Laser elemental analysis of ancient Egyptian teeth

Cairo University
Giza, Egypt

Abstract

Physiologically, more than a dozen of trace elements are necessary for maintenance of good health. Deficiency of some of these elements, known as essential trace elements, may lead to negative health symptoms. However, any abnormal increase in the biological tissue contents of such elements and other elements too can be severely toxic and may lead to carcinogenic effects. This shows the importance of the elemental analysis of both soft and hard human tissues for early detection of any unbalance in its normal contents. Elemental composition of the body tissues has been also used to reconstruct the dietary habits and environmental condition of extinct population. Modern paleoanthropological research increasingly uses chemical and physical methods to analyze bone material to broaden and complement information and knowledge on the biological conditions of human groups, prehistoric diets, and the etiology of various diseases.(1,2) Mineralized tissues i.e., bones and teeth have been found to be excellent “archives” related to living habits, nutrition and mobility of the ancient as well as modern human.(3) Bones and teeth are found to maintain much of their biological signature from living phase over a long time, revealing e.g., the uptake of contaminants from the surrounding environments during certain periods. This can be attributed to the fact that, once incorporated in the hydroxyapatite structure of bone and tooth matrix, a number of elements are known to leach out only very slowly.(4) Anthropological applications of elements analyses are important in investigating the relationships between nutrition and disease and estimating the health effects of trace elements deficiencies or excesses in human tissues. Enamel, unlike other human tissues, has a special property: Its composition is fixed, and this could provide a historic record of trace elements absorbed during early development stage.(5) Diets, cultural, customs, and environmental levels of trace elements in soil and water may influence element uptake. Elements analysis has been used to investigate toxic pollutants, for example lead (Pb) exposure in historical populations or to explore the source of specific nutritional deficiencies among ancient peoples.(2) Here we report on the application of laser-induced breakdown spectroscopy (LIBS) to the analysis of important minerals and potentially toxic elements within teeth, and so the luminous plasma generated during laser ablation of dental tissue has been analyzed to determine qualitative elemental composition. It is clear that the sensitivity of LIBS may be insufficient in some cases to detect ultra-trace amount of elements and isotope distinction is largely impossible. However, LIBS has the definite advantage over most other techniques used for elemental analysis of teeth that spatial information is maintained. This information is completely lost in conventional analytical techniques during sample preparation by aching or acidic dilution.(6) Therefore, determination of element levels in teeth on one hand gives us complement knowledge of the diets, diagnostic, etiology of various diseases and on the other hand provide us with information about the environmental conditions of ancient Egyptians. Laser induced breakdown spectroscopy (LIBS) is a very promising elemental analysis method in archeology because it is mainly non invasive and non destructive.

Keywords