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PATTERN OF DISEASE IN 2nd–1st MILLENNIUM BC NECROPOLIS FROM LCHASHEN, ARMENIA

ABSTRACT: Human skeletal remains offer an important source of information in the study of past peoples. Palaeopathological research contributes directly to the interaction between culture and biology in prehistoric populations. This study introduces some diseases which occur among the population of Armenia in the Late Bronze and Iron Ages (2nd–1st millennium BC). Extreme living conditions o negatively reflected on the state of health of the population. The results of this research reveal a documented list of palaeopathologies that include traumatic conditions, bone tumours, infectious diseases, dental pathology, and various other conditions that afflicted the people in their daily lives. Skull trauma was common, which suggests a high level of inter-personal violence. There was less evidence of dental caries although dental abscesses and wear were more prevalent. The frequencies of signs such as osteomyelitis, leprosy, abscesses, and so forth, testify to the fact that the people experienced a variety of forces and durations of stressful influences, both internal and external. Individuals from the Sevan region may have had more chronic infections due to continued exposure to pathogens during their lives as well as traumatic injuries. Cases of trepanation were also noted.

KEY WORDS: Armenia – Palaeopathologies – Traumas – Trepanation – Osteomyelitis – Bone tumours

INTRODUCTION

The Armenian homeland is located on the Armenian plateau, central and eastern Anatolia and southwestern Caucasus, the highlands which dominate the lowlands of Greater Syria and Mesopotamia to the south. The Armenian plateau – a crossroads linking the worlds of the East and West. The areas surrounding the Black Sea coast at certain stages of history appeared to be in a "crater" of interrelations of various cultures (Martirosya 1964). Overland lines of contact between the Near East through the Armenian highlands up to Caucasus and onto the Balkans, and through Caucasus and the Balkans in the North Black Sea coast and in the return direction. The ethnic history of the region has developed under the influence of the interaction of various groups since the early Bronze Age, among which the Indo-European played a leading role, the tribes having created one of the most advanced cultures of the world. The dispersal of these Indo-European languages have been accompanied by immigration and some gene (Balaresque *et al.* 2010) flow from the Armenian highlands to the various historical seats of the Indo-European languages. The expansion to steppes of wheeled vehicles invented in the Near East and "kibetka-houses" on wheels allowed cattlemen-farmers to move easily on the open Eurasian steppe spaces. A broad comparison of the Mediterranean groups to the territory of the Armenian highlands, Caucasus, Near East, and Central Asia, reveals the presence of biological similar groups in the geographical scope of all this vast territory of Eurasia (Khudaverdyan 2011a). These affinities are apparently caused by migrations of Indo-Europeans (specifically Indo-Iranians) from their Near East homeland. The anthropological fact we raise also has a historical basis (Lang 2005, Nechitailo 1991, Petrosyan 2003, Pystovalov 2002), as the distribution of morphological signs is connected with resettlement, and the mixture of tribes is accompanied by concrete historical and cultural phenomena.

Many anthropological contributions have been made on skeletal populations from Armenia. Most of these,

however, concern osteometric study, especially, craniology and odontology (Abdueshvili 1982, Alekseev 1974, Khudaverdyan 2009a, 2011a). Together with osteometric study, pathological examination can also provide useful information on the biological properties of the skeletal population. The analysis of pathology is an essential tool in investigating diseases that occurred in ancient populations. Through the data they provide on evolutionary processes, biological relatedness, diet, health, activity patterns, and levels of violence, human remains tell a story of adaptation and change not available from any other source. The quality of living of the members of past societies can be assessed by analysing their remains (Larsen 1997). Very little is known about the health and lifestyle of the inhabitants of 2nd–1st millennium BC (Khudaverdyan 2005, 2009a, 2011b, Sarafyan, Khudaverdyan 1999). The purpose of the study reported herein was to provide an overview of the health and lifestyle of the individuals interred at the Lchashen burial site (Sevan pool).

MATERIAL AND METHODS

The Yerevan Medical University had an archive of palaeopathology from Alexander Sarafyan, which had been taken for the Khudaverdyan (2005) report (photo A. Sarafyan). The Lchashen site is a mass (500) burial site, which includes at least 100 adult individuals of both sexes and all ages (Alekseev 1974), accompanied with many stone and bone tools, as well as ornamental objects. Many sites are found here within a very large cemetery. Mnacakanyan (Yerevan) was excavated from 1957–1967, but the excavations are still going on (Petrosyan 2003). The distribution of sex is predominantly male (62 individuals), 23 individuals were females (Alekseev 1974).

Frequencies of observed palaeopathological conditions were compared with others groups in Landjik and the Black Fortress, located the on the Shiraksky plateau of Armenia (Khudaverdyan 2009a). One mass burial from Landjik site (end of the fourth millennium/beginning of the third millennium) were excavated and they contained the remains of at least 10 individuals, together with rich archaeological grave-goods (Petrosyan 1994). Most of these skulls were in a good state of preservation. Of these two males, five females, two children (2–9 years) and one juvenile between 13 and 19 years were the only non-adults present in the sample. The Black Fortress (2nd millennium BC) site is a regular cemetery, which has been excavated since 1993, but the excavations are still going on (Avagyan 2003, Ter-Markaryan 1991, Ter-Markaryan, Avagyan 2000). All of the burials appear to have been typical interments of the Late Bronze Age, oriented in an east-west direction. A total of 13 individual skeletons were exhumed from the burial which included two males, eight females, and two children (4–9 years). Several kinds of pathological conditions were scored in the sample of human remain from Lchashen, including trauma, infectious diseases, bone tumours, dental disease and trepanations.

In the literature, the terms fracture, injury, and trauma are often used inter-changeably, and the discussion of trauma or injuries may include the grouping of sharp-force weapon injuries and blunt-force trauma. This arises from the numerous definitions of trauma in the palaeopathological and forensic literature (Byers 2002, Roberts 1991). Cranial trauma is a likely sign of violence and is more often seen in males than in females, and occurs more often on the frontal and parietal bones (Filer 1997, Khudaverdyan 2005, Merbs 1983).

The overall health of a population involves a number of contributing factors, such as systemic stress, infection, and diet (Larsen 1997). For each of these factors, there are specific skeletal indicators that reflect particular aspects of community health. Many dental diseases are the result of the diet of an individual. Other defects can be the result of childhood stress or infections (Goodman *et al.* 1984, Mays 1998). Three main dental pathological conditions, caries, abscesses, and tooth wear were chosen for this study. Dental caries is defined as destruction of the enamel, dentine, and cement (resulting from acid production by bacteria in dental plaque) manifesting as a cavity in the crown or root surface (Hillson 1996). Caries are recorded at individual tooth level noting the position and severity of the largest carious lesion visible. Dental abscesses frequently lead to tooth exfoliation and cause a remodelling process that usually destroys the alveolus and reduces the size of the alveolar process at the site of the tooth loss (Ortner 2003). Abscesses can be caused by various factors, such as pulp necrosis, periodontal infection, and trauma. Periapical abscesses can be fatal if the resulting infection spreads into the sinuses (Williams *et al.* 1983). Although periapical abscesses can occur on the roots of every tooth, Herrera *et al.* (2000) found that molars are most frequently affected. In the present study, abscesses were recorded if any trace of infection occurred in the alveolus around the tooth root. Molar dental wear was recorded using Scott's scale (1979), while incisor, canine, and premolar wear was scored using Smith (1984).

Together, these skeletal markers and pathological conditions reflect the health and lifestyle of a past population. The use of a variety of skeletal indicators provides a more thorough understanding of what life was like in Late Bronze and Iron Age period of Armenia.

RESULTS AND DISCUSSION

Trauma

Traumatic injuries are frequently encountered pathologies in archaeological samples from Armenia (Khudaverdyan 2005, 2009a, b). The main interest in studying trauma is to gain information about the cultural significance of the lesions in question and to arrive at a closer understanding of the people's behaviour and types of occupations. Interpretations of the cause of trauma in antiquity range from inter- and intragroup conflict (e.g., Khudaverdyan

FIGURE 1. Cranial trauma. Materials from excavation of burial ground Lchashen.

2005, Merbs 1989, Walker 1989) to environmentally or occupationally facilitated misadventure and accident (e.g., Burrel *et al.* 1986, Kelley, Angel 1987, Khudaverdyan 2009b).

A particularly interesting case shows an incomplete sliced injury down the left temporal area. It is consistent with a glancing sword action (*Figure 1*). A sharp blow from a weapon struck the temporal bone of this individual. The fracture in the temporal bone shows marked elliptical defect which was probably caused by intentional injury with a strong blow. This was well healed. As to the condition of the surface of the damaged bones, it is possible that some medical actions were undertaken; protecting the wound from infection and suppuration, as there is no trace of osteomyelitis.

There were two other interesting traumatic changes in the Lchashen series. Possible perimortem trauma with no evidence of healing occurs on the left zygomatic of individuals from burials 2 and 43 (*Figures 2–3*). In each case conducted in the thinning on the temporal bone. Blunt trauma to the head may result in depressed (crush) deformation (*Figures 2–3*). Blunt force trauma is damage

FIGURE 2. Cranial trauma. Materials from excavation of burial ground Lchashen.

FIGURE 3. Possible perimortem trauma to the left zygomatic. Materials from excavation of burial ground Lchashen.

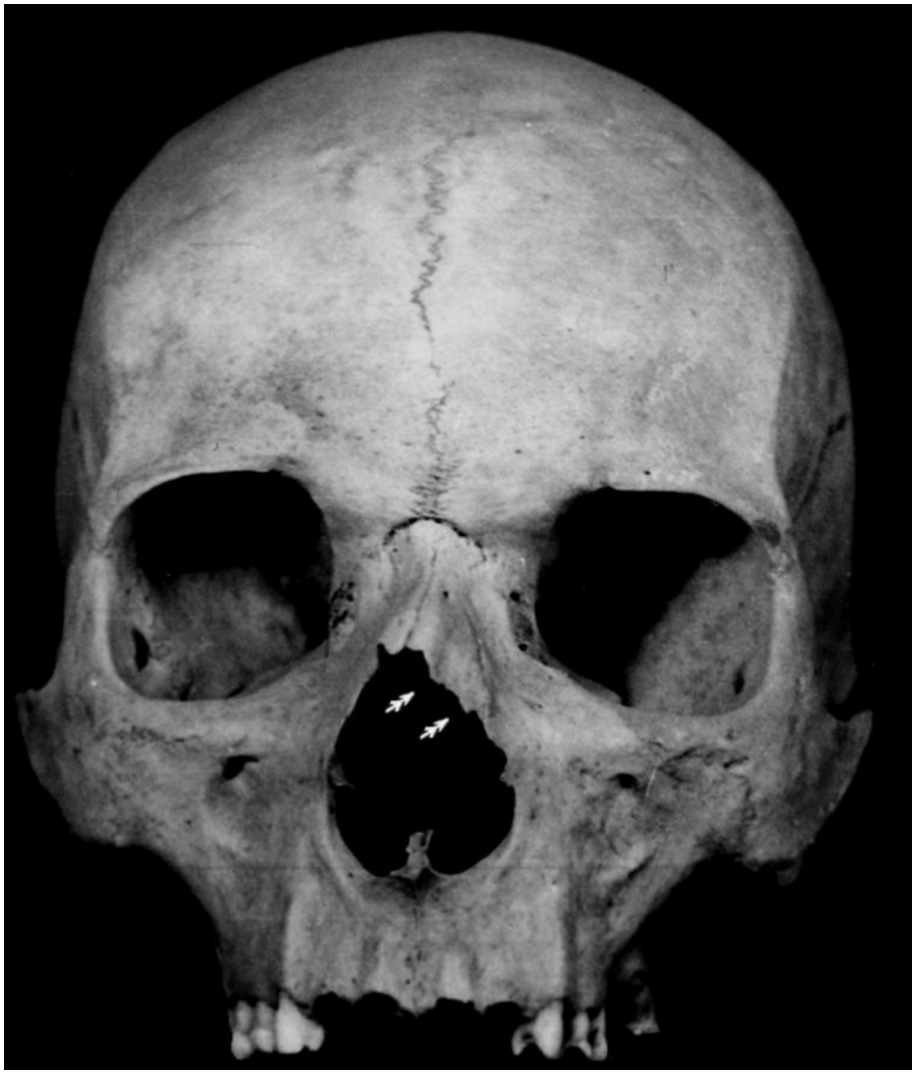

FIGURE 4. Nasal bone trauma. Materials from excavation of burial ground Lchashen.

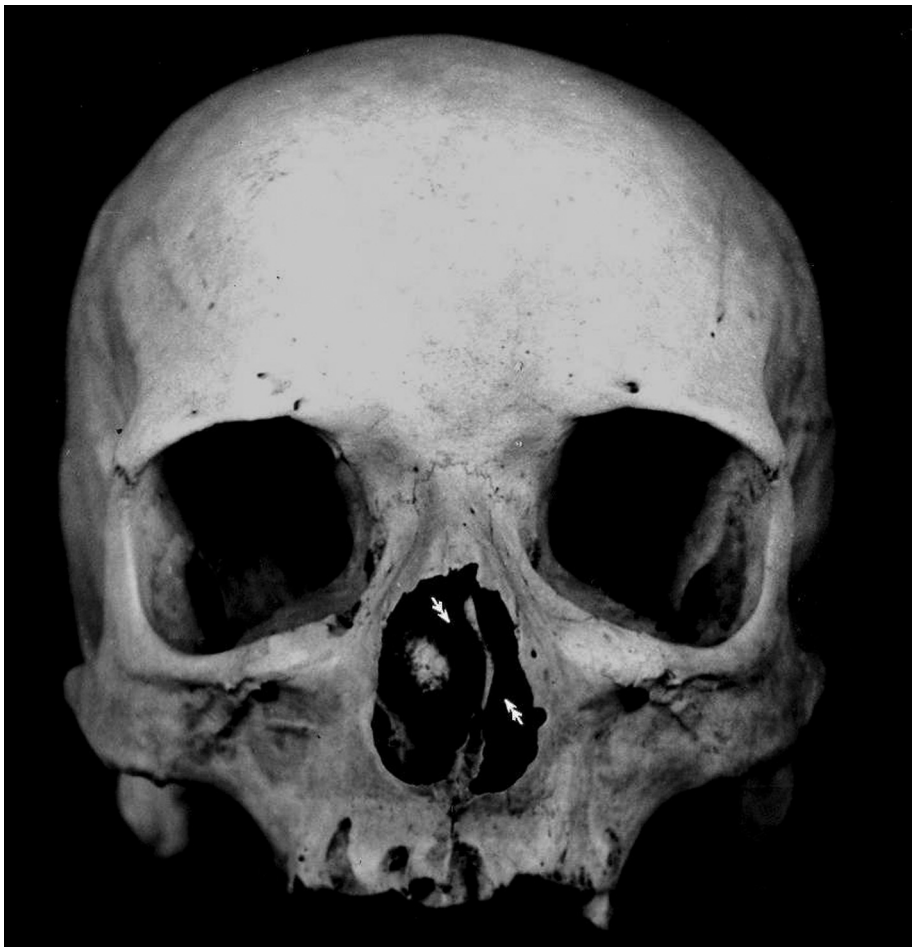

FIGURE 5. Trauma of cartilage of the nose. Materials from excavation of burial ground Lchashen.

inflicted via a number of different forces. It can be caused by fists, sticks, and bludgeon. Therefore, the area of impact is often relatively large. Flat-bladed weapons produce a groove to the temporal bone. The areas of bending are not uniformly circular, lines depends upon both the magnitude of the applied force and the local bone architecture. Accidental trauma can be considered extremely unlikely. These injuries show no signs of healing and may have contributed to cause of death.

Clinically, interpersonal violence often produces small fractures of the nasal bones. Trauma to the nasal bones is observed in two women from the Lchashen burial ground (*Figure*s *3–5*). This, not high rate of fracture of the nose is ascribed to fighting and perhaps marital difficulties, as well as accidents. Cartilage of the nose in females from Lchashen shifted and bent (*Figure 5*). The nose is considerably deformed and displacement of bone fragments is apparent. Symptoms of septal deviation usually include respiratory problems such as difficulty in breathing through the nose. Curved septum may disrupt the sinus confluence mobility that causes repeating sinusitis. Irregular air flow in the nose irritates nasal mucosa and causes chronic catarrh with mucous or purulent hypersecretion. Septal deviation can disrupt the function of pharynx mouth of the Eustachian tube, which will manifest in tubal catarrh, hearing loss and adhesion processes in the middle ear. However, it should be noted that very pronounced deviation of septum sometimes does not cause any interference if it occurred in childhood. During growth, the turbinate will hypertrophy in the wider nasal cavity, filling the void, while on the opposite side turbinate will atrophy, because of the adaptable capacity of the nasal structures (Khudaverdyan 2005).

In the woman from burial 41 (30–40 years) there was a trauma of the temporomandibular joints. Disturbance of occlusal function, deviation of the mandible, internal derangements of the temporomandibular joint, and ankylosis of the joint with resultant inability to move the jaw are all sequelae of this pathology (Ellis, Throckmorton 2005, Khudaverdyan 2005). When the condylar process is fractured and dislocated, the condylar cartilage becomes hypertrophic. This adaptation (*Figure 6*) begins immediately after trauma and continues for many months afterward. Hylander (1978) showed appreciable levels of bone strain in the condylar neck region of monkeys during both incisal biting and molar chewing. By inference, they concluded that compressive force in the condylar neck during function must indicate loading of the mandibular condyle. Using similar methodology in the miniature pig, Marks *et al.* (1997) also showed there was strain during the occlusal phase of mastication, with higher strain on the balancing side than the working side. A host of biomechanical and finite element models have been designed over the past

FIGURE 6. Trauma of temporomandibular joints. Materials from excavation of burial ground Lchashen.

25 years, some using electromyographic and bite force data, which suggest that the joint is loaded under certain, if not most, functional activities (Dessem 1989, Hylander 1975). When biting at more anterior tooth positions, both joints will experience a compressive load (Gysi 1921). This feature of the temporomandibular joints (*Figure 6*) may be associated the use of teeth in productive activity (i.e., the use of teeth as a working tool) or depends on the hardness of food. The women may have facial deformities due to fracturing of the temporomandibular joint.

In the Lchashen group, both sexes were well represented, 11 males and seven females having a depressed injury. An alternative for both sexes is that they sustained injuries in civil or domestic skirmishes involving clubs, sticks or stones. If this is the case, it may point to a quarrelsome and aggressive community. The high percentage of head injuries and the high amount of female involvement would support this suggestion. Blunt force trauma has established that among five individuals in the Late Bronze age from the Black Fortress (Khudaverdyan 2009a, b).

Post-mortem trepanations

According to Aufderheide's and Rodriguez-Martin's Encyclopedia of Human Paleopathology (1998), there are four distinguishable methods of trepanation that include grooving, scraping, drilling, and cutting. The classification of trepanations currently in use today includes: (1) surgical trepanation (*trepanatio ante mortem*), defined as any opening of the skull on a living person, (2) ritual trepanation (*trepanatio post mortem sive post huma*), any posthumous opening with the aim of obtaining a part of the skull vault to be use as an amulet or other use (Broca 1877), (3) symbolic trepanation, an operation on the skull roof of a living person that does not affect the inner compact layer of the bone (Bartucz 1950, Nemeskeri *et al.* 1960).

Trepanation is serious enough surgical procedure, could this procedure have taken place as a routine operation as long ago as 2000 BC? We do have a record of two of skulls from Lchashen with evidence of this surgery (*Figures 7–8*). The individuals had single trepanation orifices. One artificial hole of seven centimetres in the parietal bone (*Figure 8*), one of two centimetres on the left zygomatic (*Figure 8*). Trephining has been known in many parts of the ancient world and is still practiced in a few traditional communities of Africa, Melanesia and Polynesia. The practice apparently goes back to the Neolithic. When our findings were compared with those from Qaranthal, located in Jericho, the techniques of cranial trepanation from Lchashen did not differ from the Qaranthal trepanation sample.

The suggested reasons for this surgery are numerous. Researchers over the last century and a half have speculated that cranial surgery was done in cases of trauma from battle or accident, cranial infections, headaches, mental disease,

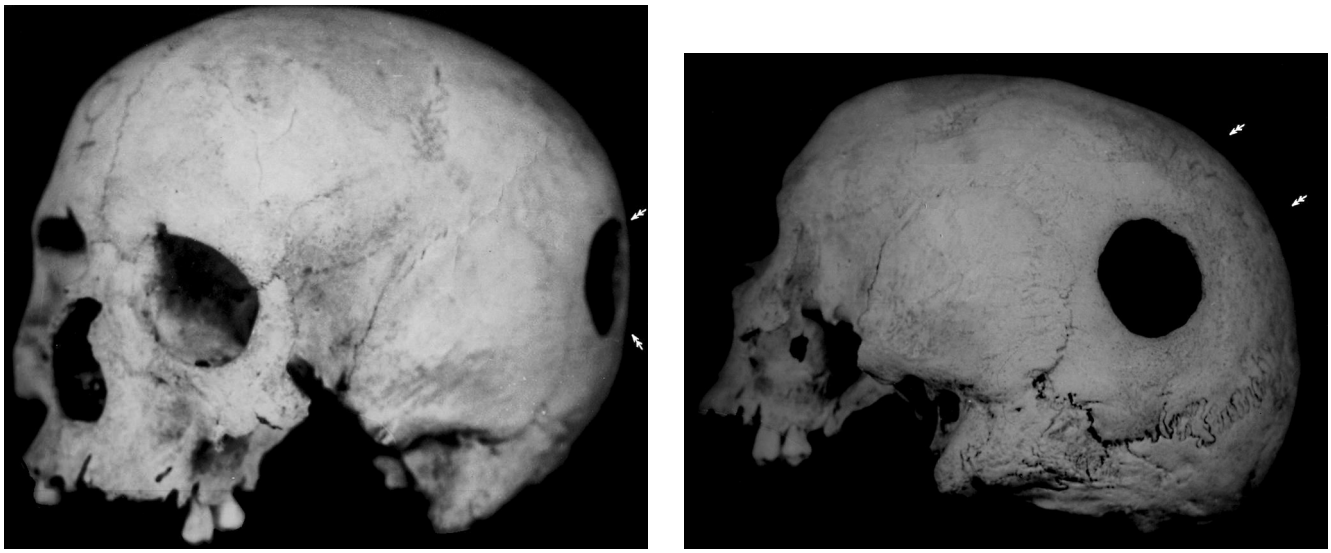

FIGURE 7. Trepanations: round trepanation. Materials from excavation of burial ground Lchashen.

FIGURE 8. Trepanation. Materials from excavation of burial ground Lchashen.

and religious rituals (Marino, Gonzales-Portillo 2000). Rituals involving the opening of the skull were believed to facilitate the exit of evil spirits that caused epilepsy. In almost every age and culture epileptic seizures were believed to be the work of evil spirits (Finger, Clower 2001).

It is accepted to name symbolical trepanations superficial (not through) manipulations where there is a slight break of the integrity of the arch of a skull (to injure a bone was accepted in certain specific places to create a certain geometrical pattern on an outer side of a brain capsule), fixed at carriers of various archaeological cultures (Mednikova 2003). The therapeutic motivation of similar actions is not excluded. Trepanation not only mentioned integuments, but also extended in a periosteal top layer compact. As Lisowski (1967) informs, the majority of cases of similar manipulation is fixed in females. The Austrian researcher's report on finding symbolically trepanned skulls (Hahnel 1991a, b). Strouhal and Jungwirth (1981) have focussed on the Egyptian Nubia a tradition of drawing of hems on a surface of the arch of a skull. More often symbolic trepanations are discovered in men, more rarely in women, children and teenagers. In Armenia, symbolical trepanations are discovered in men on the frontal bone (*Figure* 9, 12, 15).

FIGURE 9. Symbolical trepanation (lines on a skull). Materials from excavation of burial ground Black Fortress. Photo A. Khudaverdyan.

Infectious diseases

Irrespective of aetiology, osteomyelitis represents an inflammation of bone marrow. Osteomyelitis is a bone infection usually caused by bacteria, including mycobacteria, but is sometimes caused by fungi. Bacteria or fungi can infect bones by spreading through the bloodstream, spreading from nearby tissue, or directly invading the bone. When a bone becomes infected,

FIGURE 10. Subacute osteomyelitis of the maxilla. Materials from excavation of burial ground Lchashen.

the soft, inner part (bone marrow) often swells. As the swollen tissue presses against the rigid outer wall of the bone, the blood vessels in the bone marrow may become compressed, which reduces or cuts off the blood supply to the bone. Without an adequate blood supply, parts of the bone may die. *Staphylococcus Aureus* is the bacteria most commonly responsible. Osteomyelitis may also result from an infection in an adjacent soft tissue. Such an infection may start in an area damaged by an injury, or in a skin ulcer caused by poor circulation. Infectious diseases occur to a much higher frequency in malnourished individuals (Larsen 1997).

In the woman (burial 7, 30–40 years) acute hematogenous osteomyelitis of the frontal sinus is discovered and dental abscesses (*Figure 10*). Periapical abscesses can be fatal if the resulting infection spreads into the sinuses. The frontal bone is diploic with a marrow cavity capable of developing osteomyelitis. A typically fluctuant swelling over the forehead known as "Pott's Puffy Tumour" after Sir Percivall Pott who described the condition in 1760, results from frontal sinusitis and osteomyelitis eroding the anterior table of frontal bone. The term Pott's Puffy tumour has been applied to any scalp swelling associated with frontal sinusitis. Some prefer to limit it to the swelling overlying and area of osteomyelitis in a diploic bone and use the term "a ruptured frontal sinus" for those associated with frontal sinusitis (Thomas, Nel 1977). It is a serious life threatening complication of frontal sinus infection. Pott's Puffy tumour and its complications result from the unique anatomy of the frontal sinus. The sinus is separated from the frontal bone marrow by only 100 to 300 μm. The sinus mucosa, marrow cavity, and frontal bone have a common venous drainage via valveless diploic veins (Breschet's canals). Frontal sinus infection can thus invade the marrow cavity causing osteomyelitis and erode through the thin anterior and posterior table producing subperiosteal and extradural abscess respectively (Feder *et al.* 1987, Lund 1987).

Chronic osteomyelitis occurs more frequently in the mandible than in the maxilla and is often associated with suppuration. It is usually more diffused and widespread (Eyrich *et al.* 2003, Lavis *et al.* 2002). Kazunori Yoshiura (Reinert *et al.* 1999) classified mandibular osteomyelitis into four basic patterns, as lytic, sclerotic, mixed, and sequestrum patterns. Our case presented with the latter

FIGURE 11. Chronic osteomyelitis. Materials from excavation of burial ground Lchashen.

pattern (4). Chronic osteomyelitis will result in deformity of the affected bone (*Figure 11*). With an infection of the bone, the subsequent inflammatory response will elevate this overlying periosteum, leading to a loss of the nourishing vasculature, vascular thrombosis, and bone necrosis, resulting in the formation of sequestra. *Figure 11* confirmed the presence of a deep sequestra. Although most cases of chronic osteomyelitis of the jaws result from dental origins, other sources of infection are possible (Eyrich *et al.* 2003). It may also occur following penetrating trauma. Viral fevers (e.g., measles), malaria, anaemia, malnutrition, also contribute to the development of osteomyelitis.

Leprosy, or Hansen's disease, is a chronic infectious disease caused by *Mycobacterium leprae* that is transmitted through contact with skin lesions or through inhalation of droplets containing the pathogen that are coughed or

FIGURE 12. Facies leprosa: rhinomaxillary changes. Materials from excavation of burial ground Lchashen.

exhaled into the air by infected individuals (Roberts, Manchester 2005). While leprosy is infectious, it does not always lead to disease; in general, an individual becomes infected only after prolonged exposure and often does not present any physical signs or symptoms of the disease for 2–5 years, owing to the very long incubation period (Ortner 2003, Roberts, Manchester 2005). Leprosy varies in expression from a mild, or tuberculoid, infection (also known as high-resistance leprosy) to the most severe infection, referred to as the lepromatous type (also known as low-resistance leprosy) (Andersen *et al.* 1994, Ortner 2003). Skeletal involvement can occur with any degree of infection, but it is most acute in the lepromatous form. However, the skeleton is not affected in most cases; only 5% of individuals with leprosy develop bony lesions (Ortner 2003).

The Lchashen series of Sevan pool represents a remarkable material for the study of past mycobacterial infections (*Figure 12*) and very rich in leprous cases (four men and two women). The morphological aspects of the rhinomaxillary changes are characteristic of a *facies leprosa*. And one individual from Karmir (9^{th}–8^{th} millennium BC) has nasopharyngeal lesions, including significant remodeling of the nasal aperture margins (Khudaverdyan 2011b).

Cribra orbitalia

Cribra orbitalia is a condition most likely caused by iron deficiency (Aufderheide, Rodriguez-Martin 1998, Larsen 1997). Cribra orbitalia is a type of porotic hyperostosis that solely affects the orbital roofs (Aufderheide, Rodriguez-Martin 1998, Larsen 1997). Porotic hyperostosis can be caused by different conditions such as anaemia, scurvy, rickets, osteomyelitis, periostitis, inflammatory processes of the scalp (Larsen 1997, Ortner 2003). Many researchers suggest iron deficiency anaemia as the main cause for porotic hyperostosis (Aufderheide, Rodriguez-Martin 1998). Other researchers suggest parasitic invasion as the major cause that affects the bone due to the blood loss (Holland, O'Brien 1997). The overall frequencies of cribra orbitalia in the Lchashen are 8% (Movsessian, Kotchar 2001). In the skeletons of the 4^{th}–3^{rd} millennia BC from the Armenian highlands anaemia traces (Landjik) are found in eight individuals (n=10). At the Black Fortress seven individuals suffered from anaemia.

Bone tumours

An osteoma is a benign osteogenic tumour characterised by compact or cancerous bone proliferation. It may be classified as peripheral, central, or extra-skeletal. A peripheral osteoma arises from the periosteum, a central osteoma from the endosteum, and an extra-skeletal osteoma in the soft tissue (Larrea-Oyarbide *et al.* 2008). Osteoma is referred to as developmental anomalies, true neoplasms, or reactive lesions triggered by trauma, muscle traction, or infection (Larrea-Oyarbide *et al.* 2008, Ogbureke *et al.* 2007). Osteomas are found mainly in the craniofacial bones. A peripheral osteoma occurs most frequently in the paranasal sinuses. Other locations include the orbital wall, temporal bone, pterygoid processes, and external ear canal (Larrea-Oyarbide *et al.* 2008). A solitary peripheral osteoma of the jaw bones is quite rare, involving the mandible more often than the maxilla (Chaurasia, Balan 2009, Khudaverdyan 2005, Larrea-Oyarbide *et al.* 2008). The most frequent sites affected in the mandible are the posterior body, followed by the condyle, angle, ascending ramus, coronoid process, anterior body, and sigmoid notch (Chaurasia, Balan 2009, Ogbureke *et al.* 2007). It has been reported that osteomas can occur at any age and that males and females are equally affected (Chaurasia, Balan 2009). Peripheral osteomas are slow-growing lesions and, clinically, they usually remain asymptomatic. Woldenberg *et al.* (2005) suggested that some peripheral osteomas may be reactive rather than neoplasms, probably associated with trauma. Also, some authors have reported that as many of the peripheral osteomas are located on the lower border of the mandible, it is possible that muscle traction plays a role in the development of peripheral osteomas (Ogbureke *et al.* 2007, Woldenberg *et al.* 2005).

In this paper, we present a large solitary peripheral osteoma located in the mandible and causing a facial deformity in a 40–50-year-old woman (*Figure 13*). In our case, the lesion had reached significantly large dimensions and caused facial asymmetry.

Exostoses are bony excrescences that usually stop growing after puberty, differentiating them from osteomas.

FIGURE 13. Osteoma. Materials from excavation of burial ground Lchashen.

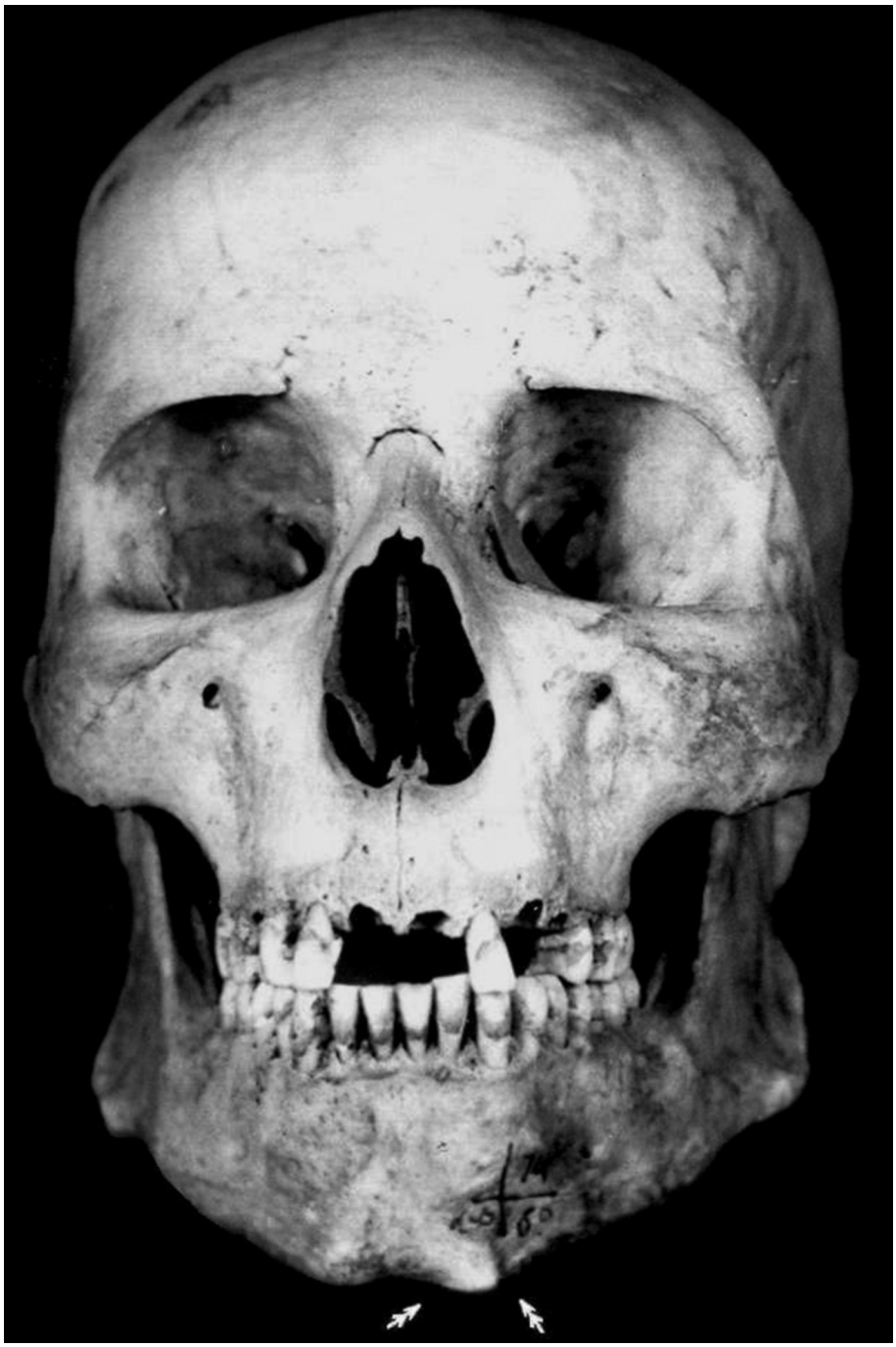

FIGURE 14. Exostoses. Materials from excavation of burial ground Lchashen.

Exostoses localisation was observed in the man in area the gnation (*Figure 14*). A case of osteoblastoma in the mandible of young adult individual is presented. Benign osteoblastoma is an osteoid and bone forming benign tumour of bone. It is an uncommon lesion that accounts for 1% of all bone tumours and about 3% of all benign bone tumours (Ivković *et al.* 2000). On examination the tumour was an oval mass measuring 5.5 cm at its greatest diameter (*Figure 15*). Rare neoplasm localisation was observed in the woman (26–31 years) from the Black fortress – one on the left mandibular joint, a condylar process (burial 13), fungiform forms, another – on the right (Khudaverdyan 2009a).

Dental diseases

The dental system is a valuable source of information to understand the quality of life of ancient peoples in a particular historic and geographical frame. Many dental diseases are the result of the diet of the individual.

Dental caries

Dental caries is an infectious disease that destroys the tooth structure, the root and the crown (Aufderheide, Rodriguez-Martin 1998, Brothwell, Sandison 1967). Ortner (2003) mentions that caries are caused by acid-producing bacteria in dental plaque that initiate the destructive process. Larsen

FIGURE 15. Osteoblastoma. Materials from excavation of burial ground Lchashen.

(1997) argues that caries do not refer to lesions in teeth resulting from the invasion of microorganisms, but that the disease is characterised by the focal demineralisation of dental hard tissues by organic acids produced by bacterial fermentation of dietary carbohydrates, especially sugars. According to Larsen (1997), there are several modifying factors for the development of dental caries: crown size and morphology, enamel defects, occlusal surface attrition, food texture, oral and plaque pH, speed of food consumption, some systemic diseases, age, child abuse, heredity, salivary composition and flow, nutrition, periodontal disease, enamel elemental composition, and the presence of fluoride and other geochemical factors. In Lchashen 2 adults suffered from dental caries (*Figure 16)*. Caries were observed in six people from Landjik (3, n=8) and the Black Fortress (3, n=10) (Khudaverdyan 2009a, b).

FIGURE 16. Dental caries and antemortem tooth loss. Materials from excavation of burial ground Lchashen.

Dental wear

Dental wear is, in general, a destructive process that can lead to specific pathological conditions (Comuzzie, Steele 1989). Wear on human teeth is determined by the complex interactions between masticatory functions, cultural factors, and non-masticatory functions. In extreme cases, wear can result in the complete loss of crown height (Larsen 1997). Furthermore, severe wear can result in the lingual tilting of molars, in an attempt to enlarge the occlusal surface (Comuzzie, Steele 1989). Premature dental wear of the functional chewing surface in subjects depends on the hardness of food consumed and the need for prolonged chewing, grinding of something (i.e., the use of teeth as a working tool). Abrasion reflects the physical content of the diet and, for example, has been shown to differ between nomadic hunter-gatherers and early agriculturists (Smith 1972, 1989a, b). Primitive methods of grinding flour, using querns and mortars, result in the inclusion of silica from stalks and husks as well as grit from the mortars and querns into the flour. This, like ash or dirt adhering to baked foods, adds abrasives to the food ingested and causes severe abrasion (Smith *et al.* 1984). The average dental wear in group Lchashen was moderate to severe (*Figure 17*). At Lchashen, dental wear is discovered in 27 adults. The most heavily worn teeth in the group Lchashen were the canines, premolars, and molars. Dental wear is found in two individuals from the Landjik burial ground. The most heavily worn teeth were the first molars and the incisors. The trend of dental wear in the Black Fortress group was somewhat different than the Landjik group. The most heavily worn teeth in the Black Fortress group were the mandibular molars. Dental wear is found in four individuals from the Black Fortress burial ground (Khudaverdyan 2009b).

Dental abscesses

Abscesses of the tooth frequently lead to its exfoliation and cause a remodeling process that usually destroys the alveolus and reduces the size of the alveolar process at the site of the tooth loss (Ortner 2003). Some researchers state that abscesses are caused by *Streptococcus milleri*, *Fusobacterium nucleatum*, or *Streptococcus mitis* (Lewis *et al.* 1986). Abscesses can be caused by various sources, such as pulp necrosis, periodontal infection, and trauma. Periapical abscesses can be fatal if the resulting infection spreads into the sinuses (*Figure 10*). Although periapical abscesses can occur on the roots of every tooth, Herrera *et al.* (2000) conclude that molars are most frequently affected with an occurrence of 69%. Most abscesses happen in patients that already suffer from periodontal disease (Herrera *et al.* 2000). In Lchashen 41 adults suffered from dental abscesses (Khudaverdyan 2011b). Regarding the skeletal population from Landjik, three adult individuals showed evidence of dental abscesses. At the Black Fortress, one adult suffered from dental abscesses (Khudaverdyan 2009b).

CONCLUSION

The study of historic Armenia populations has greatly increased during the past decade, as evidenced by numerous publications devoted specifically to this subfield of osteology (e.g., Khudaverdyan 2005, 2009a, b, 2011b). The Sevan region (Armenia) was not an ecologically favourable place for human populations. The developing economy – the rudiments animal husbandry – promoted the occurrence and spread of infections among the ancient population of Armenia. Bad hygienic conditions and dirt should render

FIGURE 17. Heavy dental wear on the maxillary dentition. Materials from excavation of burial ground Lchashen.

infections of cumulative influence on skeleton morphology. Archaeological evidence suggests that the Armenian Highland had a higher population density (Kyshnareva 1990). The large number of graves in the cemeteries point to a very significant demographic development in this period: a great increase of the population as compared to that of previous times. The spectacular increase in the population size of communities led to more complex social organisations. The appearance of fortified settlements in the period was probably not related only to defence from an outside enemy, but signified the formation of social hierarchy. Judging from the moulds found in fortified settlements, the inhabitants of these settlements might have been controlling the production of strategically important metal objects (mostly tools and weapons). They might also have been controlling their trade relations. The palaeopathologies in the skeletal material from Armenia are very diverse. The results of this study further this notion, as there are a number of significant trends for various skeletal indicators of health and lifestyle that suggest the population in Armenian experienced stress and biological changes over time. The examination of the human remains determined that the palaeopathologies encountered include fractures, osteomyelitis, bone tumours, dental diseases. Trauma is a frequent pathology among Lchashen sample. It may point to a quarrelsome and aggressive community. The Lchashen population had a low frequency of caries. In the Lchashen sample there were significant differences in dental wear on the molars in approximately half of the comparisons between males and females, with females experiencing greater wear on average than males. The presence of significantly different rates of wear between males and females may be due to differences in food processing strategies, access to particular food sources. The sample examined consists of two skulls with trepanations and six skulls with symbolic trepanations. We believe that the Lchashen site represents a unique and highly valuable collection of human skeletal remains from the Late Bronze and Iron Age. Further work needs to be done to extract more cultural and biological information offered by the excavation of the populations from Armenia. Further excavations at the site, and the continual study of their remains, will soon enhance our understanding of skeletal biology and mortuary pattern from Armenia.

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