Comparative Analysis of Arterial Stiffness Between Patients with Chronic Obstructive Pulmonary Disease and Healthy People

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Abstract

Background: Analyze and compare the difference in arterial stiffness between patients with chronic obstructive pulmonary disease (COPD) and healthy people.

Methods: A retrospective analysis of 83 patients with COPD who were treated the observation group; 80 healthy people were selected as the control group during the same period. Pearson correlation analysis software was used to analyze the correlation between arterial stiffness and ultrasound index in COPD patients.

Results: The ultrasound RI and PI level of observation group were lower than those of control group and PI level ($t=6.326, 8.321, P=0.000$). Observation group IMT (1.36 ± 0.13) mm, total plaque area (19.75 ± 2.19) cm^2 , plaque number (1.67 ± 0.64) were higher than control group IMT (0.94 ± 0.10) mm, total plaque area (5.84 ± 1.32) cm^2 , number of plaques (0.82 ± 0.30) ($t=4.574, 7.493, 5.093, P=0.000$). The arterial stiffness (1585.49 ± 14.36) cm/s and ABI level (1.63 ± 0.24) of the observation group were higher than the arterial stiffness (1142.45 ± 10.77) cm/s and ABI level (1.12 ± 0.16) of the control group ($t=6.392, 5.109, P=0.000$). Arterial stiffness in COPD patients was negatively correlated with ABI, RI, PI levels ($P<0.05$); positively correlated with IMT, total plaque area, and plaque number ($P<0.05$).

Conclusion The arterial stiffness of COPD patients is higher than that of healthy people; the ultrasound index can be used as an auxiliary indicator for clinical prediction of arterial stiffness, which is helpful to improve the accuracy of prediction and thus better guide clinical intervention in high-risk groups of COPD in time.

Background

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory system disease dominated by continuous airflow limitation. It is caused by exposure to toxic substances. With the development of the disease, COPD can develop into pulmonary heart disease and respiratory failure, accompanied by cardiovascular disease and other extrapulmonary diseases, which seriously threaten the life safety of patients [1, 2]. It is predicted that COPD will become the third leading cause of death in the world in 2020. The occurrence and development of this disease are closely related to abnormal inflammation caused by harmful substances and cardiovascular disease [3, 4]. The occurrence of COPD can lead to the decrease of vascular endothelial function, the increase of carotid intima-media thickness, the formation of atherosclerotic plaque and the increase of arterial stiffness, thus increasing the incidence of cardiovascular events [5]. Arterial stiffness is an independent risk factor for evaluating and predicting cardiovascular events. Early evaluation of arterial stiffness in patients with COPD is of great significance for the treatment and prognosis of the disease. Pulse wave velocity can reflect the patient's arterial stiffness and predict the occurrence and development of cardiovascular events. It is a classic index to reflect arterial stiffness in clinical practice, but its accuracy is easily affected by the pathological state of patients, resulting in reduced prediction accuracy [6, 7]. It is particularly important to find indicators related

to arterial stiffness as auxiliary predictors of clinical COPD to improve the accuracy of disease prediction. Ultrasound is a commonly used clinical method for measuring arterial stiffness, but there are few reports on other ultrasound indexes and arterial stiffness. Based on this, this article compares and analyzes the arterial stiffness of patients with COPD and healthy people, and further analyzes the ultrasound index. The correlation with arterial stiffness aims to provide a reference for clinically better predicting the occurrence and development of COPD.

1. Data And Methods

1.1 General Data

83 patients with COPD hospitalized in our hospital from August 2017 to August 2019 were retrospectively analyzed and set as the observation group. Inclusive criteria: ① meet the clinical diagnostic criteria of COPD in *The Guidelines for Diagnosis and Treatment of Chronic Pulmonary Obstructive Pulmonary Diseases* [8]; ② with long cough and progressive dyspnea; ③ with obvious history of exposure to toxic smoke or dust; ④ complete ultrasound examination and arterial stiffness test, and be able to cooperate with experimental research. Exclusion criteria: ① patients with hematological diseases, malignant tumors or organic diseases; ② patients with autoimmune diseases, diabetes, hypertension and coronary heart disease; ③ patients with severe liver and kidney dysfunction and other cardiopulmonary diseases; ④ patients with hyperlipidemia and hyperuricemia. There were 46 males and 37 females in the observation group, aged 39–78 years old, with an average age of 61.34 ± 2.91 years old; the course of disease was 1–10 months, with an average of 4.24 ± 0.73 months; BMI was 20–25 kg/m², with an average of 22.41 ± 2.15 kg/m². Disease severity: 36 cases were mild, 30 cases were moderate, and 17 cases were severe. 80 healthy persons in the same period of physical examination were selected as the control group. There were 41 males and 39 females, aged 30–80 years old, with an average age of 61.87 ± 3.04 years old; BMI was 19–26 kg/m², with an average of 22.32 ± 2.31 kg/m². There was no statistically significant difference in general data between the two groups, and there was comparability. ($P > 0.05$).

1.2 Methods

1.2.1 Detection of Carotid Artery Disease with Ultrasound

① Detection method: After admission, both groups will complete relevant examinations, explain disease-related knowledge to patients and their families, inform patients of the importance and necessity of ultrasound examination, and improve patient cooperation. IU22 color Doppler ultrasound (manufacturer: Philips) was used for inspection, and the probe frequency was 2–10 MHz. During the examination, take the supine position, fully expose the neck, place the ultrasound probe at the 2 cm position of the carotid artery bifurcation to complete the carotid artery intima media thickness (IMT) measurement; resistance index (RI) and pulsatility index (PI) were measured at the carotid artery bifurcation position 1 cm near the heart to further determine the total plaque area and plaque number. In order to improve the accuracy of detection data and reduce the detection error, each study object completed three measurements, and the

average value was taken ^[9]. ☒ Judgment method: according to the detection results of the two groups, IMT > 1.2 mm indicates the patient has atherosclerotic plaque formation (for stable plaque, flat plaque and hard plaque are mainly, while unstable plaque is mainly composite plaque and hard plaque) ^[10].

1.2.2 Measurement of Arterial Stiffness

☒ Detection method: BP-203III arterial stiffness tester (manufacturer: Omron) is used to complete the brachial ankle pulse wave velocity (baPWV) and ankle-brachial blood pressure index (ABI) detection. During the test, the temperature in the control room was 22–25°C, and the subjects were all wearing thin clothes, taking a lying posture, and rested for 5 minutes before starting the test. Firstly, blood pressure and heart rate were measured, and then baPWV and ABI tests were completed. Each case was measured twice, and the average value was taken ^[11]. ☒ Judgment method: baPWV ≥ 1400 cm/s indicates arterial stiffness, otherwise it is normal; ABI > 1.4 indicates abnormally elevated ^[12].

1.2.3 Correlation Analysis

Correlation analysis software SPSS Pearson was used to analyze the correlation between arterial stiffness and ultrasound index in patients with COPD.

1.3 statistical methods

Statistical software SPSS20.0 was used to process the data. The measurement data of normal distribution was expressed as $(\bar{x} \pm s)$. The mean comparison between the two groups was performed by independent sample “t” test; the count data was expressed in cases (%), and the comparison between groups was performed by χ^2 . Pearson correlation analysis was used for correlation analysis, and $P < 0.05$ indicated that the difference was statistically significant.

2. Results

2.1 Comparison of Ultrasound Examination Results between the Two Groups

The level RI and PI of the observation group were lower than those of the control group ($P < 0.05$); The level of IMT, total plaque area, and number of plaques of the observation group were higher than those of the control group ($P < 0.05$), see Table 1.

Table 1
Comparison of ultrasonic examination results between the two groups ($\bar{x} \pm s$)

Group	Cases	RI	PI	IMT(mm)	patch area(cm ²)	patch numbers(a)
Observation group	83	0.62 ± 0.14	2.61 ± 0.38	1.36 ± 0.13	19.75 ± 2.19	1.67 ± 0.64
Control group	80	0.81 ± 0.22	2.95 ± 0.36	0.94 ± 0.10	5.84 ± 1.32	0.82 ± 0.30
T Value	/	6.326	8.321	4.574	7.493	5.093
P Value	/	0.000	0.000	0.000	0.000	0.000

2.2 Comparison of Arterial Stiffness and ABI between the Two Groups

The level of baPWV and ABI in the observation group were higher than those in the control group ($P < 0.05$), see Table 2.

Table 2
Comparison of arterial stiffness and ABI between the two groups ($\bar{x} \pm s$)

Group	Cases	baPWV(cm/s)	ABI
Observation group	83	1585.49 ± 14.36	1.63 ± 0.24
Control group	80	1142.45 ± 10.77	1.12 ± 0.16
T Value	/	6.392	5.109
P Value	/	0.000	0.000

2.3 Correlation Analysis of Arterial Stiffness and Color Doppler Ultrasound Index in Patients with COPD

Pearson correlation analysis indicated that the level of baPWV and ABI in patients with COPD were negatively correlated with RI and PI ($P < 0.05$); they were positively correlated with IMT, total plaque area, and number of plaques ($P < 0.05$), see Table 3 .

Table 3
Correlation Analysis of arterial stiffness and color Doppler ultrasound index in patients with chronic obstructive pulmonary disease

Related factors	RI	PI	IMT	patch area R Value	patch numbers
	R Value	R Value	R Value		R Value
	P Value	P Value	P Value	P Value	P Value
baPWV	-0.693(0.000)	-0.721(0.000)	0.701(0.000)	0.668(0.000)	0.784(0.000)
ABI	-0.712(0.000)	-0.689(0.000)	0.667(0.000)	0.712(0.000)	0.722(0.000)

3. Discussion

COPD is a common respiratory disease, which is characterized by persistent airflow limitation. Its occurrence and development are closely related to the chronic inflammatory reaction caused by the exposure of airway and lung to toxic substances. Previous studies generally believed that COPD is related to the incidence of chronic bronchitis and obstructive pulmonary disease, but the pathogenesis of COPD is still unclear^[13]. The body of patients with COPD is in a state of hypoxia and the level of inflammatory factors increases, which leads to an increase in the level of vascular endothelial cell adhesion factors and a decrease in the elastic fibers of the blood vessel wall, causing arterial vascular disease, affecting the patient's heart function, and increasing the incidence of cardiovascular disease. About one-third of patients with COPD die of cardiovascular disease, so it is important to strengthen the early diagnosis of patients with COPD and take timely clinical intervention to reduce the incidence of COPD^[14].

Arterial stiffness is a commonly used index for clinical prediction of carotid artery disease, which is a non-invasive examination. It was found that age, dyslipidemia, course of disease, V-type involvement and high mean arterial pressure were independent risk factors for increased arterial stiffness in patients with COPD^[15, 16]. In this study, the level of RI and PI of the patients with COPD in the observation group were lower than those in the control group ($P < 0.05$); the IMT, total plaque area, and number of plaques in the observation group were higher than those in the control group ($P < 0.05$); The arterial stiffness and ABI level of patients with COPD in the observation group were higher than those of healthy subjects in the control group ($P < 0.05$), indicating that the continuous development of COPD will lead to increased arterial stiffness and abnormal ultrasound examination. The main reason for this phenomenon is that the increased arterial stiffness is the early manifestation of arteriosclerosis, which can be effectively diagnosed by ultrasound. Measurement of arterial stiffness in high-risk groups of atherosclerosis can not only detect subclinical vascular structure changes in time, but also guide clinical treatment.

Patients with COPD have no typical clinical symptoms in the early stage of onset. With the development of the disease, it will lead to abnormal arterial function, metabolic disorders and other syndromes, which will lead to increased arterial stiffness and aggravation of the disease. At present, PWV is the main clinical examination for arterial stiffness, which has the advantages of simple operation, accurate results

and non-invasive, which is suitable for large-scale screening of asymptomatic population ^[17]. However, pulse wave propagation is affected by arterial stiffness. The greater the segmental arterial stiffness, the faster the pulse wave velocity ^[18]. The detection of arterial stiffness is often affected by the nature and thickness of arterial wall, and the accuracy of prediction is closely related to the pathological state of patients. In order to reduce the influence of related factors in the process of arterial stiffness detection, this study further analyzed the relationship between arterial stiffness and ultrasound results in patients with COPD. The results showed that arterial stiffness and ABI levels were negatively correlated with RI and PI levels ($P < 0.05$), and positively correlated with IMT, total plaque area and plaque number ($P < 0.05$), indicating that there is a correlation between arterial stiffness in patients with COPD and the results of ultrasound examination, which can be used as an auxiliary detection index of arterial stiffness.

Conclusion

In conclusion, arterial stiffness in patients with COPD is higher than that in healthy population, and there is a correlation between arterial stiffness and ultrasonic index. Therefore, ultrasonic index can be used as an auxiliary detection method for arterial stiffness, so as to improve the accuracy of prediction of carotid artery lesions and better guide clinical treatment.

Abbreviations

COPD
chronic obstructive pulmonary disease
IMT
intima media thickness
RI
resistance index
PI
pulsatility index
baPWV
brachial ankle pulse wave velocity
ABI
ankle-brachial blood pressure index

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of Linxi Hospital of Kailuan General Hospital.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article

Competing interests

All of the authors had no any personal, financial, commercial, or academic conflicts of interest separately.

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Authors' contributions

Zhang XH, Liu P conceived of the study, and Liu YQ and Zhang ST participated in its design and coordination and Huang QL helped to draft the manuscript. All authors read and approved the final manuscript

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