

## The forgotten bones of the dolmen of Carrascal (Aqualva, Sintra, Portugal). Examining old human remains\*

*Los huesos olvidados del dolmen de Carrascal (Aqualva, Sintra, Portugal). Examinando los restos humanos antiguos*

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### ABSTRACT

The dolmen of Carrascal (Sintra, Portugal) was discovered at the end of the 19<sup>th</sup> century. The human bones housed in the *Museu dos Serviços Geológicos* (Lisbon) were re-analysed in the scope of a research program that is investigating the past lifeways of Late Neolithic populations from the central and southern regions of Portugal. Recent fieldwork under the scope of the Recovery and Valorisation project of the monument undertaken by the Sintra Municipality allowed constructional aspects of the tomb to be clarified, and the recovery of further osteological and archaeological remains. The radiocarbon dates obtained from the human bones enable us to assign this monument to an initial phase of the funerary practices associated with megalithic monumentality in Western Iberia. The assemblage comprised a minimum of 9 adults (both sexes) and 5 non-adults. Evidence of infectious disease, degenerative and metabolic changes, and a remodelled trepanation performed on a right parietal bone were noted. The dental remains yielded particularly interesting information regarding non-masticatory use of teeth, in form of chips and notches in anterior teeth. The data were compared with other collections exhumed from coeval tombs to obtain insights into the health status and behaviours of these prehistoric populations.

### RESUMEN

*El dolmen de Carrascal (Sintra, Portugal) fue descubierto a finales del siglo XIX. Los restos óseos humanos*

*depositados en el Museu dos Serviços Geológicos (Lisboa) han sido re-analizados con un programa que investiga el estilo de vida de las poblaciones del Neolítico Final de las regiones del centro/sur de Portugal. Según los recientes trabajos de campo enmarcados en el proyecto de Recuperación y Valorización del monumento llevados a cabo por el Municipio de Sintra, estos han permitido clarificar aspectos de la construcción y la recuperación del material osteológico y arqueológico. Los datos de radiocarbono de los restos óseos humanos nos permiten encuadrar las prácticas funerarias en una fase inicial del megalitismo en el oeste de la península ibérica. La colección comprende un mínimo de 9 adultos (ambos sexos) y 5 no adultos. Se han observado evidencias de enfermedades infecciosas, cambios degenerativos, alteraciones metabólicas y una trepanación remodelada realizada en un parietal derecho. Los restos dentales ofrecen información particularmente interesante con respecto a otros usos no masticatorios de los dientes. Esto se manifiesta en forma de astillas y agujeros en los dientes anteriores. Estos datos han sido comparados con otras colecciones contemporáneas de Portugal con el objetivo de observar la salud y el comportamiento de estas poblaciones prehistóricas.*

**Key words:** Late Neolithic; Western Iberia; Bioanthropology; Dolmen; Collective burials; Trepanation; Non-masticatory use of teeth.

**Palabras clave:** Neolítico Final; Península ibérica occidental; Bioantropología; Dolmen; Entierros colectivos; Trepanación; Uso no-masticatorio de los dientes.

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## INTRODUCTION

Although interest in the megalithic monuments of Portugal, as in other parts of Europe<sup>1</sup>, is of some antiquity, it is generally agreed that the emergence of prehistoric archaeology in Portugal occurred during the second half of the 19<sup>th</sup> century (Diniz and Gonçalves 1993-1994; Cardoso and Boaventura 2014). This was mainly due to the archaeological work of two members of the *Comissão Geológica de Portugal*, Carlos Ribeiro and Nery Delgado, who recognized the importance of human remains found in funerary contexts during their geological survey work. In 1880, following the excavation of several monuments in the region of Lisbon, Carlos Ribeiro published his results in a monograph. This contains rigorous descriptions and beautiful charcoal drawings of the monuments and their associated artefacts. These are accompanied by discussion regarding the importance of understanding the megalithic building techniques, how the terrain and geological background conditioned their construction, and the type of raw materials used in the making of artefacts and their significance (Cardoso and Boaventura 2014). It is no surprise that many of these materials are currently housed in the Geological Museum in Lisbon. Among these is the series from the dolmen of Carrascal, the human remains from which are analysed in this paper. This study was undertaken as part of the exhaustive re-analysis of skeletal collections long forgotten in museums and private collections that began in the late 1990s<sup>2</sup> (Silva 2003a, 2004, 2005, 2008, 2012, 2017; Silva *et al.* 2006, 2012, 2014, 2016; Silva and Ferreira 2007, 2016-2017; Boaventura *et al.* 2013, 2014a, 2014b, 2016). This renewed interest in these skeletal assemblages arose from fuller recognition of the information that they could yield, providing valuable details about the individuals represented, including data about their biological profile, and the types of diseases and injuries they suffered<sup>3</sup> (Silva 2017).

<sup>1</sup> Silva, A. M. 2002: *Antropologia funerária e Paleobiologia das populações Portuguesas (Litorais) do Neolítico final/Calcolítico*. Tese de Doutoramento. Departamento de Antropologia, Faculdade de Ciências e Tecnologia da Universidade de Coimbra. Policopiado.

<sup>2</sup> Vide n. 1.

<sup>3</sup> Vide n. 1; Silva, A. M. 1993: *Os restos humanos da gruta artificial de São Pedro do Estoril II. Estudo Antropológico*. Relatório de investigação em Ciências Humanas. Coimbra, Departamento de Antropologia, Faculdade de Ciências e Tecnologia da Universidade de Coimbra. Policopiado.

Silva, A. M. 1996: *O Hipogeu de Monte Canelas I (IV – III milénios a.C.): Estudo paleobiológico da população humana exumada*. Trabalho de síntese. Provas de Aptidão Pedagógica e Capacidade Científica. Coimbra, Departamento de Antropologia, Faculdade de Ciências e Tecnologia da Universidade de Coimbra. Unpublished.

Álvaro Figueiredo performed the first preliminary analysis of the human remains of dolmen of Carrascal in 2004. In 2007, Maria Hillier conducted a second analysis in connection with the PortAnta Program: “Megaosteology”, under the scientific supervision of two of the present authors (AMS and RB). The report was incorporated in Boaventura’s PhD thesis (Boaventura 2009) with archival studies, the first radiocarbon and stable isotope analyses and the comprehensive study of the archaeological materials. Finally, in 2017, AMS undertook a detailed study of the complete human osteological collection, the main focus of the present work.

## THE DOLMEN OF CARRASCAL: SOME INTRODUCTORY NOTES

The dolmen of Carrascal is located in the village of Agualva, in the municipality of Sintra, Lisbon district (Fig. 1). It is situated at geographical coordinates (WGS84) N 38° 46’24”, W 9°17’13”. In this region, a great diversity of tombs was used in the 4<sup>th</sup> and 3<sup>rd</sup> millennia BCE - dolmens, *hypogea*, *tholoi* and natural caves (Fig. 1). The limestone substrate of this region allowed the preservation of organic matter, a rare occurrence in the current Portuguese territory. Although most tombs were the subject of early excavations, the degree of preservation of archaeological and anthropological materials allows a combined analysis of the funerary practices, material culture and populations. Classified as a National Monument since 1910, the dolmen of Carrascal is inventoried with the National Site Code (*Código Nacional de Sítio - CNS*) 4295 (Endovelicus System Information - General Directorate of Cultural Heritage). The monument is also known as the dolmen of Agualva (Ribeiro 1880). The area surrounding Carrascal presents a concentration of different types of tombs, published by him (Ribeiro 1880) as well: close by is the Belas cluster, which includes the dolmens of Monte Abraão (*CNS-655*), Pedra dos Mouros (*CNS-11301*) and Estria (*CNS-3001*). In the immediate vicinity, other tombs are known, such as the dolmen of Conchadas (*CNS-2095*, Leisner and Ferreira 1959), the natural caves of Colaride (*CNS-3528*), the rock-cut tombs of Tojal de Vila Chã 1 to 4 and Baútas (*CNS-3077* and 1979, Leisner 1965: 80-82), and the *tholos* of Agualva (*CNS-654*; Ferreira 1953; Silva *et al.* 2016).

The first archaeological excavation at the dolmen of Carrascal took place in 1875, as part of a larger study by Carlos Ribeiro (1880: 67-69; Boaventura 2009). The archaeological studies developed under his direction with the Geological Commission included the excavation of a group of tombs from the Lisbon

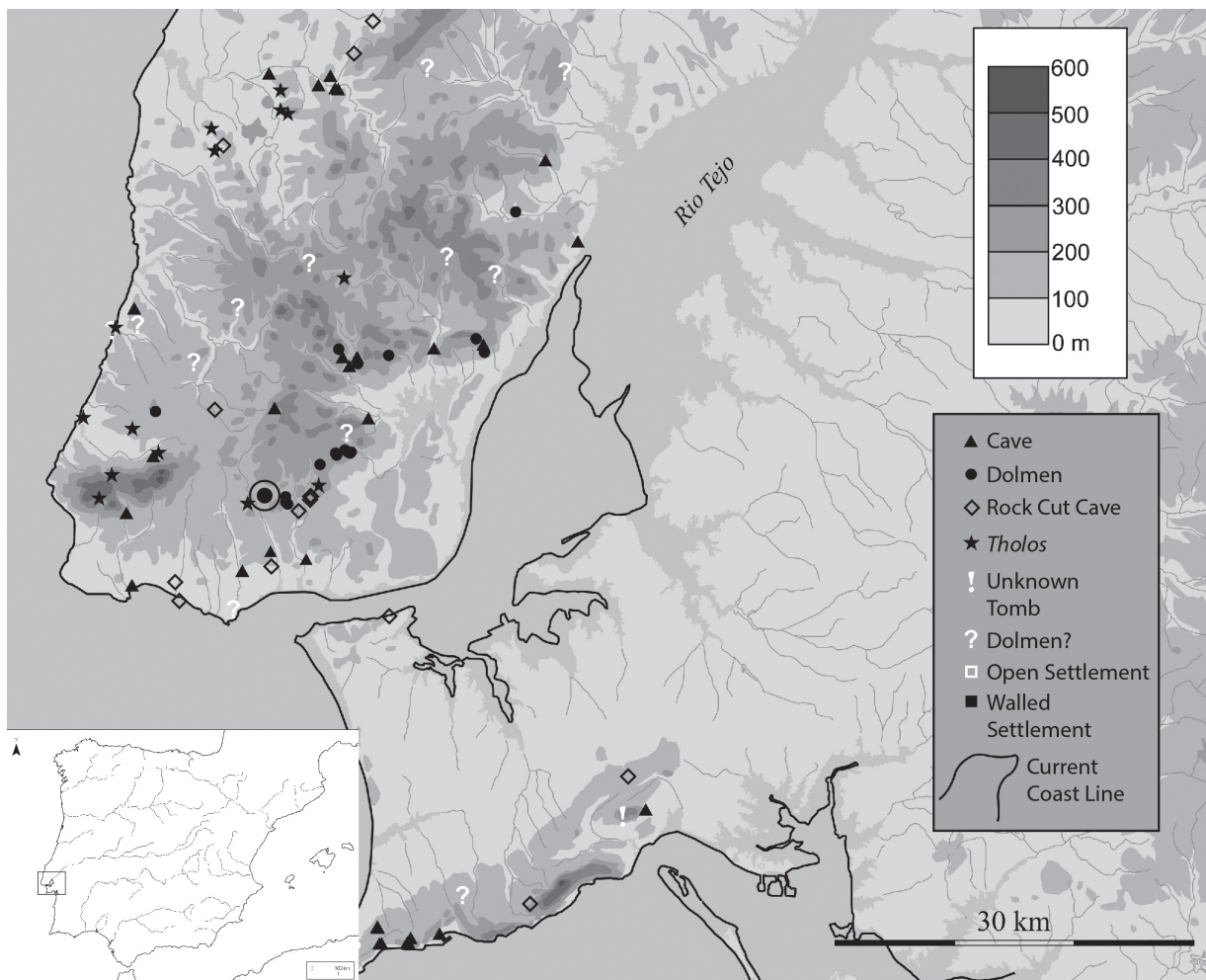


Fig. 1. Burials from the 4<sup>th</sup> and 3<sup>rd</sup> millennia in Portuguese Estremadura. Cartography by Maia Langley and Rui Boaventura. In detail location of the dolmen of Carrascal in Iberian peninsula.

area (Ribeiro 1880), including dolmens (Monte Abraão, Estria, Pedra dos Mouros, Carrascal, Pedras Grandes, Alto da Toupeira 1), a *tholos* (Monge), rock-cut tombs (Casal do Pardo and Folha das Barradas), and natural caves (Olelas, Leceia, Ponte da Laje, Porto Covo and Poço Velho). In 1944, Georg and Vera Leisner produced new plans and sections of this monument, as well as the first photographic record. There are differences in the measurements of the chamber and passage, and even in the number of orthostats, between the publications of Carlos Ribeiro (1880: 67) and Vera Leisner (1965), which seem to indicate a deterioration of the monument following the excavation in the late 19<sup>th</sup> century. Thanks to field records, detailed publications, and the preservation of the archaeological materials in the Geological Museum, these monuments

were republished by several researchers. Recently these tombs have been reanalyzed with modern methods, including radiocarbon dating, anthropological studies and sometimes new excavations (Gonçalves 2008, 2009; Boaventura 2009). Between 2016 and 2017, a team from the Archaeological Museum of São Miguel de Odrinhas (municipality of Sintra) carried out new fieldwork in Carrascal as part of a conservation project. This fieldwork provided an updated plan and new information about the constructional techniques and post-depositional processes (Jordão *et al.* 2017) (Fig. 2), the recovery of a small number of human remains, some uncharacteristic flint artefacts and a fragment of a possible schist plaque.

The excavation by Carlos Ribeiro produced few artefacts. That indicated, in his view, that the monu-

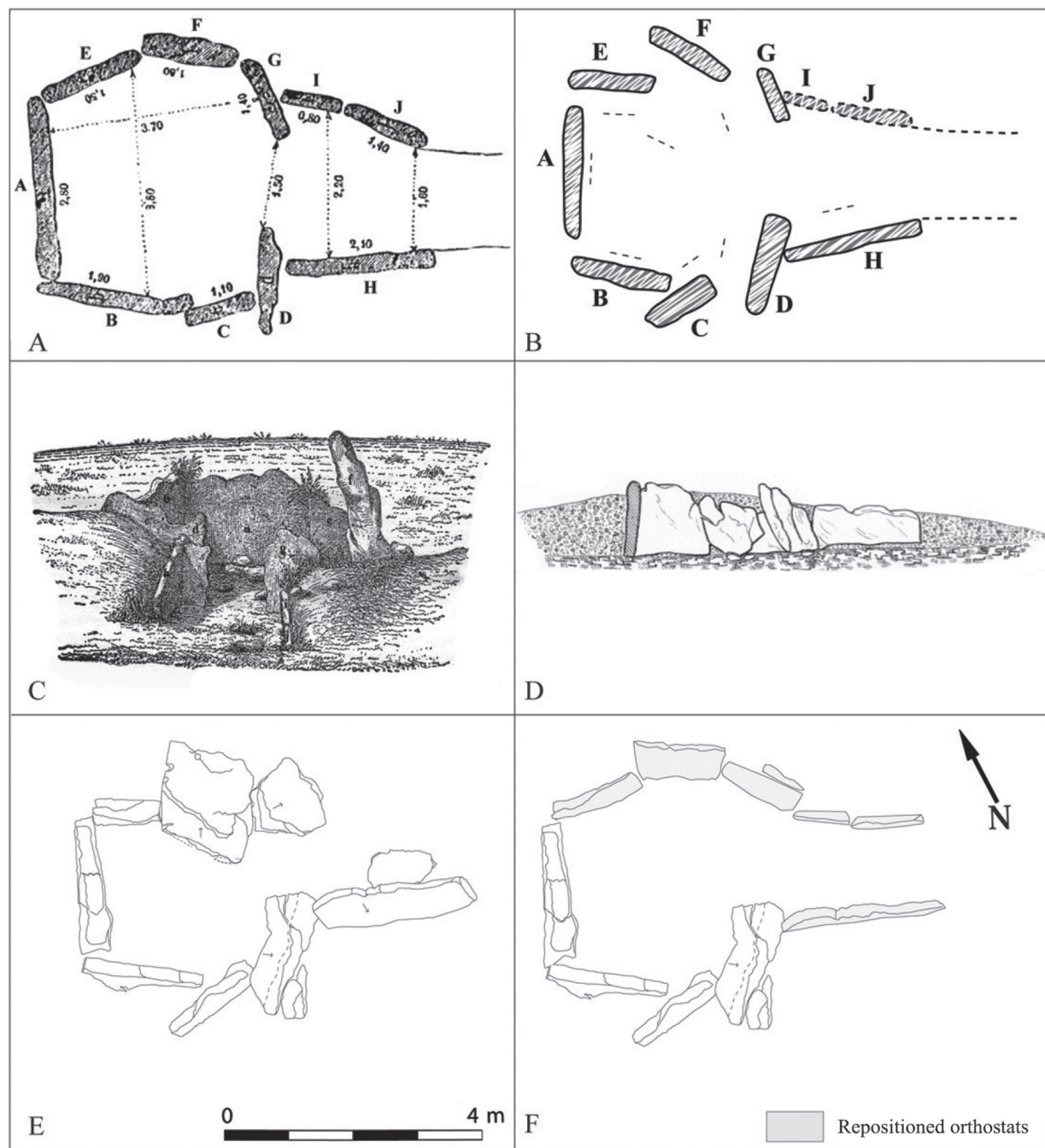


Fig. 2. Plans of the dolmen of Carrascal: A., C. by Carlos Ribeiro (1880); B., D. by Vera Leisner (1965); E. before 2016-2017 intervention, F. after 2016 excavation and restoration work (Jordão *et al.* 2017). Layout of the composition after Jordão *et al.* (2017, fig. 3).

ment had been previously excavated. In spite of this observation, it seems possible that the set of votive artefacts was originally restricted, both in number of burials and archaeological material, since it is unlike-

ly that excavators before would have collected material exhaustively. Identification of the material from the dolmen of Carrascal among the collection of the Geological Museum proved to be an arduous task. Rui



Boaventura (2009: 71-72) identified materials from this monument that had been mistakenly included in other series housed in the Geological Museum, through critical reading of the sources (Ribeiro's field notebook, the Leisner archive, bibliography) and through the analysis of all the sets of material from the Ribeiro excavations. Although Ribeiro mentions the presence of pottery, none was found at the Geological Museum. It was possible to identify only the lithic materials: small blades with discontinuous retouch, two geometric armatures (trapezoids) and a fragment of a thick retouched blade. Also noteworthy is the presence of a wristguard that may have been recovered from the passage (Boaventura 2009: 70), indicating a later Bell beaker use of this monument, a very common feature in the Lisbon region.

In architectural terms, this dolmen has a polygonal chamber (c. 3.5 m) with seven orthostats and a short passage (2.4 m). This architectural type is the most frequent among dolmens of the Lisbon region (Boaventura 2009: 15). The geology may have influenced the architecture in this region, where they fall into one or other of only two generic groups: 1) dolmens with a polygonal chamber of seven uprights and short passage (like Carrascal), and 2) dolmens with elongated trapezoidal or sub-rectangular chamber with no differentiated passage.

## MATERIAL AND METHODS

The human remains are housed in the Museum of Geology with the designation of *Dolmen do Carrascal (DC)*, labelled as MG538. One left frontal bone fragment was stored with the assemblage from the *tholos* of Aqualva (code MC185). However, an old annotation, the colour of the sediments and a refit with a bone fragment from this dolmen, confirmed the correct provenience of this cranial fragment (Silva and Ferreira 2016-2017). The human bones recovered during the fieldwork of 2016/7 (Jordão *et al.* 2017), three teeth and a cranial bone, were included in the present analysis.

The minimal number of individuals (MNI) was estimated following Herrmann *et al.* (1990) adapted by Silva (1993). For the non-adult sample, maturation was also taken into account, as recommended by Silva<sup>4</sup>. Other parts of the skeleton, such as pars petrosa, were also considered, due to their particular characteristics that allow them to be identified as belonging to one individual. The representativeness of the adult bones was analysed in more detail to evaluate the presence of bones from all parts of the skeletal, and thus

obtain inferences about bone preservation and burial practices.

Under the scope of the demographic analysis of these remains, age-at-death of the non-adult was estimated using dental mineralization according to AlQahatani *et al.* (2010) and Smith (1991). For adult individuals, the fusion of the sternal end of the clavicle (MacLaughlin 1990) allowed the identification of young adults (< 30 years) and individuals that died with more than 30 years of age. Sex diagnosis was obtained through standard methods (Ferembach *et al.* 1980). Morphological analysis included metric parameters, as estimation of the platimeric and platynemic indices (Martin and Saller 1956) to provide data about the flatness of lower long bones, and thus inferences about daily behaviours. To assess the variability and affinity of these individuals, several non-metric post-cranial traits were scored following Saunders (1978) and Finnegan (1978).

All skeletal elements were macroscopically inspected for signs of developmental variations and pathologies, such as oral pathology, trauma, infection and joint diseases. Dental wear was scored according to Smith (1984), adapted by Silva<sup>5</sup>. For insights about the health status of these individual, cariogenic lesions (Lukacs 1989), presence of calculus (Martin and Saller, 1957) and antemortem tooth loss were registered. Enamel linear hypoplasia (LEH), a non-specific stress indicator was recorded to evaluate the childhood illness experience of these individuals. All dental remains were examined macroscopically and with hand lens for the evidence of non-masticatory behaviour, mainly in form of chips and notches. These were scored according to Bonfiglioli *et al.* (2004).

The remaining pathologies and lesions were described and when possible, differential diagnosis were presented and discussed.

## RESULTS

109 bone fragments and 138 teeth compose the human osteological sample. These belong to adult and non-adult individuals. Bones from all parts of the skeleton are present, including phalanges and small carpal bones (Tab. 1). Among the taphonomic alterations observed are the presence of three proximal phalanges (two hand and one foot) with black stains, probably due to precipitation of manganese oxides, several bone and teeth fragments with yellow or orange stains due to the use of pigments, and bite marks of rodents on the linea aspera of a right femoral fragment.

<sup>4</sup> Vide n. 3 Silva 1993, 1996, and n. 1.

<sup>5</sup> Vide n. 3 Silva 1996.

Bone fragments	Number
Permanent teeth	129 (+3*)
Deciduous teeth	6
Skull fragments	59 (+1*)
<i>Menton</i>	1
Thoracic vertebrae	1
Right humerus	2
Left Radius	1
First Metacarpal	1
Left Capitate	2
Proximal hand phalanges	4
Intermedium hand phalanges	6
Distal hand phalanges	3
Left femur	3
Right femur	5
Left tibia	2
Right tibia	3
Right fibula	1
Left patella	1
Right patella	1
Right first metatarsal	1
Left navicular bone	1
Proximal foot phalange	8
Distal foot phalange	2

Tab. 1. Human bone fragments (not individuals) preserved from dolmen of Carrascal. \* Recovered during fieldwork carried out in 2016/7 and not housed in the *Museu dos Serviços Geológicos*.

The skeletal remains from the dolmen of Carrascal correspond to a minimal of 14 individuals, 9 adults (>16 years) and 5 non-adults. The detailed age profile of this sample can be seen in figure 3. The youngest individual would be around 2.5 years old at the time of death, based on the dental remains. The level of calcification based on the sample of lower right third molar revealed the presence of two individuals 18.5 years old, and one 20.5-22.5 years old, based on the upper third right molar. No further anatomical bone sections were available for a more specific age at death estimation. Four cranial fragments displayed an advanced state of obliteration of the sutures suggesting the presence of older individuals. Sex diagnosis was not possible with metric analysis. Morphological traits suggest the presence of adults of both sexes.

The only morphological metric analysis possible was estimation of the platymeric index in one right femoral

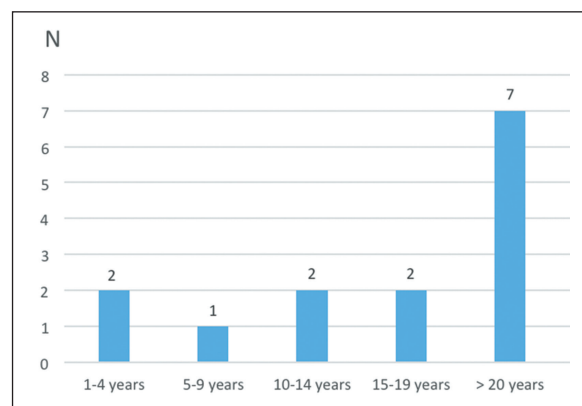


Fig. 3. Age profile of the sample exhumed from the dolmen of Carrascal (Aqualva, Sintra).

fragment, which expresses flatness (66.7). This fragment reveals the presence of hypotrochantic fossa, a non-metric skeletal trait. Robustness could only be confirmed macroscopically through the presence of several robust long bones. A thick cortical layer was observed in a fragment of a proximal diaphysis of femur, suggesting high levels of loading. All these data provide indirect evidence of significant mobility among these individuals.

Signs of infection (periostitis) were observed in fragments of right femur (n=4) and distal tibia (n=3), the latter also exhibiting extensive deposition of new bone corresponding to an active lesion (Fig. 4A).

Among cranial bones, signs of active and remodelled infection were observed in two right parietal and one frontal bone fragment (Fig. 4B). In the posterior part of one right parietal bone fragment, two depressed areas are visible. Both exhibit signs of remodelled periostitis and the preserved sagittal suture had already started to obliterate. The anterior one, upon the sagittal suture, has a long axis of 32 mm and minimum of 11 mm of minor axis (medial-lateral; preserved area). Posterior to this, another depressed area was noticed, 45 mm long with a minimum width of 32 mm. Signs of remodelled infection are also visible in the endocranium. These two areas could be interpreted as depressed cranial fractures. A fragment of frontal bone (which includes the fragment that was previously included with the material from the *tholos* of Aqualva) shows active signs of infections in both supraciliary arches, more pronounced in the left one.

Evidence of a complete remodelled trepanation was observed in a fragment of the anterior part of an adult right parietal bone (Fig. 4D). Next to the fragmented medial border, signs of an orifice are visible. The long axis of the hole is around 15mm and the diploë is completely covered by compact bone. No signs of compli-



Fig. 4. Dolmen of Carrascal (Aigualva, Sintra): A. distal fragment of right tibia exhibiting active signs of infection, including new bone formation; B. signs of infection associated with a depression in a right parietal bone fragment; C. right lower first molar with almost half of the mesial crown broken *ante mortem*; D. evidence of a complete trepanation in a right parietal bone fragment (in colour in the electronic version).

cations are visible, except a slight porosity. These signs of healing confirmed that the individual survived a certain time after this trauma. The appearance of the lesion suggests that drilling method was used. This technique, although less commonly observed in recent studies of Portuguese prehistoric collections, was described for older discoveries from this region of the Iberian peninsula (Silva 2003a, 2017). Although trepanation seems the most probable diagnosis other types of trauma cannot be excluded. On the anterior fracture border of this piece, signs of infection are visible that seem not to be directly related to the described trauma.

Degenerative alterations, namely osteoarthritic and enthesal changes, were difficult to investigate in this collection due to the almost total absence of the relevant anatomical regions. Slight osteoarthritic lesions were recognised on the proximal extremity of a right radius. This fragment also exhibits minimum enthesal changes in the bicipital tuberosity. The same degree of lesions was found in the lateral supracondylar ridge of a right humerus, in three proximal hand phalanges and three intermediate phalanges of the hand (n=4) in the region of the attachment for the flexor ligaments.



In the articular surface of a right patella a small lesion compatible with osteocondritis dissecans (OD) was observed. OD is a pathological condition of the subchondral bone and surrounding cartilage of synovial joints, associated with strenuous activity and/or trauma (Aufderheide-Rodríguez-Martín 1998; Vikatou *et al.* 2017). In the patella, these lesions seem to be related to minor injuries to the articular surface (Desai *et al.* 1987). Reports of OD in archaeological skeletal remains are few and the majority demonstrate low OD prevalence (< 1 %) (Vikatou *et al.* 2017). In 2002 Silva<sup>6</sup> described several cases in coeval samples, although none affecting the patella. Another possible diagnosis for the observed alteration is osteoarthritis.

Eight teeth (8/97; 4 anterior) reveal linear enamel hypoplasia, including three canines each with two lines (Tab. 2). These teeth belong to an MNI of three individuals, representing 30 % of the individuals, one of the highest frequencies of LEH described for Portuguese samples of this period (<sup>7</sup>, Silva 2017), although the small sample size has to be considered. These enamel defects are records of growth disruptions, revealing that the individuals concerned suffered developmental stress during their infancy (Hillson and Bond 1997).

Pathologies	Results
Dental wear	2.1 (n=117)
Calculus	40/117 = 34.2%
Cariogenic lesions	2/117 = 1.7%
Linear enamel hypoplasia - Permanent teeth	8/97 = 8.2%
Enamel hypoplasia – Deciduous teeth	0/6

Tab. 2. Wear, oral pathologies and enamel hypoplasia observed in the sample recovered from the dolmen of Carrascal.

Mild porosity was observed in an incomplete skull, formed of frontal and both parietal bones. The porosity is slight and remodelled. These skeletal changes are related to the healing of an infection or to a metabolic disease. Among the latter, anaemia has long been suggested, whether acquired from parasites or nutritional deficiencies or through genetic conditions (Rivera and Lahr 2017).

In one occipital fragment, two non-perforating defects are visible. One is visible in the exocranium, with a diameter of 20 mm x 22 mm exposing the diploe.

<sup>6</sup> *Vide n. 1.*

<sup>7</sup> *Vide n. 1.*

A second one is noted in the endocranium, with a diameter of 17 mm x 10.5 mm. The contour of this latter defect is more irregular. Both seem to show evidence of remodelling around their margins. The nature of these osteolytic defects is difficult to establish. They can be due to trauma, tumours, acute or chronic infections. From the features they exhibit, and the context, the latter seems to be more plausible although taphonomic causes cannot be excluded.

In oral pathology, the dental mean wear is low, 2.1 (n=117). Deposits of calculus were recorded on 35 % of the permanent teeth, predominantly at a low level. Two left upper second molars exhibit small cariogenic lesions, at the level of enamel-dentine junction (Tab. 2).

Notches were observed in upper incisors (n=2/13). Chips were scored in anterior (n=8/41) and posterior teeth (n=7/62), being more frequent in superior (20.5 %) than in lower teeth (8.5 %), and in anterior (19.5 %) than in posterior ones (11.3 %). The largest lesion was observed on one right lower first molar, where almost half of the mesial crown was broken antemortem (Fig. 4C). This mixed pattern probably reflects a combination of non-masticatory activities (performed with anterior teeth) with the ingestion of hard food such as hard fruits (posterior teeth).

Concerning the chronology of these remains, the few artefacts recovered from this tomb place it in an early phase of Portuguese megalithic monumentality. The presence of geometric armatures, the absence of arrowheads, and the limited amount of material together assign this monument to an initial phase of megalithic funerary practices in Western Iberia. This relative chronology is fully confirmed by radiocarbon dating (Tab. 2). Since the first two dates (Beta-228577, Beta-225167) to be obtained indicated a relatively early chronology, it was considered important to confirm that, selecting another two samples from different adult individuals. All four dates fall within the same chronological spectrum, between 3600 and 3300 cal BCE. Bayesian analysis was undertaken to identify the duration of funerary activity that is implied by these four dates. The model chosen (Fig. 5) assumes that the four samples fall randomly within a single phase of funerary deposition, beginning in 3900-3390 cal BC (95 % probability: Boundary Carrascal start) and ending 3630-3170 cal BC (95 % probability: Boundary Carrascal end). The estimated duration of funerary deposition –0-619 years (95 % probability)– lacks precision since the model assumes these four samples are a random selection from a larger number of burials, and the actual end of activity at the site could hence fall somewhat later than the samples chosen.



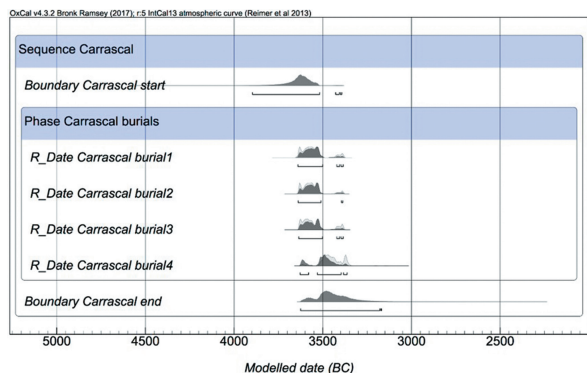


Fig. 5. Probability distributions for the four dated samples from Carrascal (Aqualva, Sintra) and the modelled start and end dates of funerary deposition.

The isotope values seem to confirm the homogeneity of the Carrascal burials: four samples provided stable carbon and nitrogen data to assess inferences about the diet of these individuals (Tab. 3). Specifically, the results of stable carbon show that these individuals have a C3 plant terrestrial diet consistent with animal husbandry and farming (Guiry *et al.* 2016). These elements are very significant, given the scarcity of settlements of this period in the Lisbon region, generically attributable to the Middle and Late Neolithic (Neves and Diniz 2014; Sousa 2016-2017).

**DISCUSSION**

The study of the human remains recovered from the dolmen of Carrascal (DC), offers the opportunity to

understand the lives, activities and health conditions of these individuals who passed away around 5500 years ago. For the interpretation of the data, this assemblage was compared with the human remains from the dolmen of Ansião (DEA), a contemporaneous sample recovered from the same type of funerary monument near the city of Coimbra (around 200 km north of DC), and with the human remains recovered from the *tholos* of Aqualva (TA), close to Carrascal but around 600 years younger.

All three tombs contained human remains of individuals of both sexes, including adults and non-adults. Although the tombs from the Lisbon region contain fewer individuals, the proportion of adults versus non-adults is very similar (Tab. 4). This is in accordance with the expected non-adult ratio of 36 % to 50 % in archaic populations, according to Acsádi and Nemeskéri (1970) and observed in many coeval archaeological samples (Silva 2002, 2003a; Cunha *et al.* 2015; Fernández-Crespo and De-la-Rúa 2016). Another observed trend is the under-representation of very young children. This bias, the under-representation of individuals who died before the age of 5 years, particularly under one year old, is systematically observed in coeval assemblages (Silva 2002, 2003a; Cunha *et al.* 2015; Fernández-Crespo and De-la-Rúa 2016). This bias has been attributed to age related mortuary practices, differential preservation due to taphonomic agents, and to incomplete archaeological recovery due to biased excavation techniques (Saunders and Barrans 1999). Although all these factors may have contributed, differential mortuary practices have probably the greatest impact, since excavation techniques have improved considerably in the last two decades and, at least in some samples, differential preservation between adult and non-adult bones seems not to be a significant factor.

Sample number	Sample type	Laboratory reference	Radiocarbon date (BP)	Calibrated date (2s) (cal BC)*	Isotopic analysis
0538.0004.1	Right femur	OxA-35900	4766 ± 30	3640-3384	δ 13C = - 19.3 δ 15N = 8.8
0538.0004.7+.8	Right femur	Beta-228577	4770 ± 40	3644-3381	δ 13C = - 19 δ 15N = 9.4
0538.0008.6	Right femur	OxA-35901	4752 ± 31	3638-3382	–
0538.0004.6	Left femur	Beta-225167	4640 ± 40	3620-3350	–
538.0009.2 (a)	Mandibular fragment		–		δ 13C = - 19.3 δ 15N = 8.9
538.0009. 2 (b)	Mandibular fragment		–		δ 13C = - 19.3 δ 15N = 9.7

Tab. 3. Results of radiocarbon dating and isotopic analysis from human skeletal samples from the dolmen of Carrascal (adapted from Boaventura 2009 with the additions).

Sample	Adults	%	Non- adults	%
Dolmen of Carrascal	9	64.3	5	35.7
Dolmen of Ansião	23	62.2	14	37.8
Tholos of Aqualva	8	66.7	4	33.3

Tab. 4. Proportion of adults versus non-adults in the samples of the dolmen of Carrascal, the dolmen of Ansião and the *tholos* of Aqualva.

Comparison of dental pathologies between these groups revealed no significant differences between dental wear and calculus, but difference in cariogenic lesions and LEH (Tab. 5). All groups show low to medium levels of dental wear. Deposits of calculus are frequent, but predominantly small. DC and DEA display a low prevalence of caries. The high caries rate for TA may be inflated by the small sample size, but consumption of cariogenic foods could have changed during the 600 years that separated these individuals from the others. It would be significant to compare the frequency of antemortem tooth loss and periapical lesions, since they can be related to caries rates, but unfortunately the maxilla samples are very limited. Major differences were found in the frequency of LEH, varying between complete absence at TA and presence in 8.5 % of the teeth from DC. These data suggest that the individuals from DC were subject to higher physiological stress during childhood. It is important to highlight that DEA also exhibits more stress markers in adult bones (infections, porotic hyperostosis, trauma) (Tab. 6), reflecting hard living conditions during adult life. Alternatively, following the osteological paradox, these individuals could have been more resistant, and have survived several episodes of stress (Siek 2013).

	Dolmen Carrascal	Dolmen Ansião	Tholos de Aqualva
Dental wear	2.1 (n=117)	4.0 (n=41)	3.77 (n=22)
Calculus	34% (40/117)	–	40% (8/20)
Cariogenic lesions	1.7% (2/117)	2.6% (1/40)	30% (6/20)
Linear enamel hypoplasia	8.2% (8/97)	1.2% (6/506)	0% (0/20)

Tab. 5. Dental data from the dolmen of Carrascal, dolmen of Ansião and *tholos* of Aqualva.

Degenerative diseases, osteoarthritis and enthesal changes are not significant in these assemblages, and when present, are mild in severity. This must, however, be viewed against the paucity of observations.

	Dolmen Carrascal	Dolmen Ansião	Tholos de Aqualva
Infections	Skull and long bones	Skull and long bones	Long bones (Tibia)
Osteoarthritis	Slight	Slight	Slight
Enthesal changes	Slight	Slight	Slight
Trauma	Skull: 2 depressed fractures; Skull: trepanation	Skull: 5 depressed fractures; Skull: 2 perforations	No evidence
<i>Osteocondritis dissecans</i>	Right patella	No evidence	Proximal phalange of foot

Tab. 6. Bone pathologies observed in the samples of dolmen of Carrascal, dolmen of Ansião and *tholos* of Aqualva.

The prevalence of cranial trauma stands out in both dolmen samples. In DEA, signs of trauma include depressed cranial fractures, trepanation and two possible osteolytic lesion, despite the low number of preserved fragments. For DEA, besides depressed fractures, two perforating lesions were observed, probably due to an arrowhead (Silva 2003b). Signs of infectious disease are also more frequent at DA and DEA, in both cranial and post-cranial bones. In TA, no evidence of trauma was found, and periostitis was only observed in tibiae fragments. Although some of these trauma could be due to daily accidents, signs of interpersonal violence cannot be excluded (Silva *et al.* 2012).

The new dates from Carrascal confirm the Bayesian model proposed by Boaventura (2009: 73) for the Lisbon region, establishing the beginning of the construction of megalithic monuments in this region between 3760 and 3350 cal BCE, prior to the appearance of the first engraved schist plaques. In this first phase, there are burials in natural caves such as Algar do Bom Santo, Porto Côvo, Algar do Barrão, Salemas, Feteira but also in orthostatic megalithic monuments including the dolmens of Pedras Grandes, Trigache 4 and Carrascal. In general, a range of very different types of tombs coexisted in Central and Southern Portugal during the middle centuries of the 4<sup>th</sup> millennium: small monuments, dolmens with short passages, *hypogea*, and natural caves. The chronology obtained for Carrascal indicates that this monument was erected and used during an initial phase of megalithic monumentality, before the end of the Middle Neolithic. The available information seems to indicate that it would be the oldest monument of the so-called Belas “cluster” (Boaventura 2009: 73). There is little evidence for the later use of this tomb,

with limited artefactual material and no radiocarbon dates. The identification of a fragment of a possible engraved schist plaque in the recent excavation (Jordão *et al.* 2017) may indicate a brief later visit at some time between the end of the 4<sup>th</sup> millennium and the beginning of the 3<sup>rd</sup> millennium cal BCE. In the Bayesian model proposed by Boaventura (2009: 73), engraved schist plaques belong to the period between 3130 and 2900 cal BCE, corresponding to the second phase of megalithic monumentality in the region of Lisbon.

## FINAL REMARKS

In the last 20 years, numerous forgotten human skeletal collections from prehistoric tombs in central and south Portugal, housed in museums or private collection, have been exhaustively analysed<sup>8</sup> (Silva 2003a, 2004, 2005, 2008, 2017; Silva and Ferreira 2007; Silva *et al.* 2014; Boaventura *et al.* 2013, 2014a, 2014b, 2016). These studies have been framed by new methodological and interdisciplinary approaches that allow a better interpretation of the biological and social aspects of these prehistoric communities. It was in this perspective that the material from the dolmen of Carrascal was reanalysed.

This dolmen received the dead of a small human community, including individuals of both sexes, adults and non-adults. Despite the incompleteness of the assemblage, the observed skeletal lesions offer insights into the illnesses and injuries that these individuals suffered. In pathological terms, this assemblage stands out through the presence of cranial trauma, including a probable case of trepanation, and the evidence of non-masticatory dental use of teeth. At least three individuals (of 14) suffered developmental stress during their infancy, as attested by the presence of linear enamel hypoplasia.

In sum, the present study confirms once again, despite all the limitations and difficulties, the potential new knowledge to be gained from re-analysis of old assemblages by a multidisciplinary team using modern techniques, throwing new light on the living conditions of prehistoric human communities. It also adds additional data for future discussion about which factors could have managed the burial type (dolmens, natural caves, among others) selected by these prehistoric populations to buried their dead.

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## BIBLIOGRAPHY

- Acsádi, G. and Nemeskéri, J. 1970: *History of human life span and mortality*. Akadémiai Kiadó, Budapest.
- AlQahtani, S. J.; Hector M. and Liversidge, H. 2010: "Brief communication: the London atlas of human tooth development and eruption". *American Journal of Physical Anthropology* 142 (3): 481-490. <https://doi.org/10.1002/ajpa.21258>
- Aufferdeide, A. and Rodriguez-Martín, C. 1998: *The Cambridge Encyclopedia of Human Paleopathology*. Cambridge University Press. Cambridge.
- Boaventura, R. 2009: *As antas e o Megalitismo da região de Lisboa. Tese de Doutoramento em Pré-História*. Faculdade de Letras da Universidade de Lisboa. Lisboa. <http://hdl.handle.net/10451/587>
- Boaventura, R.; Ferreira, M. T.; Neves, M. J. and Silva, A. M. 2014a: "Funerary practices and anthropology during the middle-late Neolithic (4th and 3rd Millenia BCE) in Portugal: old bones, new insights". *Anthropologie* LII (2): 183-205.
- Boaventura, R.; Ferreira, M. T. and Silva, A. M. 2013: "Perscrutando espólios antigos: A Anta de Sobreira I (Elvas)". *Revista Portuguesa de Arqueologia* 16: 63-79.
- Boaventura, R.; Ferreira, M. T. and Silva, A. M. 2014b: "Perscrutando espólios antigos – 2: Um caso de reutilização funerária medieval na anta de São Gens 1 (Nisa, Norte alentejano)". *Almadan online* 2ª série, 19 (1): 60-76.
- Boaventura, R.; Silva, A. M. and Ferreira, M. T. 2016: *Perscrutando espólios antigos: o espólio antropológico do Tholos de Aqualva. Água e Terra, Colher Sementes, Invocar a Deusa. Livro de Homenagem a Victor S. Gonçalves*. Estudos e Memória 9, UNIARQ. Lisboa: 295-307.
- Bonfiglioli, B.; Mariotti, V.; Facchini, F.; Belcastro, M. G. and Condemi, S. 2004: "Masticatory and non-masticatory dental modifications in the Epipalaeolithic necropolis of Taforalt (Morocco)". *International Journal of Osteoarchaeology* 14 (6): 448-456. <https://doi.org/10.1002/oa.726>
- Cardoso, J. and Boaventura, R. 2014: "Carlos Ribeiro (1813-1882) e as antas de Belas: um contributo para a história da ciência em Portugal no século XIX". *Estudos Arqueológicos de Oeiras* 21: 35-80.
- Cunha, C.; Silva, A. M.; Pereira, D.; Tomé, T.; Paredes, J. and Cabrita, C. 2015: "Children of the grave: contribution of non-adult individuals in some human osteological series from collective burials in the Late Prehistory of the Iberian Peninsula". In L. Rocha, P. Bueno-Ramirez and G. Branco (eds.): *Death as Archaeology of Transition: thoughts and materials. Papers from the II International Conference of Transition Archaeology: Death Archaeology (Évora, Portugal 2013)*. British Archaeological Reports, International Series 2708, Archaeopress. Oxford: 177-188.

<sup>8</sup> Vide n. 1.



- Desai, S. S.; Patel, M. R.; Michelli, L. J.; Silver, J. W. and Lidge, R. T. 1987: "Osteochondritis dissecans of the patella". *Bone & Joint Journal* 69 (2): 320-325.
- Diniz, M. and Gonçalves, V. S. 1993-1994: "Na segunda metade do século XIX: Luzes e sombras sobre a institucionalização da Arqueologia em Portugal". *O Arqueólogo Português* Série 4, 11-12: 175-187.
- Ferembach, D.; Schwidetzky, I. and Stloukal, M. 1980: "Recommendations for age and sex diagnosis of skeletons". *Journal of Human Evolution* 9: 517-549. [https://doi.org/10.1016/0047-2484\(80\)90061-5](https://doi.org/10.1016/0047-2484(80)90061-5)
- Fernández-Crespo, T. and De-la-Rúa, C. 2016: "Demographic differences between funerary caves and megalithic graves of northern Spanish Late Neolithic/Early Chalcolithic". *American Journal of Physical Anthropology* 160 (2): 284-297. <https://doi.org/10.1002/ajpa.22963>
- Ferreira, O. da V. 1953: "O monumento pré-histórico de Aqualva (Cacem)". *Zephyrus* 4: 145-166.
- Finnegan, M. 1978: "Non-metric variation of the infracranial skeleton". *Journal of Anatomy* 125: 23-37.
- Gonçalves, V. S. 2008: *A utilização pré-histórica da Gruta de Porto Covo (Cascais). Uma revisão e algumas novidades*. Câmara Municipal de Cascais. Cascais.
- Gonçalves, V. S. 2009: *As ocupações pré-históricas das furnas do Poço Velho (Cascais)*. Coleção Cascais, Tempos Antigos, Câmara Municipal de Cascais. Cascais.
- Guiry, E.; Hillier, M.; Boaventura, R.; Silva, A. M.; Oosterbeek, L.; Tomé, T.; and Richards, M. P. 2016: "The transition to agriculture in south-western Europe: new isotopic insights from Portugal's Atlantic Coast". *Antiquity* 90 (351): 604-619. <https://doi.org/10.15184/ajq.2016.34>
- Herrmann, B.; Grupe, G.; Hummel, S.; Piepenbrink, H. and Schutkowski, H. (1990). *Praehistorische Anthropologie. Leitfaden der Fels- und Labormethoden*. Springer Verlag. Berlin.
- Hillson, S. and Bond, S. 1997: "Relationship of enamel hypoplasia to the pattern of tooth crown growth: a discussion". *American Journal of Physical Anthropology* 104 (1): 89-103. [https://doi.org/10.1002/\(sici\)1096-8644\(199709\)104:1<89::aid-ajpa6>3.0.co;2-8](https://doi.org/10.1002/(sici)1096-8644(199709)104:1<89::aid-ajpa6>3.0.co;2-8)
- Jordão, P.; Mendes P. and Relvado, C. 2017: "Intervenção Arqueológica no Projecto de "Recuperação e Valorização da Anta do Carrascal (Aqualva, Sintra)". In J. M. Arnaud and A. Martins (eds.): *Arqueologia em Portugal. 2017 - Estado da Questão*. Associação de Arqueólogos. Lisboa: 541-555.
- Leisner, V. 1965: *Die Megalithgräber der Iberischen Halbinsel. Der Western 3*, Text und Tafeln. Walter de Gruyter Co. Berlin.
- Leisner, V. and Ferreira, O. da V. 1959: "Os monumentos megalíticos de Trigaache e de A-de-Beja". In *Actas e Memórias do I Congresso Nacional de Arqueologia (Lisboa 1958)* 1: 187-233. Lisboa.
- Lukacs, J. 1989: "Dental paleopathology: methods for reconstructing dietary patterns". In M. Iscan and K. Kennedy (eds.): *Reconstruction of life from the skeleton*. Alan, R. Liss Inc. New York: 261-286.
- MacLaughlin, S. M. 1990: "Epiphyseal fusion at the sternal end of the clavicle in a modern Portuguese skeletal sample". *Antropologia Portuguesa* 8: 59-68.
- Martin, R. and Saller, K. 1956: *Lehrbuch der Anthropologie*, vol. 3. G. Fisher. Stuttgart.
- Martin, R. and Saller, K. 1957: *Textbook of anthropology*. G. Fisher. Stuttgart.
- Neves, C. and Diniz, M. 2014: "Acerca dos cenários da acção: estratégias de implantação e exploração do espaço nos finais do 5º e na primeira metade do 4º milénio AC, no Sul de Portugal". *Estudos do Quaternário* 11: 45-58.
- Reimer, P. J.; Bard, E.; Bayliss, A.; Beck, J. W.; Blackwell, P. G.; Ramsey, C. B., ...and Grootes, P. M. 2013: "IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP". *Radiocarbon* 55(4): 1869-1887.
- Ribeiro, C. 1880: *Estudos prehistoricos em Portugal: noticia de algumas estações e monumentos prehistoricos*. Tipografia da Academia. Lisboa
- Rivera, F. and Lahr, M. M. 2017: "New evidence suggesting a dissociated etiology for cribra orbitalia and porotic hyperostosis". *American Journal of Physical Anthropology* 164 (1): 76-96. <https://doi.org/10.1002/ajpa.23258>
- Saunders, S. 1978: *The development and distribution of discontinuous morphological variation of human infracranial skeleton*. Dossier 81: National Museum of Man, Mercury Series.
- Saunders, S. R. and Barrans, L. 1999: "What can be done about the infant category in skeletal samples?". In R. D. Hoppa and C. M. FitzGerald (eds.): *Human growth in the past: studies from bones and teeth*. Cambridge Studies in Biological and Evolutionary Anthropology 25. Cambridge University Press. Cambridge: 183-209.
- Siek, T. 2013: "The osteological paradox and issues of interpretation in Paleopathology". *Vis-à-Vis: Explorations in Anthropology* 13 (1): 92-101.
- Silva, A. M. 2003a: "Portuguese Populations of the Late Neolithic and Chalcolithic Periods exhumed from Collective burials: an overview". *Anthropologie* XLI (1-2): 55-64.
- Silva, A. M. 2003b: "A Neolithic skull lesion probably caused by an arrowhead". *Antropologia Portuguesa* 19: 135-140.
- Silva, A. M. 2004: "Os ossos humanos da Necrópole do Neolítico Final de Pragais: um testemunho do passado". In: *Arqueologia: Coleções de Francisco Tavares Proença Júnior*. Instituto Português de Museus: 112-117.
- Silva, A. M. 2005: "A Antropologia das Grutas de Alapraia e S. Pedro do Estoril". In V. Gonçalves (ed.): *Cascais há 5000 anos*. Câmara Municipal de Cascais. Cascais: 29-31.
- Silva, A. M. 2008: "Os ossos humanos". In V. S. Gonçalves: *A utilização pré-histórica da gruta de Porto Covo (Cascais)*. Câmara Municipal de Cascais. Cascais: 148-157.
- Silva, A. M. 2012: *Antropologia funerária e Paleobiologia das populações Portuguesas (Litorais) do Neolítico final/Calcolítico*. Textos Universitários de Ciências Sociais e Humanas. Fundação Calouste Gulbenkian Fundação para a Ciência e a Tecnologia. Lisboa.
- Silva, A. M. 2017: "Illness and injuries in Prehistory: the challenge of paleopathological study of old bones". In M. Diaz-Zorita Bonilla, J. Escudero Carillo, I. López Flores, J. Lucena Romero, E. Mora Rosa and S. Robles Carrasco (eds.): *Paleopatología y Bioarqueología, contextualizando el registro óseo. Actas del XIII Congreso Nacional de Paleopatología*. Asociación Profesional de Bioarqueología y Asociación Nacional de Paleopatología. Sevilla.
- Silva, A. M.; Boaventura, R.; Ferreira, M. T. and Marques, R. 2012: "Skeletal evidence of interpersonal violence from Portuguese Late Neolithic Collective burials: an overview". In R. Schulting and L. Fibiger (eds.): *Sticks, Stones, and Broken Bones: Neolithic Violence in a European Perspective*. Oxford University Press. Oxford: 317-340.
- Silva, A. M.; Boaventura, R.; Pimenta, J.; Detry, C. and Cardoso, J. L. 2014: "Perscrutando espólios antigos: A Gruta de Pedra Furada 1 (Vila Franca de Xira)". *Estudos Arqueológicos de Oeiras* 21: 159-182.
- Silva, A. M. and Ferreira, M. T. 2007: "Os ossos humanos 'esquecidos' da Praia das Maçãs. Análise antropológica da amostra óssea do Museu Arqueológico de São Miguel de Odrinhas". *Conimbriga* 46: 5-26. [https://doi.org/10.14195/1647-8657\\_46\\_1](https://doi.org/10.14195/1647-8657_46_1)
- Silva, A. M. and Ferreira, M. T. 2016-2017: "Perscrutando espólios antigos 5: Contributo da análise dos restos ósseos humanos". *Estudos Arqueológicos de Oeiras* 23: 219-232.
- Silva, A. M.; Ferreira, M. T. and Codinha, S. 2006: "Praia da Samarra: análise antropológica dos restos ósseos humanos depositados no Museu Arqueológico de São Miguel de Odrinhas". *Revista Portuguesa de Arqueologia* 9 (2): 157-170.
- Silva, A. M.; Gil, P.; Soares, J. and Tavares da Silva, C. 2016: "Short report: Evidence of non masticatory dental use in Bronze age individuals exhumed from the Necropolis of Casas Velhas (Melides, Setúbal)". *Bulletin of the International Association for Paleodontology* 10 (1): 31-38.
- Smith, B. H. 1984: "Patterns of molar wear in hunter-gatherers and agriculturalists". *American Journal of Physical Anthropology* 63: 39-84. <https://doi.org/10.1002/ajpa.1330630107>
- Smith, B. H. 1991: "Standards of human tooth formation and dental age assessment". In M. A. Kelly and C. S. Larsen (eds.): *Advances in Dental Anthropology*. Wiley-Liss Inc. New York: 143-168.
- Sousa, A. C. 2016-2017: "Os tempos do Neolítico na região de Lisboa. Estudos Arqueológicos de Oeiras". *Oeiras* 23: 459-518.
- Vikatou, I.; Menno L. Hoogland, L. and Waters-Rist, A. 2017: "Osteochondritis Dissecans of skeletal elements of the foot in a 19th century rural farming community from The Netherlands". *International Journal of Paleopathology* 19: 53-63. <https://doi.org/10.1016/j.ijpp.2017.09.005>