A study on Refractive index of plasma of blood of patients suffering from Tuberculosis

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***ABSTRACT*— The paper presents the data of refractive index of plasma of tuberculosis patient's blood .The refractive index of plasma of blood are measured using Abbes' refractometer. The experimental values are compared with normal plasma of blood. The values of plasma of blood of patients suffering from tuberculosis vary from 1.343 to 1.352, whereas refractive index of plasma of normal blood is 1.351. Hence, the values of refractive index of tuberculosis blood are slightly lower when compared to that of normal blood. This optical parameter can be served as a potential tool in the medical discipline if it is standardized.**

Key words- Human plasma of blood, Refractive index profile, Tuberculosis, Abbes' Refractometer.

I. INTRODUCTION

Any ailment in the human body is first reflected in blood picture and urine. The important parameter which the pathologists are interested is the refractive index profile of human blood and urine. Tuberculosis (TB) remains the single largest infectious disease causing high mortality in humans, leading to 3 million deaths annually, about five deaths every minute. Approximately 8-10 million people are infected with Mycobacterium tuberculosis every year [1]. Out of the total number of cases, 40 percent of the cases are accommo-dated in South East Asia alone. In India there are about 500,000 deaths occurring annually due to TB [2], with the incidence and prevalence being 1.5 and 3.5 millions per year. Tuberculosis is a chronic granulomatous infection caused by *Mycobacterium Tuberculosis*. Tuberculosis can cause an increase in Erythrocyte Sedimentation Rate (ESR), anaemia and lymphopenia. Studies have also documented an increase in platelet counts in pulmonary and pleural tuberculosis [3], [4]. In this study, we aimed to investigate the other coagulation parameters based on our previous study [3] in which we found increased peripheral platelet counts in patients with pulmonary tuberculosis. Currently 1/3 of the world's population are infected with tuberculosis bacillus with 8 million new cases and 3 million deaths due to tuberculosis estimated annually [5], [6], [7], [8], [9], [10]. In the present paper, we communicate the results of our study of refractive index of plasma of blood of tuberculosis patients.

II. MATERIALS AND METHODS

About 45 patients suffering from Pulmonary T. B. (all males) were selected to study refractive index of plasma of blood. Samples of volume 5 ml were drawn in the anticoagulant - EDTA at Andhra Pradesh Chest Hospital, Hyderabad and brought to the laboratory in siliconised bottles and stored at 4˚C until use. The experimental investigations were completed within three hours after the collection. Plasma was separated from blood samples by centrifuging the blood at the rate of 1500 rpm about 15 minutes and the blood samples were prepared by mixing equal amount of plasma and erythrocytes. By this process hematocrit of sample is maintained to be constant.

A. Experimental

The speed of light in a vacuum is constant. When light passes through any other medium, it travels more slowly because the light gets constantly absorbed in the medium and reemitted by the atoms of the media material. As light passes from one medium to another as from air to water, the result is a bending of light rays at an angle. This physical property occurs because there is a change in the velocity of light going from one medium into another. The ratio of the speed of light in a vacuum to the speed of light in another substance is defined as the refractive index *n* for the substance.

It is not necessary to measure the speed of light in a sample in order to determine its index of refraction. It is possible to determine the refractive index of the sample accurately, by measuring the angle of refraction and knowing the index of refraction of the layer that is in contact with the sample. All the refractometers use this principle with a few alterations in their optical design.

Whenever light changes speed as it crosses a boundary from one medium into another its direction of travel also changes, i.e., it is refracted. The relationship between light's speed in the two mediums (vA and vB), the angles of incidence (•A) and refraction (•B) and the refractive indexes of the two mediums (*n*A and *n*B) is shown below (Fig. 1)

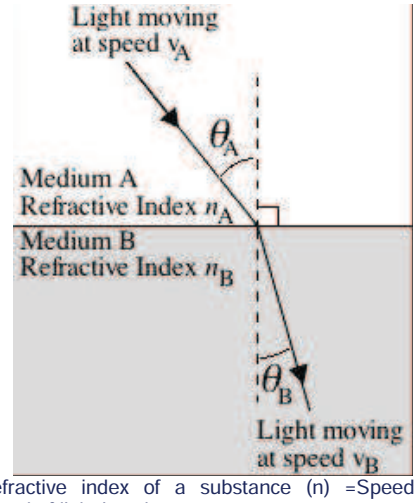

Fig. 1. Refractive index of a substance (n) =Speed of light in vacuum/Speed of light in substance
- VA/VB = sin •A/sin •B = nB/nA

In most liquids and solids the speed of light, and hence the index of refraction, varies significantly with wavelength. It is necessary to use monochromatic light for accurate measurements. The widely used wavelength of light for refractometry is the sodium D line at 589 nm. The cited values of refractive indexes such as 1.33 for water are based on yellow light at a wavelength of 589 nanometres.

Temperature also affects refractive index, and cited values are based on a standard temperature. Since the density of a liquid usually decreases with temperature, the speed of light in a liquid will normally increase as the temperature increases. The index of refraction normally decreases as the temperature increases for a liquid Most of the refractive index measurements are determined at 20 or 25 ℃.

Description: The instrument to measure the refractive index of the samples is called refractometer. One such instrument is called Abbe' refractometer. which can give the refractive index directly. In the Abbe' refractometer the liquid sample is sandwiched into a thin layer between an illuminating prism and a refracting prism. (Fig. 2) The refracting prism is made of a glass having a high refractive index of 1.75. The refractometer is suitable to measure the refractive index of the samples less than that of the refracting prism. A light source is projected through the illuminating prism, having the bottom surface made rough so as to enable that surface generate light rays travelling in all directions.

B. Experimental procedure

Inspection of the Fig. 2 shows that light travelling from point A to point B will have the largest angle of incidence (•i) and hence the largest possible angle of refraction (•r) for that sample. All other rays of light entering the refracting prism will have smaller •r and hence lie to the left of point C. Thus, a detector placed on the back side of the refracting prism would show a light region to the left and a dark region to the right. (Fig. 2)

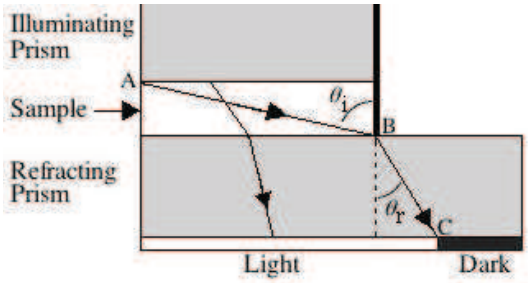

Fig. 2. Cross section of part of the optical path of an Abbe refractometer.

Samples with different refractive indexes will produce different angles of refraction and this will be reflected in a change in the position of the borderline between the light and dark regions. With a proper calibration of the scale on the refractometer, the position of the borderline can be used to determine the refractive index of any sample.

Take a few drops of plasma sample in between the illuminating prism and refracting prism. Place this refract meter opposite the sodium lamp and subject the sample to 589 nm wavelength of light. Through one eyepiece of the refractometer, we find some dark and white regions.

Adjust the refractometer knob to coincide the borderline of the dark and light regions with the centre of the cross wires and note down the reading on the instrument through another eyepiece, where the horizontal line coincides, to get the Refractive index of the sample.

Fig. 3. Abbes' Refractometer

III. RESULTS AND DISCUSSIONS

The below table (Table 1) presents the data on refractive-index of plasma of the refractive index values of plasma of blood of patients suffering from tuberculosis varies from1.343 to 1.352, whereas refractive index of plasma of normal blood is 1.351. Hence, the values of refractive index of tuberculosis blood are slightly lower when compared to that of normal blood.

TABLE I
DATA ON REFRACTIVE INDEX OF PLASMA OF BLOOD OF TUBERCULOSIS PATIENTS

Sample Code	Refractive index
HB01	1.349
HB02	1.347
HB03	1.349
HB04	1.35
HB05	1.347
HB06	1.346
HB07	1.344
HB08	1.348
HB09	1.346
HB10	1.345
HB11	1.347
HB12	1.348
HB13	1.346
HB14	1.352
HB15	1.345
HB16	1.346
HB17	1.348
HB18	1.346
HB19	1.349
HB20	1.345
HB21	1.348
HB22	1.349
HB23	1.346
HB24	1.346
HB25	1.347
HB26	1.345
HB27	1.347
HB28	1.345
HB29	1.351
HB30	1.349
HB31	1.346
HB32	1.347
HB33	1.349
HB34	1.346
HB35	1.345
HB36	1.347
HB37	1.349
HB38	1.346
HB39	1.343
HB40	1.347
HB41	1.348
HB42	1.348
HB43	1.346
HB44	1.347

The refractive index of biological tissue is a fundamental parameter in applications of optical diagnosis and laser treatments. In the present work, the refractive index of blood plasma of healthy persons and patients suffering from TB using the technique of Abbes' refractometry. This optical parameter can be served as a potential tool in the medical discipline if it is standardized. The below graph (Fig. 4) shows the variation of refractive index of plasma of blood of patients suffering from Tuberculosis with normal.

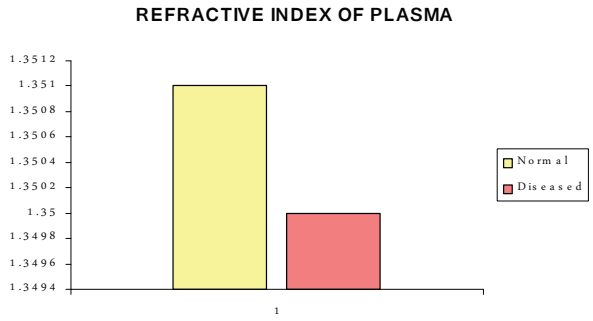

Fig. 4. The refractive index of the blood plasma of the patients suffering from Tuberculosis compared to normal.

REFERENCES

[1] *World Health Organization, "The World Health Report: Making a Difference", 1999 (110).*
[2] *Revised National Tuberculosis Control Programme: Key factor and Concepts, New Delhi, Central TB Division, Directorate General of Health Services, Ministry of Health and Family Welfare, 1999.*
[3] *Kartaloglu Z, Bilgic H, Aydilek R, Cerrahoglu K, Koylu R, Kunter E, "Platelets in Pulmonary and Pleural Tuberculosis" [Abstr.], Tubercl and Lung Dis, 76 (Suppl 2), pp. 30, 1995.*
[4] *Hui KP, Chin NK, Chan TB, Tan WC, "Platelet Count as an Independent Predictor Differentiating Between Tuberculosis and Non-tuberculosis Pneumonia", Tubercl and Lung Dis, 75, pp. 157. 1994.*
[5] *S. H. E. Kaufman, "Protection Against Tuberculosis, Cytokines, T cell and M Macrophage", Ann Rheum Dis., Vol. 61, No. Supply 2, pp. 54-58, 2002.*
[6] *S. Mustafa, F. A. Shaban, R Al- Attiyah, A. T. Abal, A. M. El - Shamy, Andersen, "Human Th1 Cell Lines Recognize the Mycobacterium Tuberculosis ESAT-antigen and its Peptides in Association with Frequently Expressed HLA Class II. Scand", J Immanuel, Vol. 57, No. 2, pp. 125-134. 2003.*
[7] *Neil W. Schluger, "Recent Advances in our Understanding of Human Host Responses to Tuberculosis", Respire Res, Vol. 2, No. 3, pp. 157-163, 2001.*
[8] *J. E. Wigginton, D. Kirschner, "A Model to Predict Cell Mediated Immune Regulatory Mechanisms During Human Infection with Mycobacterium Tuberculosis", J Immunol, Vol. 166, No.3, pp.1951-1967. 2001.*
[9] *M. Gonazalez-Jaurrero, O. C Turner, J Turner, P. Maretta, J. Brooks, I. M. V. Orme, "Temporal and Spatial Arrangements of Lymphocytes Within Lung Granulomas Induced by Aerosol Infection with Mycobacterium Tuberculosis", Infecti Immun, Vol. 69, No. 3, pp. 1722 - 1728, 2001.*