Minnesota Section.

University of Minnesota, May 28, 1930.

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A Parallelism Between Blood Sugar, Blood Calcium and Blood Coagulability in Normal and Jaundiced Dogs.

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(Introduced by Arthur D. Hirschfelder.)

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It has been noted by many early observers, among them Wright,[1] that the coagulation time of blood was decreased after meals. Schreiber[2] and Kehr[3] suggested the preoperative and postoperative use of intravenous glucose in obstructive jaundice, but it was not used extensively until Crile and Walters advocated it 5 years later. Partos and Svec[4] pointed out that a relation existed between the sugar content and coagulability of the blood, namely, that with increasing blood sugar the clotting time is reduced. They demonstrated this effect following the injection of various substances which produce a hyperglycemia, *e. g.*, glucose, epinephrine, theobromine sodium salicylate and morphine. Ravdin[5] presented a series of experiments in which he attempted to justify the use of intravenous glucose in cases having lesions of the biliary apparatus and who were poor operative risks.

In determining coagulation time we used 2 methods simultaneously in all cases, (1) that of Lee and White[6] and (2) a modification of the method of Wright[7] (using pieces of glass tubing 40 mm.

[1] Wright, A. E., *Brit. Med. J.*, 1894, ii, 57.

[2] Schreiber, E., *Centralbl. f. Chir.*, 1913, ii, 1200.

[3] Kehr, H., *Ergebn. d. Chir. u. Orthop.*, 1914, viii, 471.

[4] Partos, A., and Svec, F., *Cerch. f. d. ges. Physiol.*, 1927-8, ccxviii, 209; 1928, ccxix, 481.

[5] Ravdin, S., *J. Am. Med. Assn.*, 1929, xciii, 1193.

[6] Lee, R. I., and White, P. D., *Am. J. Med. Sci.*, 1913, cxlv, 495.

[7] Wright, A. E., *Brit. Med. J.*, 1893, ii, 223.

long and 2 mm. internal diameter). Tests for coagulation were made every half minute. The two methods usually checked within one-half minute; often the results were identical; occasionally a minute's difference was observed, especially in cases where the coagulation time was very long, as in the jaundiced animal. Serum calcium determinations were made by the method of Kramer and Tisdall.[8, 9] Blood sugars were determined, using the Folin-Wu technique.[10] Serum bilirubin was determined by Thannhauser and Anderson's modification[11] of van den Bergh's method. All experiments were done on dogs fasted over night.

Both normal and jaundiced dogs were used. We confirmed the results of previous workers, that an increased blood sugar, produced by the injection of glucose intravenously or by other methods, is accompanied by an increased coagulability. However, the coagulability does not increase simultaneously with the blood sugar, but lags behind for from 15 minutes to one and a half hours; nor does the coagulability decrease with the blood sugar, but in many cases stays up several hours after the sugar content is again normal. It was noted that with increasing time following total obstruction of the common bile duct, it became increasingly more difficult to bring the coagulation time down to normal, although the blood sugar curve became more and more flattened out as jaundice progressed. In a few experiments where the dogs had been without food for longer periods of time than 12 hours, the blood sugar rose only slightly after intravenous injection of glucose, returned to normal or subnormal very quickly, and the effect on the coagulation time was less. In well fed jaundiced dogs, however, an injection of 50-75 cc. of 50% glucose brought the coagulation time down to well within the normal range and maintained it there for several hours.

No rational explanation has been offered for the mechanism by which an increase in blood sugar reduces the coagulation time of the blood. We have found, however, that the intravenous injection of glucose in sufficient amounts and concentration causes a rise in the blood calcium, as well as an increased coagulability. This increased coagulability seems to parallel the blood calcium curve more closely than that of the blood sugar, as the accompanying table will show:

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[8] Kramer, B., and Tisdall, F. F., *J. Biol. Chem.*, 1921, xlvii, 475.

[9] Tisdall, F. F., *J. Biol. Chem.*, 1923, lvi, 439.

[10] Folin, O., and Wu, H., *J. Biol. Chem.*, 1920, xli, 367.

[11] Thannhauser, J. S., and Anderson, E., *Deut. Arch. f. Klin. Med.*, 1921, cxxxvii, 179.

TABLE I.
Normal dog No. 5, wt. 19 kg., fasted over night.

Time	Coagulation Time		Blood Sugar	Serum Calcium
	Lee and White	Wright		
Normal	11 min.	11 min.	76 mgm. %	10.0 mgm. %
Injection of 75 cc. of 50% glucose intravenously in 15 Min.				
5 min.	8 min.	8 min.	230 mgm. %	10.2 mgm. %
15 "	4 "	4 "	168 " "	13.6 " "
30 "	5½ "	5 "	102 " "	14.2 " "
1 hr.	4 "	4 "	72 " "	13.4 " "
1½ "	4 "	4 "	74 " "	12.6 " "
2½ "	3 "	3 "	68 " "	12.4 " "
3½ "	4 "	4 "	68 " "	11.7 " "

The injection of hypertonic sodium chloride (isotonic with 50% glucose) produced a moderate rise in blood sugar, a rise in blood calcium over a period of several hours and a corresponding decrease in the coagulation time of the blood.

We are led to conclude, therefore, that the reduction in the coagulation time of the blood following the intravenous injection of glucose or of substances which produce a hyperglycemia, is accompanied by an increase in the blood calcium which persists after the blood sugar has returned to normal and closely parallels the coagulability of the blood.

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Evaluation of X-Ray Evidence as a Criterion of Strangulation Obstruction.

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Recently Wangensteen and Lynch[1] indicated that the accumulation of gas in the small intestine as visualized by X-ray examination was an early and reliable criterion of obstruction to the continuity of the bowel. In this study an attempt has been made to evaluate the significance of X-ray evidence in the early recognition of strangulation obstruction.

Strangulation obstruction in dogs was established under aseptic conditions employing local anesthesia (procaine) of the abdominal wall fortified by the preliminary injection of morphine sulphate.

[1] Wangensteen, O. H., and Lynch, F. W., PROC. SOC. EXP. BIOL. AND MED., 1930, xxvii, 674.