The usefulness and precision of computed tomography for *Canis lupus familiaris* dental morphometry
• its application to a Mesolithic Iberian dog •

Joana Correia[1], João Requicha[1,2], Hugo Pereira[1], Carlos Viegas[2]; David Gonçalves[3], Lara Alves[1], Catarina Ginja[3], Cleia Detry[4], Graça Alexandre-Pires[5], Sandra de Jesus[6], Ana Elisabete Pires[1,3]

1- Faculdade de Medicina Veterinária, Universidade Lusófona, Lisboa, Portugal; 2- Departamento de Ciências Veterinárias, Universidade de Trás-os-Montes e Alto Douro, Vila Real, Portugal; 3- LARC - Laboratório de Arqueociências, Direção Geral do Património Cultural, Lisboa, Portugal and CIBIO-InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Universidade do Porto, Vairão, Portugal; 4- UNIARQ - Centro de Arqueologia da Universidade de Lisboa, Faculdade de Letras de Lisboa, Universidade de Lisboa, Lisboa, Portugal; 5- CIISA - Departamento de Morfologia e Função, Faculdade de Medicina Veterinária, Universidade de Lisboa, Lisboa, Portugal; 6- CIISA - Departamento de Clínica, Faculdade de Medicina Veterinária, Universidade de Lisboa, Lisboa, Portugal

Contact the authors: ana.elisabete.pires@gmail.com

Credits: JPRuas

• How to discriminate teeth from a dog or a wolf in the archaeological record ?

A large reference database (DB) for discriminating odontometric parameters is essential but difficult to obtain in living specimens. To potentially expand such DB, we attempted to validate the precision of measurements obtained via computed tomography (CT) images.

How? By assessing if measurements obtained in skulls from deceased extant dogs through a caliper were similar to the ones obtained via CT scans.

Reference collection of extant dogs skulls (FMV, U.Lusófona)
Credits: Rita Sousa

Caliper (precision 0.01 mm)

Computed tomography (CT) scan
(HiSpeed LX/i, General Electric, USA)

• Which teeth were measured ? Which measures were taken ?

The mesiodistal lenght (MD) and vestibular palatine width (VP) of 22 canines and 23 fourth premolar maxillary (PM[4]) teeth were measured via caliper and CT images. Measurements from left and right teeth were pooled together to enlarge the sample. Two observers took 5-6 measurements (in 2 consecutive days) independently for each method of measurement and the median value was used in this research.

• How were differences evaluated ?

The relative **technical error of measurement (%TEM)** was estimated for both approaches while differences, correlations, and agreement between methods were evaluated through **non-parametric Wilcoxon, Spearman correlation and Bland-Altmann analysis[1]**.

Maxillary 4th Premolar

Maxillary Canine

Schematic image of maxillary 4th premolar (PM[4]) and canine teeth illustrating the studied odontometric measurements: the mesiodistal lenght (MD) or length as the highest distance measured at the level of the wider surface of the crown above the cervix (blue arrow), and the vestibular palatine width (VP) or width, measured at the furca perpendicular to MD (green arrow).

• RESULTS •

- **Data revealed a small % technical error for both caliper and CT (<5%)** *except in the* inter-observer assessment of the canine VP width obtained via the CT method.

% TEM	Caliper [min-max]	CT [min-max]
Intra-observer	Obs1 [0.63-3.29] Obs2 [0.74-2.28]	Obs1 [0.76-3.0] Obs2 [1.70-2.81]
Inter-observer	[0.72-3.27]	[3.22-6.40]

- **Comparison between methods cannot be extrapolated from one tooth to another and instead needs to be tested for each tooth**:

for observer 1 only	Measurement (mm)	Maxillary PM[4] tooth		Wilcoxon test; effect size	Agreement: Bland-Altmann analysis	Canine tooth		Wilcoxon test; effect size	Agreement: Bland-Altmann analysis
		Caliper	CT			Caliper	CT		
	Mesiodistal (MD) mean±SD [min-max]	16.59±3.16 [10.6-23.27]	16.64±3.17 [10.89-23.37]	*p<0.01*; r=.44	YES	9.30±2.37 [5.63-14.4]	9.20±2.24 [5.97-14.68]	*non significant*	YES
	Vestibular palatine (VP) mean±SD [min-max]	6.70±1.22 [4.07-9.04]	6.62±1.21 [4.26-9.11]	*p<0.05*; r=.31	NO	5.83±1.64 [3.03-10.2]	5.82±1.61 [3.28-9.99]	*non significant*	NO
	Spearman correlation	*p<0.01*				*p<0.01*			

- **In general, CT measurements tended to underestimate the caliper values – a need to refine landmarks in CT images was identified**;
- **Despite these ambiguous results, the absolute difference between methods in average never exceeded 1 mm** which legitimizes the use of CT as a complement for data acquisition which has been accomplished so far exclusively through direct measurements of dog teeth;
- A more detailed analysis using more observers is advisable to further refine our results;
- **CT images** from living animals stored at veterinary clinics **potentially provide reliable data to include in databases for *Canis lupus familiaris***;
- **For some archaeological *Canis* specimens, on which the caliper cannot be used** (e.g. when carbonate concretions cover up the tooth), **tomographic images may be the only practical alternative to collect odontometry data.**

• THE CASE OF A MESOLITHIC IBERIAN DOG •

Credits: JPRuas

A 7,680-7,450 cal BP years-old Mesolithic Iberian dog, excavated from Concheiros de Muge, Cabeço da Arruda (Portugal), whose direct measurements of all teeth with a caliper is impaired by the presence of post-depositional concretion.

Maxillary canine, mandibular canine and maxillary 4th premolar teeth images of the Muge Mesolithic dog obtained by CT scan using a bone algorithm and shown in three planes using Horos medical imaging software[3]: sagittal (A, D, G), transverse (B, E, H) and dorsal (C, F, I). The studied odontometric parameters were measured in the dorsal plane after the tooth was positioned in the latter planes.

Odontometric data via caliper[2] and CT images analysis

		Right						Maxilla														Left
		110	109	108	107	106	105	104	103	102	101	201	202	203	204	205	206	207	208	209	210
		2M	1M	4PM	3PM	2PM	1PM	C	3I	2I	1I	1I	2I	3I	C	1PM	2PM	3PM	4PM	1M	2M
MD Lenght	Caliper	nd	16.28	19.33	13.40	nd	10.95							nd 8.27	11.00 11.00		nd 12.09	11.70 13.11	14.00 19.60	19.30	
	CT	9.54																			
VP Width	Caliper	nd	7.02	8.82	7.07	nd 5.10					nd 6.50		7.50 5.12	nd 5.14	6.00 6.49	9.00					

Teeth are named according to the modified Triadan nomenclature[4] and the more commonly used in Paleontology[5,6]. "nd" stands for not determined. Absent teeth are enclosed by orange circles. Absolute differences |caliper-CT| range from 0 to 0.89 and 0.4 to 1 mm for length and width, respectively.

MD Lenght	Caliper	nd	nd	nd	11,60			nd				11.30	5.20	10.60		13.50	21.60				
	CT	9.27	23.73	13.95	11.71			12.11	5.77			11.60	5.66	10.84		13.09	23.87				
VP Width	Caliper	nd	nd	nd	nd			nd				8.2	nd	9.87							
	CT	6.12	6.58	6.78	5.26			6.62	4.16			7.58	4.04	4.97		6.21	9.87				

	3M	2M	1M	4PM	3PM	2PM	1PM	C	3I	2I	1I	1I	2I	3I	C	PM1	PM2	PM3	PM4	M1	M2	M3
	411	410	409	408	407	406	405	404	403	402	401	301	302	303	304	305	306	307	308	309	310	311

	Right			Mandible			Left

All teeth were able to be measured via computed tomography

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