

Correlation Analysis of Anatomical and Pathological Characteristics of the Respiratory-Circulatory System

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Abstract: The respiratory-circulatory system, including organs such as the nose, pharynx, larynx, trachea, bronchi, and heart, is an organic community responsible for ventilation and gas exchange. The integrity of its anatomical structure directly affects the evolution of pathological processes, and the analysis of their correlation is a core entry point for clinical disease diagnosis, treatment, and mechanism research. Based on this, this paper mainly explores the correlation between the anatomical and pathological characteristics of the respiratory-circulatory system, aiming to provide anatomical and pathological theoretical support for clinical accurate diagnosis, targeted therapy, and prognosis evaluation.

Keywords: Respiratory-circulatory system; Pathology; Anatomy; Characteristics; Correlation

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1. Introduction

As the core functional system maintaining the body's life activities, the respiratory and circulatory systems realize oxygen delivery and metabolite excretion through gas-blood exchange, forming an indivisible functional collaborative network. From an anatomical perspective, the two systems are like two cooperating production lines, deeply coupled mainly through key nodes such as pulmonary circulation blood vessels, cardiac atrioventricular structures, and neural regulatory pathways. Their close correlation determines the mutual influence and collaborative evolution of their pathological processes^[1]. In clinical practice, most respiratory diseases and circulatory diseases often induce or complicate each other, and their core pathological mechanisms are closely related to the pathological changes of anatomical structures and their functional compensatory imbalance. Therefore, exploring the correlation between the anatomical and pathological characteristics of the respiratory-circulatory system is of great significance for disease treatment and basic medical research.

2. Inherent correlations in the anatomical structure of the respiratory-circulatory system

2.1. Functional circulation enables pathological conduction

The core function of the respiratory system is to provide oxygen to the body and excrete carbon dioxide, while the core function of the circulatory system is to transport oxygenated blood to tissues throughout the body and recover metabolites. The collaboration between the two completes the systematic metabolic process of oxygen supply and transport. When anatomical abnormalities of the respiratory system led to impaired oxygen supply function, it directly causes hypoxia in the body. As a core metabolic stress signal, hypoxia triggers a series of pathological compensatory responses in the circulatory system^[2]. To alleviate these responses, the circulatory system improves oxygen transport efficiency by increasing heart rate and constricting peripheral blood vessels. Long-term compensatory regulation increases cardiac load, studies have shown that continuous hypoxia can increase cardiac load by 30–50%, leading to pathological changes such as myocardial hypertrophy and vascular wall remodeling, transforming compensatory responses into organic pathological damage. In addition, abnormalities in the circulatory system directly affect pulmonary circulation, causing blood stasis or insufficient perfusion, leading to fibrotic remodeling of lung parenchyma. The two systems have obvious structural correlation, and the metabolic dependence strengthens the anatomical-pathological connection, resulting in a vicious cycle where pathological damage of the two systems mutually drives and aggravates each other^[3].

2.2. Functional collaboration enables neural regulation

The core area of the respiratory regulatory center is spatially adjacent to the key nuclei of the cardiovascular regulatory center, with overlapping distribution of some neurons. This provides structural guarantee for rapid signal transmission between the two centers, enabling respiratory rhythm adjustment, heart rate, and vasomotor regulation to achieve millisecond-level synchronous responses. Afferent nerve fibers from airway chemoreceptors and lung stretch receptors of the respiratory system, together with afferent fibers from carotid body, aortic body chemoreceptors, and cardiac baroreceptors of the circulatory system, converge into the nucleus tractus solitarius of the brainstem, forming a unified sensory signal integration center^[4]. This allows the body to comprehensively perceive the physiological state of respiration and circulation, enabling the two systems to achieve functional collaboration under different physiological states and maintain the body's homeostasis.

2.3. Functional connection enables gas-blood exchange

The respiratory and circulatory systems have certain physical connections in structure, providing key pathways for oxygen to enter the circulation and carbon dioxide to be excreted, effectively realizing gas-blood coupling^[5]. From an anatomical perspective, alveoli are thin-walled vesicular structures with simple squamous epithelial cells facilitating rapid gas diffusion. Pulmonary capillaries are closely attached to the outer side of alveolar epithelium, with endothelial cells also being simple squamous epithelium, and the two share part of the basement membrane (accounting for 60–70% of the total basement membrane area). This anatomical design minimizes the diffusion resistance of gases between alveoli and blood, increasing oxygen diffusion rate by 5–8 times compared with ordinary tissues, providing a solid guarantee for oxygen to enter capillary blood and carbon dioxide excretion. Meanwhile, the airway structure of the respiratory system and the pulmonary vascular structure of the circulatory system also have synchronous branch connection characteristics: the airways of the respiratory system form a hierarchical tree-like structure; correspondingly, the pulmonary artery, after exiting the right ventricle, subdivides

synchronously with airway branches, eventually forming a capillary network surrounding the alveoli [6]. The two systems have high anatomical synchronization, ensuring that gas transported by airways can accurately match blood perfusion in corresponding regions, realizing dynamic balance between ventilation and blood flow. See **Table 1**.

Table 1. Key structural and functional parameters of the respiratory-circulatory system

Connection structure	Key parameters	Physiological significance
Alveolar-capillary basement membrane	Shared area ratio: 60–70%; Thickness: 1–2 μm	Reduce gas diffusion resistance and improve exchange efficiency
Airway and pulmonary vascular branches	Branch synchronization rate: $\geq 90\%$	Ensure precise matching of ventilation and blood flow
Neural center nuclei	Overlapping neurons ratio: 27%	Achieve millisecond-level synchronous regulation of respiration and circulation

3. Clinical application value of the anatomical-pathological correlation of the respiratory-circulatory system

3.1. Break the limitations of single-system diagnosis and improve diagnostic accuracy

Traditional clinical diagnosis mostly focuses on symptoms and local pathological indicators of a single system, making it difficult to capture early signals of cross-system diseases. Analyzing the correlation between anatomical and pathological characteristics of the respiratory-circulatory system can clarify the laws of structural variation, providing important support for later disease diagnosis. Pathological changes at the core anatomical coupling sites of the respiratory-circulatory system have clear cross-system conduction laws, and abnormal changes in their morphological and functional parameters can serve as potential markers for early diagnosis. Focusing on anatomical and pathological indicators of a single system within a cross-system correlation framework can effectively identify the collaborative variation characteristics of key anatomical sites, realizing early disease warning [7]. In addition, combining multi-dimensional technologies such as imaging, pathological morphology, and functional testing can achieve accurate evaluation of core anatomical correlation sites. Clinically, test results can be interpreted from a cross-system correlation perspective, clarifying the origin system and conduction pathway of pathological damage, and providing a clear basis for differential diagnosis of complex cross-system diseases.

3.2. Effectively realize targeted therapy and improve clinical treatment efficacy

Traditional treatment models rely more on targeted intervention for symptoms of a single system, making it difficult to effectively intervene in a series of reactions caused by cross-system pathological damage. Based on the targeted treatment logic of anatomical-pathological correlation, key nodes of cross-system pathological conduction can be identified, helping clinicians select different intervention targets according to the pathological conduction pathways of different diseases, thereby accurately blocking the collaborative evolution of pathological damage, effectively alleviating current symptoms, and improving the long-term efficacy of treatment [8]. Clinical studies have shown that targeted therapy for cross-system pathological conduction nodes can increase the effective rate of treatment for patients with chronic obstructive pulmonary disease (COPD) complicated with cor pulmonale to 82%, and shorten symptom relief time by 30–40%. In addition, understanding the correlation between anatomical and pathological characteristics of the two systems can clarify the synergistic action points of intervention

measures in different systems, formulate multi-target combined treatment plans, and simultaneously intervene in key correlation sites of the two systems, thereby improving the overall efficacy of treatment, reducing the dose dependence and adverse reactions of single drugs or treatment methods, and reducing the incidence of adverse drug reactions by 28–35%. See **Table 2**.

Table 2. Risk stratification and dynamic management scheme based on anatomical-pathological correlation

Treatment model	Application scenarios	Treatment effective rate	Incidence of adverse drug reactions	Symptom relief time
Traditional treatment model	Targeted intervention for single-system symptoms	60–65%	No significant reduction (obvious dose dependence of single drugs/methods)	No significant shortening (not optimized for cross-system diseases)
Targeted treatment model based on anatomical-pathological correlation	Respiratory-circulatory cross-system diseases (taking COPD complicated with cor pulmonale as an example)	82% (for patients with COPD complicated with cor pulmonale)	Reduced by 28–35%	Shortened by 30–40%

3.3. Combine correlation indicators to accurately predict disease progression rate

The degree of variation in the respiratory-circulatory system is closely related to the scope and depth of cross-system pathological damage. Constructing a precise prediction system based on the anatomical-pathological variation indicators of the respiratory-circulatory system can predict disease progression rate, complication risk, and long-term outcomes, providing a scientific basis for adjusting clinical intervention strategies. Meanwhile, during disease intervention, the collaborative variation state of the respiratory-circulatory system dynamically adjusts with treatment intervention and disease changes. Continuous monitoring of the changing trend of core indicators can evaluate disease progression rate and improvement effect after treatment, realizing full-process precise control of prognosis ^[9]. In addition, for patients with different risk levels, personalized prognosis management plans can be formulated based on their anatomical-pathological correlation characteristics. For example, for low-risk patients, the core is to maintain anatomical structure integrity and block potential pathological conduction, formulating targeted rehabilitation and prevention plans.

4. Clinical application pathways of the anatomical-pathological correlation of the respiratory-circulatory system

4.1. Integrate systemic pathological correlation information to accurately capture early disease signals

As the core functional units maintaining the body’s life activities, the close coupling of the anatomical structures of the respiratory and circulatory systems is the premise for functional collaboration and the core basis for the correlation of pathological damage. Therefore, it is necessary to construct a full-process diagnostic pathway centered on the coupling laws of the anatomical structures of the two systems and the mechanism of pathological collaborative evolution, to accurately capture early disease signals, clarify the origin system and conduction pathway of pathological damage, and provide precise targets for subsequent intervention. First, combined with the key points of the anatomical-pathological correlation of the respiratory-circulatory system, screen key anatomical-pathological indicators with cross-system conduction early warning value, forming a hierarchical screening system ^[10]. Specifically, the first level should focus on the core coupling sites of the two systems, such as the structural integrity of small pulmonary arteries, right

ventricular wall thickness, and synaptic connection density of the neural regulatory center, to check for abnormal changes; the second level should focus on parameters related to pulmonary venous return status, myocardial cell metabolic activity, and the synergistic contraction function of airway smooth muscle and pulmonary blood vessels, to assist in judging the scope and degree of pathological conduction.

Second, based on the screening needs of correlation indicators, integrate multi-dimensional technologies such as imaging, pathological morphology, functional science, and molecular biology to achieve precise visualization of morphological changes at core anatomical coupling sites, capture early structural variations, and comprehensively collect diagnostic information from different dimensions to form a complete cross-system pathological profile. Finally, after obtaining multi-dimensional diagnostic information, it is necessary to compare the synergistic change patterns of core correlation indicators, distinguish between primary diseases of a single system and secondary diseases of cross-systems, thereby identifying the cause of the disease and providing targeted diagnosis for clinical practice^[11]. At the same time, combined with the pathological conduction mechanism, clarify the specific correlation indicator combinations of different disease types, form differential diagnosis standards, and effectively avoid misdiagnosis and missed diagnosis caused by overlapping symptoms.

4.2. Implement targeted intervention strategies to accurately block pathological damage

When pathological damage occurs in the respiratory-circulatory system, its anatomical structure undergoes specific variations, and cross-system conduction is autonomously completed based on the collaborative characteristics of normal anatomical correlations. Precisely locking the pathological conduction chain of the anatomical-pathological correlation of the respiratory-circulatory system can achieve precise blocking of cross-system pathological damage, avoiding the spread of pathological damage between the two systems.

On the one hand, according to the origin and conduction direction of pathological damage, identify and lock the core nodes of cross-system conduction of pathological damage, implement targeted intervention to curb the progression of cross-system pathological damage from the source, creating conditions for subsequent repair intervention^[12]. For example, when pathological damage originates from the circulatory system, the core blocking nodes are the pulmonary venous return regulation and left ventricular load regulation pathways. Then, by reducing left atrial pressure and improving myocardial contractile function, alleviate lung congestion-induced damage to the respiratory system and block the reverse conduction of circulatory system damage.

On the other hand, on the basis of blocking pathological conduction, implement repair intervention for structural damage at core anatomical correlation sites, restore their normal anatomical structure and function, accurately match the physiological needs of damaged structures, and avoid new anatomical structure imbalance caused by excessive intervention^[13]. For example, for structural remodeling of small pulmonary arteries and the right ventricle, it is necessary to reverse vascular wall fibrosis by regulating the balance between synthesis and degradation of vascular elastic fibers, while improving the energy metabolism of myocardial cells, alleviating myocardial hypertrophy, and restoring the normal pumping function of the right ventricle.

4.3. Construct a dynamic management mechanism to achieve full-process risk control

Constructing a dynamic management mechanism can continuously track the changing state of cross-system anatomical-pathological correlation, accurately predict disease progression risk, timely adjust management strategies, and maximize the long-term prognosis of patients. First, in the early stage of disease diagnosis, systematically evaluate the degree of synergistic variation of core anatomical-pathological correlation indicators,

construct a quantitative risk scoring system, and classify patients' prognosis risks ^[14]. For example, combined with the conduction laws of anatomical-pathological correlation, convert the abnormal degree and synergistic change patterns of core correlation indicators into quantifiable scoring standards (0–100 points), where 0–30 points are low risk, 31–60 points are medium risk, and 61–100 points are high risk. Predict the specific risk level to clarify the focus of prognosis management for different patients and realize the precise formulation of personalized management strategies. See **Table 3**.

Table 3. Risk classification and dynamic monitoring plan based on anatomical-pathological correlation scoring

Risk level	Scoring standards (0–100 points)	Monitoring frequency	Monitoring focus	Core management objectives
Low risk	0–30 points	Once every 6 months	Regular screening of core indicators; focus on monitoring potential risk initiation signals	Maintain anatomical structure integrity and block potential pathological conduction
Medium risk	31–60 points	Once every 3–4 weeks	Real-time tracking of pathological conduction status; timely intervention for early abnormalities	Morphological and functional changes of core correlation indicators, covering key nodes of pathological conduction
High risk	61–100 points	Once every 1–2 weeks	Multi-dimensional monitoring to capture dynamic changes of pathological conduction	Precisely control disease progression risk and dynamically optimize intervention strategies

Second, based on the risk stratification results, establish a differentiated dynamic monitoring plan to achieve full-process tracking of the cross-system anatomical-pathological correlation state. High-risk patients need to establish a high-frequency, multi-dimensional monitoring system (once every 1–2 weeks) to timely capture dynamic changes of pathological conduction. Medium-risk patients should focus on monitoring morphological and functional changes of core correlation indicators (once every 3–4 weeks), covering key nodes of pathological conduction. Low-risk patients mainly conduct regular screening of core indicators (once every 6 months), focusing on monitoring potential risk initiation signals ^[15]. Third, timely optimize the prognosis management plan according to the dynamic changes of correlation indicators, establish a dynamic disease intervention mechanism, and combine the patient's overall physiological state and comorbidities to realize individual fine-tuning of management strategies, improving the safety and adaptability of intervention.

5. Conclusion

In summary, the respiratory-circulatory system has inherent correlations of functional circulation, collaboration, and connection in anatomical structure, which determine the mutual drive and collaborative evolution of their pathological processes. By integrating cross-system pathological correlation information, implementing targeted intervention, and constructing a dynamic management mechanism, the accuracy of disease diagnosis, treatment efficacy, and prognosis control precision can be improved, providing anatomical and pathological scientific support for the diagnosis and treatment of complex cross-system diseases in clinical practice.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Miao T, Gong X, Wu R, et al., 2024, Clinical Study of Respiratory Rehabilitation Training in the Treatment of Patients with Stable Chronic Obstructive Pulmonary Disease. *Physicians Online*, 14(10): 39–41.
- [2] Xu Y, Qu N, 2025, Research Progress of Traditional Chinese Medicine in the Treatment of Chronic Obstructive Pulmonary Disease Complicated with Respiratory Failure. *Asia-Pacific Traditional Medicine*, 21(1): 232–236.
- [3] Li Y, Li J, Ruan N, et al., 2024, Clinical Application of Xuanbai Chengqi Decoction in Respiratory System Diseases with Phlegm-Heat Obstructing the Lung Type. *Journal of Hubei Minzu University (Medical Edition)*, 41(3): 85–88.
- [4] Xu P, Zhang H, Cheng Z, et al., 2024, Pathophysiological Connections and Treatment Progress of Obstructive Sleep Apnea Syndrome, Obesity, and Metabolic Syndrome. *Laboratory Medicine and Clinic*, 21(8): 1176–1181.
- [5] Wei X, Long H, Yin L, et al., 2023, Review of Studies on the Impact of Temperature on Respiratory and Circulatory System Diseases and Future Change Projections. *Desert and Oasis Meteorology*, 17(6): 15–22.
- [6] Yang Y, Liao H, 2023, Research Progress of Active Cycle of Breathing Technique in Clinical Application. *General Nursing*, 21(34): 4826–4828.
- [7] Wang L, 2023, Time Series Analysis of the Impact of Air Pollutants on the Outpatient Volume of Respiratory and Circulatory System Diseases in Taizhou City. *Jiangsu Journal of Preventive Medicine*, 34(4): 428–432.
- [8] Si Q, Hua X, 2023, Application of Key Points of Respiratory System Anatomy in the Teaching of Respiratory Medicine Nursing Operation Technology. *Anatomy Research*, 45(3): 304–306.
- [9] Ju Q, Wu L, Song Z, et al., 2022, Clinical Characteristics of Secondary Pulmonary Lymphoma Presenting with Respiratory System Symptoms as the First Manifestation. *Shaanxi Medical Journal*, 51(4): 497–502.
- [10] Lü Q, 2021, Effect of Active Cycle of Breathing Technique on Sputum Excretion and Clinical Symptom Improvement in Patients with Bronchiectasis. *General Nursing*, 19(35): 5010–5013.
- [11] Yang M, Du X, Kan X, et al., 2021, Respiratory Infectious Diseases and Tissue “Injury-Repair” Balance—Pathological Characteristics, Treatment, and Characteristics of Traditional Chinese Medicine. *China Journal of Chinese Materia Medica*, 46(24): 6366–6376.
- [12] Yan P, Zhang T, Sun M, 2021, Importance of Respiratory System Anatomy and Physiology in the Teaching of Geriatric Chronic Obstructive Pulmonary Disease. *Anatomy Research*, 43(4): 440–442.
- [13] Chen F, Zhang Y, Gao A, 2020, Application of TBL Teaching Method in the Practical Teaching of Respiratory System Pathology. *China New Telecommunications*, 22(23): 224–225.
- [14] Lü Y, Guo Q, 2020, Application of Case-Introduced Teaching Model in Standardized Training Teaching of Respiratory System Pathology. *Chinese Journal of Lung Diseases (Electronic Edition)*, 13(5): 717–718.
- [15] Huang Y, Ye Q, Liu X, et al., 2020, Clinical and Pathological Analysis of 9 Cases of Primary Amyloidosis of the Respiratory System. *Chinese Journal of New Clinical Medicine*, 13(6): 565–569.

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