11144

Composition of Bone in Extreme Osteoporosis Associated with Hepatoma.

ARILD E. HANSEN, L. S. PALMER AND J. WESLEY NELSON.

From the Department of Pediatrics, University of Minnesota, Minneapolis, and the Department of Agricultural Biochemistry, University of Minnesota, St. Paul.

The presence of a marked degree of decalcification of the entire skeleton in a 10-year-old boy suffering from extensive carcinomatous involvement of the liver prompted the investigation herein reported. A preliminary report of the clinical and laboratory studies in this case was given last year by Hansen, Ziegler and McQuarrie.[1] The osteoporosis developed early in the course of the disease and continued to progress throughout the 18 months he was under observation. The specimen of rib bone obtained shortly after exitus was freed from all muscular attachments, cleaned, weighed and stored at −20°C until ready for analysis. The entire specimen was prepared for analysis in each case. The manner of preparation of the specimens, the chemical methods, and system of calculations were the modification of Kramer and Howland's[2] procedure, and are reported elsewhere.[3] The results of the analyses, calculated on green, dry, and dry extracted bases are presented in Table I, together with similar data obtained on the rib bones of a 9-year-old boy having no demonstrable abnormality of the osseous system.

The data in Table I show that there had been a marked replacement of bone minerals by lipid and water, amounting to 27.8% when regarding the bones of the control subject as normal. Slightly more than 80% of this was lipid (alcohol-ether soluble) material. The data also show that the dry, lipid-free bone of the hepatoma patient had 31.4% less Ca, 33.8% less P, 39.0% less Mg and 37.9% less CO_2 than that of the control. On the basis of the system of calculation employed, it appears from these results that there was relatively more $CaCO_3$ and $Mg_3(PO_4)_2$ than $Ca_3(PO_4)_2$ withdrawn from the bone. The calculated ratio, residual Ca:residual P, is thus about 5% less in the abnormal bone. This difference, however, is probably not significant, for it is within the range of such

[1] Hansen, Arild E., Ziegler, M. R., and McQuarrie, I. *Proc. Am. Soc. Exp. Path., Arch. Path.*, 1938, **25**, 757.

[2] Kramer, B., and Howland, J., *J. Biol. Chem.*, 1926, **68**, 711.

[3] Neal, W. M., and Palmer, L. S., *J. Agr. Res.*, 1931, **42**, 107.

TABLE I.

Percentage Composition of Green, Dry, and Dry Extracted Bone from Child with Hepatoma (Case 1, L.C.) Together with Similar Data from Child with No Abnormality of the Osseous System (Case 2, G.L.).

	Case 1, L.C.	Case 2, G.L.			
	Rib	7th rib	8th rib	Mean	Difference*
H_2O	48.05	36.00	33.76	34.88	
Alcohol and ether extract { Green	16.32	3.68	3.24	3.46	
Alcohol and ether extract { Dry	31.42	5.75	4.89	5.32	
Ash { Green	14.87	35.56	35.72	35.64	58.2
Ash { Dry	28.63	55.56	53.93	54.75	47.8
Ash { " extracted	41.74	58.95	56.70	57.83	27.8
Ca { Green	5.08	13.75	14.15	13.95	
Ca { Dry	9.78	21.49	21.36	21.43	
Ca { " extracted	14.36	22.80	22.46	22.63	31.4
P { Green	2.41	6.24	6.34	6.29	
P { Dry	4.64	9.75	9.57	9.66	
P { " extracted	6.76	10.35	10.06	10.21	33.8
Mg { Green	0.067	0.196	0.182	0.189	
Mg { Dry	0.129	0.307	0.275	0.291	
Mg { " extracted	0.188	0.326	0.289	0.308	39.0
CO_2 { Green	0.75	2.06	2.11	2.09	
CO_2 { Dry	1.44	3.22	3.18	3.20	
CO_2 { " extracted	2.10	3.42	3.34	3.38	37.9
Ca as $CaCO_3$ (.91 × $\%CO_2$)	1.91	3.11	3.04	3.08	38.0
P as $Mg_3(PO_4)_2$ (.86 × %Mg)	0.16	0.28	0.25	0.27	40.7
Residual Ca (%Ca — Ca as $CaCO_3$)	12.35	19.69	19.42	19.56	36.9
Residual P (%P — P as $Mg_3(PO_4)_2$)	6.60	10.07	9.81	9.94	33.6
Ratio $\frac{\text{Residual Ca}}{\text{Residual P}}$	1.871	1.955	1.980	1.968	4.9
$CaCO_3$ (2.27 × $\%CO_2$)	4.77	7.77	7.59	7.68	37.9
$Ca_3(PO_4)_2$ (5 × %Residual P)	33.00	50.35	49.05	49.70	31.6
Ratio $\frac{Ca_3(PO_4)_2}{CaCO_3}$	6.918	6.480	6.462	6.471	+7.0
$Mg_3(PO_4)_2$ (3.6 × %Mg)	0.68	1.17	1.04	1.11	38.7
Total $CaCO_3 + Ca_3(PO_4)_2 + Mg_3(PO_4)_2$	38.45	59.29	57.68	58.49	34.3

*Percentage difference between normal specimen and specimen from hepatoma case.

values reported by Howland, Marriott and Kramer.[4] More significant is the calculated $Ca_3(PO_4)_2$:$CaCO_3$ ratio, which is definitely higher in the abnormal bone. It has been shown[4] that this ratio decreases in rickets and that it also decreases in phosphorus deficiency,[5] but rises in calcium deficiency. Therefore, it appears that the situation encountered in this bone abnormality is more analagous to calcium deficiency than to either phosphorus deficiency or rickets.

[4] Howland, John, Marriott, W. McKim, and Kramer, Benjamin, *J. Biol. Chem.*, 1926, **68**, 721.

[5] Neal, Wm., Palmer, L. S., Eckles, C. H., and Gullickson, T. W., *J. Agr. Res.*, 1931, **42**, 115.