et al (17) performed a prospective study and demonstrated that the principal risk factors were: 1. Tumour size greater than 3 cm in diameter 2. Tumour stage II or higher 3. Lobectomy or pneumonectomy. The only mortality observed in this study was due to sudden cardiorespiratory arrest which followed cardiac arrhythmias presumed to be due to myocardial infarction. Pulmonary angiography and postmortem examination however revealed that the main contributing factor was multiple bilateral pulmonary emboli. No significant cardiac disease was present. 66% of our patients underwent pneumonectomy with only three patients in stage I whereas advanced tumour(stage II or IIIa) was observed in nine patients. In contrast to Coon (10) and Ziomek et al (16, 17), only two patients with adenocarcinoma were observed in our study.

Diagnosis of DVT and pulmonary embolism is difficult. Any patient suspected of having DVT

11

should receive a duplex ultrasound scan or venogram. Sudden cardiorespiratory arrest due to pulmonary thromboembolism is an uncommon but almost always fatal complication following lung resection. The complications of lung surgery were reviewed by Nagasaki et al (10) and Ginsberg et al (4) who observed an incidence of proven fatal pulmonary embolism of 14% and 13% respectively amongst patients died in the postoperative period. Results of our study show the most frequent cause of sudden cardiorespiratory arrest to be major pulmonary thromboembolism. There was an evidence in 83% of patients of thrombus in the deep veins of the legs although this was symptomatic in only two patients. Institution of anticoagulant therapy following diagnosis of DVT did not prevent sudden cardiorespiratory arrest in these cases. Pulmonary symptoms anteceding the major event were only identified in two patients. Post-mortem examination demonstrated that in the presence of major embolus the lungs were severely oedematous.

The clinical presentation of pulmonary emboli following lung resection may be varied and depends on the size of the emboli. Symptoms may include mild dyspnea or alternatively may be extreme and cause sudden cardiorespiratory arrest. The diagnosis of pulmonary thromboemboli in the presence of physiological changes occurring secondary to recent thoracic surgery often leads to misdiagnosis. Thus the presence of bronchospasm, focal pulmonary collapse, or pulmonary oedema are most commonly considered to be primary symptoms and not secondary to emboli. Dyspnea and the above clinical signs may however be induced by the presence of emboli of varying sizes. This is supported by our own findings of pulmonary oedema as a common accompanying feature of large pulmonary emboli.

In the presence of acute cardiorespiratory arrest little may be done to treat patients successfully. Prevention of the occurrence of thromboembolism and thus secondary major adverse events is the only effective therapy for these problems. The effect of pneumatic compression of the legs during surgery and graduated compression stockings in the prevention have been shown by Scurr et al (14) and were proposed by the authors. The incidence of both deep vein thrombosis and fatal pulmonary embolism in patients undergoing thoracic surgical procedures has been shown to be reduced to two thirds in patients with the use of a protocol of administration of 5000 IU subcutaneous heparin 8-12

hourly commencing early after surgery (1, 6). This regimen has shown to decrease the incidence of DVT in thoracic surgical patients by approximately 50 percent (1). This protocol was utilised in some of our patients thus emphasising the need to further investigate a more suitable and efficacious protocol of prophylaxis.

Two of the patients in our group suffered minor symptoms which pre-empted a major embolus. We speculate that, had an earlier diagnosis of the former been made, then active treatment may have prevented the latter. A high level of expertise is required to diagnose the occurrence of pulmonary emboli which are smaller than those described above. Patients with limited pulmonary function are those most likely to suffer rapid onset of haemodynamic instability in the presence of moderate sized emboli (13). These patients are, however, also most likely to have other causes of respiratory insufficiency such as bronchospasm. Ventilation/perfusion scans and pulmonary angiography are methods of diagnosis that should be utilised. Following diagnosis, anticoagulation with intravenous heparin and oral anticoagulants in order to achieve the prothrombin time between 2.0 and 2.5 of normal is mandatory although this did not prevent fatal pulmonary embolism in two of the patients.

We conclude that pulmonary embolism is the most common cause of sudden cardiorespiratory arrest in the early postoperative period following lung resection. Treatment options are limited but consideration should be given to both aggressive prophylaxis and to earlier diagnosis as well as treatment of minor emboli.

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