Bromine and selenium in human aorta

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SUMMARY The bromine and selenium concentrations of healthy and atheromatous human aorta and of other organs are reported. No relation between age and concentration in the aorta is found. The selenium levels of the aorta are similar to those of other internal organs; the content of the three layers show no significant differences. The bromine concentrations of the media are higher than those of the other layers, which are similar to those of the internal organs. A possibly greater concentration of bromine in atheromatous medial tissue is indicated.

Many diseases and malfunctions of the body, such as cancer, coronary heart disease, and multiple sclerosis, have been associated with abnormal trace element concentrations.^{1,2} Wester,² for example, describes significant increases and decreases in the concentrations of some elements between healthy and injured heart tissue.

During studies of two of the lesser known elements, bromine,³ and selenium,⁴ methods for measuring them in human tissue and body fluids were developed. Little is known about the role of bromine in the body, but our findings (Table 1)

accumulating this element. Atherosclerotic aorta tissue was also analysed and compared with healthy tissue.

Fatty material from atherosclerotic lesions is known to contain peroxides of fatty acids, which are not present in healthy tissue.⁶ One of the functions of selenium in the body is that of non-specific antioxidant, and it is a constituent of the enzyme that prevents the accumulation of toxic peroxides within the cell.⁷ Peroxides can also be decomposed by selenomethionine, a predominant selenium amino acid in the body.⁸ Since increased selenium in animal feed has been shown to increase the activity of lipid antioxidants⁹ it seemed pertinent to investigate the selenium content of healthy human aorta and to compare this with the levels in diseased material. Layers of healthy intima, media, and adventitia were analysed individually and compared with diseased tissue and plaque regions. Age dependence was also investigated.

Table 1 Bromine content ($\mu\text{g/g}$ dry weight) of human tissue

Tissue	No.	Mean	SD	Range	Median
Blood	22	21.9	6.4	10.5-33.8	22.5
Brain	22	9.2	4.1	4.0-16.4	8.5
Heart	24	15.4	4.6	8.4-23.4	15.1
Kidney	24	29.0	7.2	15.3-45.4	28.4
Liver	24	12.0	5.5	4.5-32.1	11.8
Lung	24	35.8	14.9	3.3-63.8	34.7
Pancreas	14	13.4	7.2	3.3-29.7	13.0
Pectoral muscle	14	9.4	6.1	1.2-25.5	7.7
Spleen	24	21.8	7.6	8.3-41.0	21.9
Stomach	14	28.6	16.2	10.4-73.0	24.7

suggest that it may well be an essential element for man.⁵ The highest bromine levels were found in human aorta, and this tissue showed an unusually broad range of concentrations (6.3-101 ppm dry weight, mean 48.4, standard deviation (SD) 26.7 ppm). This prompted a study to find whether the bromine concentrations in aorta are age-related and which, if any, of the aortic layers is responsible for

Methods

SAMPLING

Samples of aorta were collected post mortem from subjects who had died from various causes. Their ages ranged from 1 day to 79 years. They had had no known unusual exposure to bromine or selenium.

The samples were separated visually into those showing atherosclerosis and those that were apparently healthy. The layers of intima, media, and adventitia were separated as far as possible, and the plaque regions were removed and collected.

METHODS OF ANALYSIS

The aortic material was freeze-dried and analysed by

thermal neutron activation analysis. Bromine was determined instrumentally³ with the 777 KeV photopeak of ⁸²Br, and selenium was measured by the radiochemical separation technique developed by Raie and Smith.⁴

Results

Tables 1 and 2 show the levels of bromine and selenium in healthy tissue taken from subjects who had died as a result of violence.

Tables 3 and 4 compare the bromine and selenium concentrations of 'healthy' and diseased aortic tissue.

Table 2 Selenium content ($\mu\text{g/g}$ dry weight) of human tissue

Tissue	No.	Mean	SD	Range	Median
Blood	25	0.77	0.11	0.59-1.02	0.74
Brain	13	1.59	1.06	0.66-4.34	1.23
Hair	46	2.24	0.84	1.27-4.11	1.96
Heart	9	1.38	0.61	0.47-2.44	1.43
Kidney	8	4.18	0.81	2.85-5.01	4.38
Liver	14	2.47	0.80	1.50-3.83	2.54
Lung	8	1.43	0.63	0.35-2.28	1.33
Spleen	9	1.59	0.29	1.04-1.94	1.65

Table 3 Bromine content ($\mu\text{g/g}$ dry weight) of human aorta

Type	Tissue	No.	Mean	SD	Range	Median
Normal	Intima	9	70.6	20.8	42.9-101	69.7
	Media	9	86.2	15.1	67.5-110	90.6
	Adventitia	9	52.3	10.9	37.9-70.5	50.5
Atheroma	Intima	9	64.8	38.8	21.0-127	48.8
	Media	9	104	17.1	85.8-139	103
	Adventitia	9	60.8	15.8	29.0-80.9	61.4
Total	Intima	18	67.7	30.4	21.0-127	66.9
	Media	18	95.0	18.1	67.4-139	94.7
	Adventitia	18	56.5	13.9	29.0-80.9	53.4

Table 4 Selenium content ($\mu\text{g/g}$ dry weight) of human aorta

Type	Tissue	No.	Mean	SD	Range	Median
Normal	Intima	3	1.20	0.22	0.79-1.72	1.09
	Media	3	0.96	0.02	0.82-1.08	0.98
	Adventitia	3	1.07	0.05	0.87-1.32	1.01
Atheroma	Intima	6	1.67	0.68	0.93-2.78	1.58
	Media	7	1.23	0.32	0.82-1.87	1.20
	Adventitia	7	0.95	0.43	0.38-1.65	0.92
Total	Intima	9	1.51	0.63	0.79-2.78	1.58
	Media	10	1.15	0.30	0.82-1.87	1.10
	Adventitia	10	0.99	0.37	0.38-1.65	0.96
	Plaque	3	1.05	0.42	0.58-1.39	1.17

STATISTICAL INTERPRETATION

The Spearman correlation procedure was applied to test for any relation between age and bromine or

between age and selenium concentration in the aorta; none was found.

Wilcoxon's sum of ranks test showed the bromine concentration in the media to be significantly higher than that in the intima or adventitia. The selenium content of the three layers showed no significant differences.

After separating aorta showing significant atheroma from visually healthy specimens, Wilcoxon's sum of ranks test was reapplied to the data. The selenium concentrations in the atheromatous tissue were found to be similar to those in the corresponding layers of healthy tissue. The calcific plaque regions were similar in selenium content to the surrounding tissue.

The bromine content of diseased intima and adventitia was found to be indistinguishable from that of healthy tissue. The media, however, showed higher bromine concentrations when atheromatous. Wilcoxon's sum of ranks test showed this to be probably significantly higher, but the small number of samples analysed precludes any more positive interpretation.

Discussion

The selenium content of the aorta is evenly distributed and is generally similar to that of other internal organs (Table 4). Aorta showing significant atheroma is indistinguishable from visibly healthy tissue in selenium content. This suggests that the build-up of fatty material known as atherosclerosis is unrelated to the selenium content of the tissue.

The bromine concentration in the media is greater than that in the other aortic layers and is possibly higher in atheromatous tissue than in 'healthy' material. Gaunt *et al.*¹⁰ have recognised that lipids provide binding sites for bromine, noting a rapid increase in lipid-bound bromine in adipose tissue of rats fed with brominated maize oil. The increased lipid content of the atheromatous lesions could therefore provide a greater number of binding sites for bromine, which might explain the difference between healthy and diseased tissue levels.

The medial layer of human aorta is known to contain age-dependent lipids, which are not found in the other layers,¹¹ but since no age relationship was found, the increased bromine content of this layer cannot be specifically associated with these age-dependent lipids.

Conclusion

For all age groups the media of the aorta contains more bromine than the layers on either side of it,

and bromine is possibly further concentrated in atheromatous medial tissue, perhaps bound to lipids.

The selenium content of human aorta is similar throughout its layers and is similar to that of most of the internal organs. It neither increases nor decreases with age, and atheroma does not significantly alter its concentration in the aorta. It seems unlikely, therefore, that the build-up of toxic peroxides, which causes atherosclerosis, results from a deficiency of selenium in the aorta.

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