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Systematic Review

Postoperative Cardiovascular Morbidity and Management after Lung Surgery: A Retrospective Study and Literature Review

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Abstract

Background: Lung surgeries are considered as important surgical procedures as they go a long way to improve the quality of life in patients suffering from different lung conditions. Multi-factorial etiopathogenesis is attributed to patients who undergo lung surgery as a method of treatment to improve their lives after being diagnosed with certain critical lung diseases. The aim of this review is to ascertain the quality of life and a cross-sectional review of some of the cardiovascular challenges in patients who received lung surgery as a treatment option. In our practice as thoracic specialists, different procedures are recommended as treatment options in variable clinical presentations of diseases of lungs and their surrounding tissues. Every surgical procedure has its benefits and complications, and what makes a surgical procedure ideal is the availability of alternative management options to resolve any complications after surgery. Ideally, complications are least anticipated although they are highly inevitable. Cardiovascular morbidities are amongst the most common complications after lung surgery. In the present study, 26 patients who had suffered from cardiovascular challenges after lung surgery from December 2019 to January 2020 have been investigated. These complications include disturbances of normal heart rhythm (arrhythmia) in 15 (57.7%) patients, ischemic diseases of the heart like myocardial infarction recorded in four (15.4%) patients, cardiac failure caused by thrombo-embolic disease in two (7.7%) patients, and more than one cardiovascular challenge in five (19.2%) patients. These complications occurred between two weeks to one-month postoperatively after lung surgery.

Keywords: Cardiovascular, Morbidity, Critical Lung Diseases, Complications, Lung Surgery

Introduction

Postoperative cardiovascular complications after lung surgery to date persist as a big challenge in quick clinical diagnosis and management, thereby raising the toll in morbidity and mortality. These challenges hike the cost in providing quality and standardized clinical care to patients, whence assessing the risk levels in these patients on admission and/or preoperatively, intraoperatively, and postoperatively would reduce the number of casualties and also provide a better management approach to the encountered cases. Lung surgery improves the function of lungs and quality of life in selected groups of patients with advanced pulmonary problems.[1] For instance, the main derivative of Lung Volume Reduction Surgery (LVRS) in individuals suffering from severe emphysema and its complications is to improve lung performance (function) and quality of life by way of decreasing dyspnea or respiratory distress. In an instance of carefully selected group patients with severe emphysema, hyperinflation or respiratory distress, surgery can be performed as a safe and effective treatment in specialized high-volume medical facilities.[2,3] The management of Chronic Obstructive Pulmonary Disease (COPD) may be of slower progression but cannot reverse damage to lung parenchyma. In addition to medical therapy, surgery improves lung function and quality of life.[4] The National Emphysema Treatment Trial (NETT) analyses the results of the two surgical groups of over 500 patients who had significant improvement of lung

function and respiratory rate , walking distance, quality of life and to a larger extent improvement in chances of survival after surgery.[4] By resection of the most destroyed areas, hyperinflation of the lung can be reduced and in combination with reshaping of the diaphragm lung function will improve.[5] Nowadays, in specialized centres, Video Assisted-Thoracoscopic (VATS) approach has become a gold standard for thoracic cases.[6] In NETT's documented, about 91% of the patients were without intraoperative complications but about 60% encountered one or multiple postoperative complications. A total of about 20% had major cardiovascular problems.[7] Cardiovascular problems including arrhythmias, myocardial infarction and pulmonary emboli are documented after lung surgery in comparison with other thoracic interventions.[8,9]

Objectives

Attention should be heeded when selecting patients in a multidisciplinary manner in a high-volume medical center to ensure successful outcomes. Intra-lung deficits such as air leaks postoperatively and pneumonia together with some disturbing cardiovascular problems among many others are the most common after lung surgeries. An important score in evaluating individual ricks in patients undergoing lung surgery is the Glenfield BFG score. The score was introduced to the LVRS in March 2013. Between the period of March 2013 and July 2015, an extra group of 71 patients underwent LVRS at Glenfield Hospital, Leicester- United Kingdom. This second cohort, which had a 90 mortality of 1.4% (1); 56% (39) were put in the low-risk category, 40% (28) in the moderate-risk category and 4% (3) in the high-risk category. Glenfield score remained a very important predictor of time to morbidity (hazard of a ratio 18.8, 95% CI 3.0 -118.1, p = 0.002). At 90 days the Glenfield score had an under receiver operator characteristic curve (AUROC) of 0.84. Kaplan–Meier's survival rate of patients was up to 1 year after lung surgery. Survival is demonstrated based on the Glenfield BFG group's findings. Low risk, score 0–1; moderate risk, score 2–3; high risk, and score 4–5.[10] The thoracic revised cardiac risk index (ThRCRI) for predicting the risk of major cardiovascular complications after lung surgery by Brunelli et al. also plays a very important role in the risk assessment of patients during the preoperative phase to differentiate patients needing further cardiologic testing from those who can proceed without any further cardiovascular testing. The index acts as a specific tool for cardiac risk evaluation before surgery. The validation was done in an external population comprising of candidates having undergone major lung surgeries or resections to evaluate cardiac risk stratification across the different survey groups.[52] A total of 2,621 patients were surveyed. 2431cases of lobectomy, 190 cases of pneumonectomy all in a single centre conducted from 2000 to 2009. Four classes of risk (A, B, C, and D) were made according to the ThRCRI. Different results were obtained which quantified the occurrence or probability of major cardiac complications including; cardiac arrest, complete heart block, acute myocardial infarction, pulmonary oedema, and cardiac death during admission. The probability of major cardiac events was assessed in the four risk categories which portrayed a discriminative potential of the index score. The majority of cardiac morbidity was 2.2% comprising of 59 cases. The four classical risk templates were according to their recalibrations in the ThRCRI. The incidence of high cardiovascular morbidity risks groups represented by A, B, C, and D were 0.9%, 4.2%, 8%, and 18%, sequentially with the coefficient of p less than 0.0001.[53]

Methods and materials

For carrying out this study, the following electronic databases from January 2000 and beyond to January 2020 were accessed: Medline/Pub med, Scopus-Elsevier, Science Direct, Excerpta Medica Database (EMBASE), Web of Science, Google Scholar, World Health Organization Library Database (WHOLIS), and Cochrane. Specialists and resourced experts in the field of the present study were contacted for scientific ideologies and briefing. There were no barriers to language or publication status. Our search was extensive (not limited to the last ten years frame as it corresponds to the period of recurrence within a decade). We used the following terms in our search: postoperative cardiovascular morbidity and management after lung surgery, postoperative complications and management after lung surgery, postoperative cardiovascular complications and management after non-cardiac surgery.

Study design

All study designs were eligible for inclusion provided they were on Postoperative morbidity and management after lung surgery.

Study participants

Owing to the wide range of functions that fall under the umbrella term "Postoperative morbidity" this study was based on postoperative cardiovascular morbidity and management after lung surgery. In our study, 26 patients were also reviewed who suffered from cardiovascular challenges after lung surgery from December 2019 to January 2020. The study was non gender bias and did not give preference to age groups taking into consideration comorbidities and genetic predispositions which could influence the outcome. These complications included disturbances of normal heart rhythm (arrhythmia) in 15 (57.7%) patients, ischemic diseases of the heart like myocardial infarction in four (15.4%) patients, cardiac failure caused by thrombo-embolic disease in two (7.7%) patients, and more than one cardiovascular challenge in five (19.2%) patients (Figure 1).

Types of postoperative morbidities and management

We included postoperative cardiovascular complications, if the description was adequate for us to establish that they were postoperative cardiovascular complications and management after lung surgery. In instances where details were unclear or required further findings, we contacted the study authors, whenever possible for more information.

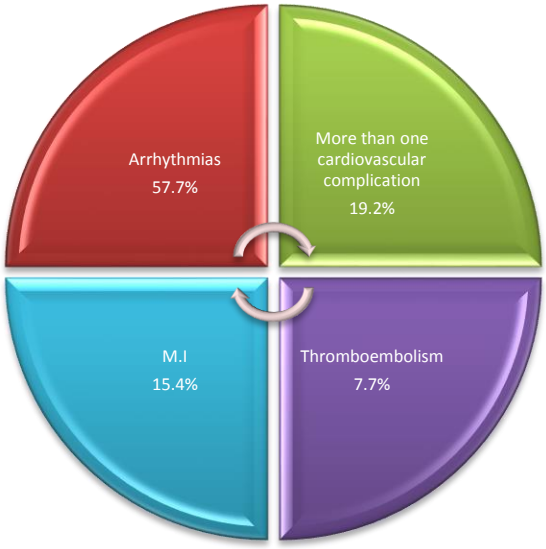

Figure1. Cardiovascular morbidity chart

Results

Any of the following predicted results were anticipated:

1. Specific localization of the cardiovascular complication.
2. Clinical types of the cardiovascular complications.
3. Types of surgical manipulations.
4. The role of the treatment/management strategies of various complications and their efficacy.

A retro-analysis between the BFG score of 71 patients and 2621 patients in the ThRcRi revealed that the latter group had a large domain with the coefficient of risk (P) being greater than 0.0001, and the p value in the BFG (p = 0.002). It could however be recalled that both groups had almost the same accuracy in evaluating the risks in the study groups. Seventy one in a hundred makes 7.1 units. 2621 < 0.0001, 71= 0.002: 71/10=7.1 units in a hundred and the inverse would show the true value of p in both surveys, i.e. 7.1=2621x where is x the true value of p. Hence, x = 7.1/2621, where x = 0.002 + 0.001. According to both studies, the risk groups of patients with cardiac morbidity after lung surgery were put into four classes; A (low risk) of 18% and 56%, B (Moderate risk) of 8% and 40%, C (high risk) of 4% and 4.2%, and D (Mortality) of 0.9% and 1.4% (Figure 2). An extremely important tool in determining the outcomes of surgical procedures is the Charlson Comorbidity Index (CCI). The CCI

predicted the chances of survival for patients undergoing surgery for a ten-year period taking into consideration the individual count per comorbidity according to age. The CCI was the principal index guide for both the BFG and ThRcRi for categorizing patients into four risk groups.[52]

Data extraction and management

Critical appraisal of all identified citations was done independently to establish the possible relevance of the articles for inclusion in the review. Studies were reviewed for relevance based on types of participants, interventions (management), and outcome measures. Total sampling of full literature of relevance to our study was done extensively and full texts of the articles identified as guide material were obtained by the authors. Where appropriate, the authors of studies were contacted for further information and data were reported in a narrative manner.

Assessment of quality in the studies

Studies were not scored for quality purposes but for academic value.

Current status of knowledge

Our searches retrieved over 150 studies, of which 76 were included in this review. Study characteristics including Randomised Controlled Trials (RCTs) and cohorts met the inclusion criteria.[61,41,64,70,71,73,74]

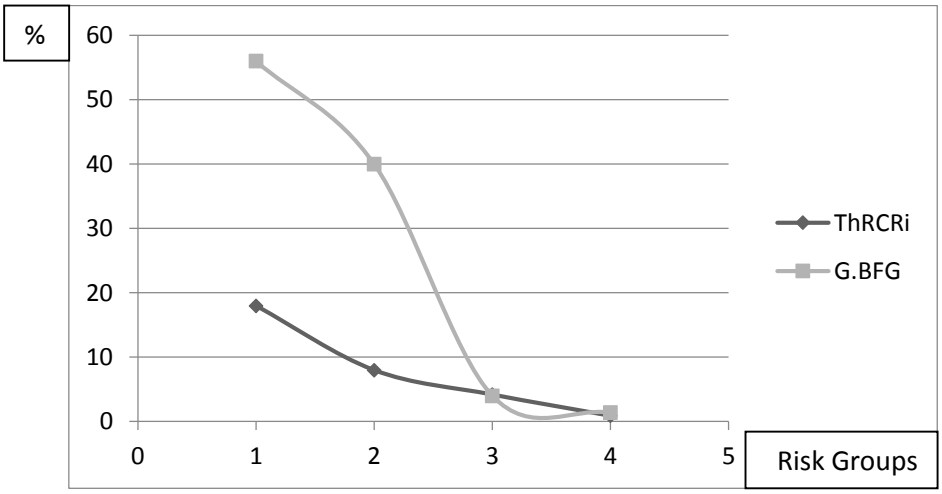

Figure 2. Correlation between survival after lung surgery and risk of cardiovascular morbidity

Discussion

Cardiovascular problems including arrhythmias, Myocardial Infarction (MI) and Pulmonary Emboli (PE) are reported after lung surgery in comparison to other thoracic interventions. Arrhythmia is considered as the most frequent amongst the complications after lung surgery. Within the NETT, around 22% of patients developed postoperative arrhythmia requiring further medical therapy [4], against 57.7% in the clinical review. Myocardial infarction and pulmonary embolus were reported within 1% - 15.4% and 0.8%- 7.7% respectively.[2]

Myocardial infarction and cardiac arrest

The MI, cardiac arrest, and other ischemic abnormalities are less common than heart rhythm disturbances after lung surgeries. MI is a leading cause of death and to an extent the high cost after non-cardiac surgery; this has prompted intensive research to develop strategies of identifying before-surgery persons at risk of adverse cardiovascular manifestations.[11,12] Acute progression of coronary disease in the months before surgery cannot be excluded, but this seems unlikely because of patient's stable clinical course. Rapid expansion of coronary stenosis results from plaque expansion, clot formation, and an inflammatory repair process after surgery.[13,14] Very likely to occur are incidence of plaque rupture and thrombosis of an insignificant genesis. This can only be observed in nonsurgical cases with acute coronary thrombosis and in autopsy of surgical patients with perioperative myocardial infarction.[13,15,16] These findings underscore the limitations of current diagnostic methods in identifying lipid-laden coronary plaques vulnerable to rupture and thrombosis, regardless of the severity of obstruction.[13,15]

Table 1. Arrhythmias and pharmacological remedy groups

Arrhythmia	Pharmacological agents (Drugs)	Heart Rate (beats/min)	Ventricular Activity
Sinus tachycardia	Cyclic adenosine monophosphate (cAMP, cyclic AMP, or 3',5'-cyclic adenosine monophosphate)	100–180	Normal QRS; regular RR
Bradycardia or A-V block	Competitive antagonist (atropine) of the muscarinic acetylcholine receptor types M1, M2, M3, M4 and M5	< 50	delayed QRS; regular RR
A-V nodal re-entry, and angina	Adenosine + Diltiazem (calcium channel blocker)	140–220	Normal QRS; regular RR
Ectopic atrial tachycardia	Esmolol(cardioselective beta-1 receptor blocker)	120–220	Normal QRS; regular RR
Junctional tachycardia	Lopressor (metoprolol), a beta-1 selective receptor blocker	80–150	Normal QRS; regular RR
Atrial flutter	Lanoxin (digoxin), cardiac glycosides	260–320	Normal QRS; regular RR
Atrial fibrillation	Dronedarone or Corvert (Ibutilide), Class III antiarrhythmic agent for acute cardioconversion	100-175	Normal QRS; irregularly irregular RR
Multifocal atrial tachycardia	Verapamil or metoprolol (calcium channel or beta-1 receptor blocker)	110–170	Normal QRS; regular RR

Coronary vasospasm is a pathological condition that plays a role in acute plaque rupture leading to death, and spontaneous vasoconstriction or vasospasm resulting from inadvertent cardiovascular traction at the time of surgery could possibly elaborate on the development of the acute coronary syndrome in our patient.[17,18] Nonetheless, despite our understanding of the relationship between perioperative myocardial ischemia and infarction, there is little information regarding the management of intraoperative myocardial infarction.[11,19] Primary angioplasty is the treatment of choice for acute myocardial infarction when thrombolytic therapy is contraindicated, such as immediately after surgery.[20,21] This treatment option in patients will reduce the volume of infarction, as shown by the small elevation in troponin I concentrations, the absence of neo ECG Q waves, and preserved left ventricular function which is necessary longevity. Issues relating to the complexities after a lung surgery needs consideration in managing patient's coronary diseases in their acute stages.[22,23] There is the possible risk of postoperative mechanical ventilation if the patient's lung function had been only slightly improved after therapy and is a candidate for continuing an elective procedure after the initial procedure even though myocardial ischemia had been documented. There is the necessity for urgent communication and coordination among the anaesthesiologist, surgeon, and cardiologist when an acute coronary event is suspected intraoperatively and postoperatively.[54] The basic principles of therapeutic management of individuals undergoing lung surgery requires special monitoring and care after the procedure, especially in regulating airway pressures to avoid lung air leaks when unexpected postoperative mechanical ventilation is paramount.[33,44,46,49]

Disturbances of normal heart rhythm (Arrhythmia)

Cardiac-arrhythmia is the most common among the post-operative challenges, but atrial arrhythmias seem to be rare after lung surgery. Fluid overload in the postoperative period, tissue hypoxia and atelectasis can cause atrial arrhythmias. Adequate postoperative fluid management as well as electrolytes and also preventing fluid overload by use of diuretics can help in reducing the occurrence of postoperative cardiac-arrhythmias. Similarly, in normal and asymptomatic individuals, temporary adjustment of blood thinners (anticoagulation) treatment is indicated as a precautionary measure.

Should patients exhibit signs of electrolyte lost, pharmacological agents such as anti-arrhythmic agents are used or cardioversion is recommended with electrolyte infusion therapy. Postoperative stress also predisposes patients to development of different forms of arrhythmias. Recurrent physiological problems including rheologic hypoxemia, diffused hypercarbia in circulation apparatuses, myocardial perfusion deficit (ischemia), endogenous or exogenous catecholamines, electrolyte or acid-base imbalances, and drug effects, as well as mechanical factors, such as instrumentation.[24,34,45,50,55,69] Atrial fibrillation after lung surgery is the best-studied postoperative arrhythmia. Proposed mechanisms for postoperative atrial fibrillation include acute atrial distention or stretch, atrial inflammation from surgical trauma or pericarditis, and electrolyte and volume shifts during bypass that can alter atrial repolarization.[25,40] Notice should be taken that; however, the development of arrhythmias as known as arrhythmogenesis may be multifactorial; an arrhythmia associated to a single predisposing factor may simplify a complex case. An example is hypokalemia which predisposes a patient to the development of perioperative ventricular arrhythmias. Catecholamine release, however, increases cellular potassium uptake and thus, decreases serum potassium levels.[26,62,65,67] In this context, it may not be clear whether a given arrhythmia is related to hypokalemia, is catecholamine-mediated with hypokalemia as an epiphenomenon, or results from a combination of both factors. Besides their complexity, it is clear that identification and finding solutions for the correction of potential predisposing factors are essential for the prevention and management of postoperative cardiac-arrhythmias. The severity of these disturbances is time bound, combined with assessment of cardiac function, and often determines what therapy is instituted. Self-terminating arrhythmias or those that are managed without specific pharmacological agents, in the case of a transient stress and without overt cardiac morbidity, usually do not require therapy at all. Also, the development of a transient, hemodynamically important cardiac-arrhythmias in a patient are likely to remain if the stress persists for some time (Table 1).[2,27,68]

Cardiac failure caused by thrombo-embolic disease

As a preventive measure against thrombo-embolic disease which is a potential cause of cardiac failure, prophylactic blood thinners (anticoagulants) with unfractionated heparin are recommended postoperatively. As reported by Geerts et al., obesity, age over 40 years, medical history of previous thromboembolism, varices and estrogen use are important risk factors for venous thromboembolism.[28] The main aim of prevention against clot formation is to reduce the high prevalence of Venous Thromboembolism (VTE) among hospitalized patients, the clinically silent nature of the disease in the majority of patients, and the incidence of the disease, including cost, and the likelihood of mortality associated with unprevented thrombi when can lead to thromboembolism. Both Deep Vein Thrombosis (DVT) and Pulmonary Embolism (PE) produce few specific symptoms, and the clinical diagnosis is unreliable. Since the first manifestation of the disease may be fatal PE, it is inappropriate to wait for symptoms and then rely on the diagnosis and treatment of established VTE. Unrecognized and untreated DVT may also lead to long-term morbidity from the postphlebitic syndrome and may predispose patients to future episodes of recurrent VTE.[29,30] An alternative to prophylaxis would be the use of serial surveillance tests such as duplex ultrasonography in high-risk patients.[31,32] This approach is expensive and can be applied only to limited numbers of patients at risk. In addition, non-invasive screening tests, such as impedance plethysmography or duplex ultrasonography, have only moderate sensitivity and positive predictive value when used in asymptomatic, high-risk patients such as those undergoing major lung surgeries. Routine screening has also not been demonstrated to reduce the frequency of clinically important outcomes, such as symptomatic VTE or fatal PE. Broad application of effective methods of prophylaxis has been more cost-effective and is probably safer than selective, intensive surveillance.[42,60,63] We recommend a therapeutic dose of anticoagulants for the duration of about three to six months following surgery. Oral forms of anticoagulants can either be established with a vitamin-K antagonists or substitutes of oral factor-Xa-inhibitors such as rivaroxaban. Close monitoring and dose adjustments are necessary in order to obtain therapeutic anticoagulation, but anticoagulation medications can be recommended for use after lung surgery in case of the indication of any risk of thrombosis.[2,35,38]

Postoperative quality of life (QoL) assessment after lung surgery

Postoperative cardiovascular challenges are amongst the most frequent nuisance after lung surgery which makes it very difficult for immediate QoL assessment postoperatively, not until these problems are resolved. Actually, QoL assessment within the first two weeks to one month after lung surgery up-to-date remains a greater challenge. However, Patient Reported Outcome Measures (PROMs) three months after lung surgery showed significant improvement in over 80% of patients who received lung surgery as a treatment option.[22,23] Notwithstanding the positive results obtained after lung surgery, NETT also demonstrated that comorbidities, genetic predisposing factors and age (liability) play a greater role in the outcome after surgery and depending on the gravity these challenges the outcome after surgery could be favourable or unfavourable.[4]

Conclusion

Results of this review confirmed that candidates for lung surgeries are recommended based on specialists' advice and the clinics of the cases presented together with the individual's examination protocols. In several clinical preambles, the presented cases also had other comorbid conditions. A well-coordinated team of thoracic surgeons, anaesthesiologists and pulmonologists with expertise is of utmost importance in the management of patients after lung surgeries.[35,38,41,43,47] The key to successful and result oriented outcomes depends on adequate evaluation of potential candidates, proper methods of patient selection, and optimization of patients' pharmacologic and non-pharmacologic clinical therapies at the period of rehabilitation. Also, before the surgery commences, adequate attention to surgical techniques and anaesthesia during the perioperative period, and early extubation and mobilization with adequate pain control after surgery should be considered. Lung surgery can improve the quality of life;[23] this had been shown in the results of 150 consecutive bilateral lung volume reduction procedures in patients with severe emphysema in clinical trial by Cooper et al. which presented low postoperative mortality and acceptable morbidity. Preoperative preparation, vigilant surgical techniques and anticipation of potential postoperative morbidity is mandatory for successful outcomes before, during and after the postoperative phase (s) of lung surgery.[59,66,72,75]

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Authors' Contributions

SN supervised the process of data collection and monitored the works of the other authors. AV read through the information gathered for final approval. AS participated in the literature search. FK prepared the initial manuscript and participated in the literature search. All authors have read and approved the final version of the manuscript.

Conflict of Interest

The authors declare that they have no competing interests. In addition, this study did not attract any financial obligations or liabilities.

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Availability of data and materials

The data used and/or analysed during the current study are available from the corresponding author on reasonable request.

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