Estimated red blood cell thickness in microcytic anemia due to iron deficiency anemia and thalassemia

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Abstract

Anemia is one of the most common hematological disorders that are still the present in all countries around the world. Microcytic anemia is a specific kind of anemia presenting with small red blood cell. In this paper, the author discusses on the estimated red blood cell thickness, a new proposed parameter, comparing between that of iron deficiency anemia and thalassemia and further extrapolate on the clinical implication.

Keywords
Thickness, Red blood cell, Iron deficiency anemia, Thalassemia

Introduction

Anemia is one of the most common hematological disorders that can be seen around the world. Microcytic anemia is the group of anemia presenting with small red blood cell. In differential diagnosis for microcytic anemia, there are many possible disorders. However, the two common disorders are iron deficiency anemia and thalassemia. These two abnormalities show common characteristic as microcytic anemia but there are some differences [1 – 4]. It is noted that at the same level of average size of red blood cell or its volume, which is defined as mean corpuscular volume (MCV), the mean hemoglobin content (MCH) in case of thalassemia is usually higher than that of iron deficiency anemia [1 – 4] (Table 1). Also, the prone for destruction can be seen in red blood cell of thalassemia [1 – 4]. In this paper, the author discusses on the estimated red blood cell thickness comparing between that of iron deficiency anemia and thalassemia and further extrapolate on the clinical implication.

The hypothesis/Idea

The author proposed this idea based on basic physical principle. Volume, assigned as “V”, is the result of multiplication between “area” and “height”. For red blood cell, area can be implied by surface area, which is normally presents in circular shape and hereby proposed as “A”. The “A” in this work is the actual
effective area which is the area with hemoglobin. This can be implied by MCH. Focusing on height, it is hereby called as estimated red blood cell thickness and represented as “T” (Figure 1).

**Evaluation of the Hypothesis/Idea**

Calculation for estimated red blood cell thickness in thalassemia and iron deficiency anemia is done. The verification of the idea can be done by basic comparison between the finding in case of thalassemia and iron deficiency anemia. It is noted that the case with less estimated thickness of red blood cell must have red blood cell that is more prone to shearing force that occurs in circulation.

**Experimental data**

According to the mathematical modeling, the estimated thickness of red blood cell can generally represented as “V/A”. The primary assumption is comparison is performed at the same volume of red blood cell; hence, V is a constant. Focusing on “A”, it is hereby a variable. The effective area for thalassemia is different from that of iron deficiency anemia since there is a difference in the MCH. The more MCH in thalassemia implies more “A”. Thus, the “A” in case of iron deficiency anemia is less. As a result, the finalized calculated “T” for iron deficiency anemia is higher than that of thalassemia.

**Discussion**

According to this study, the finalized estimated thickness of red blood cell in thalassemia is less than that of iron deficiency anemia. Based on the proposed idea, this must reflect that the red blood cell in thalassemia must have more prone to destruction from shearing force. Of interest, this observation from theoretical approach is concordant with the real observation in the clinics [5]. Indeed, both iron deficiency anemia and thalassemia have small red blood cell but the difference in fragility is observed. A possible explanation for this fact can be explained by the proposed idea on the estimated thickness of red blood cell in this work.

Indeed, the author has recently proposed for another concept to explain the nature of fragility of the red blood cell in thalassemia that the reduction in the cut surface area (above view: Figure 1) of the red blood cell might be the cause of fragility [6]. However, in this work [6], the primary assumption is there is existence of work resulting from osmotic fluctuation. In this paper, the additional concept on the dimension of thickness (side view: Figure 1) adds up the new contributing factor to the fragility of red blood cell in thalassemia. The new concept in this work based mainly on the red blood cell structure, not dealing mainly with external parameter such as osmotic force.

The proposed concept in this work can also be further implicated in the other abnormalities of red blood cells. The proposed concept can be well implicated in the other tropical hemoglobinopathies. The good example should be the hemoglobin E disorder [7 - 9] which presents the similar red blood cell parameter to thalassemia (microcytic and hypochromic appearance with a significant higher MCH comparing to that of iron deficiency anemia). Also, the concept can be also applied for other erythrocyte shape pathologies such as spherocytosis. In congenital form, there is no microcytic anemia and the decreased red blood cell thickness should not be observed. On the other hand, in autoimmune hemolytic anemia with microspherocytes induced by immune reaction, the fragility of the cell can be observed. The thin microcytic red blood cell might be detectable in this specific disorder, which needs further study for verification.

What do we already know about the subject? There has been no previous note on red blood cell thickness in hematology.

What does your proposed theory add to the current knowledge available, and what benefits does it have? The proposed theory brings new possible red blood cell parameter that can be useful in clinical hematology. This might be specifically useful for differential diagnosis of hematomatological disorder.

Among numerous available studies, what special further study do you propose for testing the idea? Further studies using the electron microscopic examination for exact measurement of the thickness of red blood cell in both studied conditions are required to confirm the idea.
Table 1. Known information on red blood cell parameters in iron deficiency anemia and thalassemia.

<table>
<thead>
<tr>
<th>red blood cell parameters</th>
<th>iron deficiency anemia</th>
<th>Thalassemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. diameter</td>
<td>Small</td>
<td>Small</td>
</tr>
<tr>
<td>2. volume (MCV)</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>3. content (MCH)</td>
<td>Very low</td>
<td>Low</td>
</tr>
<tr>
<td>4. thickness</td>
<td>No data</td>
<td>No data</td>
</tr>
</tbody>
</table>

Figure 1. Schematic diagram showing the “thickness” of red blood cell.

References