Exploring chronic arsenic poisoning in pre-Columbian Chilean mummies

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ABSTRACT

This paper explores to what extent arsenic poisoning affected pre-Columbian northern Chile populations living between Arica and Iquique cities. We hypothesize, the pre-Columbian inhabitants of this region, will show arseniasis according to modern geographic endemic levels. Continuous exposure to high levels of arsenic causes serious health problems. Today, in the Camarones valley, where many Chinchorro people lived, arsenic levels are 100 times above the 10 μg/L recommended by the World Health Organization (WHO). Using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) we determined arsenic levels in a single strand of hair of 45 Arica mummies coming from ten sites (Morro 1, Morro 1/5, Yungay 372, Camarones 8, 9, 15D, and 17 and Azapa 140, Sermenia and Patillos), ranging from Chinchorro (ca. 5000–2000 years B.C.) to the Late Intermediate Period (1000–1400 years A.D.). Each hair was cleaned using distilled ionized water and placed on double sided mounting tape and ablated using a 266 nm Nd-YAG UV laser. Hair samples were also investigated for potential diagenesis.

Results indicate minimal diagenesis. Arsenic hair (AsH) concentrations in the mummies ranged from <0.8 to 262.2 μg/g. We noted AsH variability within burial sites as well as regional variation. The Morro mummies have the highest mean group value (58 ± 103.8 mg/g). Contrary to hypothetical expectations, some Arica Chinchorro mummies have high values, perhaps indicating inter site mobility related to exogamous marriage and mummification rites. Our study shows that ancient people of northern Chile were significantly affected by arsenic poisoning throughout generations. Finally, this study calls attention to naturally occurring eco-toxic contaminants and its impact on ancient Andean people.

1. Introduction

Arsenic is a colorless, odorless and tasteless potent poison commonly found in contaminated rivers and in groundwater in many parts of the world, including the Atacama coastal desert region (Ahmad et al., 2001; Figueroa, 2001; Yañez et al., 2005). We hypothesize and debate here that ancient Andean societies of northern Chile were highly contaminated by arsenic. We suspect that even the Chinchorro, the earliest inhabitants of this region, were already affected by arseniasis beginning 7000 years ago. Several scholars have reported high arsenic levels in today’s northern Chilean environment (Cornejo, 2004; Figueroa et al., 1988; Figueroa, 2001; Yañez et al., 2005). Natural water sources, particularly in the Camarones valley located about 100 km south of the modern city of Arica, have arsenic levels 100 times higher than the 10 μg/L normal limit recommended by the World Health Organization. Chronic arsenic poisoning produces a myriad of health problems ranging from premature birth, stillbirths, neonatal death, skin disorders, growth arrest, neurological disorders and various types of cancer (Ahmad et al., 2001; Hopenhayn-Rich et al., 2000; Nordström et al., 1979). In addition, arseniasis causes teratogenic anomalies such as cleft palate and neural tube defects including spina bifida to name a few (Ahmad et al., 2001; Centeno et al., 2002; Hood, 1972). In northern Chile, particularly in the modern city of Antofagasta, about 700 km south of Arica, the correlation between drinking highly arsenical (800 μg/L) waters during the 1960s and its associated health consequences including increasing infant mortality and lung cancer for example have been well established (Ferreccio et al., 2000; Hopenhayn-Rich et al., 2000). Elsewhere (i.e. Bangladesh) similar health problems have been reported (Ahmad et al., 2001). Arsenic ingestion can be...