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Degenerative Joint Disease Incidence and Spinal Column Joint Pathologies in the Paleopopulation from Medieval Anchialos, Excavated in Gladston Street, Pomorie. (Preliminary Results)

*V. Russeva**

Institute of Experimental Morphology, Pathology and Anthropology with Museum, Bulgarian Academy of Sciences

*Corresponding author: e-mail: victoria_russeva@yahoo.com

Anthropological investigations of the Middle Ages necropolis of Anchialos from 11-12 c. AD register development of degenerative joint disease. In spite of the small sample size, which doesn't allow statistical analysis, obtained results enrich the knowledge about the health status and life quality in the ancient population. Most individuals over 30-40 years of age developed the studied changes, but, except in three cases, where joint changes can be interpreted as secondary developed process to other condition, degenerative joint disease in population didn't lead to heavy disability.

Key words: joint disease, Middle Ages, Anchialos

Introduction

Data about health condition of individuals derived from skeletal series are scarce, but valuable in reconstruction of adaptation of paleopopulations to environmental conditions. This work aims study of the pathological changes on the main joints of limbs and vertebral column in a medieval population of Anchialos excavated in a sector from the modern street Gladston, Pomorie in order to detect age and sex specifics in their dissemination. The degenerative joint disease (DJD), as well as dental caries, is highly dispersed in ancient populations up to modern time, varying through time, geographic zones and populations [13], and is also found in studied population. Their dependence both of genetic predisposition and environmental conditions [6] makes from them a good marker in a study of population health status and social and biological adaptation strategies of past communities.

In the studied material there are also recognized cases of other joint pathologies. The affected individuals possibly exhibited symptoms as the ones suffering from DJD

development and respectively it can be supposed, that they were treated, both, medically and socially, as the affected from the latter condition. This is one of the reasons these cases to be discussed with the problem for spreading of DJD changes in the studied population. On the other hand, it has been noted by researchers that joint disease in paleoanthropological material should be studied with all the complex of pathological changes presented in the available material from the skeleton and a connection is already found between DJD and some other pathological affectations [14].

Materials and Methods

Archaeological excavations on the necropolis of the Middle Age Anchialos, sector from the modern street Gladston, Pomorie, present human bone remains from inhumations [18]. Most of the individuals are recognized in primary burials (remains from 19 skeletons, 73.1%). After singular bone fragments, which duplicate bones or bone locations found in the material of the main skeleton, or fragments, which characterize individuals with distinctly different anthropological identification (mostly of age determination) in some complexes are recognized reburied fragments. These materials identified more seven individuals at least. Only in grave N 12 are registered one skeleton in primary position in a stone sarcophagus and reburied bones and bone fragments from at least 11 more individuals in the sarcophagus and around it (including these secondary buried bones to the statistic the proportion of primary to secondary burials distorts, becoming 19 primary to 18 secondary burials, or 51.35 to 48.65%).

In anthropological investigation age at death is achieved using assessment of cranial sutures obliteration after Olivier-Simpson and Meindl-Lovejoy [2, 19] (60% of cases), pubic simphyseal and iliac auricular surface relief [11, 19] (20% of identified in combination of cranial sutures obliteration and 10% only by latter features). In one case age is ascertained in broad limits after finished skeletal development as grown-up, and in one case – after dental wear. Sex identification is achieved by the summarized methods [1, 5, 20] with priority of results derived from the pelvic girdle bones (50% of buried; only after cranial features are identified 30% of investigated). Measurements of long bones of the limbs – head diameters of humerus, radius and femur and bicondylar breadth of humerus and femur, correlated to tables of Dwight, Krongman, Thieme and Pearson [5, 10] are taken into account in addition (60% of identified).

In age and sex distribution in adults is ascertained a relatively high number of aged males over ca. 50 years at death. Skeletal remains from females point to a younger age than males (**Table 1**). Both sexes are unevenly distributed, males outnumbering the females with 16 skeletons, identified as males (75%) to five females. Among the studied burial complexes special attention attracts grave N 12, the stone sarcophagus. Skeletal remains from this complex allow recognition of at least 12 individuals. They are distributed by age and sex similarly to the remaining material from the necropolis (**Table 1**).

In assessment of pathological changes on skeletal remains are used classifications for paleoanthropological materials [3, 12]. According to the fragmentary state of the material the main joints of limbs are assessed for development of pathology after present fragments, or in most cases after data from a fragment of only one of the bones included in the joint, which lowers to some degree the certainty of the results. This way are studied the shoulder, elbow, wrist, hip, knee and ankle joints. For the wrist joint are used exclusively data for the present distal ends of radius and ulna and results concern mostly radio-carpal joint and in less cases ulno-carpal and radio-ulnar joints. Affectation of the vertebral column was assessed in three main sections: cervical, thoracic and lumbar, to the latter are included data from proximal joint surface of the sacrum. Such

Table 1. Age and sex distribution of individuals with age at death over 18-20 years

	Adultus 20-40 years		Maturus 40-60 years		Senilis Over 60 years		Over 20 years			Identified	Total
Sex	M	F	M	F	M	F	M	F	0		
N	3	2	7	2	4	-	1	1	1	18	21
%	16.67	11.11	38.89	11.11	22.22	-				85.71	
%*	14.29	9.52	33.33	9.52	19.05	-	4.76	4.76	4.76		
Gr. N 12		2	3		1		1	1	1		9

M - males; F - females; N - number of identified; % - percent from identified in main age intervals; %* - percent from total recognized individuals; Gr. N 12 - minimum adult individuals in the grave N 12

approach renders some uncertainty of the results, which is even more raised in relation to the small sample.

For analysis of distribution of changes on the articulations are defined five stages of development as follows: unaffected, pronounced in clear edges of the articulation surfaces and smooth articulation surfaces; initial development – with coarsening of the edges of the articulation surfaces (**Fig. 4 –** *3*); developed – with thickening and exostoses on the edges of articulation surfaces (**Fig. 4 –** *7*); advanced – with big exostoses on the edges of articulation surfaces, abrasion on the articulation surfaces and osteochondrothic changes (**Fig. 4 –** *1, 2, 6*). On this stage is supposed development of disability, which impacts the life of the affected individual. The last stage is defined by high restriction of movements in the joint with advanced disability (**Fig. 4 –** *4, 5*), which supposes surviving of the individual for relatively long period of life exclusively after support by other members of the society. Because of the small sample size the age distribution of joint disease is assessed after calculation of average degree of affectation of joints, which again reduces the possibility for interpretation.

Results and Discussion

All defined stages of development of DJD are registered in the population from medieval Anchialos. With less cases of lack of affectation the elbow appears as most often developing DJD (**Table 2**). In spite of this in studied series more risk appears for development of severe cases of pathological changes on joints of lower limbs – the hip and knee, where are concentrated cases, which suppose developed severe disability. Age distribution of DJD on studied limb joints points to development of these changes from most individuals over 30-40 years, 40-50 years being the peak of frequency of the pathology (**Figs. 1, 2**). The small sample doesn't allow a specific tendency to be derived. It appears a phenomenon of higher affectation of the left side in bones from upper limbs, situation, which could be caused by an insufficient data in the material.

In vertebral column the thoracic section appears as more affected of DJD changes (**Table 1**). The graph, obtained after calculated mean values of affectation for 10-year

Table 2. Distribution of the DJD on the studied joints of limbs

		Shoulder		Elbow		Wrist		Hip		Knee		Ankle	
		dx	Sn	dx	sn	dx	sn	dx	sn	dx	sn	dx	sn
Unaffected	N	4	3	1	1	3	3	3	4	3	4	2	2
	%	30.8	20.0	10.0	8.3	37.5	37.5	27.3	36.4	23.1	30.8	33.3	28.6
Innitial affectation	N	3	4	5	5	3	2	3	1	4	2	1	3
	%	23.1	26.7	50.0	41.7	37.5	25.0	27.3	9.1	30.8	15.4	16.7	42.9
Developed	N	4	4	3	3	2	2	2	4	2	4	2	1
	%	30.8	26.7	30.0	25.0	25.0	25.0	18.2	36.4	15.4	30.8	33.3	14.3
Advanced development	N	2	4	1	2			1	2	2	1	1	1
	%	15.4	26.7	10.0	16.7			9.1	18.2	15.4	7.7	16.7	14.3
Disabled	N				1		1	2		2	2		
	%				8.3		12.5	18.2		15.4	15.4		
Total		13	15	10	12	8	8	11	11	11	13	6	7

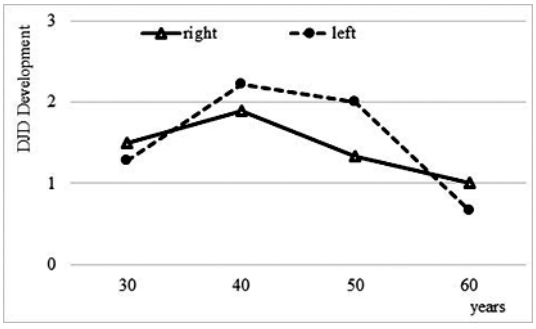

Fig. 1. Age distribution of mean affectation of the DJD on studied joints of upper limbs: 0 – unaffected; 1 – initial affectation; 2 – developed; 3 – advanced development; 4 – disability

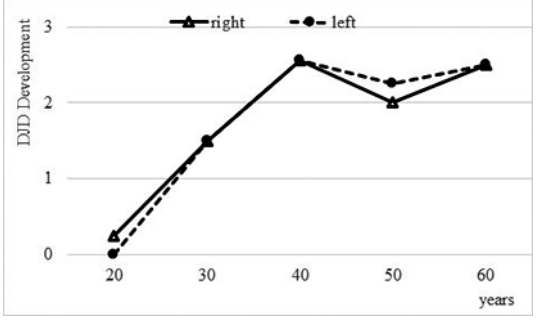

Fig 2. Age distribution of mean affectation of the DJD on studied joints of lower limbs: 0 - unaffected; 1 - initial affectation; 2 - developed; 3 - advanced development; 4 - disability

age intervals (**Fig. 3**) points to highest affectation in the age interval between 30-40 years of death. This situation is explained with worsened health in those, who died at younger age and difficulties to distinguish cases of development of distrophic changes as a secondary process of another main infectious disease, especially in initial stages of development. It can be supposed that most of the people from studied population

Table 3. Distribution of the DJD on the main sections of the vertebral column

	C	%	T	%	L	%
Unaffected	2	28.57			1	12.50
Innitial affectation	1	14.29	1	14.86	2	25.00
Developed	1	14.29	3	42.86	2	25.00
Advanced development	3	42.86	3	42.86	3	37.50
Total	7		7		8	

C - cervical section; T - thoracic section; L - lumbar section (reburied sections from a vertebral column from grave N 12, possible DISH – excluded)

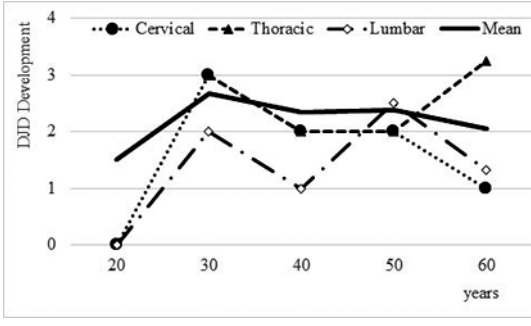

Fig. 3. Age distribution of mean affectation of the DJD on vertebral column:
0 - unaffected; 1 - initial affectation; 2 - developed; 3 - advanced development; 4 - disability

obtained some degree of DJD changes on vertebral bodies at the age of 30-40 years. This pathology rarely reached highly developed stages and respectively rarely led to disability in the population.

There appear two cases of heavy disability after excessive development of DJD changes in limb joints. All they are found in individuals with complicated health status and can be interpreted as connected to other pathological processes. One of these is registered in an individual from the grave N 13, a male, between 40-50 years at death. Here DJD changes from highest degree, after developed scale, are observed in left elbow. The fragments from the left hip joint also show last stage of development of DJD changes with possible heavy disability. Progressive arthritis changes are registered on the found vertebrae. The condition of the hip joint could be explained with possible luxation as inborn predisposition or traumatic consequence. Here the DJD changes can be interpreted as secondary process on the affected joint. In complex with changes on the vertebral bodies the condition of hip joint could be also explained with an infectious disease, which led to rheumatism in childhood and worsened health condition of the individual during his later life. The DJD changes in the left elbow possibly progressed after the fracture on the left radius, which could be a result of the overloading the joint in use of a walking stick in difficult locomotion. Registered fractures on four ribs, recognized as two left and two right, one of which is affected on two places and a defect from a trauma on right tibia could be also a result of incidences in difficult locomotion and week muscle and skeletal composition.

The other case of last stage of development of DJD changes after the used scale is registered again in elbow, on single reburied left humerus in material from grave N 12, which cannot be categorically associated with other fragments from the postcranial

skeleton. From the same complex comes a reburied single bone, right femur, with developed changes on the head, pointing to disability in hip joint possibly after luxation, presenting condition similar to the observed in the individual from grave N 13. Again as in the latter case material from reburied bones from grave N 12 presents advanced vertebral column pathology **(Fig. 4 –** *10*), identified as possible DISH (diffuse idiopatic skeletal hyperostosis). All these bones could have come from one skeleton of a disabled individual. Here the condition of the elbow could be explained again with overloading the arms during walking with a stick. Observed advanced DJD changes in the hip should be regarded as a secondary process on the traumatized joint.

In skeletal remains from studied necropolis are recognized two individuals, with specific changes, who possibly showed similar condition as affected from DJD changes for their contemporaries. It can be supposed that in the period they were treated in similar way in social and medical aspect like those affected from DJD changes. One case is the registered ankylosis of vertebrae from the thoracic section – reburied bone fragments in and around sarcophagus (gr. N 12), discussed above. Five thoracic and first lumbar vertebrae (T-8 – T-12 – L-1) are situated to the north wall of the sarcophagus in anatomical position. Vertebrae from the upper part of the thoracic section, which changes could be evaluated as developing same condition, but couldn't get in correct articulation with the rest of the found vertebra because missing bones are found disarticulated. Outside the sarcophagus, near its east wall are found more two thoracic vertebrae with same pathology. All these bones allow reconstruction of T-1/T-6 and T-8/L-1 sections of the vertebral column of one individual. On the right side of vertebral bodies of all these vertebrae are formed thick bone layers, "wax" appearing, which are most developed on the T-8/T-9, fused together **(Fig. 4 –** *10*). The condition is specific to DISH [12]. The T-2 and T-3 show ankylosis on their neural arches. After developed spondylosis one first cervical vertebra and a lumbar vertebra from the complex could also be associated to the vertebral column of this individual.

In skeleton from grave N 19, female, about 40-50 years at death, is registered other severe abnormality on the spinal column **(Fig. 4 –** *8, 9*). Here C-2 and C-3 vertebrae are fused together in their neural arches and C-4 and C-5 are fused in neural arches and vertebral bodies. On the first cervical vertebra is developed advanced spondylosis on the edges of articulation surface with dens axis of the second cervical vertebra, possibly after abnormal position of the skull according to the vertebral column with bending backward. The find resembles an inborn condition, reminding of Klippel-Feil syndrome [4]. Changes are also found in the pelvic area, where the coccyx fuses with sacrum in bent position to the right side. The sacrum and right iliac bone are also fused together. The individual should have been at least partially disabled. Possible interpretation of the fusion of cervical vertebra in connection of the ossifications on sternal ends of six ribs and sacroiliac joint could be also development of a condition described as ankylosing spondylitis [12], known in Bulgarian paleopopulations as Bechterew disease [17]. The latter interpretation corresponds better to the relatively advanced age of the individual.

Being highly dispersed in the Bulgarian Middle Ages series [7, 8, 9] DJD changes affected most of individuals over 30-40 years of age in different stage of development. This pathology appears as one of the main reasons for disability in the late mature and senile age. With other finds from the Bulgarian Middle Ages series [7, 8, 9] cases of DISH and possible ankylosing spondylitis (Bechterew disease) or Klippel-Feil syndrome point to their dispersal also in the Bulgarian Middle Ages, as not a rare condition [15]. Again, as found from other researchers of spreading of this pathology in the Middle Ages [15, 16], the individual with developed DISH from our investigated series could be apprised as a member of high social strata of the group, which used the graveyard and performed burials in the sarcophagus.

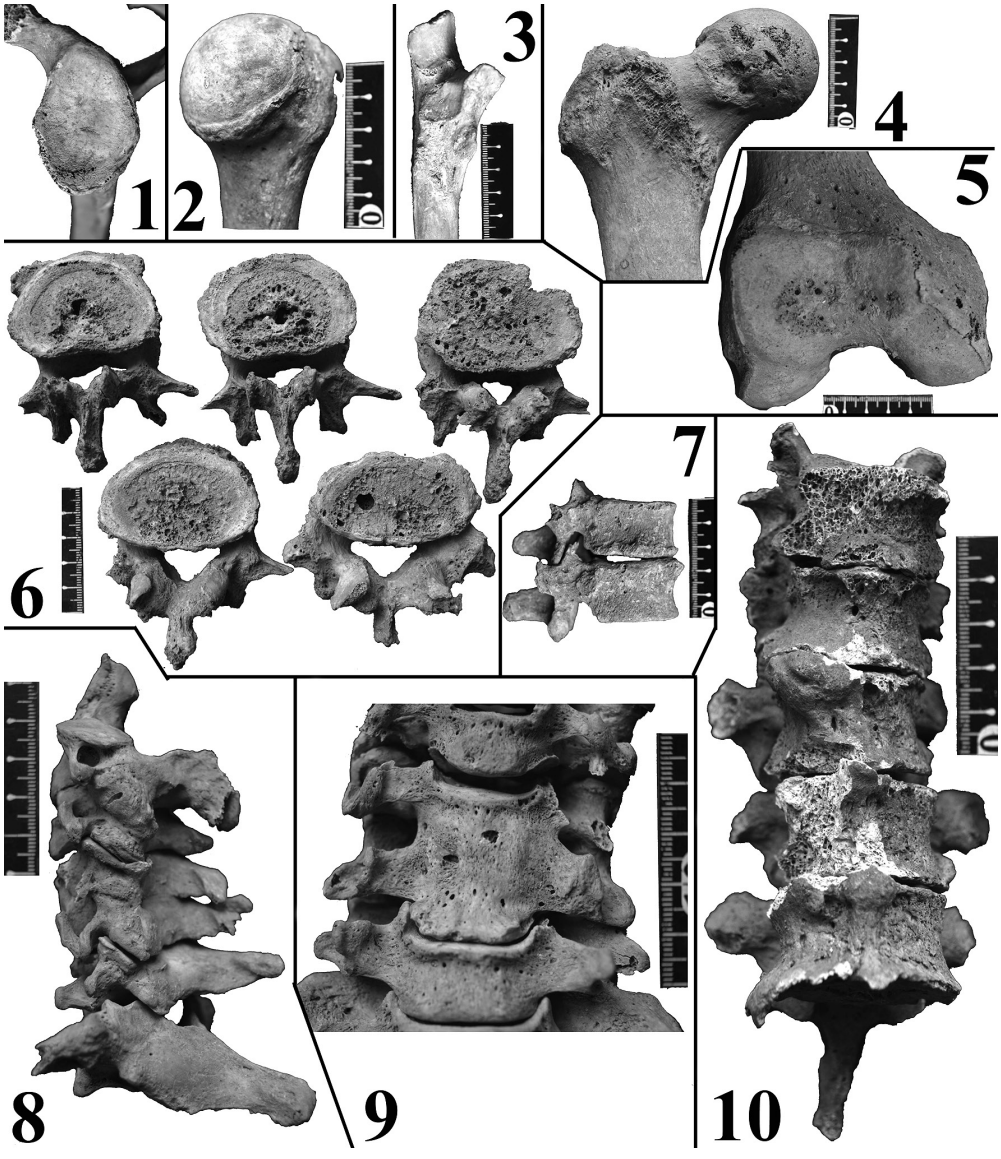

Fig. 4. Degenerative joint disease and spinal column joint pathologies, Anchialos, site in Gladston Str. *1* – Glenoid fossa, left scapula, grave N 18, male, 50-60 years, advanced DJD changes on the articular surface edge and destruction of articulation survace; *2* – Head of right humerus, grave N 24, male, 30-40, up to 45 years, advanced DJD changes; *3* – Right ulna, proximal part, grave N 7, male, 60-65 years, initial development of DJD on the articulation surface edge; *4* – Right femur, proximal part, grave N 13, male, 40-50 years, disability after possible hip joint luxation; *5* – Right femur, distal part, grave N 13, disability after development of DJD as a secondary process to hip joint condition with articulation surface edge exostoses and articulation surface eburnation; *6* – Lumbar vertebrae, grave N 13, advanced development of DJD with osteophitosis of articulation surface edges and osteohondrosis of articulation surfaces; *7* – Two thoracic vertebrae, grave N 24, developed DJD changes, marked by exostoses on the vertebral edges; *8* – C-2 – C-7 vertebrae, grave N 19, female, 40-50 years, ankylosis between C-4 – C-5; *9* – Grave, N 19, ankylosis between C-4 – C-5, detail; *10* – Thoracic vertebrae, reburied in grave N12, development of DISH

Conclusions

Studied population presents relatively favorable situation according to development of DJD changes. Most pronounced cases can be qualified as secondary occurred in connection to other pathological condition, or in life adaptation in disability after progress of another affectation. Cases of advanced disability are in result of development of spinal cord joint diseases, recognized in one case as DISH and in the other as possible ankylosing spondylitis (or Bechterew disease) or Klippel-Feil syndrome. Obtained results will add to the investigation of distribution of this pathology in the Bulgarian Middle Ages.

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