

ERYTHROCYTES ARE DISEASES DETECTORS – A STUDY BY DIELECTROPHORESIS

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Abstract: The paper reports the dielectrophoretic behavior of erythrocytes of blood drawn from the patients suffering from jaundice. The erythrocytes suspended in isotonic solution were subjected to non-uniform electric field (NUEF) produced by spherical field geometry. For this purpose, a pin-pin electrode chamber was constructed in the Laboratory. The parameters dielectrophoretic collection rate (DCR) and threshold voltage (V_{th}) are measured at constant cell concentration, frequency and voltage of applied field for normal and diseased (jaundice) blood. The study reveals significant differences in DCR and V_{th} of erythrocytes of jaundice patients, when compared with that of healthy persons.

Keywords: Erythrocyte, Jaundice, Dielectrophoretic collection rate (DCR) and Threshold Voltage (V_{th}).

1. Introduction

The study of non-uniform electric field effects on biological cells reveals the electrical make up of the basic unit of life. Visometric analysis of blood of patients suffering from thrombosis has been studied [1]. The results indicate that the viscosity of blood increases significantly due to thrombosis. Neonatal Jaundice in Pakistan has been reported [2]. The study was taken up for 414 neonates, the mean total bilirubin on admission was 19.7 ± 8.16 mg percent and the mean age was 4.9 ± 4.2 days. It has been concluded that high incidence can be reduced by early referral, percentage of infection, and reduction of preterm births by improved antenatal care and nutrition. Bilirubin concentration between α and β – thalassania carriers has been investigated [3]. The difference in bilirubin concentration between α and β – thalassamia heterozygotes may be attributed to more bilirubin being produced in β – thalassamia heterozygotes than in α – thalassamia heterozygotes. Pathophysiology of Jaundice was reported [4]. Various causes and the mechanism involved in the occurrence of Jaundice were discussed.

A perusal of literature reveals different methods and investigations for the diagnosis of Jaundice and other diseases but not much attention has been given to study the changes in

RBC physiology of the blood drawn from the patients suffering from Jaundice at the membrane level. Therefore, an attempt has been made to study the alterations in RBC physiology of Jaundice blood by subjecting it to dielectrophoresis and determining DCR and V_{th} of normal and diseased erythrocytes.

2. Materials and Methods

Fresh samples of normal blood of volume nearly 2 ml of different groups were collected from Lions Club blood Bank, Hyderabad. The blood samples from the patients suffering from Jaundice were collected from Princess Durru Shehavar Hospital, Hyderabad. EDTA was used as an anti-coagulant. Red Blood cells of normal and diseased blood were isolated from plasma by centrifuging the blood at the rate of 1500 rpm for about 15 minutes. The cells were washed in isotonic glucine-glucose solution (2.1% glycine and 5.5% glucose in the volume ratio of 9:1). The packed cells, when washed, were then mixed with isotonic solution. The concentration of the cells was determined using red blood cell counting chamber and spectro colorimeter, with optical density as a guide. The experimental arrangement for cellular dielectrophoretic study has been mentioned elsewhere [5].

3. Results and Discussion

The present investigation is mainly concerned with NUEF and its interaction with human erythrocytes in order to understand how electrical properties of erythrocytes from patients suffering from jaundice are influenced by the disease. For this purpose, dynamic dielectrophoretic technique has been adopted and the minimum voltage for the collection of erythrocytes at the electrode, called the threshold voltage has been measured at the frequency of 1 MHz.

Table 1 presents the data on Dielectrophoretic collection rate (DCR) and threshold voltage (V_{th}) of erythrocytes of healthy persons and patients suffering from Jaundice.

Table 1: Data on Dielectrophoretic collection rate (DCR) and threshold Voltage (V_{th}) of erythrocytes of healthy persons and persons suffering from jaundice.

Condition of the sample	DCR ($\mu\text{m}/\text{min.}$)	V_{th} (Volt)	% Variation in DCR	% variation in V_{th}
Normal	85.25 ± 5.26	19.33 ± 1.36	-	-
Jaundice	5.3 ± 15.8	21.0 ± 2.6	-35.4	8.6

It is evident from the Table 1 that the magnitude of DCR for Jaundice is less and the threshold voltage is more in comparison with the normal blood at 1 MHz. the percentage variation in the DCR for the Jaundice is 35% less with respect to DCR for the normal whereas in the case of threshold voltage the percentage variation is only 8% more with respect to the normal.

The study suggests that high concentration of bilirubin in the blood when compared with the normal level seems to decrease the dielectric property of the erythrocyte. The present study demonstrates that the erythrocyte membrane physiology is influenced or in other words perturbed due to disease. The erythrocyte seems to behave as a very sensitive sensor to pick up signals and store them in its membrane due to which it may become less dielectric than normal erythrocyte due to Jaundice.

References

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