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Clinical application of respiratory training and research progress

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Abstract: *Respiratory training has the role of regulating autonomic nerve function, improving lung ventilation, and slowing down the nervous anxiety state caused by stress. It has been applied in the therapeutic intervention of some psychosomatic diseases and the self-regulation of people's work and learning. Respiratory training has a positive effect on patient rehabilitation, and this paper briefly reviews the current application of respiratory training.*

Keywords: *Respiratory training; Preoperative; Postoperative; Psychological*

1. Introduction

In recent years,it has been discovered that respiratory training is not only essential in rehabilitating circulatory and respiratory disorders but also plays a significant role in addressing systemic diseases like spinal and orthopedic conditions,thoracic and abdominal organ diseases,and psychosomatic disorders[1, 2]. In recent years, it has been found that it also plays an important role in other systemic diseases, such as spondylolisthesis, post-surgical recovery of thoracic and abdominal organ diseases, psychiatric disorders, and post-delivery functional recovery of women after childbirth[3, 4] etc.The clinical benefits of respiratory training have been validated in improving respiratory muscle function,preventing respiratory muscle atrophy,alleviating dyspnea symptoms,enhancing endurance,reducing psychological stress,preventing complications,and improving overall prognosis.In this paper,we outline the current application status of home and international respiratory training.

2. Respiratory training in heart failure

Heart failure is a complex clinical syndrome resulting from multiple causes of abnormal structural or functional changes in the heart that cause diastolic or systolic dysfunction of the ventricles,and consequent[5].Heart failure is a complex clinical syndrome caused by a variety of structural or functional changes in the heart.Heart failure patients commonly experience inadequate blood flow to organs and tissues,along with stagnant pulmonary and/or body circulation caused by reduced ventricular systolic function,impaired ejection function,and insufficient cardiac output to meet metabolic demands[6].Consequently,this results in dyspnea and reduced exercise capacity.

Respiratory training can not only effectively exercise the patient's myocardium and diaphragm,alleviate the phenomenon of muscle vasodilatation dysfunction,and prevent ventricular remodeling,but also reduce sympathetic tension,increase the patient's ability to change air,avoid heart rate abnormalities,and promote the return to normal of the left ventricular ejection fraction(LVEF),left ventricular end-diastolic internal diameter(LVDD),and left ventricular end-systolic internal diameter(LVSD). Zhang Yi[7]et al. studied 104 patients with heart failure by comparing respiratory training with conventional treatment. LVEF, 6 min walking distance (6MWD), and post-walking oxygen saturation (SpO2) were increased, and LVDD and LVSD were decreased in the experimental group compared with the control group. Lin Sihong[8] et al. studied 92 patients with heart failure by comparing respiratory training with conventional treatment.Exercise endurance indexes 6-minute walking distance,forceful lung capacity(FVC),resting heart rate and maximum voluntary minute ventilation were significantly improved in the experimental group compared with the control group.The cardiac function indexes serum N-terminal-B brain-type natriuretic peptide precursor(NT-proBNP)and left ventricular ejection fraction(LVEF)improved significantly compared with the control group. All of the above findings indicate that respiratory training plays a significant role in the rehabilitation of heart failure patients.

ISSN 2618-1584 Vol. 6, Issue 6: 54-61, DOI: 10.25236/FMSR.2024.060608

3. Respiratory training in the respiratory system

3.1 Application in Chronic Obstructive Pulmonary Disease (COPD)

Chronic obstructive pulmonary disease(COPD)is a progressive disease characterized by airflow limitation[9].COPD is a progressive disease characterized by airflow limitation. Dyspnea occurs after activity or exertion, and as the disease worsens, dyspnea can also occur in a calm state. In addition, patients may experience wheezing, chest tightness, lethargy, persistent muscle weakness, abdominal distension, anxiety, and insomnia. Studies have shown that respiratory training in patients with COPD can effectively slow the progression of the disease and reduce lung injury[10] . On the one hand, respiratory training can improve the tolerance of respiratory muscles and promote sputum expulsion; on the other hand, it can help to establish and improve the respiratory mode for patients, change the respiratory incoordination, increase the body tidal volume and lung ventilation, improve lung function, and then enhance the physical fitness and immunity.Moreover,respiratory training can enhance intercostal muscle mass and muscle fiber quality,leading to effective exercise of the respiratory muscle groups,subsequently enhancing lung function and ultimately improving patient prognosis.

In a study comparing 27 COPD patients,Wang Qingfeng [11]found that the experimental group showed significant improvements in measures such as VC,FVC,FEV1,PEF,and respiratory rate compared to the control group.Zhan Zhao[12] and colleagues conducted a similar study with 100 patients,where the experimental group demonstrated significant improvements in mMRC score,FEV1,FVC,and GQOL-74 scores,indicating better outcomes compared to the control group.The findings presented above indicate that respiratory training is a crucial component of COPD rehabilitation.

3.2 Application in pleural effusion

Pleural effusion can cause a relative decrease in the effective volume of respiration, hindering pulmonary ventilation and air exchange[13]; A large amount of pleural effusion will not only force the patient to give up effective deep breathing, reduce the amplitude of respiratory muscles and thoracic movement, and decrease lung compliance; it will also lead to incomplete removal of secretions from the lungs, resulting in complications such as lung infections and pulmonary atelectasis, and even lead to complications such as arrhythmia and cardiorespiratory insufficiency[14].Hence,reducing the incidence of respiratory complications and enhancing lung function are crucial aspects of extending the lifespan and enhancing the quality of life for pleural effusion patients,with respiratory training serving as an effective form of rehabilitative treatment.

On the one hand, respiratory training can improve lung and thoracic compliance, effectively exercise respiratory muscles, and reduce pulmonary ventilation resistance; on the other hand, respiratory training can increase abdominal breathing and diaphragmatic movement, so that the alveoli are fully expanded, increase gas exchange, delay expiration, increase endotracheal pressure, prevent premature closure of the small airways, and effectively eliminate the residual gases; in addition, respiratory training can improve the function of the mucous membrane of the airway and reduce the secretion discharge, and reduce the incidence of pulmonary infections. In addition, respiratory training can improve the function of airway mucosa, reduce the discharge of secretions, and lower the incidence of lung infection. Huang Guojin [15]et al.Performed a comparative analysis involving 50 patients who underwent lung cancer surgery and had pleural effusion.The study revealed that the lung function parameters of patients in the experimental group were superior to those in the control group,while the drainage rate,duration,and incidence of complications(such as cardiac arrhythmia and pneumothorax)were lower in the experimental group compared to the control group.In summary,the experimental group showed enhanced lung function metrics and decreased drainage volume,duration,and complications(cardiac arrhythmia and pneumothorax)when contrasted with the control group[16].By conducting a comparison and analysis of 60 patients with tuberculous pyothorax,it was observed that there were significant improvements in the FVC,FEV1,PEF,MVV,and TLC indexes in the experimental group in comparison to the control group[17]. The above shows that respiratory training has a significant role in the rehabilitation of pleural effusion.

4. Application in the preoperative period

Preoperative respiratory training can exercise the respiratory muscle muscle strength,improve the

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lung contraction and diastolic function,so as to enhance the tidal volume of the lungs,improve lung capacity,ventilation,and then improve the cardiopulmonary function of patients with preoperative combined high-risk factors;preoperative respiratory training can effectively discharge sputum,prevent lung infection caused by the retention of internal secretions;preoperative respiratory training can also enhance the lung diffusion function and oxygen exchange capacity,improve the lung hypoxia,improve lung function,and improve blood gas index;preoperative respiratory training can increase patients'exercise endurance,surgical endurance,and reduce symptoms of dyspnea and fatigue. Preoperative respiratory training can also enhance the diffusion function and oxygen exchange capacity of the lungs, improve the hypoxia state of the lungs, improve lung function and blood gas indexes; preoperative respiratory training can increase the patient's exercise endurance and surgical endurance, and reduce the symptoms of respiratory distress and fatigue.

Zhao Haihong[18] and colleagues conducted a study comparing 237 patients,revealing that patients in the experimental group who received respiratory training before surgery showed superior outcomes in various respiratory parameters compared to the control group at the end of the experiment.These parameters included first-second expiratory volume with exertion,expiratory lung capacity, FEV1% predicted value, FEV1/FVC ratio,peak expiratory flow,PEF%predicted value, SaO2, PaO2, and PaCO2. Ou Hongmei[19] in a comparative study of 50 patients, the experimental group received preoperative respiratory training, which showed that preoperative respiratory training not only helped to improve the strength of the respiratory muscle contraction, increase the effective ventilation of the lungs, and facilitate the clearance of bronchial secretions, but also improved the pulmonary function and surgical tolerance, which helped the patients to recover from surgery and be discharged from the hospital as soon as possible. Deng Jiao[20] et al. conducted a comparative study of 88 patients, and the results confirmed that the patients in the experimental group who underwent preoperative respiratory training had shorter operation time, postoperative extubation time, postoperative hospitalization time than those in the control group, less postoperative drainage, less borg scale scores, 6-minute walk test (MWD) distances, and less rate of blood oxygen drop after walking in the 6-minute walk test (6MWT) following the operation, as well as fewer postoperative complications.

The above studies show that preoperative respiratory training not only improves respiratory function and oxygen saturation, but also enhances surgical efficacy, shortens the recovery process, and improves motor function.

5. Respiratory training in the postoperative period

5.1 Application in postoperative spondylolisthesis

Rib fractures lead to decreased stability of the chest wall, unable to support the normal shape of the thorax[21] ,the patient's respiratory function is severely affected, and even threatens the patient's life[22] .The patient's respiratory function is seriously affected, and may even threaten the patient's life. Respiratory training can not only reduce pain[23] .It can keep the airway open, facilitate sputum expulsion, and promote lung reopening.Training for the respiratory system can aid in enhancing respiratory function,facilitating gas exchange in the patient's body,and lowering the occurrence of pulmonary complications.Additionally,it plays a crucial role in promoting patients'recovery[24].A comparative study conducted by Wang Yunhua on 100 patients with rib fractures undergoing thoracic external fixation found that the experimental group had better outcomes in terms of visual analog scale(VAS)score, exertional expiratory volume in the first second(FEV1),maximal ventilation(MMV), and exertional lung capacity(FVC),as well as a lower incidence of complications such as pulmonary atelectasis, pulmonary infections,and deep venous thrombosis of the lower extremities(DVT)compared to the control group[25].The findings were in line with those from Li Shirley's[26]research.

Early symptoms of scoliosis are not obvious, the main manifestation is that the patient's spine bends to one side when standing, and the trunk is asymmetrical.If not actively controlled,scoliosis will lead to a decrease in thoracic volume and changes in bone structure,increasing pulmonary resistance and decreasing ventilation,and in severe cases,affecting respiratory function,resulting in dyspnea and other symptoms[27].In severe cases,it affects respiratory function,causing symptoms such as dyspnea;

Respiratory training can increase the patient's chest volume, increase alveolar ventilation and improve lung capacity, reduce pulmonary resistance and thus improve the respiratory status;Respiratory training can also engage and strengthen the thoracic respiratory muscles,enhance their function,boost thoracic compliance,improve mobility in the patient's diaphragm and intercostal muscles,thereby

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lowering the risk of pulmonary atelectasis. at the same time, respiratory training can remove respiratory secretions and keep the respiratory tract smooth[28]. Respiratory training can also exercise the chest respiratory muscles, improve the function of chest respiratory muscles, increase thoracic compliance, increase the mobility of diaphragm and intercostal muscles of patients, and thus reduce the incidence of pulmonary atelectasis. Wu Huiling[29] et al. conducted a comparative study on 80 cases of scoliosis patients, and the results showed that the experimental group's post-intervention lung volume (VC), lung capacity (TLC), forceful lung capacity (FVC), maximum ventilation volume (MVV), heart rate, diastolic blood pressure and systolic blood pressure were better than those of the control group;the experimental group's post-intervention Hamilton depression scale(HAMD)[30]score,Hamilton anxiety scale(HAMA)[31]score,and Hamilton anxiety scale(HAMA)score were better than the control group;The post-intervention scores on the Hamilton Depression Scale(HAMD)and Hamilton Anxiety Scale(HAMA)were lower in the experimental group compared to the control group, as well as the complication rates. Wang Liancheng[32] et al.compared 44 scoliosis patients before and after treatment and found that the Cobb angle and vertebral rotation angle(ATR)significantly improved,the Nash-Moe vertebral rotation degree significantly decreased,and the Oswestry Dysfunction Index(ODI)score significantly decreased after treatment.

In addition, J. Ding[33] et al.Patients with lumbar disc herniation who underwent laminectomy and utilized respiratory training showed significant improvement in lumbar spine function and quality of life.Jingjuan Wang[34]clinical observation of the use of respiratory training after cervical spine surgery,can well restore the patient's respiratory function,and coughing,coughing sputum and shortness of breath symptoms than before respiratory training significantly improved. Gao Li[35] et al. observed that the use of respiratory training after hip arthroplasty for elderly femoral neck fracture can reduce the probability of lung infection and promote the recovery of hip joint function.It can be found that respiratory training plays an important role in the postoperative recovery of spondylolisthesis.Regular respiratory training can effectively restore patients' lung function,enhance surgical prognosis,and prevent postoperative complications.

5.2 Application in postoperative thoracic and abdominal organs

Currently,there are meta-analyses conducted in foreign countries indicating that respiratory training can lower the likelihood of pulmonary complications in patients undergoing cardiac,pulmonary,and abdominal surgeries[36]. Cardiac and pulmonary surgery can cause certain trauma to patients,resulting in traumatic edema of the chest wall and intercostal nerve injury. This,in turn,impacts the compliance of the thorax and lungs. and postoperative wound pain, pleural irritation and pleural-lung adhesion can lead to pulmonary dysfunction, which affects the recovery of the postoperative period[37] .In abdominal surgery,as a result of the elevation of the diaphragm and the activation of the intercostal nerves through diverse procedures,the compliance of the lungs decreases,resulting in a reduction in the volume of the thoracic cavity. and the high intra-abdominal pressure in the postoperative period causes pressure on the thoracic cavity or the lobes of the lungs, which may lead to a series of lung complications[38]. This may cause a series of pulmonary complications and gastrointestinal disorders.Respiratory training can reduce the incidence of postoperative complications,allow patients to maintain good respiratory function and duration,improve the ventilation of the lungs,and promote gas exchange within the body,thus helping patients to rebuild their respiratory function,so that they can maintain a deep and slow respiratory rhythm,so that more gases can be inhaled into the lungs,maintain the ventilation level within the alveoli,and promote the respiratory cycle of the patients to enhance the ventilation and further reduce the risk of postoperative complications. This will promote the patient's respiratory circulation and enhance ventilation, which will further reduce the risk of postoperative complications.

Ning Yuan[39] et al.After conducting a comparative study on 86 patients who underwent cardiac major vascular surgery,the findings revealed that the experimental group of patients who received respiratory training displayed superior heart rate,respiratory rate,oxygen saturation,arterial partial pressure of oxygen,maximum ventilation,and 6-minute walking distance compared to the control group.Additionally,the experimental group had lower rates of lung infection,incision infection,and abdominal distension when compared to the control group. Zhou Dan[40] et al.Liu Cui[41] et al.conducted a comparative study on 113 patients who had undergone radical surgery for lung cancer.The findings revealed that postoperative respiratory training led to better results in key respiratory indicators such as respiratory rate,oxygen saturation,partial pressure of blood oxygen,maximum ventilation,exertional lung capacity,and maximum inspiratory capacity among the experimental group compared to the control group.After conducting a comparative analysis of 146 patients following right hemihepatectomy,the research outcomes revealed that individuals within the

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experimental group,who received respiratory training,exhibited remarkable enhancements in the oxygenation index and FEV1%when contrasted with those in the control group.Additionally,a decrease in the severity of dyspnea(measured using the Borg Rating Scale)and occurrences of postoperative pleural effusion,pulmonary atelectasis,and lung infections were noted in comparison to the control group.It can be noted that respiratory training significantly contributes to the recovery process following common thoracic and abdominal surgeries.Consistent respiratory training effectively restores lung function in patients,enhances surgical outcomes,and decreases the occurrence of postoperative complications[42] .

6. Application to maternal labor and delivery and its impact on the fetus.

6.1 Application in labor and delivery

Labor and delivery is a normal physiological process, the whole process of which is a persistent and intense stress for the mother. Labor pain can cause maternal nervousness, anxiety and depression[43] .The pain of labor can cause maternal mental tension, anxiety and depression, which in turn leads to weakened uterine contractions, prolonged labor, uncoordinated contraction weakness, slow cervical dilatation and fetal prelabor descent, and even stagnation of the labor process[44]. The first step is to train your body to breathe. Respiratory training can not only eliminate maternal tension and increase the body's oxygen content, promote fetal growth, but also increase abdominal strength, improve the contraction force during labor and reduce labor pain[45] .

Respiratory training has the effect of stabilizing mood and sedation. Applying respiratory training during labor can make the mother's attention shift from contraction pain to breathing regulation, so that the mother can maintain a good psychological state. Thus, it can reduce the contraction abnormalities and its secondary prolongation or stagnation of labor due to psychological factors. In addition, respiratory training itself can relax the muscles around the birth canal, promote the dilatation of the uterine opening, and promote the progress of labor. Xia Mingjing[46] et al. conducted a comparative study of 120 cases of women who were instructed to formally apply respiratory training during labor compared with those who did not use respiratory training.The outcomes indicated that both the initial active stage of labor and the second stage of labor were noticeably reduced in duration within the experimental group. Su Lang[47] a comparative study of 280 cases of primiparous women, who were instructed to apply respiratory training formally during the labor process, with and without respiratory training.The findings indicated that the experimental group exhibited reduced pain scores,shorter durations for the first,second,and third stages of labor as well as the overall labor duration,and had a higher incidence of natural vaginal deliveries.It has been observed that respiratory training is crucial in facilitating natural labor.

6.2 Application to the Fetus

Fetal distress is a condition that arises from oxygen deprivation and acid imbalance in the fetus while in the womb. Fetal distress often progresses to neonatal asphyxia.During labor,blood flow between the uterus and placenta is temporarily decreased during contractions. Normally, it returns to normal after contractions. If the mother is nervous, the partial pressure of oxygen and pH will be reduced, which will lead to prolongation of the second stage of labor; it may also increase the tension of the uterine wall, and the uteroplacental ischemia for a long period of time, which will lead to fetal distress or even intrauterine death. Respiratory training can effectively expand the lungs, constantly change the chest and abdominal pressures[48] which increases blood oxygen level, improves cardiopulmonary function and placental blood perfusion, and is conducive to fetal growth and development[49] .The effect of respiratory training on the course of labor and The effect of respiratory training on the labor process and fetal oxygen supply also reduces the number of cesarean sections due to delayed or obstructed labor and intrauterine distress. Some studies[46] showed that the incidence of intrauterine distress was lower in laboring women who underwent respiratory training. Gao Chunyan[50] et al. studied 180 cases of women who were instructed to use respiratory training during labor and delivery compared with those who did not use respiratory training.The results showed that the experimental group had a higher rate of vaginal delivery,a lower rate of cesarean section,a lower rate of fetal distress,and a rate of neonatal asphyxia of 0.This indicates that respiratory training can have a significant impact on preventing fetal hypoxia and enhancing placental perfusion.

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7. Respiratory training in alleviating negative patient psychology

The modern medical model has gradually shifted to a biopsychosocial medical model, and the psychological state of patients has received more and more attention in disease prevention and treatment. With the prolongation of the course of the disease and the repeated fluctuation of symptoms, patients suffer from different degrees of negative psychological disorders.Negative psychological disorders can restrict both physical and mental activities,diminish quality of life and psychological well-being,erode confidence in treatment,resulting in reduced cooperation during hospitalization,and possibly even suicidal thoughts and behaviors,ultimately hindering patients' recovery.

Respiratory training is an intervention technique of relaxation training, which can relax the whole body, soothe the stress reaction of the organism, and thus stimulate the organism to regulate the function of the nervous system in order to improve the negative emotions; respiratory training can improve the negative psychological state through the modulation of endorphins, monoamines, hypothalamo-pituitary-adrenal axis, and nerve conduction pathway and other pathways.In a comparative study involving 90 patients with chronic obstructive pulmonary disease,Rao Xiaoyan[51] discovered that the quality of life BI index significantly improved in the experimental group who underwent respiratory training.Additionally,the anxiety and depression scores of the participants decreased significantly. Ding Tiying [52] et al. conducted a comparative study of 118 patients with liver MRI dynamic enhancement scans and found that the depression self-assessment scale (SDS), anxiety self-assessment scale (SAS), and negative coping style scores of the patients who underwent respiratory training decreased, and the positive coping style scores increased.Respiratory training has the potential to reduce negative emotions such as anxiety and irritability in patients,promote a positive mindset,boost confidence,enhance clinical adherence,and ultimately elevate patients' quality of life.

8. Summary

Respiratory training has been developed over the years and has been successfully applied to the treatment of many diseases in clinical practice, and has achieved good therapeutic results. respiratory training is an autonomous, controllable and easy-to-learn physical therapy for the chest and abdomen[53]. respiratory training is an autonomous, controlled and easy-to-learn physical therapy for the chest and abdomen. The training process does not require the assistance of drugs, is non-invasive, painless and highly practical.It aslo does not increase the cost of treatment. The patient can improve cardiopulmonary function, alleviate the original disease, and mitigate the complications which the original disease brings anytime. At the same time, the field of its application is still expanding, and it is worthwhile to further study the clinical adaptability and therapeutic value.

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