Metallographic, XRF and SEM/EDS Analyses of Probable Roman Surgical Instruments

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Abstract

The study of ancient surgical instruments during the past was not very thorough. Scientific attention in relation to this particular category of products, was founded only in coincidence of exceptional findings in the Vesuvius area in the mid-eighteenth century. From then on, the interest in this kind of artefacts was based essentially on an archaeological/stylistic study and almost never addressed the executing practices and materials used. The work concerns the study of ten probable ancient surgical instruments using non-invasive and micro invasive diagnostic techniques. In this context, no samples were withdrawn and all investigations have been carried out directly on the pieces respecting their integrity. X-ray fluorescence (XRF) was used for the elemental analysis of the components of the alloy and of the patina; metallographic analysis was attempted to understand the executing techniques, and finally the SEM analysis was useful to recognize the morphology and any traces of processing.

Introduction

As it is clear from the classical medical literature, surgical equipment in the Roman world was highly diversified. Many tools were made of organic material such as leather, wood, papyrus, etc ... but most were made of metal: copper and copper alloys, when a surface treatment was required, wrought iron or steel when a better hardiness was needed [1]. Another characteristic aspect of Roman surgical instruments is their dual functionality. In fact, it was a common practice to mount two instruments at the ends of the same handle [2-3]. The work concerns the study of ten metal objects, probably ancient surgical instruments, found with a hundred and twenty coins of different ages and origins by the Cultural Heritage forces of Rome Carabinieri. At the time of the study, we didn't known either the circumstances of confiscation or the possible origin of the objects, which were in good conditions and showed no corrosion. The analyses were performed in the laboratories of ISCR to which they were assigned for being studied. The aim was to chemically characterize them and to study the morphology and production techniques, contributing to a chapter of classical archaeology and history of medicine, unfortunately, still barely studied.

Materials & Methods

Each specimen was treated first with sandpaper, then polished with a cloth and a diamond paste, grain size of 6 and 1 μm respectively. The surfaces were then washed with ethanol to eliminate organic compounds possibly deposited in the pores of the samples. To observe the morphology and orientation of the crystalline grains, we attacked the treated surface with an alcoholic solution of $FeCl_3$ (reagent commonly used for copper alloys [4-5]). This was poured with a pipette on the surface treated, left to work for a few seconds and then washed out with ethanol. It was necessary to repeat the procedure several times to evidence the profile of the grains. The instrument used is a ZEISS Axiophot microscope equipped with ocular 5, 10, 20 and 50X and with an image analyser Kontrol Elektronik. For the spectroscopic analysis a portable spectrometer equipped with an X-ray tube of the EIS Rome was used. This tube has a working voltage of up to 50 KV and a maximum current of 1 mA and is equipped with an anode of tungsten. The detector used is an Amptek XR-100CR, of the

type Si-PIN, which has a useful thickness of 300 microns of Si and an energy resolution of 180-200 eV to 5.9 keV. Finally, we used a miniaturized multi-channel analyser (MCA Amptek 8000), connected to a laptop. The same areas were analysed with a SEM ZEISS EVO 60 associated with an EDS system without further pretreatments.

Results

Basing on the results of quantitative analyses obtained by XRF, samples can be divided into three groups: the first consists of objects with high-purity copper alloys, with values greater than 94%, the second consisting of tin bronze artifacts, with values ranging between 3.6 and 12%, the last with brassy alloy, represented by only one sample. The metallographic investigation and description of the microstructures present in the various artifacts, point out the presence of macles, showing that all objects have been subjected to the same cycles of heating and subsequent beating [6]. The microanalysis X obtained with SEM-EDS for some instruments have confirmed the fluorescence data. Fig. 1 summarises results obtained on a probable ligula or cautery.

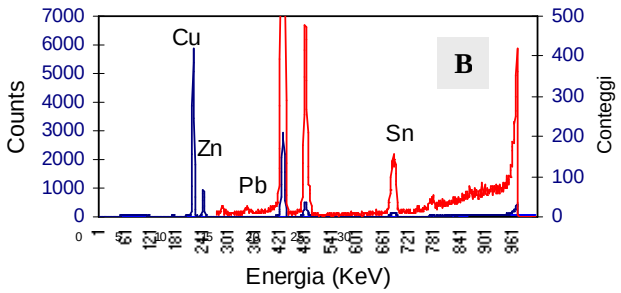

Fig. 1; **A**: probable ligula or cautery; **B**: XRF spectrum; **C**: metallographic image

Conclusions

It is not possible to define the provenance and verify the authenticity of the samples as our data are not sufficient. In order to ascertain their origin, in fact, we would have to perform additional analyses possibly compromising the integrity of the tools. Other findings may not be helpful: it is known, in fact, that in ancient times it was a common practice to reuse materials. We found feedback of our data comparing them with those obtained from a previous study, carried out by ISCR, about a set of surgical instruments of the Imperial Age from Ostia Antica.

References

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