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Oral health of German Luftwaffe pilots during World War II

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Abstract:

Introduction: The aim of this paper is to present the analysis of dental remains from the archaeological excavation of a military site used by the Luftwaffe (German Air Force) during World War II. Studying the dental data from these remains allows us to understand the health policy of the German armed forces in this context.

Materials and method: The study focuses on dental data. The percentage of the remains corresponding to four criteria were calculated: undiagnosed carious lesions, dental restorations, dental prostheses and the presence of calculus.

Results: The remains of 16 individuals were analysed. Carious lesions were present in 87.50% of the study population. Dental restorations were present in 81.25% of the study population, while fixed dental prostheses were found in 31.25% of the population. Calculus was present in the entire population. The observations also revealed the presence of exogenous dental staining, tooth loss and dental fractures.

Discussion: The study suggests a change in German health policy between World War I and World War II. Greatly improved medical systems were put in place, notably with the organisation of German military dentistry from 1933 onwards, contributing to the health of military personnel to enable them to contribute more effectively to the war.

Key words: *Oral health, Luftwaffe, military health*

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INTRODUCTION

In 1940, the Third Reich occupied part of France and from June, Luftwaffe units took control of the Beauvais-Tillé airfield after the town was bombed. They quickly began construction of new infrastructures in order to enlarge it and use it to its best advantage.¹ The Germans occupied the airfield until 1944, when they were replaced by US Air Force squadrons.

Between June 1940 and the summer of 1942, German military personnel (pilots, crew members or ground personnel) who died in the vicinity of the site were buried in a temporary cemetery in the airfield before the development of the military cemetery of La Mie-au-Roy.² Those buried in the cemetery included the sick or wounded previously hospitalised in the mil-

itary infirmary, or aircrew who died following air crashes, particularly during the Battle of Britain (July 1940 - May 1941). At the end of the war, according to the records of the Volksbund Deutsche Kriegsgräberfürsorge (VDK), the German War Graves Service, the individuals buried in the provisional cemetery were all transferred to the cemetery of La Mie-au-Roy managed by the VDK.

In 2018, as part of an urban redevelopment project, the City of Beauvais considered the development of an ice rink on the grounds of the former airfield. During preliminary works, human remains were uncovered. Members of the Archaeological Service of Beauvais quickly intervened to notify the police and justice authorities to ensure the space could be excavated as part of an archaeological operation. During this operation, the provisional

cemetery was discovered, uncovering the remains of thirty-nine graves. The archaeologists discovered that while twenty-three graves were empty or partially empty, 16 seem to have been forgotten at the time of the exhumation and remained intact.

This unexpected discovery allowed the excavation and subsequent study of these members of the German Air Force. The historical context of the individuals buried, along with the way the remains were discovered, is extremely rare in archaeological operations.³ No local knowledge of this temporary cemetery remained. However, there are still photographs of some of the graves taken in October 1944 by Fernand Watteeuw.⁴ The discovery of this type of material in France is quite rare. In fact, at the beginning of the Second World War, there was little ground warfare and part of France was soon under German occupation. The German military therefore had time to bury their colleagues and to build permanent cemeteries, such as that at La Mie-au-Roy in 1942. The provisional cemetery was only used for two years, notably during the Battle of Britain.

The opportunity to examine a specific population such as the air force can provide important and original study opportunities and allow the examination of a military population of healthy and relatively young men. In view of the preservation of the dental remains of the 16 individuals exhumed, it was of interest to report the oral health status for each individual. Then to compare the results obtained with the health policy implemented by the German military between the two world wars, in order to reflect on and compare the application of this policy during the war.

We would have liked to have gone further in studying these biological archives in parallel with historical archives. However, we were unable to identify these servicemen and therefore to link them precisely to a specific fighter or bomber group. Many archives disappeared during the German retreat and the liberation, so for these reasons such an approach was not possible.

MATERIALS AND METHODS

Osteological and dental material

The cemetery contains 39 graves in three rows of 13 graves. Of these, 23 graves had already been exhumed (only a few bone elements were found) and 16 graves contained complete individuals of which 10 were buried in airman's clothing and the other six without any effects. Of these, five had been autopsied in a military hospital. The Luftwaffe hospital was located approximately 2 km south-west of the site. The entire cemetery consists of quadrangular graves, each containing a coffin. Sometimes only traces of powdered wood remained of the coffin, while in some graves the base, walls and lid had been preserved.

The 23 incomplete burials were analysed from an anthropological point of view. However, as they only presented fragments of dental arches or a few isolated teeth, they were excluded from the rest of the study as they provided very little information on the oral condition of the individual exhumed.

In total, 16 individuals were analysed: all the dental material found was photographed, recorded and identified.⁵ The bone and dental remains that we analysed were either of very good quality (intact skull) or very fragmented, due to peri-mortem trauma (fractures of the maxilla and/or mandible at the time of death) or by taphonomic processes that have degraded the bone after burial and make analysis more difficult.⁶

The sex of each individual was determined using morphoscopic,⁷ morphometric⁸ and anthropological methods based on the coxal bone; the most dimorphic bone in the human skeleton. The estimation of age at death was analysed by the application of methods based on observation of the coxal bone, in particular the sacro-pelvic iliac region,⁹ and also on the different stages of fusion of the sternal end of the clavicle for younger individuals (under 30 years of age).¹⁰ Individual biological data are summarised in *Table 1*.

Table 1: Biological data of the study population

Individual	Sex	Age	Dental remains	Condition of skeletal remains	Presence of military equipment (uniforms, parachutes)
Sp1	Male	20-49	Complete	Good	No
Sp2	Male	20-49	Incomplete	Average	Yes
Sp4	Male	30-59	Complete	Good	No
Sp6	Male	> 50	Complete	Good	No
Sp8	Male	30-59	Complete	Good	No
Sp10	Male	20-39	Complete	Poor	Yes
Sp12	Male	30-59	Complete	Good	Yes
Sp14	Male	16-21	Complete	Average	Yes
Sp15	Male	20-39	Complete	Good	No
Sp16	Not observable	Adult	Incomplete	Average	Yes
Sp18	Male	16-21	Complete	Average	Yes
Sp20	Not observable	Adult	Complete	Poor	Yes
Sp22	Not observable	Adult	Incomplete	Poor	Yes
Sp23	Male	30-59	Incomplete	Average	No
Sp24	Male	>40	Complete	Good	Yes
Sp26	Male	24-29	Complete	Good	Yes

Methods of dental data collection

The study of dental remains was carried out with a dental probe by a dental surgeon. Each tooth was identified according to the nomenclature of the International Dental Federation (FDI) nomenclature: standardised in 1970; predominant in France and in many countries.¹¹

For each of the dental arches, the following data were recorded:

- Preservation of teeth in the arch

- The presence and location of any carious lesion
- The presence of a dental restoration, its location and the material used
- The presence and type of any dental prosthesis
- The presence of calculus
- Bone resorption and its location
- Hypoplasia
- Tooth wear.

A data collection document was created to aid data analysis (Table 2).

Table 2

BV PATINOIRE SEP 1		18	17	16	15	14	13	12	11		21	22	23	24	25	26	27	28
CONSERVATION	SA	SA	R	R	SA	I	I	I		I	SA	SA	SA	SA	PAM	SA	SA	
LESION CARIEUSE	0	0	1	1	0	0	0	0		0	0	0	0	0	-	0	1	
LOCALISATION	-	-	OCC	OCC	-	-	-	-		-	-	-	-	-	-	-	-	OCC
RESTAURATION	0	1	0	0	0	0	0	0		0	0	0	1	1	-	1	0	
LOCALISATION	-	OCC	-	-	-	-	-	-		-	-	-	OM	OM	-	MOD	-	
MATERIAU	-	AM	-	-	-	-	-	-		-	-	-	AM	CIM	-	AM	-	
PROTHESE	0	0	0	0	0	0	0	0		0	0	0	0	0	-	0	0	
MATERIAU	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
TARTRE	0	0	0	0	0	0	0	0		0	0	0	0	1	-	0	1	
RESORPTION OSSEUSE	-	P	-	APEX ABCES	-	APEX	APEX	-		-	APEX	-	APEX	APEX	-	-	-	
HYPOPLASIE	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
USURE	-	-	-	-	-	-	-	ANGLE MESIAL		-	-	PC	-	-	-	-	-	

Observations :
 - Trépanation
 - Maxillaire sur crâne
 - Fractures dentaires : 17 pan vestibulaire, 11 angle (9/10)

Key to terms

Term/Abbreviation	English		
Conservation	Status	Materiau	Material
SA	Present in the arch	AM	Amalgam
R	Restored	CIM	White stone
I	Isolated from the arch	Prothese	Prosthesis
PAM	Lost before death	Tartre	Calculus
Lesion carieuse	Carious lesion	Resorption osseuse	Osseus resorption
Localisation	Location	Apex	Apex
OCC	Occlusal	Absces	Abscess
OM	Mesio-occlusal	Hypoplasie	Hypoplasia
MOD	Mesio-occlusal-distal	Usure	Tooth wear

Observations were made separately on the maxillary and mandibular arches. Under each table additional observations were noted such as bone fractures, dental fractures and staining. Some subjects had a distance of greater than 5mm between the CEJ (cementoenamel junction) and alveolar bone which is indicative of poor periodontal health. Where this occurred on all the teeth in the arch this was described as periodontal disease.

RESULTS

Although it was expected that all subjects would be male, this was verified. The age of death of these individuals ranged from an estimated 20 to 59 years, being young and mature individuals with adult dentitions. Bone preservation varied between individuals and this influenced the options for analysis and therefore interpretation.

Among the 16 individuals:

- 5 individuals (Sp1, Sp4, Sp6, Sp12, Sp15) were very well preserved
- 11 individuals had an average to poor state of preservation, due to either:
 - peri-mortem trauma (fractures of the maxillofacial structure) related to the cause of death (air crash)
 - taphonomic processes (the decay process in biological organisms occurring between death and discovery/analysis); the decay process had degraded the

surface of the bone making analysis difficult because the bones were damaged and crumbling.⁶ The presence of clothing and parachute material affected the preservation of the skeleton. The cortical bone was damaged and crumbling making analysis more complex

Of the eight criteria observed, four were retained during the analysis: Presence of:

- Undiagnosed carious lesions: this criterion gives us clues about the diet, oral hygiene and monitoring of the population
- Dental restorations: i.e. teeth with cavities treated with various materials (amalgams, resins, stone cement).
- Dental prostheses: in our population, these were bridges or dental copings
- Calculus, reflecting the oral hygiene of the population.

Carious lesions

Untreated carious lesions affected 14 out of 16 individuals or 87.5% of the study population (*Figure 1*).

Dental restorations

Dental restorations were present in 13 out of 16 individuals (81.25%). Materials used included stone cement (white) and amalgam (silver) (*Figure 2*).

Figure 1: Sp. 4, complete mandible: Untreated carious lesion in 45



Figure 2: Sp. 18, full jaw: Different types of dental restorations: amalgam on 26 and 27, stone cement on 11



Fixed prostheses

Fixed dental prostheses, copings/caps and bridges, were observed in five individuals (31.25%) (Figure 3).

Calculus

Finally, it was of interest to note the presence of calculus. All individuals in the population, 100%, had calculus on one or more of their teeth, with an average of 14 teeth with calculus per individual (Figure 4).

A summary of all these observations is given in Table 3.

Other elements observed

- 6 individuals (37%) had dental discolouration
- 14 individuals (87.5%) had tooth loss (at least one tooth missing from an arch not replaced by a fixed prosthesis)
- In 6 individual (37.5%) we were able to observe recent tooth loss (approximately 3 months before death). Two of these were almost edentulous in the maxilla (only one tooth remaining). Of these 6 individuals, 5 had been previously been hospitalised and showed evidence of a craniotomy (in these cases a horizontal opening of the cranial cavity)
- 14 individuals (87.5%) had dental fractures
- 5 individuals (31.25%) had periodontal disease, evidenced by a distance of greater than 5mm between the cementoamel junction (CEJ) and the bone on all remaining teeth.

Figure 3: Sp 26, complete mandible: sector 3 bridge with resin inlay on the vestibular side



Table 3: Summary of the main observations of the 16 subjects

Observations	English	[min ; max]	Mean (sd)
Lésions carieuses	87.5% (14)	[1 ; 8]	3.64 (2.37)
Restaurations	81.25% (13)	[1 ; 16]	5.15 (4.22)
Prothèses	31.25% (5)	[1 ; 4]	2.40 (1.52)
Tartre	100% (16)	[2 ; 26]	14 (7.01)

DISCUSSION

In 1933, the arrival of the Nazis in power in Germany led to a gradual change in health policy, in order to prepare the military for a possible conflict. Dentists were included in the preparation for war, requiring a medical-dental health service. In 1939, at the time of the declarations of war (with Poland, France and the United Kingdom), 73.13% of 1,600 servicemen needed dental care; a significant need. To meet this demand, dental surgeons were employed in the Luftwaffe as health officers of the dental service to ensure sufficient dental care for the servicemen. The medical units and hospitals were provided with dentists and dental technicians. This type of organisation was also to be found in the Kriegsmarine (navy) and the Wehrmacht (army).¹² Together, these lesions and treatments give us additional information on the military population.

Cariou lesions, which affected 14 individuals in the population studied, can be explained by limited oral hygiene, associated with an unbalanced and often high sugar diet, which within a few months can lead to the appearance of carious lesions. At that time the servicemen were fed by the battalion kitchens (for hot meals). When the tactical situation prohibited

the distribution of hot food for 24 hours or more, servicemen were allowed to eat their ‘Eiserne Portionen’. This ration consisted of 300 g of hard crackers, 200 g of meat and 150 g of canned or dehydrated vegetables or sausage and peas, 25 g of artificial coffee and 25 g of salt. But these rations did not provide enough food and vitamins for the servicemen.^{13,14,15}

We have seen that most untreated carious lesions are early lesions (limited to the tooth enamel and therefore asymptomatic). We can assume that from the appearance of first symptoms (sensitivity or pain), servicemen were attended to by medical officers affiliated with the dental service.¹²

Dental calculus is mineralised plaque. The formation of calculus depends on various factors:

- Oral hygiene: the less plaque is removed, the more calculus builds up
- Saliva quality: quantity, pH, buffering capacity
- Exogenous factors: tobacco, medication, diet.

When calculus is not removed, it can lead to pathologies such as carious lesions, gingivitis or periodontitis. Since the 1960s, effective calculus removal has been aided by ultra-

Figure 4: Sp 6, mandibular arch: presence of lingual calculus lingual on the mandibular arch



sound.¹⁶ However, during World War II, scaling was carried out manually using curettes, making calculus removal, control and monitoring more difficult. In correlation with the servicemen's diet, the fact that 100% of the study population had deposits of dental calculus could be due to poor oral hygiene.

Concerning restorative care, observed in 13 individuals in our sample, different filling materials were observed: amalgam, stone cement, gold. These materials were in common use even at this early period of restorative dentistry.^{17,18} Restorative treatment was not linked to the age of the individuals; all age groups are represented among the 13 individuals concerned.

At the time of World War II, modern dentistry was still emerging. However, some individuals had fixed prostheses such as dental copings/caps or bridges. It was possible to carry out restorative care including fixed and removable prostheses at this time. However, aside from the cost, access to care remained difficult, particularly during wartime. The literature shows that in order to ensure efficient troops, the German military provided its servicemen with a system of dental care in order to avoid pain and ensure functional mastication.^{12,19}

The high presence of conservative and prosthetic care (81.25% and 31.25% respectively) suggests that, unlike during World War I, extraction no longer seemed to be the treatment of choice for all dental damage. During World War I a symptomatic tooth was generally extracted due to cost and time constraints.^{17,20} The high proportion of individuals presenting with evidence of restorative dental care in this study could be explained by the instigation of an oral health policy within the German military which aimed to provide more preventive treatment to ensure servicemen were more effective in the field. In 1939, out of 1,600 servicemen, 73.13% needed dental care. Dentists were employed as health officers of the Luftwaffe Dental Service from 8 November 1939. Posts for medical officers affiliated with the dental service were created and each unit was provided with dentists.¹²

We considered the aetiology of missing teeth. Bone healing allows us to distinguish whether the loss of teeth was ante-mortem or post-mortem. Alveolar bone healing suggests that the tooth loss was ante-mortem (several months or years depending on the position of the ridge). If the socket is not completely

Figure 5: Sp 6, complete mandible: ante-mortem tooth loss section



Figure 6: Sp 15, complete mandible: Recent tooth loss in the mandible, sectors 3 and 4. Note the included 38



healed, it can be assumed that the loss of the tooth occurred shortly before death (approximately 3 months). Finally, when the socket is open, or isolated teeth are found and placed in the socket, post-mortem tooth loss is indicated (Figures 5,6).

It is difficult to determine whether removable partial dentures existed as no appliances were found in the burials. This can be explained either by the removal of removable prostheses before burial or by theft. The latter is unlikely as individuals

buried in their aviator's clothing retained their gold restorations as did those who passed through the hospital before burial.

Further observations revealed that 37.5% of this sample showed dental discolouration of exogenous origin. These brown discolourations can be explained by the consumption of tobacco (supplied in the food rations) and poor oral hygiene (Figure 7).²¹

The presence of teeth in the arches, or arch segments, suggested evidence of periodontal disease in five individuals (31.25%). Two of these five individuals are almost completely edentulous (one tooth each in the maxilla). Periodontal disease is a precursor to tooth loss because the supporting tissues of the tooth are affected.²² Poor oral hygiene and an unbalanced diet can accelerate these phenomena (Figure 8).²³

These observations can give us an indication of the lifestyle of the group at the time, the diet and health policy of the military. We can ask whether this high proportion of dental care in the buried population is due to their membership of the German military (and more particularly the air force) or whether all Germans (including civilians) were treated in the same way. It would be interesting to analyse and compare these results with data from that time for the general population.

Finally, we would like to point out that our sample remains modest and that although the condition of the study material was satisfactory, not all the dental arches were complete, and it is difficult to extrapolate these results with certainty. A comparison of our data with that observed by Lan *et al.*, in their study of dental remains and waste from a World War I 'Rest Camp' is possible. Admittedly, there are chronological differences between these two studies (World War I *versus* World War II) and differences in recruitment (army *versus* air force) but there are nevertheless similarities; these are two small samples of German military personnel formed 25 years apart. The comparison is limited by the fact that the study by Lan *et al.*,

was based on a dental practice waste pit, and therefore on non-conservable teeth. This work showed a high predominance of very large carious lesions, the presence of calculus and dental wear. This can be explained by the healthcare policy in place: during World War I servicemen (whether at the front or reserve) were only eligible for dental treatment in cases of severe pain which then required extractions. The presence of calculus may be the consequence of poor oral hygiene and the consumption of military-supplied tobacco, which promotes the adhesion of calculus to dental surfaces. The low levels of dental care also illustrate the health policy of the time: due to lack of resources, and in order to avoid complications, dental extraction was the treatment of choice. From this we can deduce that German health policy changed between the two world wars. At the military level, an improved medical system was put in place, in particular with the organisation of German military dentistry from 1933 onwards, contributing to the health of the servicemen for a more effective contribution to the war.¹²

CONCLUSION

This study has given us the opportunity to analyse dental data from German servicemen who died in early part of World War II. The men belonged to German air force units based at the Beauvais airfield. Our study shows tooth loss, the presence of calculus, carious lesions, restorations and dental prostheses, and exogenous staining on a very specific selection of individuals at an important point in time.

More generally, the use of these data has enabled us to make some proposals as to the evolution of the German military's health policy from World War I (1914-1918) to World War II (acknowledging the relatively small samples). Despite the limited sample size, these biological archives provide rare opportunities to study healthcare in this specific time and context.

Figure 7: Sp 8, complete mandible: exogenous tooth staining lingually



Figure 8: Sp 15, complete mandible: periodontal disease



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