IRCS Medical Science: Anatomy and Human Biology; Biochemistry; Cell and Membrane Biology; Connective Tissue, Skin and Bone; Experimental Animals; Pathology, 9, 640 (1981)

BIOCHEMICAL CHARACTERISTICS OF CORTICAL AND CANCELLOUS RABBIT BONE

A.K. Susheela and Mohan Jha

Fluoresis Research Laboratory, Department of Anatomy, All India Institute of Medical Sciences, New Delhi, India

Paper received: 11th June, 1981

Although there are a number of reports on the chemical composition of mammalian cortical bone (1, 2), there is a paucity of information on the chemical composition of cancellous bone. As cortical and cancellous bones differ structurally, it is believed that these bones may also differ biochemically. However, there is no scientific evidence to support this view. The present report is therefore aimed at elucidating the fundamental biochemical differences between cortical and cancellous bone of rabbit. This report could be of value in understanding the response of cortical and cancellous bone to various pathological conditions.

Chemical composition of cortical and cancellous bone (means ± SD)

	Cortical bone (n = 8)	Cancellous bone (n = 6)
Inorganic (Ash) content	58%	45%
Organic content	24%	28%
Water	18%	27%
Density‡‡	1.9 ± 0.14	1.6 ± 0.16
Hydroxyproline**	2.15 ± 0.22	3.32 ± 0.32*
Nitrogen (N)**	4.66 ± 0.55	5.11 ± 0.26*
Hexosamines**	0.24 ± 0.02	0.33 ± 0.03*
Calcium (Ca^{++})††	256000 ± 9800	178000 ± 32000 *
Magnesium (Mg^{++})††	6600 ± 530	3980 ± 510 *
Zinc (Zn^{++})††	199 ± 36	222 ± 61
Phosphorus (P)†	10.23 ± 1.23	9.35 ± 2.33
Fluoride‡	805 ± 44	895 ± 58
Molar ratio Mg/Ca	0.04	0.04
Ratio P/N	2.20	1.83

**Significantly different from cortical bone at $P < 0.05$. †Data expressed as mg% of dry defatted bone. ††Data expressed as ppm of dry defatted bone. ‡Data expressed as ppm of dry defatted bone ash. ‡‡g/cc wet defatted bone.*

Materials and methods: Normal healthy rabbits aged 6–8 months were sacrificed. Cortical bone from the diphyseal region of femur and cancellous bone from the iliac crest region of the pelvic girdle were dissected out. Marrow free cortical and cancellous bones were defatted in ether acetone mixture (1:1 v/v) and dried in acetone for biochemical analysis. Dry fat free bone samples were analyzed for organic constituents. Total hydroxyproline (3), nitrogen (4) hexosamines (5) and phosphorus (6) were quantitated. The inorganic constituents *viz.* calcium, magnesium and zinc were determined by atomic absorption spectroscopy (7). The fluoride content was estimated by using ion specific electrodes (8). Density, water, total inorganic and organic contents were determined using the method by Robinson and Elliot (9).

Results and discussion: From the results obtained (table), it is evident that cortical bone contains more inorganic and less organic and water content than cancellous bone. Density of the cortical bone exceeds that of cancellous bone. Among the various organic constituents analyzed, cortical bone has significantly less hydroxyproline, nitrogen and hexosamines. Among the inorganic constituents analzyed, calcium and magnesium levels are higher in cortical bone. However, the zinc, phosphorus and fluoride contents are not significantly different between cortical and cancellous bone.

The molar ratio of magnesium/calcium (Mg/Ca) which is an index of the rate of conversion of amorphous tricalcium phosphate (ACP) to crystalline hydroxyapatite (HA) (10), was the same both in cortical and cancellous bone. The ratio of phosphorus to nitrogen (P/N) is higher in cortical bone, suggesting higher degree of calcification in cortical bone.

In conclusion it may be added that the cortical bone differs biochemically from cancellous bone with respect to a number of parameters that have been investigated. It is therefore unlikely that the responses of cortical and cancellous bone to various pathological conditions will be the same.

1. Campe, R.D. and Tomtellette, C.D. (1967) *Biochim. Biophys. Acta*, 141, 614
2. Puglierello, M.C., Vittur, F. and de Bernard, B. (1973) *Calcif. Tissue Res.*, 12, 209
3. Kivirikko, K.I., Laitinen, O. and Prockop, D.J. (1967) *Anal. Biochem.*, 19, 249
4. Minari, O. and Zilversmit, D.B. (1963) *Anal. Biochem.*, 6, 320
5. Edley, D. (1957) *Biochem. J.*, 67, 52
6. Fiske, C.H. and Subha Rao, Y. (1925) *J. Bio. Chem.*, 66, 375
7. Parker, H.E. (1963) *Atomic Absorpt. Newsl.*, 13, 1
8. Singer, L. and Armstrong, W.D. (1969) *Anal. Chem.*, 40, 613
9. Robinson, R.A. and Elliot, S.R. (1957) *J. Bone. Joint Surg.*, 39A, 167
10. Eanes, E.D. and Posner, A.S. (1965) *Trans. N.Y. Acad. Sci.*, 28, 233

We wish to thank Dr. V. Subramanium, Associate Professor, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi for providing laboratory facilities for carrying out investigations using Atomic Absorption Spectrometer. We are also grateful to the Department of Environment, Government of India for financial support.