A COMPARISON OF CAPILLARY AND VENOUS BLOOD IN PERNICIOUS ANEMIA

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Patients afflicted with pernicious anemia present many symptoms which differ strikingly from those of secondary anemia. One is the discrepancy between the general appearance of a patient with pernicious anemia and his blood count. Patients with secondary anemia having a red blood cell count of 2,000,000 or less, are not only weak and ill enough to be in bed, but have a pallor so marked as to be noticeable even to the most casual observer. In contrast with this, patients who have pernicious anemia may be up and around and may have color in the face and lips which is so good that one is often surprised at the finding of an extremely low red blood cell count, from 1,000,000 to 1,500,000. In fact, often their color is so good that the anemia is overlooked by their physicians. The pallor may be partly obscured by the lemon yellow tinge of the skin.

We have often wondered why patients with pernicious anemia retain their color so well. It might be accounted for, in part, by the fact that there is atrophy of the skin and mucous membranes which renders them abnormally transparent and thus they transmit well the red color of the little blood they possess.

It has seemed to us that there must be another factor, however, to account for this interesting phenomenon, namely, that possibly the red blood cells in this disease might have a tendency to lodge in the capillaries of the skin and therefore give a false impression concerning the gravity of the anemia. It seemed possible that one might determine whether or not this were a fact by estimating simultaneously the number of corpuscles in the capillary and venous blood and comparing the findings with those of normal blood.

We found a marked difference between the capillary and venous counts in all cases of pernicious anemia examined, whereas, in normal individuals the capillary and venous counts were practically the same. All the patients had a frank pernicious anemia with atrophy of the skin and mucous membranes, characteristic tongue, achylia and characteristic blood findings, with red cell counts of 1,000,000 or a little above when first examined. The high counts recorded were all due to the fact that the patients had been transfused some weeks or months prior to the time that the counts were made.

The capillary red blood cell count of patients with pernicious anemia was 1,264,000, or 19.3 per cent. higher on an average than the venous counts made at the same time. In every case there was a marked difference, the most marked being 3,070,000 red blood cells in the capillary blood and 1,920,000 in the venous blood—a difference

TABLE 1.—VENOUS AND CAPILLARY* BLOOD COUNTS IN PERNICIOUS ANEMIA

Date	Capillary Count	Venous Count	Reduction, per Cent.	Remarks
Case 1:				
Aug. 31, 1921.....	2,400,000	1,840,000	23.3	Transfused 10/5/20
Sept. 13, 1921.....	2,220,000	1,760,000	20.7	
Dec. 1, 1921.....	4,040,000	3,480,000	13.8	Transfused 10/10/21 and 10/28/21
Case 2:				
Oct. 25, 1921.....	5,440,000	4,800,000	11.8	Transfused 1/28/21
Case 3:				
July 29, 1921.....	3,380,000	2,280,000	32.5	Transfused 6/5/21 and 6/18/21
Oct. 7, 1921.....	5,200,000	3,880,000	25.3	
Case 4:				
Aug. 30, 1921.....	6,400,000	5,300,000	17.2	Transfused 3/21/21
Sept. 20, 1921.....	5,640,000	4,400,000	22.3	
Oct. 1, 1921.....	6,240,000	5,520,000	11.6	
Oct. 25, 1921.....	5,620,000	5,510,000	16.7	
Case 5:				
Nov. 28, 1921.....	2,240,000	1,600,000	28.5	Transfused 11/29/21
Dec. 4, 1921.....	3,440,000	2,680,000	22.0	
Case 6:				
Nov. 28, 1921.....	4,960,000	4,200,000	15.4	Transfused 1/21/21
Case 7:				
Nov. 28, 1921.....	3,070,000	1,920,000	37.4	Transfused 10/21/21
Case 8:				
Dec. 23, 1921.....	1,280,000	960,000	25.0	Transfused 12/31/21
Jan. 1, 1922.....	3,800,000	2,600,000	31.6	
Venous and Capillary Blood Counts in Normal Individuals:				
Case 1.....	5,520,000	5,540,000		
Case 2.....	4,960,000	5,120,000		
Case 3.....	5,260,000	5,400,000		
Case 4.....	5,160,000	5,000,000		
Case 5.....	6,080,000	6,120,000		
Venous and Capillary Blood Counts in Secondary Anemia:				
Case 1:				
Jan. 19, 1922.....	2,960,000	2,680,000	9.4	Transfused 1/28/22
Jan. 30, 1922.....	5,440,000	5,360,000	1.3	
Case 2:				
March 4, 1922.....	2,400,000	2,480,000	None	
Case 3:				
Jan. 30, 1922.....	5,280,000	5,200,000	1.2	Transfused 9/7/21 prior to making of counts
Case 4:				
Jan. 30, 1922.....	4,400,000	4,720,000	None	Transfused 1/23/22 prior to making of counts

* In making the capillary blood count a small slit was made in the lobe of the ear and the blood drawn up in a red counting pipet in the usual manner. For the venous counts a small amount of blood was drawn from an arm vein into a syringe and a count quickly taken from this.

of 1,150,000, or 37.4 per cent., the least marked being 6,240,000 red cells in capillary blood and 5,520,000 red cells in venous blood, a difference of 770,000 red cells, or 11.6 per cent. This difference was striking regardless of whether the counts were made when the counts were low or whether they were made after treatment by transfusion when the counts were high. In contrast with this, the difference between

the capillary and venous counts in normal individuals was not great in any case and did not exceed 1.2 per cent. in a single instance, nor did it exceed 9.4 per cent. in four cases of secondary anemia, two of which had been transfused shortly before the counts were made.

It was noted that the venous blood of patients with pernicious anemia contained an increased proportion of small cells while the capillary blood contained an increased number of macrocytes. This difference between the venous and capillary blood was so striking as to leave no doubt as to its real existence. It has seemed to us that the large red cells of the blood of patients with pernicious anemia lag in the capillary bed while the smaller cells filter through and in this way account for the marked difference between the capillary and venous counts.

This view would be in harmony with physical laws which govern deposits made by streams of water which carry a sediment heavier than water. As a stream broadens it slows, its carrying power is thereby reduced, and part of its sediment is deposited. The larger particles of a given specific gravity are deposited first or lag along the creek bed while the smaller particles of the same gravity are carried on. We have a somewhat similar condition existing in the human body though modified no doubt by biologic laws. As blood reaches the capillary bed the stream broadens and slows. Furthermore, the pulse is lost. There should exist, therefore, a tendency for the larger red cells (which are heavier than serum) to lag and for the smaller ones to be carried along readily.

One could believe also that the larger red cells might be retarded in the capillary bed by a process of filtration. This may be a factor also but against this view is the fact that in only one of four cases of leukemia which we have examined was there a great difference between the capillary and venous white cell counts (lower specific gravity than red cells) in spite of the fact that the myelocytes were larger than the leukocytes and lymphocytes.

In the belief that more light might be thrown on the subject, capillary blood cell counts were made on four patients with pernicious anemia, two of whom (Cases 9 and 10) had been transfused several months previously. Blood was withdrawn from the arm veins without the use of a constricting tourniquet to distend the veins. After this blood was taken, a tourniquet was placed around the arm for one minute, tight enough (about 180 mm. of mercury) to prevent arterial blood from entering the arm and venous blood from escaping. During this minute the hand was contracted and relaxed a number of times with a view of dislodging, if possible, any red cells which might have accumulated in the capillaries of the arm. The muscular contractions forced the blood out into the veins so that they became quite tense. At the expiration of the minute, the tourniquet was

removed for about two seconds and then quickly replaced at 180 mm. of mercury. This was done for the purpose of allowing the blood in the veins to be replaced by blood from the capillary bed. Venous blood was then withdrawn and counts were made.

The results obtained by this procedure were quite interesting. In each instance the venous count taken while the arm was at rest and before a tourniquet was applied was much lower than the capillary counts taken from the lobe of the ear. The venous counts taken after constriction of the arm with tourniquets and exercise were higher in

TABLE 2.—CAPILLARY AND VENOUS COUNTS IN PERNICIOUS ANEMIA BEFORE AND AFTER CONSTRICTION OF THE ARM AND EXERCISE

Case	Capillary Counts	Venous Counts Before Constriction	Venous Counts After Constriction and Exercise
9	4,085,000	2,505,000	3,125,000
10	3,230,000	2,670,000	3,190,000
11	1,440,000	880,000	1,120,000
12	2,880,000	2,240,000	2,560,000

TABLE 3.—CAPILLARY AND VENOUS BLOOD COUNTS IN NORMAL PERSONS BEFORE AND AFTER CONSTRICTION OF THE ARM AND EXERCISE

Case	Capillary Counts	Venous Counts Before Constriction	Venous Counts After Constriction and Exercise
13	5,170,000	5,210,000	5,490,000
14	4,800,000	5,160,000	5,280,000
15	4,960,000	5,040,000	5,080,000
16	5,040,000	5,080,000	5,120,000

every instance than the venous counts taken while the arm was at rest—in fact, the difference was so marked in each instance that we feel sure had the venous counts been taken from veins without the aid of a tourniquet they would have been relatively lower than the ones obtained.

As a control, similar counts were made on four normal persons. The venous counts taken before and after constriction and exercise were essentially the same as the capillary counts.

We wish to suggest that the relatively good color of the skin and lips in patients with pernicious anemia might be accounted for, in part, by the fact that the capillary blood is richer in red corpuscles than the venous blood and for this reason is misleading and does not give the physician a correct idea of the gravity of the situation.

CONCLUSIONS

1. Capillary red blood cell counts on patients with pernicious anemia were on an average 17.6 per cent. higher than similar counts made

on venous bloods at the same time. The difference was as great as 37.4 per cent. in one case, and in every case it was 11.6 per cent. or more.

2. Venous counts made after constriction of the arm with a tourniquet, combined with exercise of the hand, were materially higher than counts made before constriction of the arm and when the hand was at rest.

3. An increased number of macrocytes was observed in capillary blood as compared with venous blood.

4. The striking difference between the capillary and venous counts is caused, we believe, by a tendency for the larger red blood cells (macrocytes) to lag in the narrow capillary bed where the rate of flow of blood is slow and the pulse is lost.

5. It is believed that this accounts, in part, for the circumstance that a patient with pernicious anemia may have relatively good color of skin and lips even though he may be gravely anemic. This is misleading and frequently obscures the real gravity of the situation.

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