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Original article

Is the incidence of elbow osteoarthritis underestimated? Insights from paleopathology

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Abstract

***Objectives.* –** Osteoarthritis is uncommon at the elbow in contemporary populations. We sought to determine whether this was also the case in medieval and premodern times.

***Material and methods.* –** Standard criteria for osteoarthritis were applied to 496 complete elbows from a necropolis in Provence, France.

***Results.* –** Osteoarthritis was found in 27% of elbows. Significant differences were noted across periods and age groups but not between the right and left sides.

***Conclusion.* –** Our data suggest that the symptoms of elbow osteoarthritis may be far milder than expected from the underlying pathological lesions. The incidence of elbow osteoarthritis in contemporary populations is probably underestimated. The high prevalence of elbow osteoarthritis in archeological populations cannot be taken as a marker for activities placing stress on the upper limbs.

Keywords: Paleopathology; Elbow osteoarthritis; Osteoarthritis

1. Introduction

Osteoarthritis of the elbow is an extremely uncommon condition usually ascribed to work-related activities. Patients with work-related elbow osteoarthritis are eligible for compensation in France. The incidence of elbow osteoarthritis is exceedingly low in individuals without work-related risk factors. In addition, elbow osteoarthritis is rarely symptomatic. However, studies of skeletal remains from archeological sites suggest a non-negligible incidence of elbow osteoarthritis [1–3].

The objectives of the present study were to determine the prevalence of osteoarthritis in archeological populations, to compare the distribution of osteoarthritis in these populations to those reported in the literature, and to discuss possible etiological mechanisms.

2. Material and methods

Pelvic bones were obtained from the Notre-Dame du Bourg necropolis in Digne (Alpes de Haute Provence, France), which is being investigated by Démians d'Archimbaud [4]. The necropolis contains over 1000 human skeletons dating from the fourth to the seventeenth century. Anthropological and paleopathological studies of these remains are being conducted at the anthropology laboratory of the Marseille School of Medicine, Marseille, France, under the direction of B. Mafart.

We selected 496 complete elbows (including the distal humerus and proximal radius and ulna) from adults. For 185 individuals, both elbows were available (370 elbows). Of the 496 elbows, 245 were from the medieval period (11th–13th centuries) and 251 from the premodern period (16th and 17th centuries).

The gender of the individuals was determined from the pelvic bones [5] and age at death from the appearance of the auricular joint surface of the ilium (Lovejoy method [6] modified by Schmitt and Braoqua [7]). This Bayesian method yields a likelihood that the individual belongs to a given age group. We classified the remains based on whether the estimated age at death was younger or older than 30 years or younger or older than 50 years.

The most widely used method for diagnosing osteoarthritic in paleopathology [1,2,8,9] requires presence of at least one of the following lesions at one or more elbow sites:

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Table 1
Distribution of elbow osteoarthritis in an archeological population from the Notre-Dame-du-Bourg necropolis

Variable	Population	Subset	11th–13th century			16th–17th century			Total		
			OA+		Test	OA+		Test	OA+		Test
Side	Overall	Right	21	17.5%	NS [1]	43	32.3%	NS [1]	64	25.3%	NS [1]
		Left	33	26.4%		37	31.4%		70	28.8%	
	Paired elbows	Right	17	17.9%	NS [1]	24	33.3%	NS [1]	41	24.6%	NS [1]
		Left	22	23.2%		19	26.4%		41	24.6%	
Sex	Overall	Males	25	25.0%	NS [1]	42	43.3%	HS [1]	67	34.0%	S [1]
		Females	16	20.0%		21	19.8%		37	19.9%	
	<30 years	Males	0	0.0%	NS [3]	3	27.3%	NS [3]	3	17.6%	NS [3]
		Females	1	16.7%		1	5.9%		2	8.7%	
	>30 years	Males	19	33.9%	NS [1]	33	52.4%	TS [1]	52	43.7%	S [1]
		Females	12	26.7%		13	22.8%		25	24.5%	
	<50 years	Males	6	12.0%	NS [1]	12	31.6%	NS [1,a]	18	20.5%	NS [1]
		Females	3	7.3%		9	15.3%		12	12.0%	
	>50 years	Males	14	43.8%	NS [2]	20	48.8%	S [1]	34	46.6%	S [1]
		Females	7	43.8%		3	13.0%		10	25.6%	
Age	Overall	<30 years	1	6.3%	S [1]	5	15.2%	S [1]	6	12.2%	S [1]
		>30 years	34	32.1%		49	38.0%		83	35.3%	
		<50 years	9	9.1%	HS [1]	23	21.3%	S [1,a]	32	15.5%	HS [1]
		>50 years	24	45.3%		25	34.7%		49	39.2%	
	Males	<30 years	0	0.0%	NS [3]	3	27.3%	NS [1]	3	17.6%	S [1]
		>30 years	19	33.9%		33	52.4%		52	43.7%	
		<50 years	6	12.0%	S [1]	12	31.6%	NS [1]	18	20.5%	HS [1]
		>50 years	14	43.8%		20	48.8%		34	46.6%	
	Females	<30 years	1	16.7%	NS [3]	1	5.9%	NS [3]	2	8.7%	NS [1]
		>30 years	12	26.7%		13	22.8%		25	24.5%	
		<50 years	3	7.3%	S [1]	9	15.3%	NS [3]	12	12.0%	S [1]
		>50 years	7	43.8%		3	13.0%		10	25.6%	

Tests [1] chi-square test; [2] chi-square test with Yates' correction; [3] Fisher exact test. NS, not significant ($P > 0.05$); S, significant ($P < 0.05$); HS, highly significant ($P < 0.001$). Total amount of age-and sex related subgroups can be different for what is said for the entire population because difficulties for some specimens to access age and sex at death (bone alterations, equivocal diagnosis).

[a] borderline values.

osteophytes longer than 2 mm, joint surface erosions exposing the subcortical bone structure, and eburnation (hard bone polished by friction).

2.1. Statistics

For the statistical evaluation, we used the chi-square test when the total sample size was 60 or more, the chi-square test with Yates' correction when the total sample size was between 30 and 60, and the Fisher exact test when the total sample size was smaller than 30 or when the theoretical sample size was smaller than five.

3. Results

Of the 496 elbows, 134 (27%) showed evidence of osteoarthritis. Of the 185 individuals for whom both elbows were available, 65 (35.1%) had osteoarthritis in at least one elbow and 27 (14.6%) had osteoarthritis in both elbows.

Table 1 reports details on the lesions according to the epidemiological data.

4. Discussion

The prevalence of elbow osteoarthritis was similar on the left and right sides, even when only paired elbows were considered. No difference was found between males and females in the earlier population (13th and 14th centuries). Elbow osteoarthritis was more prevalent in the premodern population (16th and 17th centuries). This difference was ascribable to an increase in the prevalence of elbow osteoarthritis in males between the two periods; the prevalence in females remained unchanged.

The prevalence of elbow osteoarthritis increased with age in the overall population, in the males and in the females. In each period and in the overall population, elbow osteoarthritis was significantly more common in individuals older than 30 years or 50 years than in the corresponding younger subgroups. When males and females were analyzed separately, the prevalence remained higher in individuals older than 50 years than in younger individuals, but the differences were rarely significant, probably because of the small numbers of individuals in each subgroup.

Among elbows from individuals younger than 30 years of age, six (12%) had osteoarthritis. Goodfellow [10] reported degenerative lesions of the humeral head in individuals as young as 18 years of age.

Given the large number of elbows studied and the exclusion of remains with upper limb bone lesions due to conditions other than osteoarthritis, it is reasonable to assume that

the cases of elbow osteoarthritis identified in our study were not secondary to inflammatory or infectious joint disease.

The presence of elbow osteoarthritis in over one fourth of the elbows from the Notre-Dame-du-Bourg population is in sharp contrast with the low prevalence of clinically patent elbow osteoarthritis in rheumatological practice today. The few available studies of elbow osteoarthritis [11–15] found low prevalences. For instance, Ruelle et al. [13] found only 200 affected patients in a retrospective review of charts from a rheumatology clinic (0.56% of visits). In addition, the symptoms were mild, and two thirds of patients had no pain. Motion range limitation was the most common manifestation, with loss of extension early in the disease and loss of pronation and supination later on. Ulnar nerve entrapment occurred in 31 patients (31/200, 15.5%). The radiological changes were typical of osteoarthritis but difficult to interpret because of superposition of anatomic structures. Joint space narrowing was noted in 45% of cases, subchondral sclerosis in 40%, geodes in 20%, radial head osteophytes in 67%, and coronoid process osteophytes in 80%.

As with osteoarthritis at other sites, the pathogenesis is probably multifactorial, involving genetic and environmental influences, as well as trauma. The most common causative factor identified for osteoarthritis of the elbow is microtrauma related to use of pneumatic tools or other vibrating tools [13,14]. Foundry workers are also at risk [15]. In Germany, elbow osteoarthritis has been considered an occupational disease since 1929. Nevertheless, studies of associations with work-related activities have produced contradictory results. Roche et al. [14] found elbow osteoarthritis in only 7% of a population of miners. In a study of population residing in a mining area, Ruelle et al. [13] noted that the prevalence of elbow osteoarthritis among manual workers (32.5%) was nearly identical to the prevalence of manual workers in the population (32%). A study of 290 potters using traditional techniques found only 33 cases of elbow osteoarthritis (11.4%) [16]. These results militate against a causal relation between manual activities and elbow osteoarthritis.

To explain the difference in the prevalence of elbow osteoarthritis between contemporary radioclinical studies and our paleopathology study, we suggest two hypotheses. The first hypothesis involves a difference in physical activities. Profound lifestyle changes have occurred since the industrial revolution. The physical activities carried out in our highly mechanized world are very different from those of our ancestors, who had to rely chiefly on their muscles to provide energy. However, the impact of these changes on the human body is not well understood. In addition, little is know about the everyday activities of prehistoric and historic populations [17]. Conceivably, pressing down with the arms on a plough or harrow drawn by animals might have similar effects to holding pneumatic tools. Most paleopathologists [9,18–21] ascribe the high prevalence of elbow osteoarthritis in the past to a high level of physical activity. They assume that elbow osteoarthritis serves as a bone marker for physical activity, although this has not been convincingly demonstrated [22]. Our alternative hypothesis is that the prevalence of elbow osteoarthritis in contemporary populations is underestimated. The word "osteoarthritis" is used to designate two different concepts, one clinical and the other pathological. Clinical osteoarthritis is considered when a patient complains of symptoms and confirmed when radiographs show the typical triad of joint space narrowing, subchondral sclerosis, and osteophytosis. In the overwhelming majority of cases, the diagnosis of elbow osteoarthritis is made when imaging studies are performed to evaluate elbow pain. When there is no pain, imaging studies are not obtained and the condition escapes detection. Clinical studies have shown that pain is uncommon in elbow osteoarthritis and that the main clinical manifestation is motion range limitation, which often goes unnoticed. In Finland, a study involving routine radiographs in 5227 individuals found evidence of elbow osteoarthritis in 29% of individuals older than 50 years and 17% of those aged 40–50 years [23]. Furthermore, radiographic screening has been found less sensitive than paleopathological examination [24]: of 16 cases of knee osteoarthritis diagnosed by direct visual examination, only two (12.5%) were detected by an experienced radiologist. Paleopathologists rely only on direct observation of bones. They base the diagnosis of osteoarthritis on presence of at least one of the following abnormalities: osteophytes, joint surface alterations, and eburnation. Of these three abnormalities, only osteophytes are visible on radiographs. However, osteophytes have low specificity for osteoarthritis. Thus, the radioclinical approach and the paleopathological approach are not comparable. The presence of paleopathological osteoarthritis does not provide information on clinical symptoms. An individual may have major skeletal abnormalities but no functional impairment. Roche et al. [14] reported that discordance between clinical and radiological manifestations is particularly common in elbow osteoarthritis. As early as 1926, an autopsy study in 995 Germans found that the prevalence of elbow osteoarthritis was 26.4% [25]. This figure obtained in individuals living in an industrialized country is similar to the prevalence found in our Notre-Dame-du-Bourg populations from medieval and premodern times.

5. Conclusion

Elbow osteoarthritis is without doubt more common than suggested by the prevalence of clinical symptoms. Therefore, the high prevalence found in our archeological populations is not surprising and should not be construed as evidence of greater mechanical stress to the elbows in the past as compared to modern times. Elbow osteoarthritis often produces minimal or no clinical symptoms, even today. It follows that the diagnosis is easier to establish using paleopathological methods than clinical methods. Elbow osteoarthritis should not be used as a marker for the level of physical activity in archeological populations.

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