

α -tocopherol, oxidation would be unimpeded at this point and could continue at an excessive rate. Information on the enzyme systems concerned is necessary to an understanding of the rôle of tocopherol in muscle physiology.

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Plasma Volume Changes Following the Intravenous Injection of Pectin and Physiologic Saline in Man.

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The use of pectin as a blood substitute in the treatment of patients in shock has been proposed.¹ Since the rationale for the administration of pectin is to increase the plasma volume, information regarding the effect of this material upon the plasma volume is desirable. The present investigation was undertaken to determine the influence of the intravenous injection of a 0.75% solution of pectin[†] upon the plasma volume, and to compare the results with similar observations following the intravenous injection of physiologic saline.

Nine male patients, who were normal with respect to the cardiovascular system were studied. The plasma volume was determined by the method of Gibson and Evans² as modified by Gibson and Evelyn³ using "Evans Blue" dye (T-1824). In 5 patients after the initial determinations were made, pectin solution was injected intravenously at a rate of 10 cc per minute. In 2 patients dye was reinjected and the plasma volume was redetermined immediately upon completion of the pectin infusion. In 3 patients the second plasma volume determination was made 4 hours after the end of the pectin infusion. In all cases a final determination was made at the end of 24 hours. Similar determinations at corresponding time

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¹ Hartman, F. W., Schelling, V., Harkins, H. N., and Brush, B., *Ann. Surg.*, 1941, **114**, 212.

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² Gibson, J. G., and Evans, W. A., *J. Clin. Invest.*, 1937, **16**, 301.

³ Gibson, J. G., and Evelyn, K. A., *J. Clin. Invest.*, 1938, **17**, 153.

intervals were made in 4 patients following the intravenous injection of 1000 cc of physiologic saline.

Results. Table I shows the results obtained following the injection of an average of 690 cc of pectin in 5 patients as compared with the results in 4 patients each of whom received an intravenous injection of 1000 cc of physiologic saline. In the first 2 cases the plasma volume immediately following the injection of pectin was increased by an amount corresponding to the volume of pectin solution injected. In the next 3 cases the plasma volume 4 hours after the end of the pectin injection was significantly increased, the amount of increase being greater than the volume of the pectin solution injected. At the end of 24 hours the plasma volume was approximately its initial value in 2 patients (J.P., R.M.) while in 3 patients (L.C., J.R., E.W.) a definite increase in plasma volume was still present.

Plasma volume determinations done at corresponding time intervals following the injection of 1000 cc of physiologic saline indicate that immediately after the end of the injection the amount of increase in plasma volume was significantly less than the volume of fluid injected. At the end of 4 hours following the 1000 cc infusion the average increase in plasma volume was only 350 cc. At the end of 24 hours the plasma volume was approximately the initial level.

Discussion. We have determined the alterations in plasma volume following the intravenous injection of 0.75% pectin solution and physiologic saline in 9 men with no cardiovascular disease. The

TABLE I.
Comparison of Plasma Volume Changes Following Injection of Pectin and Physiologic Saline.

Patient	Initial plasma vol., cc	Amt injected cc	P.V. in cc at end of infusion	Increase or decrease cc	P.V. in cc 4 hrs after end of infusion	Increase or decrease cc	P.V. in cc 24 hrs after end of infusion	Increase or decrease cc
Pectin								
J.P.	2760	750	3540	+780			2800	+ 40
L.C.	2700	675	3300	+600			2940	+240
J.R.	2710	750			3630	+920	2830	+120
E.W.	3150	625			3820	+670	3580	+430
R.M.	3730	650			4700	+970	3720	— 10
Avg		689		+690		+853		+164
Saline								
R.P.	3490	1000	3980	+490			3540	+ 50
R.K.	3025	1000	3340	+315			3200	+175
F.D.	3010	1000			3340	+330	2980	— 30
J.B.	2425	1000			2810	+385	2580	+155
Avg		1000		+402		+357		+ 87

method employed permits a direct comparison of the ability of various infusions to increase the plasma volume. The data presented indicate that the intravenous injection of pectin solution effectively increases the plasma volume, and that the degree of increase corresponds to the amount injected. Furthermore, the increased plasma volume persists for at least 4 hours after the end of the infusion. In some cases a definite increase in plasma volume was present 24 hours later. These results are in sharp contrast to those obtained following the injection of 1000 cc physiologic saline. Although a larger volume of fluid was injected in the 4 experiments in which physiologic saline was used, the increase in plasma volume at corresponding time intervals was strikingly less than the amount of fluid introduced.

The 5 patients who received pectin and who at the same time received Evans Blue dye (T-1824) for plasma volume determinations all developed a purpuric rash on the ninth day after the pectin was given. In 2 instances the purpura was associated with swelling and moderate pain in several of the large joints. Both joint and skin manifestations disappeared entirely within 5 days. Complete blood and platelet counts, urinalysis and vitamin C blood level determinations were normal in each case. Subsequent reinjection of pectin in the same patients without determining the plasma volume did not produce these symptoms. No such reactions were observed following the saline experiments.

The development of the purpuric skin lesions is probably in some way related to the combination of pectin solution and the dye used in this study, since pectin given alone to the same patients who had previously developed purpura was not associated with this reaction. Pectin solution has been given to 125 patients,⁴ and in no instance have similar changes been observed. The dye given alone was not attended with purpura. The purpuric reactions which we have observed are being investigated further.

The results of this investigation indicate that pectin when injected intravenously is effective in producing marked and sustained rises in the plasma volume of normal individuals, and that pectin deserves intensive study to determine its value as a blood substitute for the treatment of patients in shock.

⁴ Personal communication, F. W. Hartman, M.D., Henry Ford Hospital, Detroit, Mich.