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Lowered Colloid Osmotic Pressure Leads to Water and Salt Retention and Edema Formation.

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Eight hundred cc. of blood were removed by puncture of the right ventricle from a dog weighing 13 kilos. The citrated blood was centrifuged and the supernatant plasma pipetted off. The corpuscles were suspended in a quantity of Ringer's solution equal to the plasma pipetted off, again centrifuged and the supernatant Ringer's solution pipetted off. The corpuscles were now suspended in Ringer's solution containing 0.1% glucose in quantity sufficient to bring up the total volume to 800 cc. This was injected into the jugular vein. 200 cc. of Ringer's solution were also injected into the jugular vein. This procedure, bleeding, removal of plasma, suspension of corpuscles in Ringer's solution and reinjection into the jugular vein, was done 5 times in 18 hours. The plasma proteins were 1.7% at the time of the third removal of blood from the dog's ventricle. The plasma proteins were 2.2% and the osmotic pressure as measured in the osmometer was 5.0 mm. Hg. at the beginning of the fifth removal of blood plasma.

The dog received 500 cc. of physiological salt solution by stomach tube at 5 different times, 2500 cc. in all. In addition he drank voluntarily 1260 cc. of water. The dog received a total of 4760 cc. of water and 31.5 gm. of salt above what his body contained at the start of the experiment. The dog put out 950 cc. of urine containing 9.3 gm. of salt in 26 hours, 3800 cc. of water and 22.5 gm. of salt were retained. The dog gained 3300 gm. in weight in 22 hours. The dog showed pitting edema and ascites at the end of 26 hours when he was sacrificed. There were 500 cc. of ascitic fluid in the abdomen and there was edema of the subcutaneous tissues of the legs at autopsy examination. Examination of the kidneys revealed normal kidneys.

The same procedure was applied to another dog of 9 kilos excepting that there were only 4 removals of blood and only 700 cc. of blood were removed each time. After removing the supernatant plasma and washing the corpuscles in Ringer, 350 cc. of Ringer's solution containing 0.1% glucose and enough gum acacia to make up

a 6% solution of gum acacia[1, 2] was added to the corpuscle volume. This mixture was injected back through the jugular vein together with an extra 200 cc. of Ringer's solution. The plasma proteins were 2.1% and the osmotic pressure of the plasma colloids were 20 mm. Hg. at the beginning of the second bleeding. The plasma proteins were 1.0% at the beginning of the fourth bleeding. The plasma proteins were 0.9% and the colloid osmotic pressure was 15 mm. Hg. 22 hours after beginning the experiment. The dog had received 3300 cc. of water and 20.8 gm. of NaCl within the 22 hours. 800 cc. of this water and 6.4 gm. of salt were injected intravenously. He put out 2600 cc. of urine in this time and 20.1 gm. of salt. His weight increased only 450 gm. in 22 hours. At autopsy there was no ascites nor signs of edema in the subcutaneous tissues or muscles excepting around the jugular veins in the neck where the gum acacia solution had been injected intravenously. Local edema about the intravenous injection site is a common finding in these experiments when the colloid osmotic pressure is lowered to 16 mm. Hg. or less, even where there is no marked retention of water and no generalized edema.

A third dog weighing 8 kilos received 2500 cc. of water and 20.8 gm. of salt, in the same manner except that no blood was removed, no plasma protein removed and no acacia given. 800 cc. of this water and 6.4 gm. of salt were injected intravenously. This dog urinated 2400 cc. containing 19.9 gm. of salt. The dog lost 500 gm. in weight in 22 hours.

These experiments prove conclusively that lowering the colloid osmotic pressure to ⅓ its normal value at the same time that large quantities of water and salt are given leads to water and salt retention and edema. And they also prove that it is the osmotic pressure and not the presence of protein that is responsible for the maintenance of normal water and salt balance in the body.

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[1] Bayliss, W. M., *Proc. Royal Soc., London*, 1916, **89**, 380.

[2] Hartman, Alexis, *et al.*, *J. Am. Med. Assn.*, 1933, **100**, 251.