Chest & Heart Journal
Vol. 40, No. 1, January 2016

ORIGINAL ARTICLE

Association between Body Mass Index and Outcomes after Pulmonary Resectional Surgery in Lung Cancer

Zahidul Islam[1], Manabendra Biswas[2], Md. Mofizur Rahman Mia[2], Anwarul A. Kibria[2], Kazi S. Islam[2], Abdur Rahim[3], Nazmul Islam[3]

Abstract

Objective: *Obesity has been thought to predispose patients to excess morbidity after lung resection because of decreased diaphragm excursion, reduced lung volumes and relative immobility. We assessed the relationship of body mass index (BMI) to acute outcomes after major lung resection.*

Methods*: We enrolled 46 consecutive patients undergoing lobectomy and pneumonectomy for NSCLC at the Department of Thoracic Surgery, National Institute Institute of Diseases of the Chest and Hospital, Dhaka, from July 2014 to June 2015. To determine the influence of preoperative body mass index (BMI) on postoperative complications, patients were classified into two groups: (1) BMI e” 23 kg /m^2; n = 22 (47.8%); and (2) BMI 18.5 to 22.9 kg / m^2; n = 24 (52.2%). Data on sex, age, cigarette smoking, HTN, Diabetes, Duration of operation, and histology and pathological stage were collected. Information on total postoperative complications, 30-day mortality rate, specific pulmonary and other complications, intensive care unit (ICU) admission and hospital stay was collected and analysed for the BMI group.*

Results*: Fifty-two percent (24 of 46) were nonobese, and 48% (22 of 46) were overweight & obese. Preoperative variables were similar in the overweight & obese and nonobese group. Overall mortality was 6.5% (3 of 46) and was not different between groups (p = 0.466). Length of hospital stay (p = 0.708) were similar. Complications occurred in 25% (6 of 24) of nonobese and 22.7% (5 of 22) of overweight & obese patients (p = 0.856). Respiratory complications occurred in 8.3% (2 of 24) of nonobese and 18.2% (4 of 22) of overweight & obese patients (p = 0.290). Significant difference was found in duration of operation at nonobese 2.6±0.6 and 3.2±0.8 at overweight & obese patients (p = 0.05); type of operation (p = 0.045). No association was found between risk factor and complication.*

Conclusions: *Being overweight or obese does not increase the risk of complications after major lung resection in contrast to patients who are normal weight. A large sample size is needed for further evaluation.*

Keywords: *Lobectomy; Pneumonectomy; Lung cancer; Body mass index*

[Chest & Heart Journal 2016; 40(1) : 32-41]

1. Registrar (Thoracic Surgery), National Institute of Disease of the Chest and Hospital, Mohakhali, Dhaka.
2. Associate Professor, Thoracic Surgery, NIDCH, ;Mohakhali, Dhaka.
3. Assistant Professor, Thoracic Surgery, NIDCH, ;Mohakhali, Dhaka.

Correspondence to: Dr. Md. Zahidul Islam, Registrar (Thoracic Surgery), National Institute of Disease of the Chest and Hospital, Mohakhali, Dhaka.

Background

Obesity is defined as 'abnormal or excessive fat accumulation that may impair health[1]. Obesity is currently the most common metabolic disease in the world[2] with more than 1.6 billion overweight adults worldwide of whom at least 400 million are obese[1]. Obesity and overweight are classified by the body mass index (BMI, kg/m^2) devised by Lambert Adolphe Quetelet (1796—1874) in 1835. Body mass index is highly correlated with body fat and is therefore one of the easiest and most effective measures in clinical assessment and epidemiological studies[2]. The World Health Organization (WHO) has estimated that around 2.3 billion adults will be overweight and more than 700 million obese by 2015[1].

According to WHO classification of BMI for south Asian countries; BMI (kg/m^2) was categorized as underweight (<18.5 kg/m^2), normal healthy person (18.5 to 22.99 kg/m^2), overweight (23 to 26.99 kg/m^2) , obese (> 27 kg/m^2)[3].

Epidemiological studies have suggested a significant inverse relationship between BMI and the incidence of lung cancer but it has only been with the recent epidemic of obesity that significant numbers of patients presenting for resection of non-small-cell lung cancer (NSCLC) have been overweight or obese[4].

Body mass index (BMI) intuitively influences the technical aspects of lung cancer surgery and its outcome[5]. Surgeons traditionally welcome the easily discerned internal anatomy of thin patients, while reluctantly facing challenges that obese patients present[5]. The greater technical and physical demands engendered by substantial girth and excess mediastinal fat are associated with increased operating time for lung resection [6]. Obesity intuitively increases the peri-operative risks of lung surgery owing to associated co morbidities such as diabetes, hypertension and coronary artery disease, and physiological impairment of ventilation[5].

Results of recent reports on acute outcomes of lung resection in obese patients are mixed: some reports substantiate this increased risk[7,8], while others demonstrate no increase in risk[4,5,9,10,11].

As complete anatomic resection remains the mainstay of attempted curative therapy for NSCLC in patients with locoregional disease [4], it is quite common nowadays for thoracic surgeons and anaesthesiologists to manage overweight or obese patients eligible for standard or major curative lung resections in stage I,II,IIIA disease[7].

The aim in our study was to explore the relationship of BMI, particularly over weight and obese with normal weight status, undergoing major lung resection for curative therapy of NSCLC, on postoperative respiratory and overall complication.

Materials and methods

The study was conducted in the Department of Thoracic Surgery, National Institute of Diseases of the Chest and Hospital, Dhaka, between the periods of July 2014 to June 2015. It was a prospective, observational study.

A Study population

Patients who were diagnosed as a case of operable (stage- I, II, & IIIA) NSCLC, lobectomies and standard pneumonectomies were performed. Standard pneumonectomy was defined as the removal of the entire lung, associated with mediastinal lymph node dissection without any resection of mediastinal, chest wall or diaphragmatic structures. A total of 46 cases of NSCLC were taken and they were divided in two groups, Group - I, 22 patents (i.e; BMI e" 23 kg/ m^2) and Group - II, 24 patients (BMI 18.5 kg/ m^2 to 22.9 kg/ m^2).

B Selection of sample:

Sample was selected from the inpatient department of NIDCH of either sex. Patients who got admitted in NIDCH and underwent major lung resection (lobectomy, bilobectomy pneumonectomy) for NSCLC at stage-I, II and IIIA disease, undergoing lung resection for NSCLC for the first time and with inducton chemotherapy was included in the study. Patients with NSCLC who has been suffering from active respiratory disease, previously treated with induction radiotherapy, with renal failure, symptomatic heart disease, with BMI <18.5 kg / m^2 was excluded in the study. Sampling was done by convenience sampling.

C Patient selection and management

Operability and staging procedures was determined by standard clinical examination, some laboratory investigations and radiographic procedures such as complete blood count, liver funtion test, renal function test, blood glucose level, chest X-Ray P/A and lateral view, computed tomography (CT scan) of chest, both flexible and rigid bronchoscopy, ultrasonography of whole abdomen including chest, bone scan, nuclear imaging [whole-body 18F-fluorodeoxyglucose (FDG)-positron emission tomography (PET scan)] as appropriate. Final staging was done after histopathology report. Preoperative respiratory function was assessed routinely by spirometry and occationally blood gas analysis (ABG) if needed. Preoperative cardiac function evaluation was routinely performed by echocardiography with left ventricular ejection fraction (EF) and pulmonary artery pressure (PAP) was estimated. Diabetes was well controlled preoperatively and postoperatively by short acting insulin. Hypertension was well controlled preoperatively and postoperatively by antihypertensive drug. Smoking was stopped at least two weeks before surgery. Patient with any abnormality of these investigation sort out properly, if correctable/manageable, managed properly or excluded from this study..

Postoperative analgesia was achieved, in conjunction with anaesthesiologists, using a combination of epidural analgesia (when technically feasible and not contraindicated), and oral and parenteral adjuncts as needed to improve pulmonary and physical therapy.

Patients were instructed preoperatively regarding incentive spirometry. Postoperatively, they received two assisted sessions of chest physiotherapy daily, starting on the first postoperative day, and were asked to repeat the physiotherapy programme six times during the day until discharge. Therapeutic bronchoscopy was instituted early, based on clinical findings and correlation with chest films.

D Postoperative complications

Postoperative death was defined as the 30-day mortality rate or longer if mortality occurred during the index hospitalisation. Complications were classified as: a) respiratory and b) other complications. Respiratory complications were classified as follows: I) Major complications: (i) acute respiratory failure; (ii) adult respiratory distress syndrome (ARDS); (iii) acute lung injury (ALI); (iv) pneumonia; (v) pulmonary embolism; and (vi) pulmonary oedema vii) bronchopleural fistula. II) Minor complications: (i) sputum retention and (ii) atelectasis not requiring toilette bronchoscopy.

b) Other complications included: i) haemothorax, ii) empyema, iii) chylothorax,iv) cardiac dislocation v) wound infection vi) neurological complications; and vii) abdominal / urinary tract complications.

E Body mass index

Height and weight were measured preoperatively: BMI was calculated as patient weight in kilograms divided by the square of patient height in metres (kg / m^2). The WHO BMI classification for south asian people was used as follows: underweight (BMI < 18.5 kg/ m^2); normal weight (BMI from 18.5 kg/ m^2 to 22.9 kg/ m^2); overweight (BMI 23 kg/ m^2 to 26.9 kg/ m^2) and obese (BMI e" 27 kg/ m^2) [3].

Patients were then classified into two groups: Group- I, BMI e" 23 kg/ m^2; and Group- II, BMI 18.5 kg/ m^2 to 22.9 kg/ m^2. Group- I, BMI e" 23 kg/ m^2 were divided into two subgroups: overweight patients (BMI: 23 kg/ m^2 to 26.9 kg/ m^2); obese patients (BMI: e" 27 kg/ m^2).

F Follow up

All patients with satisfactory outcome were discharged. After discharge patients were followed up at one month interval for two times. In follow up patients were evaluated clinically, and radiologically, for any evidence of complication. If complication was detected, he/she was admitted and treated accordingly.

G Statistical methods

Statistical analyses was carried out by using the Statistical Package for Social Sciences version 20.0 for Windows (SPSS Inc., Chicago, Illinois, USA). A descriptive analysis was performed for all data. The mean values was calculated for continuous variables. The quantitative and qualitative observations were indicated by frequencies, percentages. Chi-Square test and Odds ratio with 95% CI was used to analyze the categorical variables, shown in cross tabulation and unpaired t-test was used to analyze the continuous variable and expressed as mean (±SD) and further analyzed using logistic regression analysis for their possible independent association. A P-value was considered to be statistically non significant if >0.05 and statistically significant if d” 0.05.

Observations and Results

During the study period, 46 patients underwent major lung resection for NSCLC. Patients were devided into two group. In Group-I, BMI e”23 included overweight and obese were 22 patients and in Group-II, BMI 18.5 - 22.9 included normal weight were 24 patients, of them 35 (76.1%) were male and 11(23.9%) were female. The female sex was comparatively more frequent in the high BMI group than normal. The mean age was (55.6±11.3) years (range: 25—80) are listed in Table-I. No statistically significant difference between the two groups was evident in terms of age (p=.054) and sex(p=.228). As many as 30 patients (65.2%) were smokers or former smokers at the time of diagnosis of whom13(59.1%) in group - I and 17(70.8%) in group -II. Total 15(32.6%) patients were diabetic and 12(26.1%) patients were hypertensive are listed in Table-II. No statistically significant difference between the two groups was evident in terms of smoking(p=0.403), diabetes (p=0.602) and hypertension(p=0.396).

In case of tissue diagnosis, 30(65.2%) patients were squamous cell carcioma, 14(30.4%) were adenocarcinoma and 2(4.4%) were large cell carcinoma. Lobectomy was done in 42(91.3%) patients and pneumonectomy was done in 4(8.7%) patients. It was observed that in diagnosis, squamous cell carcinoma was found 14(63.6%) in group I and 16(66.6%) in group II. Adenocarcinoma was found 7(31.9%) in group I and 7(29.2%) in group II. Large cell carcinoma was found 1(4.5%) in group I and 1(4.2%) in group II. The difference was not statistically significant (p<0.05) between two groups are listed in table III. In type of operation, lobectomy was found 22(100.0%) in group I and 20(83.3%) in group II. The difference was statistically significant (p<0.05) between two groups are listed in table III.

Mean duration of operation was found at all patients were 2.9±0.7 (2-5) hrs , and 3.2±0.8 hrs in group I and 2.6±0.6 hrs in group II. In pathological staging, stage- I was 7(15.2%) patients, stage- II was 30(65.2%) patients and stage-IIIA was 9(19.6%) patients. Mean duration of operation was statistically significant (p<0.05) between two groups. Pathological staging was not statistically significant (p>0.05) between two groups that is listed in table IV. Mean duration of operation was found 3.2±0.8 hrs in group I and 2.6±0.6 hrs in group II. In pathological staging, stage II was found 14(63.6%) in group I and 16(66.7%) in group II. Mean duration of operation was statistically significant (p<0.05) between two groups

Mean duration of hospital stay was found at all patients were 31.9±6.2 (25-52)days. It was observed mean duration of hospital stay was found 30.0±5.7 days in group I and 32.8±6.7 days in group II. The mean duration of hospital stay was not statistically significant (p>0.05) between two groups(Table-V). Total 3(6.5%) patient needed ICU support. Two patients in group-I and one patient in group-II. One patient recovered from ICU and two patients were died. No statistically significant difference between the two groups was evident in terms ICU admission (p = 0.499). Four patients (18.2%) received induction chemotherapy in group-I but not found in group in group II. Induction chemotherapy was statistically significant (p<0.05) between two groups. Five patient(10.9%) was resection margin positive of whom 2/22(9.1%) in group -I and 3/ 24(12.5%) in group -II. The resection margin positive was not statistically significant (p=0.550) between two groups.

Three patients (6.52%) died within the first 30 days of operation. One patient belonged to the group with normal BMI and died at 6^{th} POD. Causes of death was respiratory failure due to pneumonia with septic shock,. Two deceased patients belonged to the high BMI group; one of them died at 6^{th} POD after respiratory failure due to pneumonia with septic shock, another patient died at home on 18^{th} POD, 4 days after discharge with respiratory distress. This patient suffered postoperatively with bronchopleural fistula and collapse of remaining lobe(Table -VI, VlI). No statistically significant difference between the two groups was evident in terms mortality (p = 0.466).

Respiratory complications were more frequent in the high BMI group (18.2% vs 8.3%, crude OR = 2.44; 95% CI: 0.32-22.09; p=0.290) but not statistically significant between the two groups (Table -VI, VlI). In the ‘normal weight' group, we observed 2/24 pulmonary complications (8.3%); one of them developed pneumonia with ARDS with respiratory failure.He died at ICU on 6^{th} POD. Another patient developed prolong air leak with IT collection. After discharged patient was readmitted for post pneumonectomy space infection. After tube thoracostomy patient was recovered . In the higher BMI group we observed

4/22 pulmonary complications (18.2%); they were pneumonia in one case that resolved after conservative treatment; pneumonia with ARDS with respiratory failure in one case, who died on at ICU; bronchopleural fistula and collapse of remaining lobe with respiratory failure in two cases, one who recovered after treatment at ICU and another patient died at home 4 days after discharge on 18th POD.

Non respiratory complications were more frequent in the normal BMI group(16.7% vs 4.5%, crude OR = 0.24; 95% CI: 0.01-2.65; p=0.201) but not statistically significant between the two groups (Table -VIII, IX). In the 'normal weight' group, we observed 4/24 non pulmonary complications (16.7%);

Respiratory complications were more frequent in the high BMI group (group I) (18.2% vs 8.3%, crude OR=2.44; 95% CI: 0.32 to 22.09%).

At first follow up one month after discharged, three patients developed metastatic lesion. One patient in thoracic vertebrae, one patient in brain and another patient developed two metastatic lesion in opposite lung. At second follow up two months after discharged, this patient developed pleural effusion in same hemi thorax needed tube thoracostomy At the second follow up, one month after first follow up, one patient developed pleural effusion needed readmission and tube thoracostomy. In the high BMI group, we observed 1/22 non pulmonary complications (4.5%). (Table -Vlll).

Table-I

Distribution of the study patients by age and sex (n=46)

	Group-I (n=22)		Group-II (n=24)		Total (n=46)		P value
	n	%	N	%	N	%	
Age (years)							
≤50	9	40.9	5	20.8	14	30.4	
51-60	6	27.3	11	45.9	17	37.0	
>60	7	31.8	8	33.3	15	32.6	
Mean±SD	52.2	±12.0	58.7	±10.0	55.6	±11.3	$^{a}0.054^{ns}$
Range (min-max)	25	-77.0	32	-80.0	25	-80.0	
Sex							
Male	15	68.2	20	83.3	35	76.1	$^{b}0.228^{ns}$
Female	7	31.8	4	16.7	11	23.9	

Group I- Over weight & obese
Group II- Normal BMI
ns= not significant
a p value reached from unpaired t-test
b p value reached from chi square test

Table-II

Distribution of the study patients by risk factors (n=46)

Risk factors	Group-I (n=22)		Group-II (n=24)		Total (n=46)		P value
	n	%	N	%	N	%	
Smoking							
Yes	13	59.1	17	70.8	30	65.2	0.403^{ns}
No	9	40.9	7	29.2	16	34.8	
DM							
Yes	8	36.4	7	29.2	15	32.6	0.602^{ns}
No	14	63.6	17	70.8	31	67.4	
HTN							
Yes	7	31.8	5	20.8	12	26.1	0.396^{ns}
No	15	68.2	19	79.2	34	73.9	

ns=not significant
P value reached from chi square test1

Table-III

Distribution of the study patients by diagnosis and type of operation (n=46)

	Group-I (n=22)		Group-II (n=24)		Total (n=46)		P value
	n	%	N	%	N	%	
Diagnosis							
Squamous cell carcinoma	14	63.6	16	66.6	30	65.2	0.977[ns]
Adenocarcinoma	7	31.9	7	29.2	14	30.4	
Large cell carcinoma	1	4.5	1	4.2	2	4.4	
Operation							
Lobectomy	22	100.0	20	83.3	42	91.3	0.045[s]
Pneumonectomy	0	0.0	4	16.7	4	8.7	

s=significant; ns=not significant
P value reached from chi square test

Table-IV

Distribution of the study patients by duration of operation and pathological staging (n=46)

	Group-I (n=22)		Group-II (n=24)		Total (n=46)		P value
	n	%	N	%	N	%	
Duration of operation (hrs)							
Mean±SD	3.2	±0.8	2.6	±0.6	2.9	±0.7	[a]0.005[s]
Range (min-max)	2.0	-5.0	2.0	-4.0	2.0	-5.0	
Pathological staging							
I	4	18.2	3	12.5	7	15.2	[b]0.860[ns]
II	14	63.6	16	66.7	30	65.2	
IIIA	4	18.2	5	20.8	9	19.6	

s=significant; ns=not significant
[a]P value reached from unpaired t-test
[b]P value reached from chi square test

Table-V

Distribution of the study patients by duration of hospital stay (n=46)

Duration of hospital	Group-I (n=22)		Group-II (n=24)		Total (n=46)		P value
stay (day)	n	%	N	%	N	%	
dd30 8	36.4	12	50.0	20	43.5		
>30 14	63.6	12	50.0	26	56.5		
Mean±SD	30.0	±5.7	32.8	±6.7	31.9	±6.2	0.135[ns]
Range (min-max)	25.0	-52.0	26.0	-45.0	25.0	-52.0	

ns= not significant
P value reached from unpaired t-test

Table-VI

Distribution of the study patients by resection margin and pre operative chemotherapy (n=46)

	Group-I (n=22)		Group-II (n=24)		Total (n=46)		P value
	n	%	N	%	N	%	
Resection margin							
Positive	2	9.1	3	12.5	5	10.9	0.542ns
Negative	20	90.9	21	87.5	41	89.1	
Pre operative chemotherapy							
Yes	4	18.2	0	0.0	4	8.7	0.028s
No	18	81.8	24	100	42	91.3	

s=significant; ns=not significant
P value reached from chi square test

Table-VII

Distribution of the study patients by ICU admission (n=46)

ICU admission	Group-I (n=22)		Group-II (n=24)		Total (n=46)		P value
	n	%	N	%	N	%	
Yes	2	9.1	1	4.2	3	6.5	0.499ns
No	20	90.9	23	95.8	43	93.5	

ns=not significant
P value reached from chi square test

Table-VIII

Distribution of the study patients by post operative complication (n=46)

Post operative complication	Group-I (n=22)		Group-II (n=24)		Total (n=46)		P value
	n	%	N	%	N	%	
No complication	17	77.3	18	75.0	35	76.1	0.856ns
Complication	5	22.7	6	25.0	11	23.9	
Respiratory complication	4	18.2	2	8.3	6	13.0	0.290ns
Non respiratory complication	1	4.5	4	16.7	5	10.9	0.201ns
Death	2	9.1	1	4.5	3	6.5	0.466ns

ns=not significant
P value reached from chi square test

Discussion and limitations

Obesity is associated with an increase in cancer risk and cardiovascular disorders, and is accompanied by decreased life expectancy and impaired quality of life in the general population [13]. Excess body weight/mass has been explored as a predictor of postoperative outcomes after a variety of surgical procedures[5]. A recent review of the link between excess BMI and outcomes after nonbariatric general surgery identified mixed results, with increased morbidity and mortality associated with extreme obesity, whereas being overweight or moderately obese did not confer an increase in perioperative risk[5,14]. Similar mixed findings have been reported for outcomes from cardiovascular surgery[5]. In contrast, underweight is consistently associated with increased risk of operative morbidity and mortality in noncardiac[5] surgery.

Nutritional status is known to influence postoperative morbidity in patients undergoing gastrointestinal surgery, oesophageal surgery and lung cancer surgery[9]. Although several investigators have demonstrated that weight and relative weight are inversely associated with the risk of lung cancer[10,15], recent studies found a low incidence of low BMI in operable lung cancer [9,15] and the majority of operable lung cancer patients were over- rather than underweight [9]. This finding is most likely due to two conditions: (i) operable patients are often in the early and mainly not-advanced stages of lung cancer rather than the late cachectic stage; and (ii) with the recent epidemic of obesity in industrialised countries, significant proportions of patients presenting for the resection of NSCLC are overweight or obese[4,7].

Obese patients do suffer from more comorbidities such as diabetes, renal impairment, deep vein thrombosis and stroke, preoperatively; therefore, postoperative complications after surgical intervention are expected to increase with obesity[10]. But in our study we found no significant difference between risk factors with BMI groups. We also found no significant association between risk factors and perioperative complications probably due to selection of patient, well control of risk factor and special care for this patients.

Saina Attaran et al.2012 found in Group A (patients with BMI e"30), postoperative histology showed 161(48.5%) patients with squamous cell cancer, 138 (41.6%) with adenocarcinomas and 27 (8.1%) with other cancer types, excluding small cell and carcinoid tumours[10]. Our result was also similar with this result. In this group, postoperative staging showed 96 (28.9%) patients as stage I(a), 120 (36.1%) as I(b), 10 (3.0%) as II(a), 58 (17.5%) as II(b), 39 (11.8%) as III(a) and 9 (2.7%) as III(b)[10]. Our result was not similar with this result, we found more patient in stage-II disease. Postoperative histology showed that resection margins were positive in 19 (5.7%) patients in Group A and 16 (4.8%) in Group B[10]. we found 2 (9.1%) in group-I and 3 (12.5%) in group-II patients.

Obesity is associated with increased operating time [6]. We also found similar result. But whether obesity is associated with increased risk is uncertain based on recent clinical reports [5,6]. The growing obesity epidemic mandates that surgeons understand the implications of the extremes of BMI for perioperative and long term outcomes after major lung resection[5,7]. We explored the interactions of BMI and outcomes after major lung resection. we found no increase in perioperative risk with normal weight vs overweight and obese status.

F Petrella et al. clearly suggest that overweight and obese patients present a higher pulmonary complication rate than do normal weight patients: increased intra-operative difficulties, frequent bleeding complications, co-morbidities and impaired preoperative pulmonary function may justify this result[7].

Although intuitive, it has not hitherto been demonstrated that pulmonary complications are fivefold more frequent in overweight patients[7]. Several mechanisms have been proposed to explain pulmonary abnormalities in obese patients: obesity-induced abnormal respiratory system mechanics, impaired central responses to hypercapnia and hypoxia, sleep-disordered breathing and neurohormonal abnormalities such as leptin resistance[17]. Obesity imposes a significant mechanical load leading to a reduction in total respiratory system compliance, increased lung resistance and a relative state of respiratory muscle weakness leading to increased work of breathing[17].

S. Attaran et al.2012 did not show the same trend after lung resection for lung cancer[10]. The main reason for that could be the low rate of complications after lung resection in general. When comparing patients with normal weight with the ones who have a higher BMI, an improved survival rate has been observed in patients with a high BMI. Surgical resection for lung cancer, survival is significantly higher in patients with a BMI of e"30 compared with those with a BMI of <30 [10]. No similar study has ever shown an obesity survival paradox after resection for lung cancer. Theoretically, it can be expected that cancers, which result in weight loss, may be more aggressive in nature and a rapid weight loss after developing cancer can negatively affect cell regulatory systems resulting in progression of the cancer [10]. Moreover, overweight patients have shown biochemical evidence for better nutrition than the normal weight patients [18]. They have more adipose tissue, therefore are less likely to suffer from energy deficits [18] and may have a better tolerance rate for further postoperative treatment.

However, a recent meta-analysis failed to establish a positive correlation between high BMI and increased postoperative complications or mortality rates [19]. Similarly, in our study, we did not observe any difference between the postoperative complications in terms of morbidity and mortality between patients with high and normal BMI.

Morbidity and mortality after resections for NSCLC are lower now than in the past . Although reported perioperative mortality rates have ranged widely in individual series, a large registry report of nearly 8,000 patients demonstrated 3.1% 30-day mortality. A recent multi institutional prospective trial of more than 1,100 patients reported 1.4% 30-day mortality. *Francesco Petrella et al.2011* found 6% mortality[7]. Our 6.5% mortality rate is, therefore, well within accepted standards. Most studies report at least one aspect of TNM staging to be related to prognosis [20]. Performance status is a well-known prognostic indicator in many diseases, including NSCLC[20].

Low BMI was recently identified by Thomas et al. as an independent risk factor for increased complications after major lung resection, including pulmonary complications and death[11]. Low body weight is often associated with low serum albumin, and the latter has been shown to adversely influence postoperative morbidity and mortality following thoracic surgery in general and pneumonectomy in particular [21]. There are a number of potential explanations for these findings. Adipose tissue, particularly nonvisceral adipocytes, secretes cytokines that regulate inflammation, endovascular homeostasis and insulin sensitivity. Adipose tissue is capable of scavenging inflammatory toxins, and lipoproteins that are often increased in the obese can bind to and neutralize endotoxins [14]. In contrast, low BMI may not be a specific cause of increased risk, but instead may be a result of other acute or chronic processes that themselves increase risk such as smoking and chronic obstructive pulmonary disease (COPD). Extreme loss of muscle mass (sarcopenia) may be related to decreased effectiveness of muscles of respiration and relative inactivity, both of which may contribute to increased perioperative risks, especially for pulmonary complications. Sarcopenia is common in patients with COPD and in those with lung cancer[22].

This study is unable to draw conclusions regarding resource utilization or costs associated with evaluating and managing obese patients with NSCLC. Even in the absence of more complications, obese patients require heavy resource utilization for preoperative evaluation and perioperative care. Increased use of staff and specialized equipment, such as patient lifts and specially designed operating room and floor beds, leads to increased cost. Obese patients require longer times in the operating room owing to challenges in airway management, positioning, and the technical performance of the procedure . Obese patients also have greater medication requirements. Thus, while not fully explored by this study, it is likely that lung resection in the obese patient is an expensive and labor-intensive endeavour.

Another limitation of this study is that tumour biomarkers such as epidermal growth factor receptors were not tested for our patients. This may have resulted in a confounding bias, which should be addressed in future studies.

Conclusions and Recommendations:

Respiratory complications after lobectomy and pneumonectomy for curative resection of NSCLC are not frequent in overweight and obese patients than in subjects with normal weight patients. No statistical difference was observed regarding nonrespiratory complications and 30-day mortality rate. The operative time was observed increased significantly in overweight and obese patients than in subjects with normal weight patients. Our results suggest that it is unwarranted, based on current knowledge, to avoid surgical intervention in obese patients who are otherwise appropriate candidates for resection of NSCLC.

References

1. World Health Organization Obesity and overweight. Fact sheet No. 311. September 2006.
2. Formiguera X, Canton A. Obesity: epidemiology and clinical aspects. Best Pract Res Clin Gastroeneterol 2004;18:1125—46.
3. *WHO expert consultation* Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies *Lancet* 2004; 363: 157–63

4. Smith PW, Hongkun W, Gazoni LM, Shen R, Daniel TM, Jones DR. Obesity does not increase complications after anatomic resection for non small cell lung cancer. Ann Thorac Surg 2007;84:1098—106.
5. Mark K. Ferguson* Hae Kyung Imb, Sydeaka Watsona, Elizabeth Johnsona, Christopher H.Wigfielda and Wickii T. Vigneswarana. Association of body mass index and outcomes after major lung resection. European Journal of Cardio-Thoracic Surgery 45 ,2014, e94–e99.
6. St Julien JB, Aldrich MC, Sheng S, Deppen SA, Burfeind WR Jr, Putnam JB. Obesity increases operating room time for lobectomy in the society of thoracic surgeons database. Ann Thorac Surg 2012;94:1841–7.
7. Petrella F, Radice D, Borri A, Galetta D, Gasparri R, Solli P. The impact of preoperative body mass index on respiratory complications after pneumonectomy for non-small-cell lung cancer. Results from a series of 154 consecutive standard pneumonectomies. Eur J Cardiothorac Surg 2011;39:738–44.
8. Launer H, Nguyen DV, Cooke DT. National perioperative outcomes of pulmonary lobectomy for cancer in the obese patient: a propensity score matched analysis. J Thorac Cardiovasc Surg 2013;145:1312–8.
9. Win T, Ritchie AJ, Wells FC, Laroche CM. The incidence and impact of low body mass index on patients with operable lung cancer. Clin Nutr 2007;26:440—3.
10. Saina Attaran*, James McShane, Ian Whittle, Michael Poullis and Michael ShackclothA propensity-matched comparison of survival after lung resection in patients with a high versus low body mass index†European Journal of Cardio-Thoracic Surgery 42 ,2012, 653–658.
11. Thomas PA, Berbis J, Falcoz PE, Le Pimpec-Barthes F, Bernard A, Jougon J. on behalf of the EPITHOR Group. National perioperative outcomes of pulmonary lobectomy for cancer: the influence of nutritional status. Eur J Cardiothorac Surg 2014;45:652–9.
12. G. Alexander Patterson, Joel D Cooper, Jean Deslauriers, Antoon E. M. R. Lerut, James D. Luketich, Thomas W. Rice. PEARSON'S THORACIC & ESOPHAGEAL SURGERY. 3rd ed. Philadelphia: ELSEVIER; 2008.
13. Haslam DW, James WP. Obesity. Lancet 2005;366:1197–209
14. Valentijn TM, Galal W, Tjeertes EK, Hoeks SE, Verhagen HJ, Stolker RJ. The obesity paradox in the surgical population. Surgeon 2013;11: 169–76.
15. Jagoe RT, Goodship TH, Gibson GJ. Nutritional status of patients undergoing lung cancer operations. Ann Thorac Surg 2001;71:929—35.
16. Robinson WR, Gordon-Larsen P, Kaufman JS, Suchindran CM, Stevens J. The female-male disparity in obesity prevalence among black American young adults: contributions of sociodemographic characteristics of the childhood family. Am J Clin Nutr 2009;89(4):1204—12.
17. Mokhlesi B, Kryger MH, Grunstein RR. Assessment and management of patients with obesity hypoventilation syndrome. Proc Am Thorac Soc 2008;5:218—25.
18. Fleischmann E, Teal N, Dudley J, May W, Bower JD, Salahudeen AK. Influence of excess weight on mortality and hospital stay in 1346 hemodialysis patients. Kidney Int 1999;55:1560–7.
19. [19] Akinnusi ME, Pineda LA, El Solh AA. Effect of obesity on intensive care morbidity and mortality: a meta-analysis. Crit Care Med 2008;36:151–8.
20. Brundage MD, Davies D, Mackillop WJ. Prognostic factors in non-small cell lung cancer: a decade of progress. Chest 2002;122:1037–57.
21. Bagan P, Berna P, De Dominicis F, Das Neves Pereira JC, Mordant P, De La Tour B. Nutritional status and postoperative outcome after pneumonectomy for lung cancer. Ann Thorac Surg. 2013;95: 392–6.
22. Baracos VE, Reiman T, Mourtzakis M, Gioulbasanis I, Antoun S. Body composition in patients with non-small cell lung cancer: a contemporary view of cancer cachexia with the use of computed tomography image analysis. Am J Clin Nutr 2010;91:1133S–7S.