CHAPTER 3

THORACIC SURGERY IN RESPIRATORY FAILURE

Mehmet Akif ÖZGÜL [1]
Efsun Gonca UĞUR CHOUSEIN [2]

Respiratory failure is a syndrome that arises when gas exchange is disrupted secondary to pulmonary or extrapulmonary conditions that lead to dysfunction of one or more components of the respiratory system which comprises the thoracic wall (including the pleura and diaphragm), airways, alveoli, pulmonary circulation, and nervous system(1).

Respiratory failure is categorized into 2 main types.

Type 1- Hypoxemic respiratory failure

Type 2- Hypercapnic respiratory failure

Hypoxemic respiratory failure is characterized by a PaO2 lower than 60 mmHg. Pathophysiologic mechanisms include shunt, decreased FiO2 of inspired air, ventilation-perfusion mismatch, alveolar hypoventilation and diffusion abnormalities(1).

Hypercarbic respiratory failure is characterized by a PaCO2 higher than 45 mmHg. Underlying mechanisms involve pathologic conditions affecting the central and peripheral nervous system, muscles of respiration, upper airways, thoracic wall and pleura(1).

Respiratory failure can be acute or chronic. The patient's history, physical examination and blood gases help to distinguish between them(1).

The distinction between acute and chronic respiratory failure is relevant to postoperative morbidity and mortality. Acute respiratory failure has been found to carry an increased risk of mortality compared to chronic respiratory failure(2,3).

Therefore patients should first be treated for acute respiratory failure until becoming stable, and later reevaluated for non emergent surgeries.

Underlying diseases in patients with chronic respiratory failure, such as COPD, asthma, restrictive lung diseases and sleep apnea, should be under optimal control with long term oxygen therapy and, if needed, noninvasive mechanical ventilation(4).

PREOPERATIVE ASSESSMENT IN RESPIRATORY FAILURE:

The goal of preoperative assessment is to determine the risks of intra- and postoperative complications and to mitigate them.

Chronic respiratory failure can be secondary to many conditions, COPD being the most common. Even patients with severe COPD can tolerate noncoronary thoracic surgery well. Provided that they receive a good preoperative assessment and appropriate precautions are taken, the risk of postoperative pulmonary complications can be

[1] MD, University of Health Sciences Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital, Department of Pulmonology aozgul1970@hotmail.com
[2] MD, University of Health Sciences Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital, Department of Pulmonology efsungoncachousein@yahoo.com

CONCLUSION:

While respiratory failure is considered to bring about a high risk for any surgery, it is of particular importance in thoracic surgery as a cause of increased morbidity and mortality.

In recent years, in parallel with the extension of human lifespan, the number of patients with respiratory failure needing surgery is steadily increasing. During the same time period, we are witnessing increasing diversity of available bronchodilator treatments, improving invasive and noninvasive mechanical ventilation techniques, increased awareness of the effectiveness of pulmonary rehabilitation and the development of new minimally invasive surgery procedures and different anesthesia techniques are being developed.

Before declaring patients with respiratory failure as " inoperable", they should be given a chance to be reevaluated for operability by a center experienced in managing those patients.

REFERENCES:

1. Sneha Prasad, Suzanne O'Neil. Respiratory failure. Surgery. 2018;36(12): 688-693
2. Budweiser S et al. Predictors of survival in COPD patients with chronic hypercapnic respiratory failure receiving noninvasive home ventilation. Chest, 2007; 131:1650–8.
3. Stephan Budweiser,Rudolf A Jörres, Michael Pfeifer. Treatment of respiratory failure in COPD Int J Chron Obstruct Pulmon Dis. 2008; 3(4): 605–618.
4. David Sanchez-Lorente,Ricard Navarro-Ripoll,Rudith Guzman,Jorge Moises,Elena Gimeno,Marc Boada, Laureano Molins. Prehabilitation in thoracic surgery. J Thorac Dis. 2018; 10 (22): 2593-2600
5. Kroenke K, Lawrence VA, Theroux JF, Tuley MR. Operative risk in patients with severe obstructive pulmonary disease. Arch Intern Med 1992; 152: 967-71.
6. Calverley PM. Respiratory failure in chronic obstructive pulmonary disease. Eur Respir J Suppl. 2003. 47:26-30.
7. Matsumoto N, Tsubouchi H ,Imazu Y, Arimura Y, Yanagi S, Iiboshi H, Nakazato M. Clinical application of ghrelin for chronic respiratory failure. Endocr J. 2017; 64:1-3.
8. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global Strategy fort he Diagnosis, Management and, Prevention of Chronic Obstructive Lung Disease; 2019
9. Bapoje SR, Whitaker JF, Schulz T, Chu ES, Albert RK. Preoperative evaluation of the patient with pulmonary disease. Chest. 2007;132(5):1637–1645.
10. Iyoda A, Satoh Y, Kyobu Geka. Thoracic surgery for patients with bronchial asthma. 2012 Jul;65(8):701-5.
11. Eduardo Oliveira Fernandes, Cassiano Teixeira, Luis Carlos Correa da Silva. Thoracic surgery: risk factors for postoperative complications of lung resection. Rev Assoc Med Bras 2011; 57(3):292-298
12. Jensen JH, Steffensen BF, Brendstrup T, Petersen AK. Identification of preoperative risk factors for postoperative pulmonary complications after thoracic and abdominal surgery. Gen surg. 2018;1(1):13-18.
13. Delay JM, Jaber S. Respiratory preparation before surgery in patients with chronic respiratory failure. Presse Med. 2012 ;41(3-1):225-33.
14. Lawrence VA, Dhanda R, Hilsenbeck SG, Page CP. Risk of pulmonary complications after elective abdominal surgery. Chest 1996; 110: 744-50
15. British Thoracic Society, Society of Cardiothoracic Surgeons of Great Britain and Ireland Working Party. BTS guidelines: gui¬delines on the selection of patients with lung cancer for sur¬gery. Thorax 2001; 56:89.
16. Turkish Thoracic Society Preoperative Risk Assessment Consensus Report; 2014:21-33
17. Alessandro Brunelli, Majed Refai, Michele Salati, Francesco Xiumé, Armando Sabbatini, Predicted Versus Observed FEV1 and DLCO After Major Lung Resection: A Prospective Evaluation at Different Postoperative Periods. Ann Thorac Surg 2007; 83: 1134–1139
18. Licker M, Schnyder JM, Frey JG, Diaper J, Cartier V, Inan C, Robert J, Bridevaux PO, Tschopp JM. Impact of aerobic exercise capacity and procedure-related factors in lung cancer surgery. Eur Respir J. 2011; 37(5):1189-98
19. Risk Stratification in Lung Resection. Michele Salati, Alessandro Brunelli. Curr Surg Rep. 2016; 4(11): 37.
20. Michele Salati, Alessandro Brunelli. Risk Stratification in Lung Resection. Curr Surg Rep. 2016; 4(11): 37.
21. Canet J, Sabaté S, Mazo V, Gallart L, de Abreu MG, Belda J, Langeron O, Hoeft A, Pelosi P, PERISCOPE group. Development and validation of a score to predict postoperative respiratory failure in a multicentre European cohort: A prospective, observational study. Eur J Anaesthesiol. 2015 Jul; 32(7):458-70.
22. Anand Lakshminarasimhachar, Gerald W. Smetana. Preoperative Evaluation, Estimation of Pulmonary Risk. Anesth. Clin.2016. 34(1): 71-88
23. Chailleux E, Fauroux B, Binet F, et al. Predictors of survival in patients receiving domiciliary oxygen therapy or mechanical ventilation. A 10-year analysis of ANTADIR Observatory. Chest.1996; 109: 741–749.
24. Costello R, Deegan P, Fitzpatrick M, et al.Reversible hypercapnia in chronic obstructive pulmonary disease: a distinct pattern of respiratory failure with a favorable prognosis. Am J Med. 1997; 102: 239–244.
25. Daisuke F. Nonaka, Katherine P. Grichnik, George B. Whitener. Pulmonary Hypertension and Thoracic Surgery: Diagnostics and Advances in Therapy and Intraoperative Management. Current Anesthesiology Reports. 2014; 4(2): 135-141.
26. Claudio Caviezel, Carlson Aruldas, Daniel Franzen, Silvia Ulrich, Ilhan Inci, Didier Schneiter, Walter Wed-

er,Isabelle Opitz. Lung volume reduction surgery in selected patients with emphysema and pulmonary hypertension. European Journal of Cardio-Thoracic Surgery, 2018; 54(3): 565–571

27. Guangyuan Liao, Rongchang Chen, Jianxing He. Prophylactic use of noninvasive positive pressure ventilation in post-thoracic surgery patients: A prospective randomized control study. J Thorac Dis. 2010; 2(4): 205–209.
28. K Bauchmuller, AJ Glossop. Non-invasive ventilation in the perioperative period. BJA Education(2016) , 16 (9): 299–304
29. L. Cabrini, L. Nobile, V. P. Plumari, G. Landoni, G. Borghi, M. Mucchetti and A. Zangrillo. Intraoperative prophylactic and therapeutic non-invasive ventilation: a systematic review. British Journal of Anaesthesia 2014; 112 (4): 638–47.
30. Francisco Javier Algar, Antonio Alvarez, Angel Salvatierra, Carlos Baamonde, Jose´ Luis Aranda, Francisco Javier Lo´pez-Pujol. Predicting pulmonary complications after pneumonectomy for lung cancer. European Journal of Cardio-thoracic Surgery 2003; 23: 201–208.
31. Silver, Michael R. Nutritional Support in Patients with Respiratory Failure. Clinical Pulmonary Medicine. 1(6):375-382.
32. Yaron Shargall, Virginia R. Litle. European perspectives in Thoracic Surgery, the ESTS venous thromboembolism (VTE) working group. J Thorac Dis. 2018; 10(8): 963–968.
33. Victor Kim, Nishant Goel, Jinal Gangar, Huaqing Zhao, David E. Ciccolella,Edwin K. Silverman, James D. Crapo, Gerard J. Criner, High-Risk-COPD Screening Study Group. Risk Factors for Venous Thromboembolism in Chronic Obstructive Pulmonary Disease. Chronic Obstr Pulm Dis. 2014; 1(2): 239–249.
34. The key questions in rehabilitation in thoracic surgery Kajan Mahendran1 , Babu Naidu. J Thorac Dis 2018;10(8):924-930.
35. Attila Vagvolgyi, Zsolt Rozgonyi,Maria Kerti,Paul Vadasz,Janos Varga. Effectiveness of perioperative pulmonary rehabilitation in thoracic surgery. J Thorac Dis. 2017; 9(6): 1584–1591.
36. Diaz-Fuentes et al. Perioperative Evaluation of Patients with Pulmonary Conditions Undergoing Non-Cardiothoracic Surgery. Health Services Insights 2016; 9(1): 9-23.
37. Atsushi Shiozaki, Hitoshi Fujiwara, Hiroko Okamura, Yasutoshi Murayama, Shuhei Komatsu, Yoshiaki Kuriu, Hisashi Ikoma, Masayoshi Nakanishi, Daisuke Ichikawa, Kazuma Okamoto, Toshiya Ochiai, Yukihito Kokuba, Eigo Otsuji. Risk factors for postoperative respiratory complications following esophageal cancer resection. Oncol Lett. 2012 Apr 1; 3(4): 907–912.
38. Anjum Naveed, Hammad Azam, Humayoun Ghulam Murtaza, Rana Altaf Ahmad, Mirza Ahmad Raza Baig. Incidence and risk factors of Pulmonary Complications after Cardiopulmonary bypass. Pak J Med Sci. 2017; 33(4): 993–996
39. Yang CK, Teng A, Lee DY, Rose K. Pulmonary complications after major abdominal surgery: National Surgical Quality Improvement Program analysis. J Surg Res. 2015; 198(2):441-9.
40. Xinghua Cheng, Mark W. Onaitis, Thomas A. D'amico, Haiquan Chen. Minimally Invasive Thoracic Surgery, Lessons Learned From the History of Lung Cancer Surgery. Ann Surg 2018; 267:37–38
41. Eugenio Pompeo, Benedetto Cristino ,Paola Rogliani, Mario Dauri,and for the Awake Thoracic Surgery Research Group (ATSRG). Urgent awake thoracoscopic treatment of retained haemothorax associated with respiratory failure. Ann Transl Med. 2015; 3(8): 112.
42. Khadige M, Salleron J, Marchesi V, Oldrini G, Peiffert D, Beckendorf V. Cyberknife stereotactic radiation therapy for stage I lung cancer and pulmonary metastases: evaluation of local control at 24 months. J Thorac Dis. 2018; 10(8): 4976–4984.
43. Ferguson MK. Preoperative assessment of pulmonary risk. Chest 1999; 155:58-63.
44. Abdurahim Aloud, Gilbert Berdine, and Kenneth Nugent. Single lung ventilation in patients undergoing lobectomy. J Thorac Dis. 2018; 10(12): 6383–6387.
45. Ranjana Khetarpal, Kusum Bali, Veena Chatrath, Divya Bansal. Anesthetic considerations in the patients of chronic obstructive pulmonary disease undergoing laparoscopic surgeries. Anesth Essays Res. 2016; 10(1): 7–12.
46. Choong CK, Meyers BF, Battafarano RJ, Guthrie TJ, Davis GE, Patterson GA, Cooper JD. Lung cancer resection combined with lung volume reduction in patients with severe emphysema. J Thorac Cardiovasc Surg. 2004;127(5):1323-1331.
47. Choong CK, Mahesh B, Patterson GA, Cooper JD.Concomitant lung cancer resection and lung volume reduction surgery. Thorac Surg Clin. 2009;19(2):209-16.
48. Mutlu B. Preoperative Risk Assessment in COPD. Umut S, Erdinç E (eds). Chronic Obstructive Pulmonary Disease: From definition to treatment. Thorax Books, 2006:287-307
49. Michael S. Mulligan,Kathleen S. Berfield, Ryan V. Abbaszadeh. Management of Postoperative Respiratory Failure. Thoracic surgery clinics. 2015.25(4): 429-433.
50. Radmilo J. Jankovic, Biljana Stošic. Management of intraoperative hypoxemia during thoracic surgery Conference: Cursul National de Ghiduri si Protocoale in Anestezie, Terapie Intensiva si Medicina de Urgenta, editia a X- At: Timisoara, Romania
51. Tran DT, Badner NH, Nicolaou G, Sischek W.Arte rial pCO2 changes during thoracoscopic surgery with CO2 insufflation and one lung ventilation. HSR Proc Intensive Care Cardiovasc Anesth. 2010;2(3):191-197.
52. Saleem A, Syed W, Bhat A, Ghulam Nabi L, Ashraf Z, Naqshi H, Ganie F, Kawoosa N. Changes in Blood Gases and Hemodynamic Parameters in Patients Undergoing Lung Resection Surgery and Its Clinical Implications. J Cardiothorac Med. 2019; 7(1): 406-412.
53. Werner O, Malmkvist G, Beckman A, Stahle S, Nordström L. Gas exchange and haemodynamics during thoracotomy. Br J Anaesth. 1984 Dec;56(12):1343-9.
54. Cesar Bonome Eva FieiraHumberto Aymerich Ricardo Fernandez Maria Delgado Lucia MendezMercedes de

la Torre. Non-intubated video-assisted thoracoscopic lung resections: the future of thoracic surgery? European Journal of Cardio-Thoracic Surgery 2016; 49(3): 721–731.
55. Ary Serpa Neto et al. Association between driving pressure and development of postoperative pulmonary complications in patients undergoing mechanical ventilation for general anaesthesia: a meta-analysis of individual patient data. Lancet. 2016.4(4): 272-280
56. Vijay Saraswat. Effects of anaesthesia techniques and drugs on pulmonary function. Indian J Anaesth. 2015 Sep; 59(9): 557–564.
57. Saikat Sengupta. Post-operative pulmonary complications after thoracotomy. Indian J Anaesth. 2015 Sep; 59(9): 618–626.
58. Management of Postoperative Respiratory Failure. Michael S. Mulligan,Kathleen S. Berfield, Ryan V. Abbaszadeh, Thoracic surgery clinics. 2015.25(4): 429-433.
59. Liana Pinheiro, Ilka Lopes Santoro, Sonia Maria Faresin. Who Needs to Be Allocated in ICU after Thoracic Surgery? An Observational Study. Can Respir J. 2016; 2016: 3981506.
60. Sven Riviere Julien Monconduit Véronique Zarka Patrice MassabieStéphane Boulet Philippe Dartevelle François Stéphan. Failure of noninvasive ventilation after lung surgery: a comprehensive analysis of incidence and possible risk factors . European Journal of Cardio-Thoracic Surgery. 2011; 39(5):769–776.
61. Anand Iyer, Sumit Yadav. Principles and Practice of Cardiothoracic Surgery. Chapter 3; Postoperative Care and Complications After Thoracic Surgery. 2013; 57-84.
62. Tanya Castelino, Julio FioreJr., PetruNiculiseanu, Tara Landry MLIS, BersonAugustinBSc, Liane S.Feldman. The effect of early mobilization protocols on postoperative outcomes following abdominal and thoracic surgery: A systematic review. Surgery.2016.159 (4): 991-1003.
63. Cagini L, Capozzi R, Tassi V, Savignani C, Quintaliani G, Reboldi G, Puma F. Fluid and electrolyte balance after major thoracic surgery by bioimpedance and endocrine evaluation. Eur J Cardiothorac Surg. 2011;40(2):71-76.
64. Hajime Saito, Kazutoshi Hatakeyama , Hayato Konno , Toshiki Matsunaga, Yoichi Shimada ,Yoshihiro Minamiya. Impact of pulmonary rehabilitation on postoperative complications in patients with lung cancer and chronic obstructive pulmonary Disease. Thoracic Cancer. 2017 8(5): 451-460
65. Luciano Cardinale,Adriano Massimiliano Priola,Sandro Massimo Priola,Francesco Boccuzzi,Najada Dervishi,Elena Lisi,Andrea Veltri,Francesco Ardissone. Radiological contribution to the diagnosis of early postoperative complications after lung resection for primary tumor: a revisional study. J Thorac Dis. 2016; 8(8): 643–652.
66. Eun A. Kim, Kyung Soo Lee, Young Mog Shim, Jhingook Kim, Kwanmien Kim, Tae Sung Kim, Po Song Yang, Radiographic and CT Findings in Complications Following Pulmonary Resection. RadioGraphics 2002; 22:67– 86.