

# THE EFFECT OF HORMONES ON THE SEDIMENTATION VELOCITY OF RED BLOOD CELLS AFTER BLOCKADE OF THE RETICULO-ENDOTHELIAL SYSTEM.

By

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## CONTENTS

1. Introduction.
2. Experimental Materials and Method.
3. Results.
  - 1) Control.
    - a. The effect of normal saline injection.
    - b. The effect of withdrawal of blood for experiment.
  - 2) The effect of hormones on the sedimentation velocity of red blood cells after blockade.
    - a. The effect of thyroid hormone.
      1. Effect of thyroidectomy in normal rabbits.
      2. Effect of thyroidectomy after blockade
      3. Effect of thyroid medication in normal rabbits.
      4. Effect of thyroid medication after blockade.
    - b. The effect of parathyroid hormone.
      1. Effect of parathyroidectomy in normal rabbits.
      2. Effect of parathyroidectomy after blockade.
      3. Effect of injection of parathormon in normal rabbits.
      4. Effect of injection of parathormon after blockade.
    - c. The effect of spleen hormone.
      1. Effect of splenectomy in normal rabbits.
      2. Effect of the splenectomy after blockade.
      3. Effect of injection of spleen emulsion into normal rabbits.
      4. Effect of injection of spleen emulsion after blockade.
    - d. The effect of adrenal hormone.
      1. Effect of cortex hormone.
        - A. Effect of cortex hormone in normal rabbits.
        - B. Effect of cortex hormone after blockade.
      2. Effect of adrenalin.
        - A. Effect of adrenalin in normal rabbits.
        - B. Effect of adrenalin after blockade.
    - e. The effect of insulin.
      1. Effect of insulin in normal rabbits.
      2. Effect of insulin after blockade.
    - f. The effect of the sex hormone.
      1. Effect of the testicular hormone.
        - A. Effect of orchidectomy in normal rabbits.
        - B. Effect of orchidectomy after blockade.

- C. Effect of injection of testicular hormone into normal rabbits.
- D. Effect of injection of testicular hormone after blockade.
- 2. Effect of ovarian hormone.
  - A. Effect of ovariectomy in normal rabbits.
  - B. Effect of ovariectomy after blockade.
  - C. Effect of injection of ovarian hormone into normal rabbits.
  - D. Effect of injection of ovarian hormone after blockade.
- 3) The influence of certain physico-chemical changes of the blood on sedimentation velocity after blockade of the reticulo-endothelial system.
  - 1. Blood cells and hemoglobin.
  - 2. Blood volume, viscosity and fragility of the red blood cells.
  - 3. Globulin, albumin and fibrinogen content of the blood.
  - 4. Blood calcium, blood cholesterol and blood sugar.
- 4. Discussion.
- 5. Summary.
- Bibliography.

## 1. INTRODUCTION

It is well known that changes in the red cells occur when certain influences act upon the living organism. Since Fahraeus (21) reported in 1918 that the rate of sedimentation in pregnant woman is greater than in the normal woman, many investigators have reported on the subject. Many of these experimental reports had a direct clinical value. Such papers are those of Okada (92), Kanemori (52), Shibayama (110), Otani (86), Takebayashi (111), Hayashi (30), Okamura (93), Klinck (150), Gram (23), Schafer (106), and Kagan (149).

On the other hand, other writers insisted that the cause of the phenomenon was to be found in the serum, for example Pines and Jaffe (151), Knosp (44), Ryan, Johnson and Gesishimer (97), Pico Franceshi and Negrete (20), Klinck (150), Minamiyoshi (73), Hayashi (30), Shimizu (101), Yo (135), Yoshida (136), Jindo (145).

But as a matter of fact the causative factor is still unknown. Recently in my studies on the function of the reticulo-endothelial system by such investigators as Uno (123), Kiyono (49), Matsuhara (80), Klinck (150), a new factor has suggested itself and in the light of most recent knowledge we wish to report on the relationship between the sedimentation velocity of the red cells and the various body hormones.

## 2. EXPERIMENTAL MATERIALS AND METHOD

Normal male rabbits weighing about 2 kg. were used through out this experimental work, except when female rabbits were necessary. Westergrens apparatus was used for measurement of the sedimentation

velocity. The sample of blood was drawn from the neck vein of the fasting animal and 10% of Indian ink in saline was used for blockading the reticulo-endothelial system (R. E. S.).

### 3. RESULTS

#### 1) CONTROL

##### A) THE EFFECT OF NORMAL SALINE SOLUTION INJECTION

The India ink was diluted with normal saline solution and injected to note its intrinsic effect. The influence on sedimentation velocity (S.V.) of red blood cells after the injection of saline solution has been noted by many investigators. However Otani (86), Hotachi (35) found no change on the S. V. after saline injection while Ishiwari (41) observed that the injection of large doses of saline solution accelerate the S. V. of red cells.

The normal saline was injected daily for six days (5 cc per K. G. body weight intravenously once a day),

Table 1. 1.8 kg M

	Normal	After injection
1 hr	2	2
2 hrs	4	3.5
3 hrs	6	5.5

Table 2. 2.0 kg M

	Normal	After injection
1 hr	2	2
2 hrs	3.5	4
3 hrs	5.0	5.5

Thus no effect of the S. V. of red cells was noted after the injection of normal saline solution.

##### B) THE EFFECT OF WITHDRAWAL OF BLOOD FOR EXPERIMENT.

Variation of the S. V. of red cells during manipulation has been proved by many investigators. Thus Miwa (67) found the accelerated speed of S. V. of red cells in the artery when compared with the vein.

Otani (95) found increased velocity of sedimentation rate when blood was withdrawn, while Araki (1) and Hotaeni (35) noted no effect on the S. V. of red cells after withdrawal of blood several times with 4 to 7 days. Takashina (112) found increased rate of sedimentation when about 7 cc blood was withdrawn daily, and Takebayashi (111), Shibayama (110), Okamura (93) also found a relationship between the S. V. of red cells and quantity of blood withdrawn.

Blood was withdrawn at variable intervals and results are recorded in table 3 and 4.

Table 3. 2.0 kg M

	Nor- mal	After blood drawn				
		15'	30'	60'	2 hrs	4 hrs
1 hr	1.5	1.5	1.5	1.5	1.5	2.0
2 hrs	3.0	3.0	3.0	3.0	3.0	3.5
3 hrs	5.0	4.5	5.0	5.0	5.0	5.5

Table 4 1.8 kg M

	Nor- mal	After blood drawn			
		15'	30'	60'	4 hrs
1 hr	2	2	1.5	2	2
2 hrs	4	4	2.5	3	3
3 hrs	5.5	6	3.5	5	5.5

There are no special changes on the S. V. of red cells, after experimental venepuncture in normal rabbits as table 3 and 4 show.

## 2) THE EFFECT OF HORMONES ON THE SEDIMENTATION VELOCITY OF RED CELLS AFTER BLOCKADE.

We know that R. E. S. has an important function in the life processes as Aschoff and Kiyono have shown. It is reasonable to expect important changes in the body when the function of R. E. S. has been stimulated or inhibited. But Nagao noted that no change occurred in nutrition and development when Indian ink has been used to blockade the R. E. S. Uno (123) noted that Indian ink was absorbed by both liver and spleen. Tsunashima (115) reported the increase of S. V. after injection of colloidal silver or after splenectomy. Tsunekawa (122) and Matsuhara (80) noted an increase of S. V. when the R. E. S. was blocked by the injection of Indian ink. Seiffert (99) noted increase of sedimentation velocity after splenectomy and blockade of the R. E. S. in the guinea pig. Klinck (150) reported that the dose does not influence the S. V. when trypan blue has been injected into normal rabbits.

Table 5. 1.65 kg M

	Normal	After
		blockade
1 hr	2.0	2.5
2 hrs	3.0	4.0
3 hrs	4.5	6.0

Table 6. 2.0 kg M

	Normal	After
		blockade
1 hr	2.0	2.0
2 hrs	4.0	4.0
3 hrs	5.0	6.0

Table 7. 2.3 kg M

	Normal	After
		blockade
1 hr	1.5	2.0
2 hrs	3.0	4.0
3 hrs	4.5	5.0

The rate of S. V. was augmented by blockade of the R. E. S.

### a. EFFECT OF THYROID HORMONE

Many reports have appeared on the relationship between the S. V. of red cell and function of the thyroid gland.

Thus Trifon (115) noted the increase of S. V. when a diet containing thyroid substance was given while Bonilla and Moya (12) studied S. V. before and after thyroidectomy. Westergren (129) believes that the thyroid

exerts a definite influence upon the S. V. of erythrocytes. Vasaturo (134) has investigated the sedimentation time in thyroidectomized, thyro-parathyroidectomized animals and Wakata (130) has noted that the sedimentation velocity was accelerated by thyro-thymo-orchidectomy for at least 40 days. Tsunashima (155) reported that the S. V. of red cells decreased by thyroidectomy was later increased by administration of thyroid extract, but the rate of globulin and albumin does not stimulated. Takebayashi (111) noted no effect of S. V. of red blood cells under such conditions. Mensch (81) reported rapid S. V. in Basedow's disease, and Sugano (107) also reported decreased volume of red cells in Basedow's disease. Heing, Taterka, Goldmann (28) have studied rapid S. V. in Basedow's disease. Yun (144) also studied the influence of thyroidectomy upon erythrocyte sedimentation without any definite results.

### 1. EFFECT OF THYROIDECTOMY IN NORMAL RABBITS

The results are recorded in the following tables 8, 9, 10.

Table 8. 2.0 kg M

	Normal	After thyroidectomy		
		2 D	4 D	10 D
1 hr	2	2	2	2
2 hrs	4	4	3	4
3 hrs	5	5.5	4	5

Table 9. 2.3 kg M

	Normal	After thyroidectomy		
		2 D	4 D	10 D
1 hr	2	2	2	2
2 hrs	4	4	4	4
3 hrs	5.5	5	6	6

Table 10. 1.6 kg F

	Normal	After thyroidectomy	
		5 D	10 D
1 hr	2	2	2
2 hrs	3.5	4	4
3 hrs	5	5	6

In my study, also there was no influence of thyroidectomy upon sedimentation of red blood cells.

### 2. EFFECT OF THYROIDECTOMY AFTER BLOCKADE

The results are expressed in the following tables 11, 12, 13.

Table 11. 2.0 kg M

	Normal	Blockade and thyroidectomy
1 hr	2	2.5
2 hrs	4	4.5
3 hrs	6	6.5

Table 12. 2.0 kg M

	Normal	Blockade and thyroidectomy
1 hr	2	2
2 hrs	4	4
3 hrs	5	6

Table 13. 2.0 kg M

	Normal	Blockade and thyroidectomy
1 hr	2	2
2 hrs	3.5	4
3 hrs	5	5.5

Thus thyroidectomy after blockade has no definite effect upon the erythrocyte S. V.

### 3. EFFECT OF THYROID MEDICATION IN NORMAL RABBITS

Thyreoglandol was given at the rate of 0.5 cc per k.g. and the results are recorded in the following tables 14, 15.

Table 14. 2.0 kg M

	Nor-mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	1.5	2	2	1.5	2	2	2
2 hrs	3.0	3.5	3	2.5	3	3	4
3 hrs	4	4.5	4	3.5	4	5	5

Table 15. 2.0 kg M

	Nor-mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2	1.5	2	2	2	2
2 hrs	3.5	4	3	4	4	3.5	4
3 hrs	5.5	6	5	5.5	6	5	6

The above tables show no relation.

### 4. EFFECT OF THYROID MEDICATION AFTER BLOCKADE

Thyreoglandol also was given after blockade and results are recorded in the following tables 16, 17.

Table 16. 2.0 kg M

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2	2	2	2	1.5	2.5
2 hrs	4	4.5	4	4	4	4	3.5	5
3 hrs	6	6.5	5	5	6	6	5	7

Table 17. 2.0 kg M

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2	2	1.5	2	2	2
2 hrs	4	5	4	4	3.5	4	4	4
3 hrs	6	7	6	5	5.5	6	6	6

Thus, there was no special influence on S. V. of red blood cells after thyroidectomy or thyroid medication.

## b. THE EFFECT OF PARATHYROID HORMONE

Since Collip (14) succeeded in isolating the parathyroid hormone many articles by many investigators have appeared and it has been clearly shown that there is a relationship between calcium metabolism and this substances.

Bomsker (11) reported that two different action on the blood calcium, Oshima (91) also reported on the subject. Zimmerman (143) noted absence of any effect on the calcium and coagulation time even after parathormone was injected. Bonilla and Moya (12) and Vasaturo (134) noted increased S. V. of red cells after parathyroidectomy, but Vasaturo (134) noted decreased S. V. of red cells after thyroparathyroidectomy. Yun (144) reported increased S. V. of red cells after parathyroidectomy.

## 1. EFFECT OF PARATHYROIDECTOMY IN NORMAL RABBITS

Both parathyroid gland 2 out of 4 were removed from normal rabbits, and the results are recorded in the following tables 18, 19, 20.

Table 18. 2.0 kg M

	Normal	After parathyroidectomy	
		4 D	10 D
1 hr	2	2	2
2 hrs	4	4	4
3 hrs	6	6	6

Table 19. 1.8 kg M

	Normal	After parathyroidectomy	
		4 D	10 D
1 hr	2	2	2
2 hrs	4	4	4
3 hrs	5.5	6	6

Table 20. 1.8 kg M

	Normal	After parathyroidectomy		
		2 D	4 D	6 D
1 hr	2	2	2	2
2 hrs	4	4	4	4
3 hrs	5	6	6	6

As shown in above tables, the S. V. of red cells was increased.

## 2. EFFECT OF PARATHYROIDECTOMY AFTER BLOCKADE

The results are shown in the following tables 21, 22.

Table 21. 2.0 kg M

	Normal	Blockade and parathyroidectomy
		2.5
1 hr	2	2.5
2 hrs	4	4.5
3 hrs	6	6.5

Table 22. 1.8 kg M

	Normal	Blockade and parathyroidectomy
		2.5
1 hr	2	2.5
2 hrs	4	5
3 hrs	6	7

The rate of sedimentation was increased.

### 3. EFFECT OF INJECTION OF PARATHORMONE IN NORMAL RABBITS

Parathormone was given intravenously at the rate of 1 to 5 units per k.g. and the results are noted in the following tables 23, 24, 25.

Table 23. 2.0 kg M (5u p. k.)

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2	2	2	2	2
2 hrs	4	4.5	4	4	4	3.5	4
3 hrs	6	6.5	6	5	5.5	4.5	6

Table 24. 1.8 kg M (1u p. k.)

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2	2	2
2 hrs	4.5	3.5	4	4	4	4	4
3 hrs	6	5.5	6	5.5	6	6	6

Table 25. 1.7 kg M (2u p. k.)

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	1.5	2	3	2	2	2	2
2 hrs	3	4	4	4	4	4	4
3 hrs	5	4.5	5.3	5	6	6	6

There was no special effect on the sedimentation velocity of red blood cells after the injection of parathormone.

### 4. EFFECT OF INJECTION OF PARATHORMONE AFTER BDOCKADE

Parathormone was given as in number 3 and the results are noted in the following tables 26, 27.

Table 26. 2.0 kg M (2u p. k.)

	Normal	After Blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2	2	2	2	2	2
2 hrs	4	4	4.5	4	4	4	4	3.5
3 hrs	5.5	6	6	6	6	6	6	5.5

Table 27. 1.8 kg M (2u p. k.)

	Normal	After Blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2	2	2	2.5	2	3
2 hrs	4	4.5	4.5	4	4	4.5	4	5
3 hrs	6	7	6	6	5.5	6.5	6	7

I found that there were no effect of parathormone injection on the red cell sedimentation after blockade.

## c. THE EFFECT OF SPLEEN HORMONE

The spleen has only recently been recognized as an organ of internal secretion. The relationship between the S. V. of erythrocytes and spleen function has been reported by many investigators. Kosawa reported increased fibrinogen content of the blood after splenectomy. Kame (154) noted increased globulin and decreased albumin in blood after splenectomy. Takashima (112) and Kitaoka (60) have reported on the blood coagulation time. Sakai (105), Shibayama (110), Tsunashima (155), Matsuhara (80), Seiffert (99) reported rapid sedimentation rate of erythrocytes after splenectomy, while no effect upon the S. V. of red cells was noted after splenectomy.

## 1. EFFECT OF SPLENECTOMY IN NORMAL RABBITS

The results are recorded in the following tables 28, 29.

Table 28. 1.7 kg M

	Normal	After splenectomy	
		6 D	10 D
1 hr	2	2	2
2 hrs	4	4	4
3 hrs	5	5.5	6

Table 29. 2.0 kg M

	Normal	After splenectomy		
		2 D	4 D	6 D
1 hr	2	2.5	2.5	2
2 hrs	4	4.5	5	4
3 hrs	5.5	6.5	6.5	5

I found a rather more rapid sedimentation rate after splenectomy in normal rabbits.

## 2. EFFECT OF SPLENECTOMY AFTER BLOCKADE

The results are shown in the following tables 30, 31.

Table 30. 2.0 kg M

	Normal	Blockade and splenectomy
1 hr	2	2.5
2 hrs	4	4.5
3 hrs	5	6.5

Table 31. 1.8 kg M

	Normal	Blockade and splenectomy
1 hr	2	2.5
2 hrs	3.5	4
3 hrs	4.5	6

As the tables show the S. V. of erythrocytes was augmented.

## 3. EFFECT OF THE INJECTION OF SPLEEN EMULSION INTO NORMAL RABBITS

2% spleen emulsion was injected intravenously at the rate of 1.0 cc per k.g. The results are recorded in the following tables 32, 33.

Table 32. 1.8 kg M

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2	2	2.5
2 hrs	4	4	4	4	4	4	4.5
3 hrs	5.5	6	5.5	6	5	5	7.5

Table 33. 2.0 kg M

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2	2	2	2	2.5
2 hrs	4	5	4	4	3.5	3.5	5
3 hrs	6	7	5	6	5.5	5.5	7.5

There are no special changes in the S. V. of red cells after the injection of spleen emulsion in normal rabbits.

#### 4. EFFECT OF THE INJECTION OF SPLEEN EMULSION AFTER BLOCKADE.

The results are recorded in the following tables 34, 35.

Table 34. 1.85 kg M

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2	2	2	2	2	2
2 hrs	4	5	3.5	3.5	4	4	4.5	4
3 hrs	6	6.5	6	5.8	6	4.5	6.5	7

Table 35. 1.9 kg M

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2	2	2	2.0	2.5	3
2 hrs	4	5.5	4	3.5	4	3.5	4.5	5
3 hrs	6	6.5	6	5.8	6	4.5	6.5	7

The injection of spleen emulsion after blockade showed no special effect.

#### 1. THE EFFECT OF ADRENAL HORMONE

Since Addison reported in 1855 the syndrome known as Addison's disease, and Takamine succeeded in 1901 in isolating adrenalin, many investigators have reported on this subject. The relationship between the S. V. of red cells and adrenalin gland hormones have been investigated by such workers as Seuderi, Morros, Sarda and Gaston who studied the sedimentation time in epilepsy, and Takebayashi (111) Ishiwari (41), Okamura (93) who studied the rapid sedimentation of erythrocytes after injection of adrenalin. Watanabe (131-132) however reported no influence upon the sedimentation time.

## 1. EFFECT OF CORTEX HORMONE

Interenin by intravenous injection, was used at the rate of 1 cc per k.g. of body weight.

## A. EFFECT OF CORTEX HORMONE IN NORMAL RABBITS

My results are given in the following tables 36, 37.

Table 36. 2.0 kg M

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	3	2.5	2.5	3.5	2	2
2 hrs	5	6	5.5	5.5	5.5	5	4.5
3 hrs	8	9	8.5	9	8	7.5	7

Table 37. 2.0 kg M

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	3	3	2	2
2 hrs	4	5	6	5	5	4	4
3 hrs	6	7	7.5	6	7	6	6

In the rabbits receiving interenin intravenously, augmentation of the velocity was noted.

## B. EFFECT OF CORTEX HORMONE AFTER BLOCKADE

The results are recorded in the following tables 38, 39.

Table 38. 1.95 kg M

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	1.5	2.5	2.5	2	2.5	2	2	2
2 hrs	3.5	4.5	5	4	4	4	4	4
3 hrs	5.5	6.5	6.5	5	6	6	6	6.5

Table 39. 1.9 kg M

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2.5	2	2	2	2	2
2 hrs	4	4	4	4	4	4	4	4.5
3 hrs	5	6	6	6	6	6	6	7

There is no influence upon the sedimentation time due to interenin injection.

## 2. EFFECT OF ADRENALIN

1:1000 adrenalin solution (Sankyo) was injected intravenously at the rate of 0.5 cc per k.g. of body weight.

## A. EFFECT OF ADRENALIN IN NORMAL RABBITS

The following tables 40, 41 show the results.

Table 40. 2.0 kg M

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2.5	2	2.5
2 hrs	4	3	4	4	4.5	4	4
3 hrs	6	5	5	6.5	6.5	6	6

Table 41. 2.0 kg M

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2	2	2
2 hrs	4	3.5	3	4	4	4	4
4 hrs	6	5	5	6	6	6	6

The S. V. of red cells is decreased, but not markedly.

#### B. EFFECT OF ADRENALIN AFTER BLOCKADE

The following tables 42, 43 show my results.

Table 42. 1.5 kg M

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2	1.5	2	2	2	3
2 hrs	4	5	3.5	3	4	4	5	5
4 hrs	6	6.5	5	5	6	6	7	7

Table 43. 2.0 kg M

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2	2	1.5	2	2	2.5
2 hrs	4	5	4	4	3.5	4.5	4	4.5
3 hrs	6	7.5	6	6	6	7	5.5	6.5

The S. V. of red cells is increased after the injection of Indian ink, but is decreased after the injection of adrenalin.

#### e. THE EFFECT OF INSULIN

Since Banting discovered insulin in 1923, many investigations have been reported on the subject, especially on the relationship between insulin and blood sugar. Kanemori (52) reported decreased S. V. of red cells during convulsions due to insulin. Jindo (145) reported decrease after removal of the pancreas and increase after the injection of insulin. Pico-Francesche and Negrete (20) reported both increase of S. V. of red cells and lower blood sugar. Martens (79) recorded a relation between S. V. of red cells and necrosis of the pancreas.

##### 1. EFFECT OF INSULIN IN NORMAL RABBITS

Insulin (Lilly) was used at the rate of 1-5 units per k.g. and the results are recorded in the following tables 44, 45.

Table 44. 1.8 kg M (1u. p. k.)

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2	2	2
2 hrs	3	3	3.5	3	4	3	4
3 hrs	5	4	4	4	6	4	6

Table 45. 2.5 kg (5u. p. k.)

	Nor- mal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2	2	2.5
2 hrs	4	4	4	3.5	3.5	3.5	4.5
3 hrs	5	6	5	5	4.5	5.5	6.5

As the tables show, the velocity was decreased but not markedly.

## 2. EFFECT OF INSULIN AFTER BLOCKADE

Insulin was given at the rate of 1-5 units per k.g. after blockade and the results are recorded in the following tables 46, 47.

Table 46. 1.8 kg M (1u.)

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2	3	2	2.5	3	3	2
2 hrs	4	4.5	5	4	4.5	5	5	4.5
3 hrs	6	6.5	6.5	6	6	7	7	6.5

Table 47. 2.3 kg (5u. p. k.)

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2	2.5	2	3
2 hrs	3.7	4	4.5	5	4	5	4	5
3 hrs	5.7	6.5	6	7	6	8	6	7.5

As shown in the tables the velocity first decreased but later increased.

## f. THE EFFECT OF SEX HORMONE

Since Fahraeus (21) reported in 1918 that the velocity of sedimentation is increased in the pregnant woman as compared with the nonpregnant woman, many investigators have reported a relation between sex and the sedimentation rate. Marukami (72), Kimura (51), Ryan and Johnson (97), Ogasahara (89), Takebayashi (111), Trifon (115) reported decrease of S. V. of red cells after ovariectomy and Ogasahara (89) reported increase of S. V. of red cells but it was uncertain as to whether the reaction is entirely due to luteohormone. Takebayashi (111) reported no special influence on the S. V. of red cells after ovariectomy, except a slight increase of S. V. of red cells for a few days. Uta (124)(129) reported no effect of ovarian hormone on the S. V. of red cells and the results are not the same when the urine of pregnant women was injected. Wakata (130) reported

increase of sedimentation rate after orchidectomy but was uncertain as to whether the reaction was actually due to the operation and it was most reported by thyreo-thymectomy. Trifon (115) also reported increase of velocity after orchidectomy. Vasaturo (134) reported no definite effect on the sedimentation rate. Kanemori (52) reported increased velocity after orchidectomy but no change at all after the injection of the testicular hormone. Takebayashi (111) reported no influence of orchidectomy. Yun (144) reported increased velocity after orchidectomy.

### 1: EFFECT OF TESTICLE HORMONE

#### A. EFFECT OF ORCHIDECTOMY IN NORMAL RABBITS

Both testicles were removed. The results are recorded in the following tables 48, 49, 50.

Table 48. 2.0 kg M

	Normal	After Castration	
		5 D	15 D
1 hr	2	2	2
2 hrs	3.5	4	4
3 hrs	5	6	6

Table 49. 1.8 kg M

	Normal	After Castration
		6 D
1 hr	2	2
2 hrs	3	4
3 hrs	4.5	5.5

Table 50. 2.0 kg M

	Normal	After Castration	
		6 D	17 D
1 hr	2	2	2
2 hrs	3.5	4	4
3 hrs	5	6	6.5

As the tables show, the velocity was increased after castration.

#### B. EFFECT OF ORCHIDECTOMY AFTER BLOCKADE

Both testicles were removed after blockade, and the results are recorded in the following tables 51, 52, 53.

Table 51. 2.0 kg M

	Normal	After blockade and castration
1 hr	2	2.5
2 hrs	4	4.5
3 hrs	5	6

Table 52. 2.0 kg M

	Normal	After blockade and castration
1 hr	2	2.5
2 hrs	3.5	5
3 hrs	5	7

Table 53. 2.0 kg M

	Normal	After blockade and castration
1 hr	2	2.5
2 hrs	4	4.5
3 hrs	5	6.5

As shown in the tables, the velocity is also increased by castration.

### C. EFFECT OF INJECTION OF TESTICLE HORMONE INTO NORMAL RABBITS

The testiglandol was injected intravenously at the rate of 1 cc per k.g. and the results are shown in the following tables 54, 55.

Table 54. 1.85 kg M

	Normal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2	2	2
2 hrs	4	4	3.5	4	4	4	4
3 hrs	6	5	5	5.5	5.5	6	6

Table 55. 2.2 kg M

	Normal	After injection					
		15'	30'	60'	2 h	4 h	24h
1 hr	2	2	1.8	1.5	1.5	2	2
2 hrs	3	3	3.8	3	3	4	3
3 hrs	4.5	4	5	4	5	6	4

Thus, the velocity is also decreased by injection of testiglandol.

### D. EFFECT OF INJECTION OF TESTICLE HORMONE AFTER BLOCKADE

The results are recorded in the following tables 56, 57.

Table 56. 1.7 kg M

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2.5	2.5	2	2	2	2	3
2 hrs	4	4.5	4.5	4	4	4	4	5
3 hrs	5	6	6.5	6	6	6	6.5	7

Table 57. 1.8 kg M

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2	2	2	2
2 hrs	4	5.5	4	4	4	3	4	4
3 hrs	5.5	6.5	6	6	6	5	6	6

There was no influence due to testiglandol on the velocity after blockade.

## 2. EFFECT OF OVARIAN HORMONE

## A. EFFECT OF OVARIOTOMY IN NORMAL RABBITS

Both ovaries were removed, and the results are shown in the following tables 58, 59.

Table 58. 1.85 kg F

	Normal	After ovariectomy	
		4 D	8 D
1 hr	2	2	2
2 hrs	3.5	3	4
3 hrs	4.5	4.5	5

Table 59. 1.9 kg F

	Normal	After ovariectomy	
		4 D	8 D
1 hr	2	2	2
2 hrs	4	4	4
3 hrs	6	5.5	6

There was no special influence of the S. V. of red cells after ovariectomy in normal rabbits.

## B. EFFECT OF OVARIOTOMY AFTER BLOCKADE

Both ovaries were removed. The results are recorded in the following tables 60, 61.

Table 60. 1.76 kg F

	Normal	After blockade
		and ovariectomy
1 hr	2	2.5
2 hrs	4	5
3 hrs	6	7

Table 61. 2.0 kg F

	Normal	After blockade
		and ovariectomy
1 hr	2	2.5
2 hrs	4	4.5
3 hrs	5	5.5

The S. V. of red cells increased after blockade and ovariectomy.

## C. EFFECT OF INJECTION OF OVARIAN HORMONE IN TO NORMAL RABBITS

Ovaglandol was injected at the rate of 1 cc per k.g. and the results are noted in the following tables 62, 63.

Table 62. 2.2 kg F

	Normal	After injection				
		15'	30'	60'	2 h	4 h
1 hr	2.5	2	2	2	2	2
2 hrs	4.5	3.5	3.5	4	4	4
3 hrs	6.5	5.5	5.5	5	5	5

Table 63. 2.0 kg M

	Normal	After injection				
		15'	30'	60'	2 h	4 h
1 hr	2	2	2	2	2	2
2 hrs	4	4	3.5	4	3	4
4 hrs	6	5	5.5	5.5	5	6

The S. V. of red cells increased after the injection of ovaglandol in normal rabbits.

## D. EFFECT OF INJECTION OF OVARIAN HORMONE AFTER BLOCKADE

Ovaglandol was given as above after blockade, and the results are recorded in the following tables 64, 65.

Table 64. 2.0 kg F

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2	2	2	2
2 hrs	4	4	4	4	4	3.5	3.5	4
3 hrs	5.5	6	6	6	6	5.5	5.5	6

Table 65. 1.9 kg F

	Normal	After blockade	After injection					
			15'	30'	60'	2 h	4 h	24h
1 hr	2	2	2	2	2	2	2	2
2 hrs	3.5	4	3	3	3	4	4	4
3 hrs	4	6	5.5	5	5	6	6	6

THE S. V. of red cells decreased as a result of ovaglandol injection after blockade.

### 3) THE INFLUENCE OF CERTAIN PHYSICO-CHEMICAL CHANGES OF THE BLOOD ON SEDIMENTATION VELOCITY AFTER BLOCKADE OF THE R. E. S.

Numerous investigators have confirmed the main facts about S. V. of red cells. But Okada (92), Klinck (150), Kanemori (52) Shibayama (110) Otani (95), Hubbard and Geiger (33), Kagan (149), Minamiyoshi (73), Okamura (93) state that cells or hemoglobin are the main factors while Takebayashi (111), Pines and Joffe (96), Knosp (54), Ryan, Johnson, Geishimer (97) Pico-Franceschi & Negrete (20), Nakayama & Shimoi (84), Klinick (150), Takebayashi (111), Asahi (4), Tsunashima (155), Sano (108), Shimizu (101), Yo (135), Linzenmeir (62), Uebara (124), Murakami (72), state that some constituent of serum is the primary factor. Evidently they do not agree themselves, and a final satisfactory explanation has not been reached as yet.

#### 1. BLOOD CELLS AND HEMOGLOBIN

The Thomas-Zeiss' method and Sahli's method were used. The following table gives my results.

Table 66.

No.	Sex.	Body weight	Normal				After blockade			
			S. V.	W.B.C.	R.B.C.	Hb%	S. V.	W.B.C.	R.B.C.	Hb%
1	M	1.5 kg.	5.0	5000	6460000	80%	5.5	6800	5860000	66%
2	M	1.7 kg.	5.0	6500	5500000	70%	6.0	7200	4200000	65%
3	M	1.8 kg.	5.0	8000	6260000	70%	6.5	9600	4250000	55%
4	M	2.0 kg.	5.0	8600	6350000	75%	7.0	9000	6030000	60%

As shown in the table in every case the white cell count increased and the red cell and hemoglobin decreased after blockade.

## 2. BLOOD VOLUME, VISCOSITY AND FRAGILITY OF ERYTHROCYTES

Hedin-Koeppé's method and Hess' Viscosimeter were used and 0.58%–0.32% of salt solution used for testing fragility of the erythrocytes, and the series of saline solutions varied 0.02%. The results are recorded in the following table 67.

Table 67.

No.	Sex.	Body weight	Normal				After blockade			
			S. V.	Blood volume	Viscosity	Fragility of erythrocytes	S. V.	Blood volume	Viscosity	Fragility of erythrocytes
1	M	2.0 kg.	5.0	40	1.6	0.44% 0.48%	6.0	35	1.6	0.40% 0.50%
2	M	2.0 kg.	4.5	40	1.5	0.42% 0.50%	6.0	35	1.4	0.38% 0.48%
3	M	1.7 kg.	5.0	40	1.5	0.46% 0.50%	6.5	30	1.5	0.52% 0.50%

The results recorded, show that the blood volume decreased after blockade and there was no positive effect on the sedimentation velocity. There was also no noticeable effect on the fragility of the rod blood cells after blockade.

## 3. GLOBULIN, ALBUMIN AND FIBRINOGEN CONTENT OF THE SERUM

Abbes refraktometer was used for this work. The results are recorded in the following table 68.

Table 68.

No.	Sex.	Body weight	Normal				After blockade					
			S. V.	Protein %	Globulin %	Albumin %	Fibrinogen %	S. V.	Protein %	Globulin %	Albumin %	Fibrinogen %
1	M	1.5 kg	5	5.90	44.8	52.8	0.370	5.5	6.12	45.9	54.1	0.448
2	M	2.0 kg	5	5.03	39.5	60.5	0.367	6.0	5.03	39.5	60.5	0.388
3	M	1.7 kg	4	4.59	38.5	61.5	0.224	5.0	4.59	38.5	61.5	0.244

As shown by the table, the globulin, albumin and content show no special relation with the S. V. of red cells, and fibrinogen content was increased in them after blockade.

## 4. BLOOD CALCIUM, BLOOD CHOLESTEROL AND BLOOD SUGAR CONTENT

Kramer-Tisdal's method for calcium and Sachett's modification of Bloor's method for cholesterol, Hagedorn and Jensen's method for sugar were used. The results are recorded in the following table 69.

Table 69.

No.	Sex.	Body weight kg.	Normal				After blockade			
			S. V.	Serum calcium mg.-%	Blood cholesterol mg.-%	Blood sugar %	S. V.	Serum calcium mg.	Blood cholesterol mg.-%	Blood sugar %
1	M	1.6	4.5	12.2	195	0.232	5.0	14.3	202	0.232
2	M	1.75	4.5	13.0	215	0.240	6.0	13.6	216	0.268
3	M	2.0	5.0	11.4	258	0.241	6.0	13.0	250	0.255

As the table shows the serum calcium increased after blockade and the blood sugar also increased. There was no definite change in the blood cholesterol.

## DISCUSSION

In summarizing the above mentioned experiments, I found that the S. V. which depends upon certain physico-chemical changes in the blood is influenced by certain endocrine glands and by the R. E. S. When the R. E. S. is blocked by an injection of Indian ink, the S. V. become increased.

No influence on the S. V. by thyroidectomy in normal rabbits and no influence on the S. V. after the injection of thymoglandol was noted in normal or blocked rabbits.

After parathyroidectomy the S. V. increased in normal and blocked rabbits, and no influence was noted on the S. V. after the injection of parathormon. The S. V. increased after splenectomy in normal or blocked rabbits. But no influence on the S. V. was noted after the injection of spleen emulsion in either normal or blocked rabbits. The S. V. is increased by an injection of interenin, but it is decreased (or inhibited) in blocked rabbits.

After adrenalin injection the S. V. decreased in normal or blocked rabbits. After insulin injection the S. V. is decreased in the normal rabbits, but in blocked rabbits there is no definite effect.

Many reports agree that the S. V. is influenced by sex. The S. V. is increased in normal or blocked rabbits by castration, but no influence on the S. V. is noted in normal or blocked rabbits receiving testiglandol.

In normal rabbits the S. V. is only slightly increased by ovariectomy, but the S. V. increased in blocked ovariectomized rabbits and the injection

of ovaglandol maintains protects the S. V. in normal or blockaded rabbits, but the effect is not marked.

Since the above changes occurred in my experimental work, as the result at the time of the removal of endocrine organs or exhibitions of endocrine substances I attempted to ascertain what physico-chemical changes occurred in blockaded rabbits. I found that red cells, hemoglobin and blood volume all decreased but white cell count increased. The viscosity was not affected. Fragility of the erythrocyte, globulin and albumin did not show any remarkable change, the blood calcium increased. Blood sugar and cholesterol are not appreciably changed, and there was the increase of fibrinogen.

Thus both blood cells and seem to have an important influence on the acceleration of S. V. of red cells after R. E. S. blockade. But it is very difficult to say that these are the only influences at work on the S. V. of red cells. It is also impossible to maintain that any single organ has an influence on the S. V. of red cells from the results of extirpation of endocrine organs or administration of certain endocrine substance after R. E. S. blockade in experimental animals.

### CONCLUSIONS

1. The S. V. of red cells is increased by R. E. S. blockade.
2. The S. V. of red cells increased after parathyroidectomy, splenectomy, also after orchidectomy and ovariectomy; also after interenin injection. It is decreased after the injection of adrenalin and insulin.
3. The S. V. of red cells is increased by castration, splenectomy and ovariectomy after R. E. S. blockade, and is decreased by injection of interenin, adrenalin, insulin and ovaglandol after R. E. S. blockade.
4. The Erythrocyte count, hemoglobin and blood volume is decreased when the S. V. of red cells increased as a result of R. E. S. blockade, while the white cell count increased. There seems to be no definite relationship of the S. V. with globulin, albumin, cholesterol, viscosity or fragility of erythrocytes after R. E. S. blockade. However blood sugar, fibrinogen and serum calcium did increase somewhat.

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