Review Article

Smoking and pulmonary complications: respiratory prehabilitation

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Abstract: The severity of the clinical condition and co-morbidities of the patients for esophagectomy require a complex assessment and risk stratification before the operation, and most of the cases need complex management. We did a literature search and considered the data on risk stratification and complex management of patients who undergo thoracic surgery. Smoking cessation programs can protect against complications, which is related to the respiratory system, the heart and the convalescence of the wounds in postoperative condition, but the timing is critical due to the operation. A complex team of physicians and healthcare professionals, as well as respiratory prehabilitation, can help to improve the clinical condition, chest kinematics, lung mechanics, peripheral and respiratory muscle function, metabolism and quality of life of this type of patients. We need to consider a complex risk stratification before esophagectomy and require complex management for these patients, including smoking cessation and respiratory prehabilitation, to improve the post-operative complications.

Keywords: Esophagectomy; risk stratification; smoking cessation; respiratory prehabilitation

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Introduction

The importance of perioperative management is highlighted because esophageal cancer is the ninth most commonly diagnosed and the sixth most common cause of cancer-related neoplasms with a high perioperative risk of death (1). The best treatment option for these patients is esophagectomy as a curative approach; however, this procedure with radical lymphadenectomy is known as one of the most invasive digestive operations (1,2).

The field of esophagectomy has become more sophisticated nowadays, and more focus is needed for the intra- and postoperative care of the patients (3). Perioperative care for esophagectomy needs complex management of the patients because of the severity of the disease and the co-morbidities (3). We need to focus on functional and quality of life variables, which may help maximize surgery safety and improve the post-surgical period (3). There is still a debate in the preoperative risk stratification in thoracic surgery, including esophagectomy (4-6).

Smoking can increase the development of complications of the respiratory and cardiovascular systems and delay the convalescence of the wounds in perioperative condition. Recent evidence underlines that these risks may be mitigated by cessation of smoking in the perioperative period (from the operation to 30 days after) (7).

Respiratory prehabilitation may have a positive effect on the cardiovascular system, metabolism, muscles, and lung mechanics. It lasts 2–3 weeks before surgery. The program contains respiratory training, learning controlled breathing techniques, chest mobilization, endurance training for the upper and lower extremities and cessation of smoking (5,6).

Smoking

Among adults, the 28% of the European population who smoke and use tobacco was previously largely made up of the male population, but the gap in prevalence between male and female adults is now smaller (<5%) in Northern European countries and the United Kingdom (8). In Asia, 76% of the male population smokes in Indonesia, which is the top smoking population all over the world (9). Nearly

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half a million smoking-related deaths can be detected in every year, and physicians, health care professionals and psychologists have a crucial role to play in reducing it in the US (10). Smoking cessation programs need to focus more on general and perioperative conditions as well. Current policies can facilitate a period of mandatory abstinence from cigarettes before surgery, which can be achieved by different interventions. The primary care provider can play an important role in this (10).

What factors can support the hypothesis that cessation of smoking can reduce the risks of perioperative complications?

Some misconceptions exists that when smoking is terminated just before thoracic surgery there is no harmful effect and that does not increase the risk of postoperative respiratory complications (11). However one study reported an increased incidence of respiratory complications when the patients stop smoking in a period less than 8 weeks before the operation (12). There is another question about the significant difference in the reduction of respiratory complications as a border of stopping smoking at eight weeks, which is widely cited in anesthesiological and surgical textbooks. Otherwise, there is data about the absence of increment of cardiac and pulmonary postoperative complications if the quitting is within four weeks to elective surgery (13). There are data about the favourable effect in terms of the pulmonary complications of quitting if it is out of the 4-week time window versus patients continuing the smoking, and there is more advantage with a longer (more than eight weeks) period before surgery (13). There are also data about the effectiveness of quitting within 3–4 weeks of operation related to the reduction of impairment with the convalescence of the scaring compared to smokers who failed to quit until the operation. We need to underline the absence of the increment of the adverse events of the operation if the quitting is done within 3–4 weeks of the operation (13).

Is there a difference between cessation of smoking for the general population and in perioperative interventions?

The prevalence of smoking has decreased based on public health campaigns; otherwise, a significant proportion of the population still smokes. If all surgical patients can include in a perioperative quitting programme, this could result in a substantial reduction in the hazard of postoperative adverse events, which can cause a substantial reduction in healthcare costs. Based on the short-term perioperative period, the anesthesiologists may have a significant opportunity to make health impact because tobacco use is one of the most important causes of preventable diseases and death. It provides a useful key for the hand in anesthesiologists as perioperative physicians. Smoking has a huge impact on cardiopulmonary diseases and cancer (14). Based on our experience, the quitting rate can be much higher (70–75%) in perioperative condition (5,6).

Cessation of smoking had an additional 7% favourable effect at 3–6 weeks based on a systematic review of perioperative smoking cessation interventions (15). A smoker group was randomized to a perioperative nicotine supplementation and had a better long-term (12 months) result in terms of no smoking after the operation (16). In a clinical study, a complex smoking cessation was achieved through by varenicline and counselling within 1–3 weeks before the operation, which resulted in improvement in the short- and long-term (12 months) periods of no smoking (17-21). At the end of the long-term period, among the tobacco users with the complex smoking cessation, most of the patients did not smoke for one year. There was a significant reduction in smoking (from daily 17.8 to 7.2) ($P<0.05$), one year after the operation (22). The reduction of addictive tobacco habits can lead to a better outcome in the next smoking cessation. Some other methods of smoking cessation, including assessment and advice, nicotine supplementation or referral to a quitting line 3 weeks before the operation, have better results in terms of not smoking at one year (23).

What needs to be done?

There is need for education of health care professionals and young physicians to promote smoking cessation before the operation in the in-patient management (24). There is strong evidence about the usefulness of the smoking cessation program given the reduction of smoking-related complications, and stopping tobacco usage needs to be a part of preoperative rehabilitation (24). Smoking cessation training should be included in the education of medical students and prevention guidelines (19).

Adverse events around surgery and complications of smoking

Smoking can contribute to the three most important adverse events such as respiratory, cardiovascular and wound-related (25). Smoking can cause postoperative complications, such as pneumonia and sputum retention. Complications may develop even on those patients who had no lung disease. Contributing factors to complications include sputum retention with an abnormal response of cilium and respiratory immunity (4,25).

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Risk stratification of thoracic surgery

Preoperative physiologic assessment is to be recommended for risk stratification. The European Respiratory Society and the European Society of Thoracic Surgeons made a common agreement for risk stratification based on FEV_1, DLCO and VO2/kg measured by cardiopulmonary exercise test (CPET). FEV_1 can be measured by spirometry and DLco and needs to be measured as well if the patient has COPD or different types of pulmonary fibrosis (4,26). If FEV_1 or DL_{CO} <80% predicted, we need to perform the CPET because of reduction in respiratory reserve. Respiratory reserve after surgery can also be evaluated by lung scintigraphy or a check of removal segment's area (4). CPET is a valuable method for cardiopulmonary reserve; VO2/kg is a key element for risk stratification. There is a higher risk of complication after surgery if VO_2/kk <15 mL/kg/min (4,26). VO_{2max}/kg less than 10 mL/kg/min means a functional condition, which is not fit for the surgery. We can also use other measurements for the evaluation of tolerability of the operation based on different types of walking tests. Controversy exertional desaturation does not have a strong relationship with a higher rate of complication after surgery (4).

Elder age (>70 years) is not a contraindication factor, so there is no contraindication to thoracic surgery because of an age limit (26). Reduction and low rate of mortality and morbidity are related to complex perioperative management (5,6), which is needed for the first 30 postoperative days (6,26).

Charlson comorbidity index (CCI) can be related to postoperative complications and death (27). This composite score is based on age and different co-morbidities, like diabetes mellitus, malignant diseases, AIDS, moderate to severe kidney disease, chronic heart failure, myocardial infarction, COPD, peripheral vascular disease, stroke or TIA, dementia, hemiplegia, connective tissue disease and peptic ulcer (27).

We found 72.5% discriminative value between severe postoperative complication and kilometres by cycle, FEV_1 and 6MWD at the start of the rehabilitation before surgery gender and expansion of the operation based on risk stratification in our perioperative rehabilitation program (6).

Intervention by the perioperative multidisciplinary support team (PMST)

The PMST can consist of surgeons, anesthesiologists, psychiatrists, dentists, dental hygienists, pharmacists, nutritionists, physical therapists, the speech therapists, and nurses of surgery outpatient department, ICU and operating theatre (28). Physical and mental evaluation may be needed for the patient who is a candidate for esophagectomy. Each specialist can support the management of the patients as a member of the team. Patients can get information from educational material by every ward in the process of surgery (28).

Respiratory prehabilitation

Pulmonary rehabilitation can be a part of the multidisciplinary, complex perioperative management of the patients, which can optimize the functional condition and reduce the post-surgical complications. A specialist in pulmonary rehabilitation, pulmonologist, thoracic surgeon, anesthesiologist, general practitioner, physiotherapist, psychologist, dietician, and social worker are working together to achieve a better quality of life and functional parameters for the patients (5,6). We need to underline the relationship between the functional condition of the patient and the severity of post-operative complications, which can be an individual process in every case. There is a favourable effect if we determine the group of patients who have a chance of severe complications and provide a respiratory prehabilitation programme. We are focusing on lung mechanics, pathophysiology of the muscles involving respiration and movement, metabolism, and cardiovascular response in the prehabilitation program (5,6).

Prehabilitation program consists of different activities such as chest physiotherapy, controlled breathing techniques and different types of exercises, including respiratory training, cycling and treadmill. The training duration can be 10–25 minutes two or three times a day. The exercise intensity can be adjusted in different ways. We can use the result of the maximal CPET test to adjust the intensity of the training from 60% to 80%, using the adjustment of the maximal predicted heart rate or the patient BORG scoring (dyspnoea and leg fatigue) (5,6). We need to consider the severity of the COPD, the anatomical and functional condition of the heart and additional diseases, oxygen saturation and exacerbation rate to give an adequate intensity and modality of the training (5,6).

In chest physiotherapy we need to focus on the reduction of chest hyperinflation and expectoration. The patient can learn controlled breathing and stretching techniques and spine mobilization (5,6). We can use different devices in chest physiotherapy to improve the strength and endurance of the respiratory muscles.

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Different intensities of continuous or interval training can be chosen, and sometimes we can use the sinusoidal training, which is the most effective training modality nowadays (29,30). Patients with poor clinical condition, severe desaturation during exercise and pulmonary circulatory impairment are referred to the interval training group. The workload can change between one minute 100% and one-minute rest, or 50% and 100% or 50% and 90% in interval training (28). In sinusoidal training, the workload changes from 80% to 120% measured by CPET as a sinusoidal wave (30). The 120% of workload can be achievable at a shorter period because the ventilation has a time delay and the absolute limiting factor is the ventilation (30).

There is an option to follow a lot of functional and quality of life parameters, such as measurement of lung volumes, exercise capacity, chest kinematics, peripheral, and respiratory maximal muscle strength and voluntary time to stop the breathing. Quality of life and dyspnoea can be evaluated by CAT, mMRC, and BODE-index; an Alternative Scale and exercise physiology parameters can be determined (maximal workload, oxygen uptake, carbon dioxide output, ventilation, oxygen saturation, ventilatory equivalent for O2 and CO2, heart rate response) (31-47).

In summary, we can conclude that we need complex management for those patients who are a candidate for esophagectomy. We need to consider smoking cessation program, chest physiotherapy, exercise training and co-operation with a dietitian, psychologist and social worker. Teamwork is required including thoracic surgeon, pulmonologist, cardiologist, intensive care specialist and general practitioner to achieve the best functional condition and the less postoperative complication in the complex management of esophagectomy.

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Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

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