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Research Article

THE EFFECT OF POSTURE UPON THE VELOCITY OF BLOOD FLOW IN MAN

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INTRODUCTION

We (1) (2) have observed that a much longer time elapses in the standing still position than in the recumbent position before an intravenously injected dye attains a uniform concentration in the blood throughout the body. Measurements of the velocity of blood flow in different positions of the body have now been made by a dye method.

METHOD

The experiments were done in either the morning or early afternoon, with the subjects fasting. All experiments were preceded by a rest period of at least 30 minutes in the horizontal position. When in the upright position the subjects stood with their feet about 6 inches apart and remained as motionless as possible. About 2.5 to 3.0 cc. of a 4 to 5 per cent solution of brilliant vital red was quickly injected into a cubital vein or into a foot vein (usually the internal saphenous just below the internal malleolus). This amount of dye produced a well marked coloring of the serum and its injection rarely required more than 5 seconds. In the standing still position, the arm was held horizontally when dye was injected and down by the side when blood was collected.

In order to determine the time of the appearance of dye in the venous blood of any part of the body, venous blood from that part was collected in small test tubes which were changed at 15 second

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TABLE 1

Case	Date	Position of body	Time		Site of injection	Time (seconds) that elapsed between beginning of injection and appearance of dye in			
			Of assuming position	Of dye injection		Right arm vein	Left arm vein	Right foot vein	Left foot vein
1 W. M.	July 11, 1927	Lying	11.30 a.m.	1.41 p.m.	Right arm vein		30–45	45–60	
	July 21, 1927	Lying	8.00 a.m.	10.40 a.m.	Right foot vein	60–75 ?Trace at 45–60	60–75 ?Trace at 45–60		
	July 7, 1927	Standing still	2.04 p.m.	2.35 p.m.	Right arm vein		45–60	? slight trace at 120–135 Trace at 135–150	
	July 28, 1927	Standing still	10.19 a.m.	10.43 a.m.	Left foot vein	85–100		Trace at 160–175	
2 M. E. D.	July 26, 1927	Lying	11.00 a.m.	1.07 p.m.	Left foot vein	30–45	30–45		
	August 2, 1927	Lying	12.00 m.	3.00 p.m.	Right arm vein		30–45		?Trace at 75–90++ at 90–105*
	July 29, 1927	Standing still	1.13 p.m.	1.25 p.m.	Left foot vein	60–75	None up to 75 but ++ at 120–135†		

3 M. M.	July 19, 1927 July 13, 1927 July 26, 1927	Lying Standing still Standing still	2.00 p.m. 2.01 p.m. 3.00 p.m.	4.12 p.m. 2.23 p.m. 3.08 p.m.	Right foot vein Right arm vein Left foot vein	40–55 None up to 75§	55–70 15–30 (Slight) 75–90 (Trace)	None up to to 120‡	
4 J. G.	July 15, 1927	Standing still	11.25 a.m.	11.33 a.m.	Right arm vein		45–60		None up to 120¶
5 D. B.	July 30, 1927	Lying	10.00 a.m.	2.00 p.m.	Left foot vein	30–45 (Trace)			

* Had to keep tourniquet lightly applied to left leg in order to get any blood.
† Collection of blood from left arm vein was suspended from the 75th to 120th second.
‡ Had to stop collection after 120 seconds, because subject fainted.
§ Subject had to sit down after 75 seconds because of weakness. Fainted 15 seconds later
¶ Subject felt so faint after 120 seconds that collection had to be stopped.

intervals, starting from the time of the beginning of the injection. The blood thus collected was allowed to clot in an ice chest and was then centrifuged. The presence of dye was detected by the color of the serum.

The arm to arm circulation time for the recumbent position found by this method is longer than that reported by Blumgart and his co-workers (3). This difference can probably be accounted for by the fact that in Blumgart's method (4):

1. The injection time is shorter.
2. The distance travelled is shorter (vein to artery instead of vein to vein).
3. The recording apparatus is sensitive enough to detect the first particle of radium C that arrives within its field, whereas in our method a small amount of dye probably appears in the blood a few seconds before its concentration becomes great enough to cause a perceptible coloring of the serum.

The method we have used is, of course, a rough one but is accurate enough to show marked changes.

EXPERIMENTAL RESULTS

The data are summarized in table 1. They show two significant things:

1. A much longer time is required for the dye to travel from a foot vein to an arm vein or the reverse in the standing still position than in the recumbent position.
2. The application of a tourniquet to a lower extremity so as to produce a moderate increase in venous pressure, when the subject is in the recumbent position, appears to be just as effective as the standing still position in prolonging the appearance time of the dye.

When the subject is in the standing still position, the dye seems to take a longer time to go from an arm vein to a foot vein than in the reverse direction. Thus in cases 1, 3 and 4, more than 120 seconds elapsed in each instance before dye injected into an arm vein appeared in a foot vein (i.e., at least twice as long as in the recumbent position, and probably longer). In cases 1 and 3, on the contrary, 85 to 100 and 75 to 90 seconds respectively elapsed before dye injected into a

foot vein appeared in an arm vein (i.e., at least $1\frac{1}{2}$ times as long as in the recumbent position). This result, if corroborated by further experiments, is difficult to explain satisfactorily at present.

Observations by several workers (5), (6), (7), (8), (9), have shown that, in the standing still position, blood circulates with difficulty and collects in dependent portions of the body, owing to the effect of gravity. Our findings are in harmony with these observations.

CONCLUSION

A much longer time is required for blood to move from an arm vein to a foot vein or the reverse when an individual is in the standing still position than when he is in the recumbent position.

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