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Diagnosing patients with leukemia quickly based on spectroscopy

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ABSTRACT

This article shows that we obtained blood plasma of healthy persons and patients with leukemia, got absorption spectrum of them by spectral photometer. After analyzing these absorption spectra by the origin software, we found absorbance (Abs) of the malignant plasma were more than Abs of the healthy plasma at 414 nm, and we also found significant difference between the malignant plasma and the healthy plasma when Abs of some characteristic peaks at 414 nm, 279 nm were rationed or fitted. It is important for doctors to diagnose patients with leukemia quickly.

Leukemia, a malignant tumor of hemopoietic system, is a type of tumor proliferation of leukemic cells in bone marrow or other hematopoietic tissues, it can infiltrate organs, tissues of human body and damage them [1]. And until now we still do not know how it happens, some research showed that the virus could be the main factors and genetic, radiation, chemical toxicants and drugs could be other factors. Until today patients with leukemia are treated mostly by chemotherapy, bone marrow transplantation, biological agent treatment and gene therapy, they suffer much pains in the process of treatment, If detected early, treated timely, the patients can live longer [2].

Blood is the clinical micro sample; it is composed by plasma and blood cells, reflects medical parameters of organisms and has very important clinical significance. If it was added anticoagulant, after centrifuged, plasma and blood cell separates. Plasma suspends from above, blood cells lies at the bottom [3,4]. In the process of carcinogenesis, gene products and metabolites of cancer cells go into human's blood and they change the composition of plasma and change the micro environment of the macromolecules in the plasma [5,6]. Therefore, with these differences we can get medical basis of diagnosing cancer quickly. If we can discover the mechanisms of these differences, then we will provide a new method for quickly diagnosing cancer, it is important for treating and preventing cancer.

Double beam spectrophotometer has the characteristics of sensitivity, accuracy and rapid determination, it is widely used in petroleum, chemical, pharmaceutical, environmental protection etc. [7–9]. It is an important means to analyze the composition of the material. Therefore, after we rationed and fitted these absorption spectrum, we found the differences between malignant patient and healthy person, it provides the doctor a new way for quickly diagnosing patients with leukemia.

We used Shimadzu Corporation UV 3101 spectrophotometer made in Japan, and put deuterium lamp as light source, put photomultiplier tube as detector. We obtained 24 cases of healthy persons' plasma and 20 cases of patients' plasma with leukemia by Orthopedics Hospital of Zhengzhou in Henan province in China. We injected 3 ml distilled water into reference pool and injected 3 ml distilled water into sample pool for baseline calibration. Then we took out 0.1 ml distilled water from sample pool and injected 0.1 ml plasma of leukemia into sample pool, Mixing them up we got their absorption spectrum by spectral photometer. We set scanning speed as medium, set scanning scope as 200–500 nm, set sampling interval as 0.5 nm, set slit width as 50 nm.

We got absorption spectrum of healthy persons and patients with leukemia by spectrophotometer and analyzed them by Origin Software made in USA (Figs. 1 and 2).

Comparing absorption spectrum of patients with leukemia and healthy persons from Figs. 1 and 2, we found that absorption of patients with leukemia were more than them of healthy persons at 414 nm (Fig. 3). The absorption peak at 414 nm could be from red blood [10,11], because cancer patients are relative to hemolysis, and once people get cancer, erythrocyte's life will be shortened.

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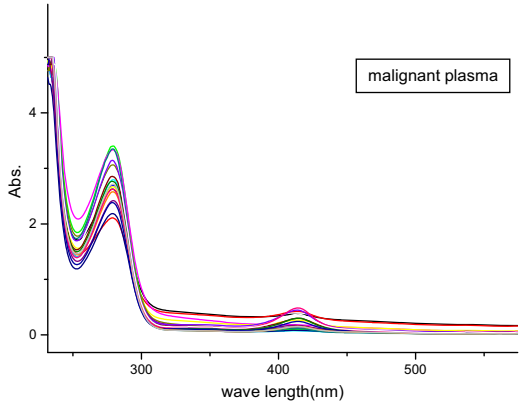

Fig. 1. 20 cases of patients with leukemia.

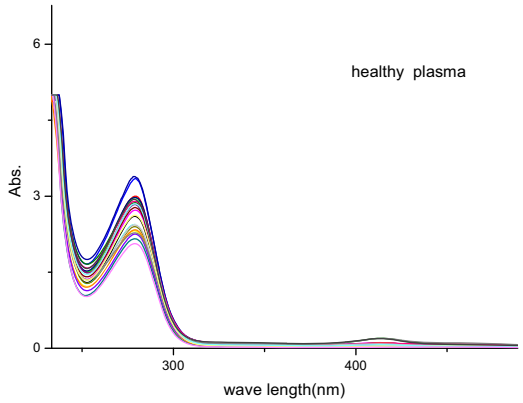

Fig. 2. 24 cases of healthy persons.

The hyperactive mononuclear macrophage system of leukemia is another cause of hemolysis [12].

From Fig. 3, we speculated that the absorption peak at 279 nm was from phenylalanine, tyrosine, tryptophan of the protein molecules. Organic compounds containing amino and carboxyl are called amino acid, amino acid is composition of the protein. The number of amino acids are more than twenty, only tryptophan, tyrosine, phenylalanine in these amino acids could contribute to absorption peak at 210–310 nm [13]. The absorption peak at 279 nm was weakened significantly and the absorption peak at 253 nm was disappeared when the protein was removed. The absorption peak at 253 nm is from the protein. It was the cause the absorption peak at 279 nm is from the protein.

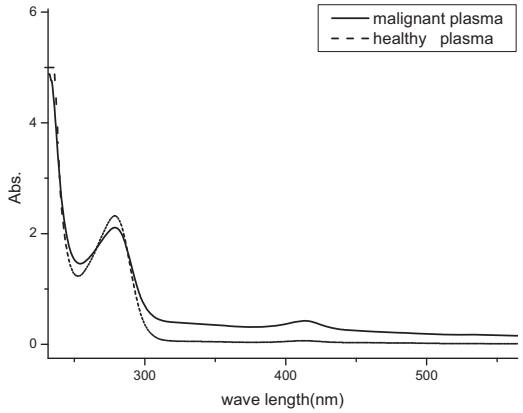

Fig. 3. Contrast between absorption spectrum of patient and healthy person.

Table 1
Ratio of Abs at 279 nm and 253 nm of patients and healthy persons.

Plasma classification	Plasma of healthy persons ($I_{279}/I_{253} > 1.86$)	Plasma of patients with leukemia ($I_{279}/I_{253} < 1.86$)
Meet	20	16
Rate	83.3%	80.0%

Table 2
Average fitting data of patients and healthy persons at 282 nm, 272 nm, 254 nm.

	Average fitting data at 282 nm	Average fitting data at 272 nm	Average fitting data at 254 nm
Healthy persons	40.93393	49.45217	37.88578
Patients with leukemia	37.23216	55.5211	50.34367

We analyzed ratio of Abs at some characteristic peaks (I_{279}/I_{253}) by Minkowski distance function and found that 20 cases of healthy persons were more than 1.86,16 cases of patients with leukemia were less than 1.86 (Fig. 4 and Table 1).

The absorption peak at 279 nm was fitted and formed three fitting peaks at 282 nm, 272 nm and 254 nm, meanwhile the absorption peak at 414 nm was fitted and formed the one fitting peaks at 414 nm by Origin Software's fitting function (Fig. 5). The size of fitting data says amino acids' relative content in the plasma [14–16] (Table 2). The fitting peak at 254 nm is from phenylalanine, the fitting peak at 272 nm is from tyrosine, the fitting peak at 282 nm is from tryptophan. These aromatic amino acids had conjugated double bonds, generating $\pi \rightarrow \pi^*$ transition and forming K absorption band under ultraviolet radiation [17,18]. Statistics of Table 2 showed that amino acids' relative content in the plasma were different between healthy persons and patients with leukemia.

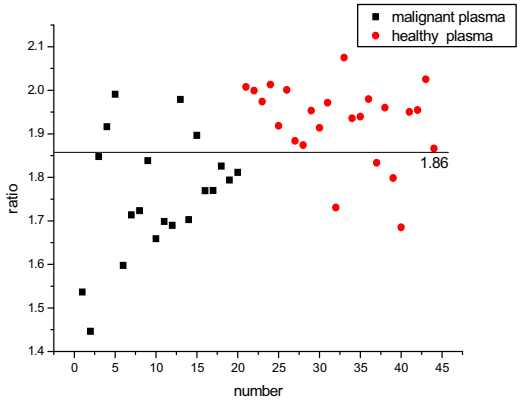

Fig. 4. Ratio of Abs at 279 nm and 253 nm of patients and healthy persons.

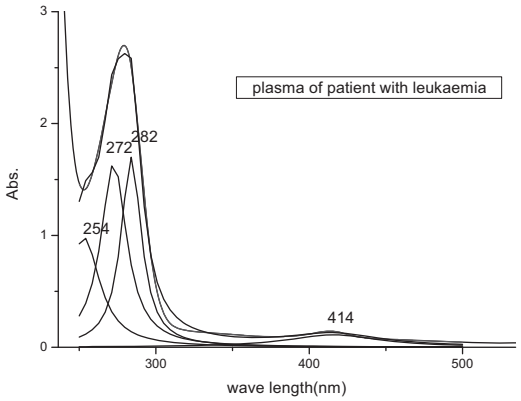

Fig. 5. Fitting peak of patients' with leukemia.