Hair Analysis: A Diagnostic Tool for Measuring Mineral Status in Humans

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Abstract

The importance of minerals in maintaining optimum body and mental functions is creating much research and interest, comparable to that of vitamins in 1930s. The use of hair mineral analysis as a screening and diagnostic tool commenced in a routine and commercial manner in the early 1970s. Its growing use would not likely have occurred as rapidly had it not been for the concomitant development of sophisticated automated and computerized instrumentation. Its present popularity amongst researchers and health practitioners parallels the growing recognition of clinical nutrition.

A brief history of the use of this screening and diagnostic tool will be discussed as well as the evolution of the instrumentation. Procedures for obtaining the sample, preparation and the actual analysis and interpretation will be covered. Examples of the usefulness of hair mineral analysis and its possible future role will also be addressed.

Introduction

It was discovered that Napoleon's hair which was analyzed in 1961 contained 100 times the normal level of arsenic, suggesting that he was poisoned (1).

Agricultural researchers in 1971, preceded the use of hair analysis for humans when animal scientists of Brigham Young University measured mineral deficiencies in cattle (2). Your author was probably the first to commence this procedure for humans in Canada in 1974 and has been involved in it since then. By 1983 there have been over 1,500 citations in the world's scientific literature to attest to the usefulness of hair analysis as a screening diagnostic tool (3). While it is being used routinely on a world-wide scale especially in the U.S.A., unfortunately its use has not been generally accepted by the Canadian Medical Establishment. This may be explained by its recent development and rapid growth. Unfortunately, some unethical laboratories have brought disrepute to the movement. They made extravagant claims and were less than careful in the analytical procedures. The U.S. Government has found it necessary to stop such practices. A group of responsible holistic

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physicians and researchers established in 1982 the Hair Analysis Standardization Board and published the recommended procedures (4). Further guidance and assistance *to* technicians is available through the American Society of Elemental Testing Laboratories (ASETL).

Lab Procedures

A significant breakthrough came when an Australian, Dr. Alan Walsh, developed the Atomic Absorption Spectrophotometer in the early 1950's. Since then the instrument of choice appears to be plasma jet spectrophotometry.

After the hair sample is received, it is washed by non-toxic detergent containing a small quantity of Ethylene-diamine-tetraacetate (EDTA) to remove any possible surface contamination. It is then filtered under vacuum on Buchner funnels and washed several times with distilled water. The semi-dry specimen is covered by acetone and air dried under vacuum. The dried specimen is weighed on an analytical balance and wet-ashed under acidic conditions in a water bath. When the digestion is finished the sample is transferred to a hot plate and under controlled temperature, is concentrated, and made to volume (1:10 dilution). The liquid sample is fed automatically into the unit where a nebulizer atomizes the sample. Argon gas carries the atomized sample into the plasma where a temperature of over 10,000 degrees C is reached. The excited atoms emit photons of radiant energy (light) with a specific wave length for each element. Photomultiplier tubes convert the emitted light to electrical energy proportional to the intensity of the spectral lines. A computer converts the signals into desired concentration units such as ppm which can then be read directly from the terminal (5).

With such sophisticated equipment, samples can be analyzed in minutes, which under the older methods would have taken hours. At the same time accuracy too, has greatly improved and costs kept down.

Obtaining Sample

A kit is mailed or given to anyone requesting a hair mineral analysis. It usually consists of:

1. Detailed instructions and diagram of how the sample is obtained.
2. A paper balance, which indicates the one gram required sample.
3. An envelope to hold and identify the sample.
4. A nutritional survey or questionnaire which details the person's food choices, lifestyle, supplements or medications being used. As well, they may include the name of one's doctor and health problem(s).

The sample then goes to the laboratory for analysis of 16 essential minerals and five toxic ones.

Interpretation of Results

The laboratory sends a report including an interpretation for use by the patient's medical advisor. The lab readings are divided into 4 columns: (1) A list of the essential minerals, toxic metals and significant ratios, (2) The normal ranges, (3) The actual results (in ppm), and (4) A graphic representation of the results.

After studying the report, along with the patient's questionnaire, a report is made as follows:

A. General Remarks.

B. Suggestions.

Depending on the individual, information is sent to guide the patient into corrective measures.

Usefulness of Hair Analysis

Jenkins of the U.S. Environmental Agency states, "if human hair samples are collected properly, cleaned and prepared for analysis correctly, and analyzed by the best analytical methods, using standards and blanks as required, in clean and reliable laboratory by experienced personnel, the data are reliable" (6). He also reported that human hair has been selected as one of the important monitoring materials for worldwide biological monitoring in the Global Environmental Monitoring Systems (GEMS) of the United Nations Environmental Program. As well, the International Atomic Energy Agency (IAEA) has in 1972, initiated a program for monitoring trace metals.

Blood analysis indicates what is happening; urine, what has happened. Hair analysis reflects what has happened at the cellular level for a period of about three months prior to the sampling. The hair follicle develops the protein keratin which strongly chelates minerals. Like the bones and other organs, hair may be the repository of essential minerals and for harmful metals such as lead (Table 1) which tend to leave the blood within a few hours. This is why hair analysis is an excellent biological biopsy material. Maugh (7)'in Science suggested that hair mineral analysis has the potential to complement blood, serum and urine mineral analysis. He pointed out that it is easily collected, stored and analyzed. The minerals concentrate 10-50 times higher than in the blood. Laker (8) in the Lancet reported that hair minerals are easier to analyze than blood, due to the presence in the blood of complex protein, porphyrins, sugars and a "host of other substances."

Dr. Lazar, speaking for the American Medical Association in 1974 presented a list of reasons that hair would be an inappropriate tissue for mineral analysis, but this was in the early years of development. Since then these problems have largely been resolved. For example, we recommend that a patient whose hair has recently been bleached or cold waved, should wait until new growth will allow a suitable sample. By knowing that a patient has been using a hair darkening product containing lead acetate, or shampoos containing selenium or zinc, allowances can be made in interpreting the results.

Table 1. Common Sources of Toxic Minerals

Aluminum	Cookware
	Antacids
	Antiperspirants
	Aluminum Cans
Arsenic	Insecticides
	Wine
	Well Water
	Coal Burning
	Seafood (Particularly Shellfish) Cadmium
	Water from galvanized pipes
	Evaporated milk
	Shellfish
	Cigarette smoke
	Sewage sludges
	Paint Pigments
Copper	Copper plumbing
	Sewage sludge
	Beer
	Swimming pools
	Copper cookware
	Mineral Supplements
Lead	Atmospheric exhaust
	Paint
	Plumbing
	Tuna Fish (canned)
	Hair dyes (lead acetate)
	Newsprint
	Lead shot
	Canned juice or fruit
Mercury	Dental Fillings
	Seafood from bottom of ocean
	Treated seed grain
	Polluted water
	Skin lightening creams
	Sewage sludge

Important Relationships

Jacob et al. (9) reported a linear correlation between hair copper levels, and liver copper levels in animals.

High cadmium has been related to hypertension (10), aluminum has been implicated in Parkinsonism and Alzheimer's Disease. Excessive aluminum results in a higher output of parathyroid which results in bone loss or decalcification of hard tissue (11). Using hair analysis Dr. Chatt in Halifax, N.S. has shown a lower level of lead in rural vs. urban and highest in individuals living close to lead smelters (12). It has been estimated that the average lead level in the human body is 1,000 times what it was 1,600 years ago (13). The Roman Empire became the first civilized society to use lead. They lined their wine casks with this metal. Some believe the high intake of lead contributed to the decline of that great Empire. Some are now saying that history is repeating itself. We Canadians have been breathing in the toxic fumes from leaded gasoline. A study by Dr. Patterson

found that children showing chronic lead body burden may have come from canned tuna which exceeds the natural concentration of some 10,000 fold. This is likely due to the lead soldered seams of the cans (14). High levels of lead are related to mental dysfunction (15, 16, 17). Drs. Pihl and Parkes of McGill University (18) found that learning disabled children had much higher lead than control children. He suggested routine screening by Hair Analysis. It has been suggested in England that lead mining should cease. A prominent Standard Oil Executive upon learning of the growing lead pollution remarked that he'd like to see no lead added to gasoline. It appears that the Canadian Government is not as concerned as it should be in introducing stronger measures against leaded gasoline.

Mercury pollution resulted in Minamata disease in Japan. As a result of mercury added to the Winnipeg River from a Dryden paper plant, high levels of methylmercury in the fish have caused health and financial damage to the natives who depended on fish from this river. A great deal of work led by John Armstrong has gone on at the Fresh Water Institute in Winnipeg, Manitoba on this problem.

Dentists and their assistants working with amalgam fillings have been found to have five times as much body mercury as controls. This can result in depression, irritability, loss of memory and hand tremor (19). High copper may result in personality changes including aggressiveness (20).

Deficiencies

Low chromium and zinc are related to glucose intolerance and diabetes (Table 2) (21-22). Low zinc is related to poor wound healing, slow growth rate, low taste perception, slow hair growth and loss, night blindness, dermatitis, acne, strong body odor and an increased risk of dental caries. When very high in the hair it indicates a need for more zinc due to the slow growth of the hair (23).

When the level of calcium and magnesium reads high, it indicates osteoporosis or decalcification of the bones and calcification of soft tissue. When calcium deposits in such tissues as the arteries it could lead to atherosclerosis. When it goes to the joints it results in osteoarthritis.

Malabsorption

When minerals are generally low in a hair sample, it does not necessarily indicate a poor diet. Rather it could be due to malabsorption. As people age, they tend to have a lower level of stomach acid (achlorhydria), necessary for mineral utilization. Likewise, they could have chronic pancreatitis insufficiency or gastro-intestinal mucosal changes preventing absorption. The low fiber intake plus the high consumption of largely nutritionless foods such as sugar, white flour and fats flatten gastro-intestinal villae, essential for absorption (24).

Table 2. Symptoms of Trace Mineral Deficiences

Element	*Signs of Deficiency*
Chromium	Glucose intolerance, insulin insensitivity
Cobalt	Pernicious anaemia, methyl-malonic aciduria
Copper	Anaemia, Leukopenia, neu-tropenia, Menke's syndrome
Iodine	Thyroid insufficiency, thyroglobulin
Manganese	Fatty acid metabolism dysfunction Mucopolysaccharide insufficiency
Selenium	Glutathione peroxidase insufficiency Increased lipid peroxidation and cardiac and muscle abnormalities
Silicon	Increased tendency toward atherosclerosis connective tissue dysfunction
Zinc	Impaired wound healing, hypogonadism, night blindness, dermato-logical changes

Future Possibilities

The cost of analyzing a single mineral in the blood can be about $50.00; the same mineral analyzed by the hair is a fraction of that. A complete Hair and Nutritional Analysis test usually costs under $50.00. It could be used in the following ways:

1. A screening tool for individuals and populations at risk due to possible toxic metal exposure.
2. A screening tool in the mining and metallurgy industry.
3. A screening tool for learning disabled children or adults (25).
4. A screening tool for those associated with violence and who misbehave in an unlawful or criminal manner (26, 27).
5. Used in conjunction with other tests such as blood and urine to discover metabolic disorders before the onset of disease so that remedial action can be taken. Examples could be hypoglycemia, diabetes, Candida yeast, schizophrenia, dementia, atherosclerosis, arthritis and many more.

Such an excellent tool should be encouraged not only by holistic practitioners, but throughout the medical community.

References

1. MCDONALD, G.: Arsenic in Napoleon's Hair, Nature, 4798,103,1961.
2. KENNY, J.: Your Body's Chemical Balance Can be Assessed Through Your Hair. Runner's World (September, 1980).
3. PASSWATER, R.A. and CRANTON, E.M.: Trace Dements, Hair Analysis and Nutrition, Keats Pub. Inc. New Canaan, CT., 1983.
4. CRANTON, E.M. et al.: Standardization and Interpretation of Human Hair for Elemental Concentrations. J. Holistic Med. Vol. 4, No. 1, 1-16,1982.
5. TAMARI, G.M.: Director Anamol Laboratories Ltd., Toronto, Ont. Private Communication, Nov. 23,1984.
6. JENKINS, D.W.: Biological Monitoring of Toxic Trace Metals. U.S. Environmental Protection Agency. Las Vegas, Nevada. EPA Project Summary, Sept. 1980.
7. MAUGH, T.: Hair: A Diagnostic Tool to Complement Blood, Serum, and Urine. Science 202, 1271-1277,1978.
8. LAKER, M.: On Determining Trace Element Levels in Man: The Uses of Blood and Hair. The Lancet, 260-263, July 31,1982.
9. JACOB, R., KLEVAY, L. and LOGAN, G.: Hair as a Biopsy Material: Index of Hepatic Copper. Am. J. Clin. Nutr. 31,477-481,1978.
10. KOPP, S.J. and PERRY, E.F.: Cardiovascular Actions of Cadmium at Environmental Exposure Levels. Science 217,837-840,1982.
11. PERL, D.P.: Intraneuronal Aluminum Accumulation in Amytrophic Lateral Sclerosis and Parkinsonism - Dementia in Guam. Science, 217, 1053-1056,1982.
12. CHATT, A. and JARV/IS, R.E.: Hair as an indicator of Multi-element Exposure. Eighth Annual Conference on Trace Elements in Environmental Health, Columbia, MD, June, 1974.
13. ERICKSON, J.E., SHIRHTA, H. and PATTERSON, C: Skeletal Concentrations of lead in Ancient Peruvians. N. Eng. J. Medicine, 300: 946, 1979.
14. SETTLE, D.M. and PATTERSON, D.C.: Lead in Albacore: Guide to Lead Pollution in Americans. Science 207,1167,1980.
15. BRYCE-SMITH, D. MATHEWS, R. and STEPHENS, R.: Mental Health Effects of Lead on Children. Ambio, 7,192,1978.
16. EISINGER, J. and VALEINKAS J.: Central Nervous System Dysfunction Due to Lead Exposure. Science 201,465,1978. 17. NEEDLEMAN, H. and GUNNUE, C: Deficits in Psychological and Classroom Performance in Children with Elevated Dentine Lead Levels, N. Eng. J. Med. 689,300,1979. 18. PIHL, R.O. and PARKES, M.: Hair Element Content of Learning-Disabled Children, Science, 198,204,1977.
19. CROSS, J.E. et al.: Methylmercury in Blood of Dentists. The Lancet, 312, Aug., 1978.
20. KLEVAY, L.M.: Hair as a Biopsy Material. Part n, Assessment of Copper Nutritive, Am. J. Clin. Nutr. 23,1194,1970.
21. BLAND, J.: Trace Tissue Mineral Analysis: An Emergent Diagnostic Technique. Thorson's Pub. Inc., New York, 1984.
22. PRASAD, A.: Trace Elements in Human Health and Disease, Vols. I and II, Academic Press, New York, 1977.
23. STRAIN, W.H. et al.: Analysis of Zinc Levels in Hair for the Diagnosis of Zinc Deficiency in Man, J. Lab. Clin. Med., 68,244,1967.
24. KOPITO, L. et al.: Sodium, Potassium, Calcium, and Magnesium in Hair from Neonates with Cystic Fibrosis. Pediatrics 49,620,1972.
25. THATCHEN, R.W. et al.: Effects of Low Levels of Cadmium and Lead on Cognitive Functioning in Chfldren. Arch. Eng. Health, 37(3), 159-166, 1982.
26. RALOFF, J.: Locks — A Key to Violence? Science News, 24,122-124,1983.
27. SCHAUSS, A.G. and JACKSON, J.: Sub-occipital Hair Mineral Tissue Levels of Functional Caucasian Population as presented at the Int. Symposium on Nutritional Medicine. Queensland Aust. June 25,1983.