The human skeleton from Dvin, Armenia: detailed anthropological and paleopathological analysis*

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Abstract

The Armenia is well known for its archaeological richness and its frequent earthquakes. Recent excavations at Dvin of Armenia have revealed a medieval building as well as domestic and ceremonial structures spanning the periods in the 12th and 13th Centuries. The present paper reviews several of damage that can be attributed with high certainty to earthquakes. Body of human and artifacts, which are found beneath collapsed ceiling, indicate a sudden unexpected destruction, typical of earthquakes. The presence of diseases (periostitis, enamel hypoplasia, mastoiditis, tuberculosis) showed that were no distinctive health in female. The she also showed evidence for muscular trauma as a result of repetitive activities, suggesting that it must have been physically active. At the proximal end of the femur belonging to the individual, there are some enthesopathies previously noted as common in horse riders. The biological analysis of the remains has demonstrated that the female suffered from a physical deformity preventing her from maintaining an upright posture during walking. The combined features of vertebral osteophytosis, new bone formation at muscle tendon and ligament insertions, suggest that the female from Dvin lived lives of heavy physical labor.

Keywords: Armenia; Middle Age; earthquake; female; paleopathology

** Authors are responsible for language correctness and content.*

Introduction

The vestiges of the capital city of Armenia, Dvin, lie some 35 km to the south of Yerevan city. The city was founded in the thirties of the fourth century by the Armenian King Khosrov II of Kotak, a descendant of the Arshakoony dynasty (332-338AD). The historians Pavstos Byuzand (4th c.) and Movses Khorenatsi (5th c.) attest that King Khosrov undertook construction work on a hill called Dvin where he transferred the court from Artashat and afforested in the vicinity of the new capital. Dvin developed and thrived till it grew into a hub of international transit trade. Dvin was in the focus of those complicated historical-political, social and cultural events since it was virtually the only city in medieval Armenia of major economic and cultural consequence. Feudal relations were dominant all over Armenia throughout the 4th-5th centuries. From the 6th to the 9th century Dvin was both the capital of Armenia and its religious centre. In the second half of the 9th century, Dvin was destroyed by earthquakes no less than five times in the space of less than 50 years.

The archaeological investigation of this famed city was begun at the close of the past century but it was only in 1937 that regular, long-term excavations were launched that have been going on to date. A lot of research and publications have been dedicated to this medieval monument (1). The Archaeological Expedition of the Institute of Archaeology and Ethnography, National Academy of Science, Republic of Armenia has uncovered many human skeletal remains in recent years. A craniological, odontological and palaeopathological project to study the human remains from this site was initiated only in 2013.

There was clear paleopathological evidence for the decapitation of three individuals (excavation in 1978, archaeologist Nyura Akopyan: female, 20-25 years; excavation in 2011, archaeologist Frina Babayan: female, 18-20 years; excavation in 2013, Akhavni Djamkochyan: male, 20-25 years) (2). Decapitation may occur for the following reasons which can be combined in a variety of individual circumstances and cultural contexts: As a form of corporal punishment in which an individual is executed by severing the head from the body through the use of an edged weapon; as a consequence of armed confrontation in which the neck becomes a target in order to disable or kill a foe; to provide a trophy of armed confrontation; as a form of relic collection of veneration. During the medieval period, execution by beheading was performed with the individual either kneeling or standing upright and appears to have been associated with ignominy (3). We learned that these unfortunate individuals were expelled from society, lived in marginal conditions. Infectious diseases, tuberculosis, leprosy were common at individuals (2). A cranial sharp-force weapon injuries were observed, which varied from small isolated punctures to multiple linear injuries. Cut marks were found on frontal and parietal bones. In the basis of a skull of the individual mechanical breaks of occipital condyles and damage of the left mastoidal were noted. Holding by hair the victim, the head of the individual cut a sword. It has also been suggested that when the mandible is involved (such as with skeleton 2, excavation in 2011) it is likely that the individual was kneeling down with their head bent which is the traditional pose adopted for judicial decapitation.

In 2017 was published article is about unusual individuals of the 9th–11th centuries from Dvin, among which traces of delay of growth processes were revealed (excavation of 2016, archaeologists Nyura Akopyan and Frina Babayan). Due to the lack of bones of the post-cranial skeleton of the individual No. 1, we can state only microcephaly. The skeleton No. 2 is characterized by the Laron-type dwarfism - Laron syndrome (4).

However, there is another skeleton which was unearthed from Dvin (excavation of 2013, archaeologist Frina Babayan). This skeleton not have previously been examined and published. The excellent preservation of the skeleton allows investigation of various aspects of the skeletal biology (body size, craniofacial morphology, dental wear, functional anatomy, as well as nutritional and pathological aspects) of Middle Age living in the Ararat region. This paper aims to improve our comprehension of biocultural adaptations, life conditions and subsistence strategies of individual in the Middle Age.

Materials and methods

The skeleton was analysed in detail, assessing for preservation and completeness (Figure 1), as well as determining age-at-death and sex of the individual. Sex and age at death of the individual were determined according to standard osteological methods. Morphological features of the pelvis and cranium were used for the sex assessment (5, 6). A combination of pubic symphysis (7, 8, 9), auricular surface changes (9), degree of epiphyseal union (6), and cranial suture closure (10) were used for adult age-at-death estimation.

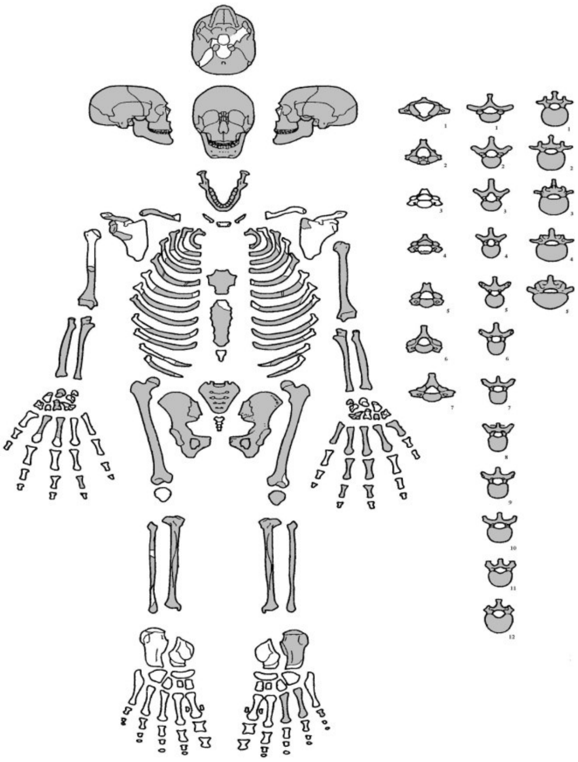

Figure 1. Available skeletal elements of the Dvin.

Available measurements were examined as far as the relevant skeletal portions were observable. Measurements were taken as outlined in Alexseev (11, 12). The results are shown in Table 1.

Next, a series of standard measurements are taken of the bones and teeth, and the presence and absence of "non-metric traits" (13, 14, 15). Maximum bucco-lingual and maximum mesio-distal diameters were measured for each tooth in the dental arcade, following Zubov (14). The thirty traits were observed using ASUDAS (Table 3).

The bone is measured on an osteometric board, and stature is then calculated using a regression formula developed upon individuals of known stature (16, 12). In addition, the skull and the postcranial skeleton were examined macroscopically to investigate any pathological changes. All skeletal elements and fragments were examined visually and with the aid of a 10x hand lens for macroscopic evidence of pathological lesions.

Results

Sex determination and age at death estimation, carried out on the basis of several highly diagnostic features, identify the individual as a young middle adult. The complete cranium is in a fairly good state of preservation (Figure 2). In particular, results of metric and morphologic analyses of the pelvis concur in indicating female sex. Age-at-death estimates, obtained using various parameters – cranial sutures synostosis, pubic symphysis morphology, ilium auricular surface morphology, are all in agreement with an age 30 years, consistent with the clavicle's medial epiphysis fusion status.

Cranio-Facial Morphology

Size and shape of the skull and face represent a valuable source of information on genetic affinity among individuals and populations. The cranial index was 82.9, which placed it in the brachycrany range, i.e. the cranium was very broad or round and a weakly developed glabella. The face is wide and medium high. The general facial angle is mezognathic. In horizontal plane, face is flattened at the top level and well-profiled at zigo-maxillary points. Piriform aperture small in height and average in width. The orbits are low and broad. All principal dimensions of the mandible and the ramus angle are medium in female. Some idea of the physical appearance female gives facial reconstruction of the skull (Figure 3).

Female skulls from the sites Dvin and Garni were selected for comparative analysis (Table 1). In general, most of the cranial dimensions (cranial length (g-op), frontal breadth, face width, simotic subtense, zigo-maxillary angle etc.) for female skull are different than other female crania from the Dvin and Garni sites. Comparison with a dataset of the medieval populations with a female shows that she was 7 and 9.5 mm longer than the mean of the female population of that period (Table 1). The female skull has a rare combination of the two angles: its zygo-maxillary angle is at its maximum in the series (136.0 degrees) with the naso-malar angle of 145.5 degrees. This is a classical picture arising at the mixing of two different global craniotypes.

The general cranial parameters of the female from Dvin are rather not typical of the ancient, medieval and contemporary population of the Armenia (17, 18).

		Dvin ♀ (excavations in 2013)	Dvin ♀ (Khudaverdyan, 2015)	Garni ♀ (Alekseev, 1974)
1	Maximum cranial length (g-op)	181	174.0 (2)	171.5 (2)
8	Maximum cranial breadth (eu-eu)	150	140.0 (2)	138.0 (2)
9	Minimum frontal breadth (ft-ft)	101	93.0 (2)	93.0 (3)
10	Maximal frontal breadth	127.5	114.0 (2)	-
12	Occipital breadth	115	112.0 (1)	-
29	Frontal chord (n-b)	114.5	105.75 (2)	-
30	Parietal chord (b-l)	114.5	109.75 (2)	-
31	Occipital chord (l-o)	103.5	99.0 (1)	-
43	Upper facial breadth (fmt-fmt)	109	103.0 (1)	-
45	Bizygomatic breadth (zy-zy)	131	-	127.0 (2)
48	Upper facial height	67	-	65.5 (2)
46	Mid-facial breadth	93	-	-
60	Maxillary alveolar length (incision-alv)	52.8	-	-
61	Maxillo-alveolar breadth (ecm-ecm)	61.5	-	-
62	Palatal length (st-o)	44	-	-
63	Palatal breadth between the second molars (enm-enm)	31	-	-
55	Nasal height (n-ns)	46	-	46.0 (1)
54	Nasal breadth (al-al)	25	-	24.0 (1)
51	Orbital breadth (d-ec)	41.5	38.5 (1)	40.0 (1)
51a	Orbital breadth (ect-d)	39	37.0 (1)	-
52	Orbital height bicondylar width	33	30.0 (1)	33.0 (1)
DC	Dacryal chord	31	-	17.5 (1)
DS	Dacryal subtense	-	-	12.3 (1)
SC (57)	Simotic chord	9.5	10.7 (1)	9.2 (1)
SS	Simotic subtense	2	5.0 (1)	4.1 (1)
MC	Maxillo-frontal chord	26.5	-	-
MS	Maxillo-frontal subtense	5.5	-	-
32	Frontal pronfile angle (n-m)	94	-	91.0 (2)
	Frontal pronfile angle (g-m)	93	-	-
72	Total facial angle	82	-	84.0 (1)
73	Mid-facial angle	84	-	-
74	Alveolar angle	79	-	-
75	Nasal inclination angle	-	-	-
75 (1)	Nasal protrusion angle	-	-	32.0 (1)
77	Naso-malar angle (fmo-n-fmo)	145.5	141.0	141.5 (2)
zm`	Zigo-maxillary angle (zm`-ss-zm`)	136.0	-	129.0 (1)
8:1	Cranial index	82.9	80.66 (2)	80.8 (2)
9:8	Fronto-transverse index	67.4	66.895 (2)	-
48:45	Upper facial index	51.2	-	51.6 (2)
54:55	Nasal index	54.4	-	52.2 (1)
52:51	Orbital index (mf)	79.91	77.93 (1)	82.5 (1)
52:51a	Orbital index (d)	84.7	81.1 (1)	-
63:62	Palatal index	70.5	-	-
DS:DC	Dacryal index	-	-	70.3 (1)
SS:SC	Simotic index	21.06	46.8 (1)	44.6 (1)

Table 1. Measurements of the female skull compared to those of the control groups (Dvin, Garni).

	Maxilla		Mandible	
	VL$_{cor}$			
	right	left	right	left
I1	7.7	7.5	6.1?	5.8?
I2	-	6.3	6.3?	6
C	-	7.5	7.1	7
P1	8.8	8.8	7.8	7.8
P2	9	8.9	7.2	7.5
M1	11	11.1	10?	10.2
M2	10.3	10.5	10?	10
M3	9.5	10.5	9.9	9.2
	MD$_{cor}$			
I1	8	8	4.8	4.8
I2	-	6,2	5	5.5
C	-	7	6	6.1
P1	6	5,9	6.5	6,8
P2	6	5,6?	6.2	7
M1	9	9	11	11
M2	8.3	8.3	11	10.8
M3	7	8	10.8	10.5
	H$_{cor}$			
M1	5	6	4	4
M2	6	5.5	4	4.2
M3	4.5	4.2	5,2	5
	MD$_{col}$			
M1	7	7.1	9	9
M2	6.9	7	9	9.2
M3	**7**	5,5	10	9.2
	MD × VL			
M1	99	99.9	110	112.2
M2	85.49	87.15	110	108
M3	66.5	84	106.92	96.6
	I$_{cor}$ (VL / MD) × 100			
M1	122.23	123.34	90.91	92.73
M2	120.29	126.51	90.91	92.593
M3	135.72	131.25	91.67	87.62
	m$_{cor}$ MD + VL / 2			
M1	10	10.1	10.5	10.6
M2	9.3	9.4	10.5	10.4
M3	8.25	9.25	10.35	9.85

Table 2. Dental features individual from Dvin.

	Maxilla	
	right	left
Labial convexity	0	0
Shovel I1	0	0
Shovel I2	-	0
Double shovel I1	+	+
Double shovel I2	-	+
Mesial ridge UC	-	0
Distal acc. ridge UC	-	+
Metacone M1	+	+
Metacone M2	+	+
Hypocone M1	+	+
Hypocone M2	+	+
Carabelly trait grade 0, M1	+	+
Carabelly trait grade 2-7, M1	0	0
Carabelly trait grade 0, M2	+	+
Carabelly trait grade 2-7, M2	0	0
C5 M1	0	0
C5 M2	0	0
C6 M1	0	0
C6 M2	0	0
Parastyle M1	0	0
Parastyle M2	0	0
Anterior fovea	0	0
Posterior fovea	0	0
Enamel extension M1	+	+
Enamel extension M2	+	+
	Mandible	
Multiple cusps P3	+	+
Multiple cusps P4	+	+
Hypoconulid (Cusp 5) M1	+	+
Hypoconulid (Cusp 5) M2	0	0
Entoconulid (Cusp 6) M1	0	0
Entoconulid (Cusp 6) M2	0	0
6-cusped M1	0	0
5-cusped M1	+	+
4-cusped M1	0	0
6-cusped M2	0	0
5-cusped M2	0	0
4-cusped M2	+	+
YM1	+	+
XM1	0	0
+M1	0	0
YM2	0	0
XM2	+	+
+M2	0	0
Tami (Cusp 7) M1	0	0
Tami (Cusp 7) M2	0	0
Deflecting wrinkle	0	0
Deflecting wrinkle	0	0
Epicristid	0	0
Protostylid	0	0
Protostylid pit	0	0

Table 3. Dental non-metric trait.

Traits	Right	Left
Humerus		
1. Maximal length	-	285
2. Total length	-	282
3. Upper epiphysis breadth	-	40.6
5. Maximal midshaft breadth	-	19.5
6. Minimal midshaft breadth	-	18.5
7. Minimal shaft circumference	49	47
7a. Midshaft circumference	-	52
6 : 5. Cross-section index	-	94.88
7 : 1. Robusticity index	-	16.492
Radius		
1. Maximal length	218	216
2. Physiological length	208	207
4. Cross-section diameter	13.5	13
5. Sagittal shaft diameter	9	9
3. Minimal shaft circumference	32	29
5 : 4. Cross-section index	66.67	69.24
3 : 2. Robusticity index	15.39	14.01
Ulna		
1. Maximal length	234	233
2. Physiological length	210	208
11. Sagittal diameter	9.5	9
12. Transverse diameter	13.5	13.5
13. Upper transverse diameter	12	13.5
14. Upper sagittal diameter	15.5	14.5
3. Minimal shaft circumference	28	27
3 : 2. Robusticity index	13.34	12.99
11 : 12. Cross-section index	70.38	66.67
13 : 14. Platyleny index	77.42	93.11
Femur		
1. Maximal length	399	400
2. Natural length	390	395
21. Condylar breadth	68	-
6. Sagittal diameter of midshaft	22.5	22
7. Transverse midshaft diameter	23.8	24
9. Upper transverse shaft diameter	26	27.5
10. Upper sagittal shaft diametere	22.5	21
8. Midshaft circumference	71	72
8 : 2. Robusticity index	18.21	18.23
6 : 7. Pilastry index	94.54	91.67
10 : 9. Platymery index	86.54	76.36
Tibia		
1. Full length	341	-
2. Condylo-talar length	325	-
1a. Maximal length	34.5	-
5. Upper epiphysis breadth	63	-
6. Lower epiphysis breadth	45	-
8. Sagittal diameter at midshaft level	23.8	-
8a. Sagittal diameter at the nutrient foramen level	25	-
9. Transverse diameter at midshaft level	18.5	-
9a. Transverse diameter at the nutrient foramen level	19	-
10. Midshaft circumference	67	-
10b. Minimal shaft circumference	62	-
9a : 8a. Cross-section index	76	-

10b : 1. Robusticity index	18.19	-
Skeletal proportions		
Intermembral index (H1 + R1) : (F2 + T1)	-	68.07
Tibio-femoral index (T1 : F2)	87.22	87.43
Brachial index (R1 : H1)	-	76.15
Humero-femoral index (H1 : F2)	-	72.43
Radio-tibial index (R1 : T1)	63.05	63.09
Body length		
After K. Pearson & A. Lee	150.45	
M. Trotter & G. Gleser	152.66	
Average	151.56	

Table 4. Postcranial measurements of a female skeleton.

	Dvin		
	Right	Left	Right and left in total
Humerus			
Crista tuberculi minoris, crista tuberculi majoris	-	2	2
Tuberositas deltoidea	-	1.5	1.5
Tuberculum majus, tuberculum minus	-	2	2
Margi lateralis, medialis et anterior Epicondili lateralis et medialis	2	1.5	1.75
In total	2	1.75	1.82
Radius			
Tuberositas radii	1.5	1.5	1.5
Margo unterossea	2	2	2
Furrows for extensor tendons	2	2	2
Processus styloideus	2	2	2
In total	1.88	1.88	1.88
Ulna			
Margo interossea, margo posterior	3	3	3
Crista musculi supinatoris	1.5	1.5	1.5
Tuberositas ulnae	2	2	2
In total	2.17	2.17	2.17
Femur			
Trochanter major	1.5	1.5	1.5
Trochanter minor	2	2	2
Tuberositas glutea	3	3	3
Linea aspera	2.5	2.5	2.5
Epicondili	2	2	2
In total	2.2	2.2	2.2
Tibia			
Tuberositas tibiae	1.5	1	1.25
Margo anterior, margo interossea	1	1.5	1.25
Linea m. solei, m. soleus	3	3	3
Furrows for extensor tendons	2	2	2
In total	1.88	1.88	1.88
Fibula			
The edges development	-	2	2

Table 5. The recording system for musculoskeletal stress (46).

Figure 2. The skull: anterior view, left lateral view, superior view.

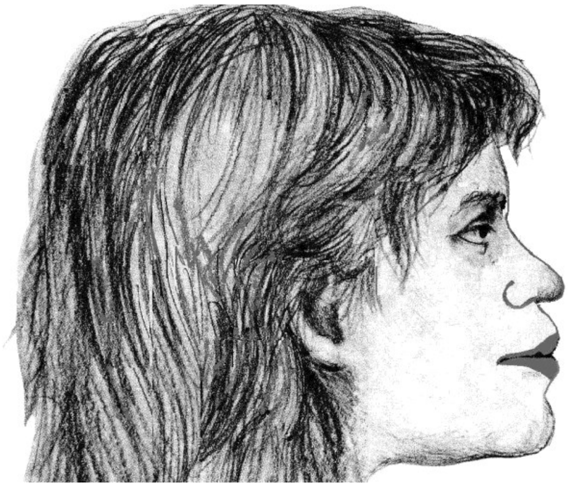

Figure 3. Facial reconstruction of the female.

Non-metric traits

Small variations in the form of the skeleton, traits that are either present or absent, may be described as non-metric variation. Non-metric traits are additional sutures, facets, bony processes, canals and foramina, which occur on the skulls and are believed to suggest hereditary affiliation between skeletons. The majority of non-metric traits were observed on the skull. Cranial traits are more likely to be genetic in origin than those noted on the remaining part of the skeleton, which can often be affected by mechanical stress. These included metopic suture (also known as the median frontal suture) (Figure 1), foramina supraorbitalia, foramina zygomaticofacialia, spina processus frontalis ossis zugomatici, stenocrotaphia, os epiptericum, os wormii suturae squamosum, os postsquamosum, os wormii suturae lambdoidea (an additional bone in the suture at the back of the head), mastoid foramen extrasutural, sutura incisive, foramen pterygospinosum. These anomalies were probably genetic in origin.

Dental morphology

It is commonly appreciated that teeth differ among human groups both as regards shape as well as size. Part of this is due to differences in the prevalence and degree of crown traits, such as incisor shoveling (19) and molar cusp number (20), but other differences involve the proportionality of crown components such as relative cusp sizes (21). Although there is a great number of studies that evaluate dental materials from Armenia (22), however, medieval materials are not available for comparison. All 30 of the tooth dimensions were surveyed (Table 2), analysis demonstrated slight differences (asymmetry) of between the right and left. The teeth in individual from Dvin have smaller crown indices.

Non-metric traits

In general, the morphology of the dental system allows to regard the individual from Dvin as belonging to the western odontological stem. Trait presence is in Table 3. Traits was found in 9 traits of upper dentition only: double shovel (UI1, UI2), distal acc. ridge (UC), metacone (UM1,UM2), hipocone (UM1, UM2), enamel extension (UM1, UM2). Traits was found in 7 traits of lower dentition only: multiple cusps (LP3, LP4), hypoconulid (Cusp 5, LM1), 5-cusped M1 (LM1), 4-cusped M2 (LM2), groove pattern LM1 (Y), LM2 (X).

Upper and Lower Limb

Basic of limb bone measurements the individual from Dvin are listed in Table 4. Body proportions have long been known to vary clinally in relation to climatic conditions, especially mean annual temperature. Determination of body proportions can therefore foster useful information on climatic adaptation and geographic origin of human populations (23). Body proportions analysis was performed on several skeletal parameters: length of the main long bones (humerus, radius, femur, and tibia). The peculiar feature of the female is that his legs are relatively long compared to his arms, as indicated by the low values of the three indices - intermembral (68), humero-femoral (72.43), and radio-tibial (63.05). The radiohumeral index index of the individual was found to be markedly lower 80 (76.15). The tibiofemoral index were found to be higher, exceeding 87.

The female was between 150.45 cm and 152.66 cm tall (see Table 4), with a mean of 151.56cm. This was considerably lower thanthe medieval mean stature for females from Ushi site (154.65cm: 156.12cm /Trotter & Gleser/ and 153.18 cm /Pearson/) calculated by Khudaverdyan et all. (24), but is within her medieval stature range, which runs from 143.8cm to 171.4cm.

Non-metric traits

Common post-cranial traits included septal aperture (a hole in the distal humerus) (Figure 4). On the anterior part of the left femoral head, there is a smooth lateral expansion toward the neck on the same plane as the femoral head (Figure 5). This is a Poirier's facet by definition. Such facets can result from the spreading of the thighs during horse-back riding.

Figure 4. Septal apertures. A region of woven bone and porosity at the base of the capitulum, pectoralis major and deltoid muscle attachments on a right humerus.

Figure 5. Roughness at the soleal line at the proximal end of the posterior side of the tibia (a), Poirier's facet, marked gluteal attachments and third trochanter in the right femur, evidence of habitual horse-back riding of individual (b)

Labor and musculoskeletal stress

Musculoskeletal stress markers have been widely used by bioarchaeologists indicators of physical activity (Table 5). These stress markers occur at the sites of the attachment of soft tissues (muscle, tendon, ligament, fascia and menisci) to bone. Individual exhibits two indentations or impressions on the inferior aspect of the occipital (Figure 6). These may indicate a mechanical stress.

The pectoralis major and deltoid muscles (Figure 4) would have been used in flexing and adducting the arm (at the shoulder) and pulling it across the chest (medial rotation). On the left humerus, a gross porosity area is visible at the insertion of the muscle supraspinatus (Figure 4) indicating a stress on the shoulder; the clavicle of the same side shows an accessory facet on its inferior face medially, due to the anomalous contact with the first rib, perhaps in carrying heavy loads.

Figure 6. Showing unusual indentations on the occipital bone.

Further, ossification exostosis (or traction spurs) on the medial and lateral border of the proximal hand phalanges was on the individual (Figure 7). Enthesopathies found on the phalanges in some cases of Dupuytren's contracture are thought to be traction spurs, i. e. bone spurs caused by mechanical stress. The proximal hand phalanges of the second, fourth and fifth digit have pitted depressions on the palmar surface at the distal parts of the bone, immediately proximal to the joint margins, termed “volar grooves” (25, p. 214). These lesions were diagnosed as “pressure-induced remodelling of the volar metaphysis of the phalanges”, caused by severe flexion contraction of the fingers as a result of neuromuscular degenration (26, p. 203).
The gluteal tuberosity of both femora and the linea aspera in their upper section are strongly developed (Figure 5). Exostosis of the trochanteric fossa has been linked to prolonged sitting posture with the lower limbs extended (27). The tibial tuberosity displays large and mature bone spurs (i.e., enthesophytes) that point superiorly. These features indicate habitual extension of the knee to allow for strength and stability. Each one of the aforementioned features alone may not be diagnostic of habitual horse-back riding (see e.g., Radi et al.) (28), but their presence in this individual as a consequence of horse-back riding is reasonable.

Figure 7. Right proximal hand phalanx of the second metacarpal of a female showing enthesopathies at the lateral and medial side (attachment of the flexor digitorum superficialis), volar grooves.

Pelvic bones testify to considerable stress experienced by ligaments of the pubic symphysis. Entheses of the upper ligament (ligamentum pubicum superius) and arcuate ligament (ligamentum arcuatum pubis) show pathological changes; on the symphyseal surfaces,there are round lesions 3–9 mm in diameter (Figure 8) indicating pubic symphysitis. This is part of the ARS (adductor, rectus, symphysis) syndrome - an injury of ligaments and muscles due to prolonged stress caused by asymmetric traction of the adductor muscles of the hips (m. adductor longus et brevis, m. gracilis) and of the distal part of the rectus abdominis. The same injury can be caused by cross-country walk in bent posture while the shin is preset in a straight or preset position.

Figure 8. Pubic bones of a male with enthesopathies at the attachment sites of pubic ligaments and signs of pubic symphysitis

Human remains are the primary evidence for study of diseases and health in the past.
Plagiocephaly. The head shape is asymmetric and is disproportionately short (Figure 1). The distance from the occipital flattening to the contralateral forehead is much shorter than its cotralateral counterpart.
Cold stress indicators. It is well known that cooling of any part of the body leads to vasodilatation of the peripheral blood vessels. Thus, cribra-like lesions in the external auditory meatiare a side-effect of adaptation to a windy climate (Figure 9a). In the auditory meati of individual there were osteophyt-like outgrowths of bone, or exostoses, observed (Figure 9a). These are amorphous tumors of osteoblastic origin, and their presence is attributed to the effect of cold water on the periosteum, leading to vasoconstriction of the blood vessels in the auditory meatus (29).
It is barely feasible that the association found between the porotic lesions and exostoses is just random. Probably related to habitual exposure to cold air and cold water. This regular cooling was a cause of various infectious diseases, which is indirectly confirmed by presence of mastoiditis in the individual (Figure 9b).
As shown in Figure 10, enamel hypoplasia often appears linearly on the enamel surface. The crowns of healthy teeth should be smooth, but aplasia occurs in depressions of the crowns of teeth with enamel hypoplasia. Although there are individual differences, the timing of crown formation by tooth type is roughly the same among individuals. Therefore, when enamel hypoplasia is seen in a certain site of a certain tooth, one can estimate the age at which the enamel hypoplasia occurred. If several lines can be seen in an individual (Figure 10), it can be speculated that this individual experienced multiple bouts of starvation or malnutrition due to serious disease. Therefore, this case is very important as such evidence. The next feature scored was dental calculus, or mineralized plaque (Figure 10). The presence of calculus was noted on teeth by scoring the amount of calculus, 1–3, and recording the location of the calculus on the tooth surface, as described by Buikstra and Ubelaker (6). The teeth most often affected include the upper molars on the buccal surface and lower incisors on the lingual surface. The analysis of calculus can provide direct evidence of the individual's diet since food remains can become caught in the plaque prior to calcification (6).

Figure 9. Cold stress manifestations, osteophytic lesions (a), and mastoiditis on the skull (b).

Notching is an indentation involving the tooth's incisal/occlusal edge, sometimes extending across all of the surface (Figure 11). Lingual surface attrition of the maxillary anterior teeth is the result of a progressive local wearing of upper anterior lingual tooth surfaces without corresponding wear on the antagonist teeth.
Periostitis is a nonspecific inflammatory reaction of the periosteum due to bacterial infection or injury (30, 31). The reaction is usually localized and results in lesions of woven bone that appear on the surface as if separate from the cortex (30). The left and right tibiae display active periostosis over much of the anterior surface (both medial and lateral of the anterior crest, Figure 12). Dense proliferative spicule growth is on the anterior surfaces of the distal humeri metaphyses in the coronoid fossa and along the lateral supracondylor ridge. A region of woven bone and porosity is located at the base of the capitulum (Figure 3).

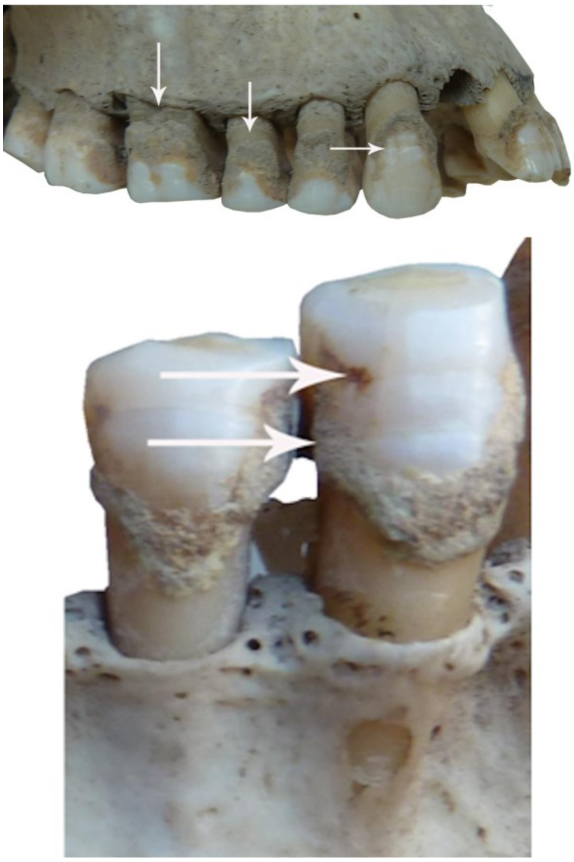

Figure 10. Linear enamel hypoplasia.

Figure 11. Multiple microfractures (chipping) on central incisors and left lateral incisor incisal surfaces. In addition, note the presence of a deep notch on the incisal surface of the upper right central incisor.

Figure 12. Active periostosis on the anterior surface of the tibia.

Degenerative joint disease is a general term referring to the degeneration of amphiarthrodial and diarthrodial joint surfaces over time (31). Diarthrodial joints are highly mobile and with extended time or physical stress can show signs of degeneration such as pitting of the joint surfaces, lipping around the articular surfaces, and in more advanced stages eburnation, or polishing, of the joint surfaces. Osteoarthritis was found on ulna, humerus, femur, tibia, fibula, while osteophytosis was found on vertebral (Figures 13-14). All expressions of osteoarthritis were slight to moderate. Osteophytosis is also slight to moderate.

Skeleton also had an unusually shaped manubrium (breast bone), which was 4mm longer at the left half compared with the right half (Figure 15). This would not have had any effect on the individual. In addition to a distorted manubrium had inflammation (possibly tuberculosis). One of the lesions reported, was on the internal (posterior) surface of the manubrium sterni (Figure 15), the other – on thoracic vertebrae (Figure 16). Vertebral bodies in the thoracic and upper lumbar region carry conspicuous, wide, pit-like vessel impressions, accompanied by traces of superficial remodeling in most cases. Given that tuberculosis is characterized by lyticlesions and is known to affect the sternum to some degree, the presence of pronounced porosity on the posteriorsurface of the manubrium could have potential associations with tuberculosis. Tuberculosis is a chronic infectious diseasecaused by one of the microorganisms of the group Mycobacterium (29, 30).

Figure 13. Lipping of trochlear notches, brachialis muscle attachment on an ulna.

Figure 14. Osteophytosis of a vertebra.

Discussion

In south-western part of the octagonal building (total area of 4×3) contains an part of the skeleton in very good condition without scapulas, humeral, ulnar, radial bones, phalanges, also without skull and the lower jaw (Figure 17). In the southern part of the building were located lefts ulnar, radial bones and phalanges. In the northern part of the building detected a skull with lower jaw and right humeral. The ceramic vessel, ceramic fragments and small number of animal bones were also found in this building. The job of the anthropologist to interpret the data as thoroughly as possible, in order to reconstruct what may have happened in the past.

The woman lived in a high risk area where buildings have been known to collapse. Part of a skeleton was under roof ruins (Figure 13). Buildings constructed on steeply sloped sites in a seismic zone are at special risk. If an earthquake is powerful enough, no building is immune from foundation failure.

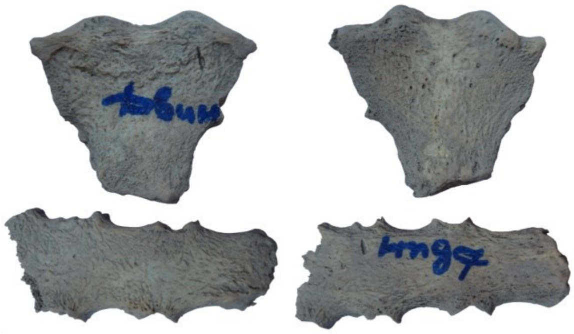

Figure 15. Distorted manubrium, periostosis, tuberculosis of sternum.

Figure 16. Pit-like vessel impressions of the associations with tuberculosis.

Figure 17. Plan of the excavated features at Dvin.

In 851, caused, according to the historian Mkhitar Airiwanétsi (1860, IV: 55), “the death of 12000 people in a single night”. Seven years later, in 858, according to Hovhannes Drasxanakertsi (32), a Catholic historian, “a terrible earthquake took place at Dvin; numerous houses and several palaces were destroyed […] and a horrible thunderous rumble filled the whole town. At the same time, the number of human victims was high and the danger was such that no one dared to remain below a roof, the population bewailed its fate in the streets and the squares, while the cold and the winter made the disaster still more terrible, because many died of the cold" (32: 133-134). Only five years later, in 863, according to the historian Asołik (33: 168), "Dvin was shaken by a powerful earthquake which caused numerous victims and destroyed some fine buildings; the quake lasted three months". The following earthquake, according to the historian Movsēs Kalankatvaci (34), took place six years later: "in 869 an earthquake of unusual power took place in the Armenian city of Dvin, and the shocks were repeated for a whole year, killing 12000 people" (34: 380). However, these four quakes were only a kind of prelude to the disastrous quake of 893, which this town ceased being the administrative and religious capital; its reconstruction took almost two centuries. The historian Thovma Arcruni (35), an eye witness of the disaster, reports that the number of victims was 70000 (during this period the population of Dvin was of the order of 100000 inhabitants) and than this earthquake was more violent than that of 858 (36: 372). As for Hovhannes Drasxanakertsi (32: 162), he too de scribes the destruction of the buildings of Dvin: "during the night an earthquake suddenly shook the city of Dvin; it caused enormous damage, infernal noise, horror and destruction in the densely populated town which was wholly destroyed: for the fortifications of its walls, the palaces of its princes and the houses of its inhabitants were seen to collapse. Everything was transformed into a desert in the twinkling of an eye. In the same way the divinely beautiful church of the patriarchal palace and many other solidly-built martyria collapsed and were reduced to rubble, turning their sites into a kind of wilderness of stone, the sight of which filled those who witnessed them with terror". According to experts, the effects of the earthquake of 893 in Dvin must have been not less than grade IX on the MM scale.

Most of the works reporting earthquake damage at archaeological sites are mainly related to ancient populated areas in the Eastern Mediterranean region such as Greece and Italy (37, 38, 39), Israel (40), Turkey (41, 42), and Syria (10). This paper presents probable evidence of seismic damage in the Dvin city. There are several important lines of evidence which suggest something "catastrophic" was occurring in this period. 1. The earthquake was the reason for the ruining and collapse of the massive stone roof. 2. Parts of human body were scattered inside the building. The similar position of body parts of the individual is commonly observed in cases of earthquake (according to eyewitness account earthquake that struck Armenia on December 7, 1988) and other similar social disasters.

The anthropological data raise an array of questions: Who was this woman? From the morphological point of view, we observe heterogeneity of traits of the female are rather not typical of the ancient, medieval and contemporary population of the Armenia (17, 18). This unfortunate individual lived in marginal conditions. The female had suffered from malnutrition and disease some time prior to death. The presence of cold stress in skull, plain testifies that she have spent a long time in the open-air and its vascular system is adapted for such conditions. Exposure to wind and cold water causes the bone surrounding the ear canal to thicken and constrict the ear canal, sometimes to the point of complete blockage (known as "occlusion"). Remains showing tuberculous lesions confirm the presence of the disease there in medieval times. Tuberculosis was diagnosed according to the morphology of the lesions and their skeletal distribution. Tuberculosis is primarily a pulmonary disease that can affect individuals of all ages, but occurs mostly among individuals with lowered immune function (43). Periostitis occurs in a variety of infectious syndromes including respiratory and enteric diseases, as well as systemic bacterial infections (such as Staphylococcus) and localized infections due to overlying skin trauma (44). Bone responds to infection in a nonspecific manner that does not allow the diagnosis of most infectious agents, so the abundance of periostitis in skeletal samples is often taken as a proxy for infectious disease in general.

The she also showed evidence for muscular trauma as a result of repetitive activities, suggesting that it must have been physically active at least for some time prior to its death. At the proximal end of the femur belonging to the individual from Dvin, there are some enthesopathies previously noted as common in horse riders (45). The biological analysis of the remains has demonstrated that the female suffered from a physical deformity preventing her from maintaining an upright posture during walking. Sitting in a soft saddle without stirrups, however, she could use his legs for balance. In intensive horseback riding for instance, the linea aspera on the femur can become very pronounced due to strain of the adductor and some other muscles. The combined features of vertebral osteophytosis, new bone formation at muscle tendon and ligament insertions, suggest that the female from Dvin lived lives of heavy physical labor.

Conclusion

Many ruins uncovered by archeological excavations in Dvin are the partial result of past earthquakes. The purpose of this report is to add to the corpus of knowledge about the medieval earthquake in the Dvin in the 12th and 13th Centuries. There are some general conclusions that can be made regarding the health of the female. Episodic stress markers point to adverse conditions such as infections, parasites, and starvation periods. Auditory exostoses may indicate exposure to cold air and/or cold water. Dental calculus is nearly universal, indicating preference for viscous food, possibly rich in proteins. Evidence of specific and non-specific infectious diseases such as tuberculous and periostitis suggests that individual, hygienic conditions fostered these diseases to a certain extent.

Acknowledgement

Dedicated to the memory of Aram Kalantaryan.

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