Preliminary Analysis of the Pathological and Traumatic Conditions on Skeletal Samples from a Plague Cemetery of Venice

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Introduction

This work is proposed as a preliminary analysis based on morphology of the diseases present in a sample of disarticulated remains found in the graveyard of the Lazzaretto Nuovo Island; complete skeletons which are currently part of a research project at the University of Florence have been omitted.
Excavated as part of the project RADIX under the supervision of the Archaeological Superintendence of Veneto and patronage of CIRA - International Center for Archaeological Research, the remains are dated to the two plague waves that struck Venice in 1576 and 1630 (Borrini, 2008; 2009).

Materials and Methods

After a screening of thousands of bone fragments brought to light during the two excavations of 2006 and 2007, 153 fragments with pathological evidence have been selected: 40 skull fragments, 24 from the chest (ribs and vertebrae), 23 from the upper limb, 56 from the lower extremity; 6 from the upper girdle (clavicle, scapula and sternum) and 4 fragments from the pelvis.
The morphological examination has been conducted by a macroscopic approach supported by a stereoscopic microscope Konus Crystal-98 with magnification from 8x to 98x.

Results and Discussion

The most frequent alterations in the sample are related to functional stresses on limbs and joints, which represent almost half of the total, evidence of vitamin deficiencies are much less common in the sample; this latter finding is significant if related to recent paleodiet studies (Borrini *et al.*, 2010) conducted on the same sample, which show adequate nutrition despite social class differences.
The differential preservation of individual bones must be taken into account to detect the areas generally more affected by each disorder. For the most common pathological condition (functional stress), the most affected areas are the lower limbs; with ossification of muscle insertion areas and very large morphological changes that exceed the pathological values provided by the Scarsini-Donatelli method (2006).
In the vertebral column, the lumbar tract especially showed osteophytic proliferation and some cases of erosive lesions due to Schmorl nodes, two samples were also associated with disc herniation modification: both of these alterations are diagnostic in repeated efforts since youth (Kelley, 1982). Another sample presents a probable discopathy which occurred when the fibrous capsule of the disc lost its elasticity and the *nucleus pulposus* spilled out from an interruption creating herniation which may have compressed nerve roots producing pain (Rogers and Waltron, 1995).
Osteoarthritis was also present with eburnation of an odontoid process and in one patella. Osteoarthritis is characterized by insidious symptoms and it usually occurs after age 40 in males and in females after the age of 55, the origin of these remains from disturbed depositions does not allow the confirmation of the age range of the subjects, but it is possible to imagine that these subjects (there is no evidence of a mutual correlation) suffered from localized pain, especially by the solicitation of the affected joints after prolonged periods of immobility such as sleeping.
Three non-associated cranial fragments showed evidence of caries sicca, and one separate humeral fragment has been altered by gummatous periostitis which is suggestive of a treponematosis (Aufderheide and Rodriguez-Martin, 1998).
Osteomyelitic evidence was present on two long bones fragments: one humerus and one femur. The humerus showed a coral-like aspect, with cloacae and overlapping plates of reactive bone surrounding a "shell" of the original structure. Osteomyelitis may result from a variety of infectious diseases including *Staphylococcus aureus* and tuberculosis (Ortner, 2003).
The second most common alterations group is the infectious and inflammatory diseases, in which are included in both specific and non-specific infections; for this reason a

large part of this set is represented by periostitis evidence, significantly more frequent on tibiae where it can be caused not only by etiologic agents (such as *Treponema pallidum* and *Mycobacterium tuberculosis*) but simply by small traumas or infections (Fornaciari and Giuffra, 2009).
As expected from pandemic related materials, none of the injuries recovered are perimortal and directly related to the cause and manner of death: all lesions appear antemortem with different stages of bone remodeling.
The diseases resulting from vitamin deficiency or other metabolic and diet disorders are extremely rare in the sample: only one case of linear enamel hypoplasia was detected and one fragment an infantile femur showed a typical arched shape due to rickets.
Rather frequent is the presence of *cribra cranii*, sometimes associated with porotic hyperostosis and *cribra orbitalia*, in this study grouped into blood disease attested on adults: not linked with weaning related problems or nutritional deficiencies of iron, but referable to *Thalassemia minor*. This result is more likely with the Venetian context, linked to the diffusion of anemia in the Italian and Adriatic area.
Only one case was found with an osteoblastic lesion; a small button osteoma in a skull fragment has been detected. Also, a tibia with traces of a possible early-stage osteosarcoma is under review: the specimen was not included in this study because it is currently on display in a temporary exhibition organized on the island of Lazzaretto Nuovo.

Conclusions

Although it is a preliminary study carried out on a significant but limited sample, it is possible to delineate some general evaluations. Compared to MNI calculated for the analyzed area, the population studied seems to be in good health. Although the majority of the subjects suffered and died from the plague which ravaged European diseases; the majority of fragments show alteration not attributable to pathogens or pathological stages themselves. As briefly described most of the macroscopic changes are linked to life style and occupational activities.
Although paleodiet studies showed that the population buried in the graveyard of Lazzaretto Nuovo belonged to different classes of post-Renaissance Venetian society, the predominance of occupational markers suggests how the life was rather active and intensive, supported by a good level of general health (except epidemics) and an almost total absence of food or vitamin deficiencies.
In conclusion it is clear how a plague site is useful for paleopathological study: it represents a true picture of the original society in which all social classes are represented and where, due to the fast-paced nature of the pandemic, all pathological stages are frozen which can be better appreciated in regards to demographic studies rather than ordinary cemeteries, where only most acute or chronic stages are preserved.

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