Behind the veil: an archaeothanatological approach to possible shrouding in a Medieval multi-faith cemetery from Santarém, Portugal

Por detrás do véu: uma abordagem arqueotanatológica de uma possível mortalha num cemitério Medieval multirreligioso de Santarém, Portugal

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Abstract Archaeothanatology has helped immensely to better understand complex burial dynamics and funerary treatment. Scholars have employed this approach in attempts to reconstruct possible shrouding of corpses prior to interment, which often degrade entirely. This approach can potentially reveal funerary evidence of burial containers despite their archaeological absence. We employ a similar approach to test the possible employment of burial shrouds at the medieval site of Largo Cândido dos Reis in Santarém, Portugal. Given the multi-faith (Islamic and Christian) nature of the site, the site presents an opportunity to examine multi-faith community funerary patterns within the same geographic space. The

Resumo A arqueotanatologia tem contribuído de um modo significativo para a compreensão da complexa dinâmica do sepultamento e do tratamento funerário do corpo. Os investigadores que se têm dedicado ao assunto, utilizam esta abordagem na tentativa de reconstruir possíveis vestígios de amortalhamento de cadáveres antes do enterramento que, na maioria das vezes, se degradam completamente. Esta abordagem pode potencialmente revelar evidências funerárias de caixões, apesar da sua ausência do registo arqueológico. Neste trabalho, utilizamos uma abordagem similar para testar a possível utilização de mortalhas no arqueossítio medieval do Largo Cândido dos Reis, em Santarém (Portugal). Dada a sua natureza multir-

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shrouding of the corpse with 'Yemeni cotton' (kafan) if often cited as traditional to Islamic funerary treatment, yet confirmation of this has been difficult to identify archaeologically. Conversely, Christian funerary treatment variably references the employment of shrouds and burial vestments, ranging from hides and cere-cloth to textiles and winding sheets. We present an analysis of 119 adult individuals, 70 Islamic and 49 Christian. The demographic makeup of this subsample is 75 males (60.03%), 36 females (30.25%), one probable female (0.84%) and seven indeterminate individuals (5.88%). Results suggest that while numerous Islamic burials show possible evidence of shrouding, the narrow and shallow construction of Islamic graves at the site likely complicate interpretations. Christian burials were easier to discern possible shrouding, due to the larger grave dimensions accompanied by skeletal evidence of constriction (e.g., verticalization of the clavicle). Altogether, we posit that Islamic funerary rites were highly prescribed and normative, such that consistent burial construction limited archaeothanatological potential for burial containers, while Christian burials were more variable in their architectural dimensions and potential for bodily wrappings.

Keywords: Archaeothanatology; bioarchaeology; taphonomy; shrouding; Medieval; Christian; Islamic.

religiosa (islâmica e cristã), o local apresenta-se como um repositório dos padrões funerários de uma comunidade multirreligiosa, inserida no mesmo espaço geográfico. O amortalhamento do cadáver com "algodão iemenita" (kafan) é frequentemente citado como tradicional para o tratamento funerário islâmico, no entanto, a sua confirmação arqueológica tem-se revelado uma tarefa difícil. Não obstante, o tratamento funerário cristão variavelmente faz referência à utilização de mortalhas. Neste trabalho são analisados 119 indivíduos adultos – 70 islâmicos e 49 cristãos. Estes incluem 75 homens (60%), 36 mulheres (30,25%), uma provável mulher (0,84%) e 7 indivíduos indeterminados (5,88%). Os resultados sugerem que, embora numerosos enterramentos islâmicos mostrem evidências de amortalhamento, a construção estreita e rasa das sepulturas condiciona a interpretação da informação recolhida. Já nos enterramentos cristãos, a presença de mortalha é mais fácil de investigar face às dimensões da sepultura, acompanhado de evidências de constrição. Os dados obtidos sugerem que os rituais funerários islâmicos eram mais normativos, enquanto que os cristãos, revelam uma maior variabilidade, quer nas dimensões das sepulturas, quer nos envoltórios corporais.

Palavras-chave: Arqueotanatologia; bioarqueologia; tafonomia; amortalhamento; Medieval; Cristão; Islâmico.

Introduction

Since the 1980s, germinal approaches arising from French anthropology have helped to synthesize osteological and anatomical knowledge of decomposition processes with archaeological field excavation methodologies (Duday and Masset, 1987). This *anthropologie de terrain*, or archaeothanatology, has helped

immensely to better understand complex burial dynamics and funerary treatment. Archaeothanatology emphasizes knowledge of the decomposition process and encourages careful attention to anatomical connections (Duday and Guillon, 2006: 152), particularly joint articulations, as they are indicative of decay and postmortem movements. For instance, a comprehensive understanding of which connections are *persistent* — those that retain their anatomical articulation for longer, and resist decomposition for a longer duration versus *unstable/labile* — those that lose their anatomical connection more readily, is critical in field recordings and reconstructing decay processes. Counterintuitively, persistent joints, though easiest to record due to their often direct articulation *in situ* (e.g. humero-ulnar articulation, lumbar vertebrae, atlanto-occipital, sacroiliac), are less informative than their labile counterparts (e.g., phalanges of the hands and feet), which can reveal much more about decay and movement (Duday and Guillon, 2006: 127). This is due to the biomechanical demands of certain bones that require either larger or more powerful ligaments, and as such, bones that are typically larger and preserve better reveal less about post-burial movements and decomposition than their more unstable counterparts (Duday, 2006: 33–34). However, cadavers do not decompose uniformly and are subject to numerous variables (climate, temperature, humidity, soil, insect activity, etc.) and as such, even various portions of the same cadaver can be in differing stages of decomposition (Pinheiro, 2006). Thus, a key goal of archaeothanatology is to chronologize and seriate decomposition of various elements in order to reconstruct the deposition of the body to distinguish between funerary rites and post-depositional factors. Presence of labile connections such as the hands and feet *in situ* is typically seen as a good indicator of a primary burial, as decomposition that took place elsewhere would have weakened or completely decomposed labile connections and made their transfer to a secondary burial in articulation less likely (Duday, 2006; 2009; Duday and Guillon, 2006). Attention to joint articulations outside of the anatomical relation — termed "necrodynamics" (Ortiz et al., 2013; Dirkmaat and Passalacqua, 2015; Wilhelmson and Dell'Unto, 2015; Mickleburgh and Wescott, 2018) — is crucial in reconstructing interment processes and further helps to demonstrate that the disarticulation of human remains does not necessarily preclude a secondary burial treatment, such as a primary burial upon an organic material platform that is also subject to decay.

One employment of this approach concerns the ability to reconstruct possible wrapping, or shrouding, of corpses prior to interment (Roksandic, 2002; Nilsson Stutz, 2003; 2006; Harris and Tayles, 2012). Broadly termed 'burial containers', these consist of the broad range of materials used to encapsulate the body for interment, such as veils, shrouds, clothing, or coffins. Despite their utility in

'protecting' the body, burial containers themselves are subject to poor preservation. This is especially the case with fabrics whose organic constituents (e.g. cellulose in the case of linen and cotton) make them highly absorbent and often susceptible to acidic burial environments (Cardamone et al., 1991), or microorganisms (Janaway, 2002). As a result, both linen and cotton degrade easily and seldom survive archaeologically except for anoxic or desiccated conditions (Janaway, 2002; Ueland et al., 2015). Burial clothing and/or wrapping also appear to facilitate absorption and draining of bodily fluids during decomposition, such that bodies can actually become mummified (Kelly, 2006; Dautartas, 2009; Voss et al., 2011; Bouquin et al., 2012). Secondary evidence of burial wrappings can occasionally preserve, such as sewing needles which likely pinned fabrics together, but if wrappings were tied or knotted together, there is often no direct trace evidence. Even wooden coffins can degrade with relative ease, leaving only trace evidence of their presence in the form of nails which held boards together, or wall effects (*effets de paroi*) that they left behind in the grave cut (Duday, 2017; Duday and Masset, 1987; Harris and Tayles , 2012).

The case of Medieval Portugal provides an interesting opportunity to explore this approach further, given the presence of differing religious communities accompanying funerary customs suggests the employment of burial containers. We present here an analysis focusing on the city of Santarém, Portugal which was under Islamic control through much of the central middle ages before transitioning to a Christian pilgrimage center in the later middle ages after the Christian conquests in the twelfth century C.E. (Custódio et al., 1996; Rodrigues, 2019). While the site undoubtedly represents a palimpsest of differing temporalities, faith communities, and funerary customs, the presence of multiple-faith groups in the same space helps to furnish a comparative approach seen in other medieval Iberian contexts (Alexander et al., 2015; Toso et al., 2021). Following in this work, we use the term 'multi-faith' here not to denote the contemporaneous usage of the same cemetery by differing religious groups, but rather to signal the multi-temporal dimensions present in most archaeological cemeteries (Waldron, 1994; 2007; DeWitte and Stojanowski, 2015; Novak, 2017). The shifting religious and political autonomy within the same geographic space offers an interesting opportunity to comparatively and diachronically analyze religiously motivated funerary customs practiced by the city's residents within relatively similar local and sedimentary conditions.

Islamic law throughout much of al-Andalus — the Islamic cultural domain within medieval Iberia — generally followed the writings of Malik ibn Anas (711-795 C.E.), who was instrumental in finding one of the four major schools of Sunni law. The Andalusian caliph al-Hakam I (d. 822) institutionalized Malikism as law by the ninth century (Payne, 1973), which

continued to garner support from caliphs such as Abd al-Rahman II (d. 961) and al-Hakam II (d. 976), and subsequently influenced the jurisprudence and religious funerary customs throughout much of al-Andalus (Chávet et al., 2006) and beyond (Fortier, 2010). Generally, death was accompanied by a ritualized procession, involving the stripping and washing of the corpse (*ghusl*) followed by enshrouding of the body in "Yemeni cotton" (*kafan*) and occasionally, tethering of the mandible to the skull (Gatrad, 1994; Tritton, 2008: 441; Bianquis, 2012; Petersen, 2013; Buturovic, 2017). In most cases, the shrouding of the body can vary by gender, with women being enshrouded in five pieces of cloth whereas men are enshrouded in three pieces. Interestingly, few individuals were allowed to be buried with their clothing, such as martyrs, victims of drowning, respiratory illness, internal ailments, fire, falling structures, and women who die in pregnancy (Buturovic, 2017).

Burial width also appears to have received considerable attention and debate. Burial width was typically narrow in order to prevent post-depositional alteration of the body. The twelfth century "Treatise of Ibn 'Abdun" from Seville attests to just how narrow tombs could be:

> Debe aumentarse un poco el largo y el ancho de los huecos de los sepulcros, porque yo he visto que a un cadáver hubo que sacarlo três veces de la tumba para arreglar el hueco convenientemente, y que outro cadáver hubo de ser metido a fuerza de apretar. (Garcia Gómez and Lévi-Provençal, 1998: 149).
>
> The length and width of the graves must be increased a little, because I have seen that one corpse had to be removed three times from the tomb to fix the hole, and that another corpse had to be forcefully squeezed [into the grave]. (Garcia Gómez and Lévi-Provençal, 1998: 149).

Given the narrowness of Islamic graves, it is not surprising that variation has also been noted in the bodily position of Islamic graves within Spain (Casal, 2003: 31) and France (Gleize, 2022), with differing elements showcasing varying angles of flexion and extension. Lozano Cosano (2016: 100) notes this could be due to both "internal" (ritual positioning, shrouding), and "external" (grave limits, shape, covering) factors. In some cases, small stones, ceramic sherds, or even wood have been found as a means of supporting or propping certain anatomical articulations to facilitate bodily position and intactness (el Aswad, 1987: 221; León Muñoz, 2008: 43). Thus, ensuring minimal post-depositional disturbance and movement was fundamentally linked to tomb construction. Graves are intentionally dug to allow for the head to be turned right, in accordance with *qibla* — the direction of Mecca — southeast in the case of Iberia (Mazzoli-Guintard, 1996; López Quiroga, 2010).

The case of burial wrappings throughout medieval Christendom is, generally speaking, more variable. The majority of funerary rituals throughout late medieval Christendom was likely simple and

prescribed, with bodies interred in an extended, supine position and arms placed at the sides or occasionally crossed over the breast (O'Sullivan, 2013), though considerable vernacular variation existed (Gilchrist, 2022: 124). Christian burial treatments seem to vary due to influences of various religious orders and changing religious and eschatological considerations for burial and the afterlife (Bynum, 1995; Mattoso, 1996). Numerous religious orders, such as the influential Order of Cluny, the Cistercians, and mendicant orders such as Dominicans and Franciscans brought about religious reforms throughout Christendom, with cascading influences on funerary preparation in Portugal and beyond (Mattoso, 1996). Ecumenical decrees, papal bulls, and theological discourse also impacted religious conceptions of death, burial, and the afterlife (Brown, 1981; Bynum, 1995), with a particular focus on preparation for Resurrection (Gilchrist and Sloane, 2005; O'Sullivan, 2013) and intercession on behalf of the soul in Purgatory (O'Sullivan, 2013: 274). Bodies were occasionally stripped of vestments and wrapped in linen shrouds, or winding sheets, in the case of late Medieval England (Daniell, 1997) in addition to other "furnishings" (Litten, 2007). Artistic depictions from Book of Hours occasionally depict a body wrapped in a shroud before being interred (Figure 1). Given the linen composition, it is not surprising that few shrouds have actually preserved archaeologically, though some shrouds have preserved such as fragments in St. Mary Spital in London as well as a complete shroud from St. Bees Priory in Cumberland (Gilchrist and Sloane, 2005: 106). Other materials could be employed as well, such as lead sheets, cerecloth (wax-inundated shrouds), and hides, although evidence is less common (Gilchrist and Sloane, 2005: 107–110). The presence of small needles encircling the corpse was observed in a few circumstances at the site of Largo Cândido dos Reis (Matias, 2008b: 651–652), suggesting the employment of burial shrouds where the fabric was pinned together rather than tied.

Given the ethnohistorical evidence and limited archaeological evidence of shrouds being employed for both funerary groups at the medieval site of Largo Cândido dos Reis explore whether archaeothanatological methods, recording procedures, and detailed photographs and drawings can be employed in a *post-hoc* manner (Roksandic, 2002; Nilsson Stutz, 2006; Harris and Tayles, 2012; Green, 2022) to discern possible shrouding.

Materials

The site of Largo Cândido dos Reis (S.LCR, Municipal site nº 74) was situated just outside the Porta de Manços in Santarém, Portugal (39°14'01.8"N 8°41'10.1"W). Excavations began in July of 2004 in a salvage framework, as a result of discovering burials during a public works project to renovate sanitation networks. Excavations continued until September 2005, discovering a total of

639 burials spanning nearly 10,000 m^2 (Matias, 2008a). The site comprised of two principal necropolis: one Islamic (n = 422 burials) and the other Christian (n = 217 burials), which were distinguished based on their funerary typological characteristics (Matias, 2008b). Islamic burials were characterized by relatively simple, narrow and shallow graves that were rectangular or ovular in shape (*darih*) with no accompanying niches (*lahd*, and/or *saqq*) (Chávet et al., 2006). The majority of burials were excavated directly into the marly limestone substrate (350; 83%), with a small portion constructed in clayey substrates (72; 17%; Matias, 2008b). Bodies were interred on their right side facing southeast towards Mecca, with no commingling (Figure 2). Christian burials were characterized by comparatively deeper graves, occasionally anthropomorphic in shape, with the body positioned in an extended supine position (Figure 3). Arms were oc-

Figure 1. Depictions of simple earthen inhumations with bodily wrapping in A) Fifteenth century (c. 1450) French Book of Hours (Heures à l'usage de Paris, Petit Palais, LDUT 0035, fol. 127[1]); and B) fifteenth century (c. 1460) Belgian Book of Hours (Walters Ms. W.197, fol. 175v[2]). (Figure 1 – Medieval manuscripts)

[1] Retrieved from: http://initiale.irht.cnrs.fr/en/decor/ 98979.

[2] Retrieved from: https://www.thedigitalwalters.org/Data/WaltersManuscripts/html/W197/description.html

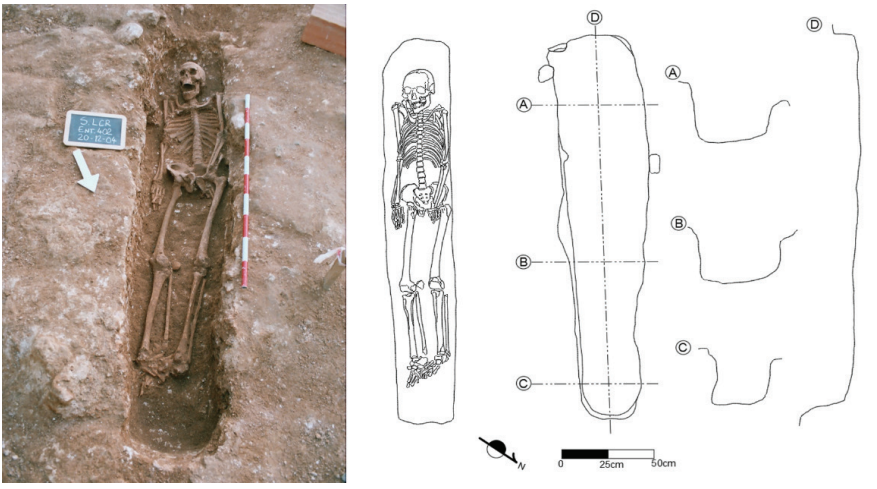

Figure 2. Photograph, burial drawing, and tomb architecture of Islamic burial Ent. 402. Note how the body has fallen dorsally into a semi-supine position. Photos courtesy of Câmara Municipal de Santarém. Photos and drawings conducted in the field by A. Matias, and subsequent digital drawings by T. Trombley.

casionally crossed over the breast, and the presence of additional individuals such as ossuaries accounted for approximately 62% of Christian graves. Similar to the Islamic tombs, the majority of graves were constructed through direct relief of marly limestone substrates (184; 86%) with a subset of collective pits (33; 14%) excavated from clayey substrates. A number of master's theses (Tereso, 2009; Gonçalves, 2010; Graça, 2010; Fernandes, 2011; Rodrigues, 2013; Neves, 2019a) and subsequent publications (Rodrigues et al. 2021) analyzing sub-samples of individuals from Largo Cândido dos Reis have helped to characterize the underlying demographics (e.g., age, sex), taphonomic, and skeletal health/pathologies present in the sample excavated from the site. The present study seeks to build upon this scholarship and further analyze the potential for bioarchaeological analyses within the site by employing a comparative approach between the two principal funerary groups.

While this has undoubtedly yielded one of the larger medieval, and specifically Islamic, cemeteries in Portugal to date, it likely represents a smaller portion of the total cemetery, currently obstructed by modern urban development. Initial assessments based on funerary typology and associated materials (e.g. ceramics) suggested these burials were medieval, with the Islamic cemetery (*maqabara*) likely dating to the ninth or tenth centuries, prior to the Christian conquests in the middle of the twelfth century (1147

C.E.), and the later Christian cemetery being established in tandem with the thirteenth century hermitage of Santa Maria Madalena (Matias, 2008a; 2008b). Recent results of AMS ^{14}C dating from a pilot project (Trombley et al., in preparation) suggest a number of Islamic burials ranged between 992 and 1158 C.E., while a Christian burial was dated to approximately 1179-1264 C.E. (405 Oss.; 830 ± 15 BP, cal C.E. 1179-1264 (2σ)). These preliminary findings seem to confirm initial chronological assessments for both the Islamic and Christian phases of the cemetery.

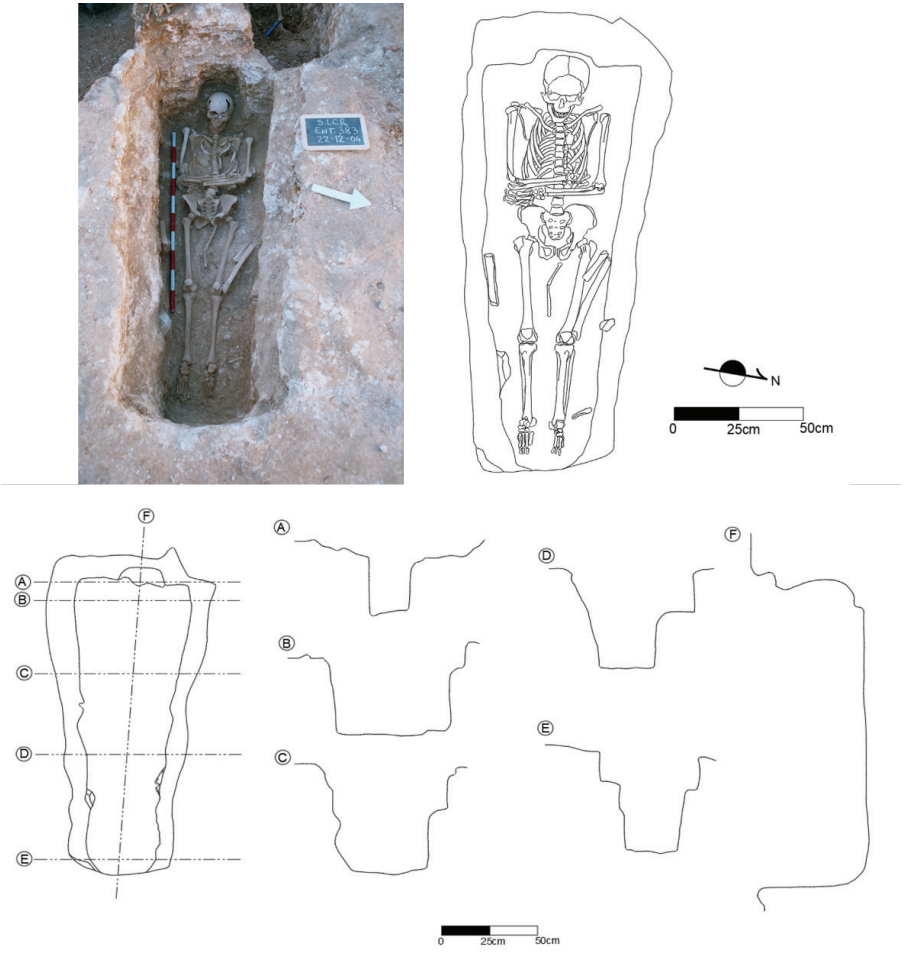

Figure 3. Photograph, burial drawing, and tomb architecture of Christian burial Ent. 383. Photos courtesy of Câmara Municipal de Santarém. Photos and drawings conducted in the field by A. Matias, and subsequent digital drawings by T. Trombley.

Only primary graves were examined here, and when paired with burials that showed sufficient skeletal preservation for discerning possible constrictions, overall limited sample sizes severely. Only adults were examined here, as children in medieval Islamic cemeteries are frequently separated from adult spheres of the cemetery (Petersen, 2013), and given the underrepresentation of non-adults in the cemetery (~16% of total sample), it's indeed possible Islamic children were buried elsewhere, or not discovered within the confines of the excavation. We examine here a total of 119 individuals — 70 Islamic and 49 Christian — for archaeothanatological evidence of burial containers. The demographic distribution can be seen in Table 1. Sex was estimated predominately on dimorphic features of the pelvis (when present), with a particular emphasis on the sub-pubic concavity, ischio-pubic constriction, ventral arc, sub-pubic angle, and greater sciatic notch (Phenice, 1969; Acsàdi and Nemeskèri, 1970; Brothwell, 1981; Buikstra and Ubelaker, 1994).

Table 1. Sample demographics in present study.

Sex	Islamic	Christian	Total
Male	43	32	75
Female	23	14	37
Indeterminate	4	3	7
Total	**70**	**49**	**119**

Methods

Detailed archaeothanatological note-taking, photos, drawings, and burial metrics were conducted in the field for each burial utilizing forms put forth by Santos et al. (1991), and subsequent analyses were carried out in a *post-hoc* archaeothanatological manner following Harris and Tayles (2012), Nilsson Stutz (2003; 2006), Roksandic (2002), and Green (2022). Skeletal elements *in situ* were analyzed for their bodily position, degree of constriction, relation to overall grave cut, and necrodynamic activity. Archaeothanatology has proven an important methodological and interpretive tool within bioarchaeological contexts in Portugal, given the range of funerary treatments observed temporally and spatially throughout the country (Neves et al., 2012; Neves, 2019b). A fundamental principle of archaeothanatology and movement of the body is understanding decomposition in relation to burial 'space.' As the body decomposes and soft tissue progressively disappears, bones subsequently become "precariously balanced" (Nilsson, 1998: 7), and the space within and outside the body in tandem with burial containers and soil porosity can often dictate where such skeletal elements end up as a result of gravity. Space is often characterized according to three definitions: external, internal, or secondary external (Duday, 2006; Harris and Tayles, 2012), though more recent refinements have built upon these conceptions (Green, 2022: 439). Internal space refers to

the space within the bodily confines (i.e., skin), often facilitated by delayed infilling of surrounding soils due to the soils being nonporous or the presence of a burial container. In supine burials, this is often marked by articulation of the pelvis, patellae, and collapsing of the ribs into the thoracic cavity where viscera were once present (Neves et al., 2012: 33). External space refers to the zone outside of the bodily confines resulting from delayed infilling of soils outside of the body. Due to this delayed infilling outside of the body, external space often suggests the employment of a burial container such as a coffin, which acted as a barrier to soils from replacing decomposing soft tissue (Duday, 2006; Harris and Tayles, 2012; Green, 2022). Skeletally, this often manifests in disarticulation and a falling of skeletal elements outside of their bodily confines.

For instance, in extended supine burials within empty space such as a coffin, the pelvis flattens with decomposition, with pubic symphyses disarticulating resulting in the lateral rotation of the femora, and the external (lateral) deposition of the patellae (Duday and Guillon, 2006; Duday, 2006). In burials where the individual is on their side, bones that are not on the floor of the grave such as the scapula or *os coxa* often fall posteriorly (Duday and Guillon, 2006), whereas the ribs will often sag, though progressive infilling by sediment where tissue once was as well as confined burials can prevent such displacement (Neves et al., 2012: 34). Finally, secondary external space refers to the movement of skeletal elements outside of the bodily confines, but not as a result of external space such as a coffin. In this case, decomposition itself, specifically putrefaction, results in the production of gases and bloating of the body as gut bacteria activity facilitates gaseous buildup as a result of consuming cellular proteins (Duday and Guillon, 2006; Hyde et al., 2013). As such, this bloating can cause an expansion of the bodily confines and facilitate alterations in the burial environment, bodily movement, and soil infilling. This results in skeletal elements that are precariously positioned (unstable) from decomposition to move according to gravity, where newly formed voids outside of the body (Duday and Guillon, 2006, 138; Green, 2022). Additionally, liquefaction of the internal organs and subsequent seeping of bodily fluids into the burial environment can attract invertebrates (e.g. worms, snails, slugs) and other necrophagous organisms, which themselves can attract additional predators (e.g., insectivores), all of which can facilitate bioturbation in and around the body (Nilsson, 1998: 7; Duday, 2006: 34). Finally, in cases where the body is in direct contact with porous/fluid soils that can readily replace soft tissue during decomposition, the burial is often characterized as exhibiting no space whatsoever. Labile joints found in direct articulation with interstitial sediment often suggests lack of space and the progressive filling of sediment that replaces voids created by decomposition, such that the thoracic cavity experiences no collapsing, there's little evidence of bodily movement, and even

the hyoid may still be in articulation. Thus, the positioning of certain articulations, such as the patellae, scapulae, hyoid, and *os coxae*, are crucial indicators of whether burials were surrounded with earthen fill, or contained empty space (Duday and Guillon, 2006).

An adaptation of the flow-chart methodology developed by Harris and Tayles (2012: 232) was employed, resulting in the following 'codes' for later tabulation:

Additionally, when possible, burial metrics (length, depth, and width) were measured for each burial in the field and later analyzed by funerary group to elucidate possible trends in tomb construction. Normality was assessed visually using histograms and normal quantile plots followed by Shapiro-Wilk tests with an $\alpha = 0.05$. While all burial metric sub-groups had fair sample sizes (> 30), only Islamic depth and Christian depth were found to be non-

Table 2. Burial container codes and descriptions (following Harris and Tayles, 2012: 232-233).

Code	Category	Description
1	Wide Coffin	Internal space accompanied by lack of constriction, disarticulation of os coxae, femora, and fall of patella outside of bodily confines
2	Loose non-durable wrapping, *or* no wrapping *or* wide grave with soft sediment	No evidence of constriction, or constriction was possibly influenced by narrow grave cut, accompanied by internal space or lack of space.
3	Tight durable wrapping	General lack of external space, with accompanied constriction, medial fall of patellae, and wall effect that conforms to outline of the body
4	Tight durable wrapping, *or* narrow coffin/grave	Similar to tight durable wrapping, but with constriction being difficult to discern between 'box' shape and conforming to the body
5	Narrow grave	Evidence of constriction with medial fall of patellae, but constriction does not conform to the body. Wall effect(s) is/are with grave cut only.
6	Tight non-durable wrapping	Evidence of constriction, with internal space, only, with patellae not falling within confines of body
7	Loose non-durable wrapping *or* tight non-durable wrapping	Similar to code 6 above, but with inability to discern if constriction is due to grave cut
8	Tight non-durable wrapping *or* tight durable wrapping *or* narrow coffin/grave.	Similar to code 4 above, but no fall of patellae within lower limb confines.
9	Loose non-durable wrapping *or* tight non-durable wrapping *or* tight durable wrapping *or* narrow coffin/grave	Constriction is evident, but inability to distinguish if constriction is due to wrapping or a narrow grave cut (i.e., indeterminate).

significant according to Shapiro-Wilk tests, whereas all other burial metrics were non-normally distributed ($p < 0.05$). As such, a two-sided Wilcox rank sum test was used with an $\alpha = 0.05$. Effect size was subsequently calculated using the rstatix package in R.Studio v 4.2.2 (RStudio Team, 2020)

Results

The distribution of potential burial containers is shown in Table 3 and Figure 4. No graves for either funerary group showcased evidence of coffins, nor decomposing in open space. A small subset of graves showcased signs of loose non-durable wrapping, or no wrapping whatsoever (Christian = 18.37%, Islamic = 10.00%). A small subset of Christian individuals (22.45%) similarly showed signs of tight durable wrapping, evidenced by skeletal constriction in wider graves (Figure 5). Only one Islamic individual showed signs that would be consistent with tight durable wrapping, Ent. 355.

Table 3. Counts and percentages of burial container scores at Largo Cândido dos Reis by funerary group.

Code	Christian		Islamic		Total	
	N	%	N	%	N	%
1	0	0.00	0	0.00	0	0.00
2	9	18.37	7	10.00	16	13.45
3	11	22.45	1	1.43	12	10.08
4	0	0.00	0	0.00	0	0.00
5	0	0.00	0	0.00	0	0.00
6	0	0.00	0	0.00	0	0.00
7	16	32.65	0	0.00	16	13.45
8	7	14.29	12	17.14	19	15.97
9	6	12.24	50	71.43	56	47.06
Total	49	100	70	100	119	100

Where: 1 = Wide Coffin, 2 = Loose non-durable wrapping or no wrapping/wide grave with soft sediment, 3 = Tight durable wrapping, 4 = Tight durable wrapping or narrow coffin/grave, 5 = Narrow grave, 6 = Tight non-durable wrapping, 7 = Loose non-durable wrapping or tight non-durable wrapping, 8 = Tight non-durable wrapping or tight durable wrapping or narrow coffin, 9 = Loose non-durable wrapping or tight non-durable wrapping or tight durable wrapping or narrow coffin.

The majority of burials could not be identified without the addition of one or more criteria. A cumulative 59.18% of Christian graves and 88.57% of Islamic graves showcased indeterminate evidence of either the employment of some form of burial container, narrow tomb morphology, or both.

Both burial depth and width were found to be statistically significant, with Islamic graves being shallower and narrower than their Christian counterparts (Table 4). Although Christian graves appeared slightly longer than Islamic graves, burial length was not significantly different between funerary groups.

Discussion

The majority of graves regardless of funerary group (76.48%) showcased signs of either burial containers, narrow graves, or both. Burials from Largo Cândido dos Reis showed no evidence of coffin burials, or decomposing in completely open

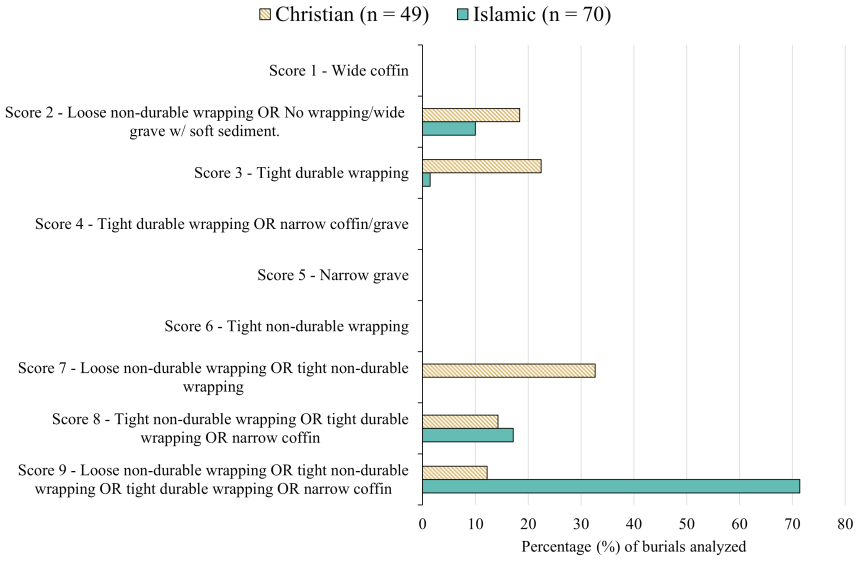

Figure 4. Distribution (%) of burial containers by funerary group.

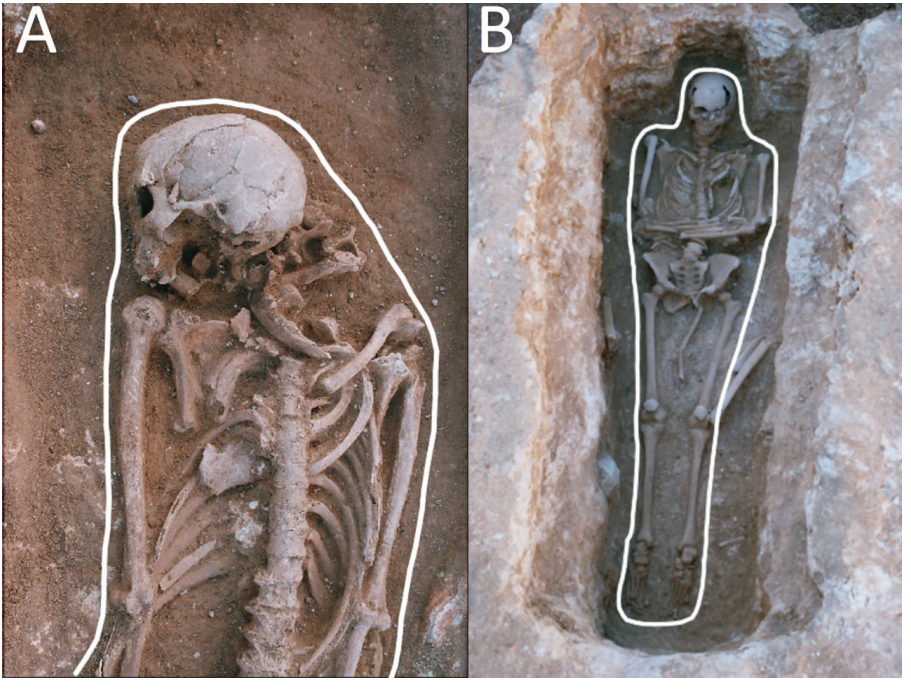

Figure 5. A) Ent. 355 (Islamic) showing signs of possible shrouding (white outline) given constriction within grave cut. B) Ent. 383 (Christian) showing signs of likely shrouding (white outline). Photos courtesy of Câmara Municipal de Santarém.

Table 4. Metric comparison of mean burial dimensions (in cm) by funerary group at Largo Cândido dos Reis.

Category	Christian		Islamic				
	N	$\overline{x}_{(s)}$	N	$\overline{x}_{(s)}$	*W*	*p*-value	Effect size
Burial Length	39	193.54 (15.91)	66	190.74 (17.35)	1455	0.27	0.11
Burial Width	64	58.88 (13.43)	150	39.29 (6.30)	8939	< 0.01*	0.68
Burial Depth	40	49.03 (16.09)	72	32.08 (12.76)	2297	< 0.01*	0.49

space (Matias, 2008b). Necrodynamic movements facilitated by space were likely due to either internal space or secondary external space, likely as a result of putrefaction where bodies experienced bloating during the excretion of gasses. Molecular techniques continue to refine our understanding of the thanatomicrobiome and epinecrotic communities (Heimesaat et al., 2012; Javan et al., 2016), and underscore the importance of bacteria in facilitating anaerobic respiration, producing gases such as hydrogen sulfide, methane, cadaverine, and putrescine (Hyde et al., 2013). The buildup of these gases causes the characteristic 'bloat' stage, but as a result can facilitate necrodynamic movements, such as the movement of forearms clasped over the abdomen (Duday and Guillon, 2006; Williams, 2022: 315). Indeed, experimental work with cadaver donors suggests substantial movements can take place during the bloat stage (Mickleburgh and Wescott, 2018; Wilson et al., 2020; Mickleburgh et al., 2022; Schotsmans et al., 2022).

One Christian burial in particular, Ent. 417, an adult male (Vicente, 2015), shows likely signs of this phenomenon (Figure 6). The burial was constructed in an anthropomorphic shape, and the body shows articulation throughout most of the skeleton, with lateralization of the femora and the right patella in an unstable articulation likely propped to the *effet de paroi* of the southeast burial wall. Unfortunately, a post-hole bisected the left distal femur, proximal tibia, and patella so we cannot see the position of where the left patella is, but it likely would have fallen laterally given the rotation of the femur. The flaring of the rib cage accompanied by the wide positioning of the humerii from the thoracic cavity suggest that the upper arms and elbows maintained a sizeable distance from the thoracic cavity due to skin, muscle, and fat tissue. Some soil infilling preserved the overall shape of the thoracic cavity, with upper ribs (1-5) falling into the thoracic cavity and lower ribs (6-12) flaring outwards. The position of the hands is disarticulated from their respec-

Figure 6. Christian burial Ent. 417. Note the flaring of the rib cage, distance of the humerii from the thoracic cavity, and inferior position of the forearms in relation to the respective hands (approximately 5-7 cm), all suggesting necrodynamic movements during putrefaction and bloat. Photo courtesy of Câmara Municipal de Santarém.

tive forearms, with the right arm crossed above the mid chest, and the left arm crossed above the right ilium. The joints of the hands, being labile, disarticulated from the forearms first, before further movement of the forearms occurred. In the case of the right hand, this resulted in the hand bones being positioned atop the stomach, which explains their disarticulated/jumbled positioning within the thoracic cavity as they fell with gravity, whereas the left hand being positioned above the lower lumbar and left ilium explains their comparatively better state of articulation. Each forearm has moved some 5-7 cm inferiorly after the disarticulation of the hand as the body continued to decompose and gravity facilitated further movements. Altogether, burial 417 exemplifies much of the necrodynamic movements observed at Largo Cândido dos Reis, whereby movements took place within the bodily confines (internal space) or as a result of putrefactive bloat (secondary-external space) (Mickleburgh and Wescott, 2018; Wilson et al., 2020; Mickleburgh et al., 2022; Schotsmans et al., 2022).

Necrodynamics and post-depositional movements were observed in every Islamic grave, with most individuals exhibiting a dorsal 'fall' towards the north-west wall of the grave. In numerous cases, individuals were found to exhibit an *effet de paroi* directly against the north-west wall. Given the relatively standard burial width ($\overline{x}$ = 39.29 cm, s = 6.30 cm; see also: Table 3) for Islamic graves at the site, it appears that the distance from the north-west grave wall directly corresponds to whether the individual fell completely dorsally or experienced an *effet de paroi*. In cases where the body was situated closer to the south-east grave wall with accompanying sufficient space, the body fell dorsally such that the right leg (femur, tibia, and fibula) retained a right decubitus position while the left leg appeared in dorsal position (Figure 7). One Islamic burial (SP7089) in Nîmes, France showed signs of wrap-

Figure 7. Islamic burial Ent. 166, with possible shrouding/tight wrapping. Note how the right and left forearms and hands are positioned posterior/dorsally to their respective ossa coxae, suggesting the arms were positioned behind the back prior to the dorsal fall. Note the right decubitus position of the right femur, while the left femur is in supine position. Photo courtesy of Câmara Municipal de Santarém.

ping due to the position of the patella *in situ*, despite decomposing in empty space (Gleize et al., 2016). The individual was situated far enough from the southeast wall such that the patella was not held in place via an *effet de paroi,* suggesting it had remained *in situ* via a shroud.

Only one Islamic individual showcased evidence of what might be consistent with tight durable wrapping: Ent. 355 (Figure 5). The individual showcases signs of clavicular verticalization, and overall skeletal constriction that conforms to most of the post-crania, situated within a wider grave cut (48cm). Notably, the cranium, cervical vertebrae, and mandible are in a state of disarray and disarticulation, possibly from secondary external space resulting from decomposition and delayed soil infilling, such that soft tissues are not immediately nor progressively replaced by surrounding sediment (Williams, 2022: 321). Alternatively, decomposition may have taken place *in situ* but within the confines of a burial container, such that cranial and cervical elements did not fall outside the confines of a durable wrapping. Given the Islamic funerary tradition of interring the individual on their right side, Ent. 355 showcases dorsal falling, but remained remarkably constricted throughout the entirety of the dorsal fall. While this suggests tight wrapping, Ent. 355 also showcases signs of possible Diffuse Idiopathic Skeletal Hyperostosis (DISH), with L1-L4 showing contiguous ossifications along the anatomical right side of the vertebrae (Matias, 2008a: 671–672). These ossifications were hypertrophic, and distinctly patterned along the right side, likely as a result of the descending aorta in the left side (Ortner, 2003: 559–560). It is thus possible that limited bodily movement can be explained by the employment of a burial container, or limited post-depositional movement and torsion in the thorax due to the presence of vertebral pathology, or a combination of the two. Notably, Ent. 355 ex-

perienced secondary disturbance in the lower appendicular skeleton as a result of a subsequent Christian grave cut (Ent. 392), which further limits our potential to discern constriction, necrodynamics, and possible shrouding.

Another burial, Ent. 166 (and adult male of indeterminate age), shows potential evidence of tight, durable shrouding given the position of the upper extremities (Figure 7). Ent. 166 appears to have experienced a dorsal fall, but rather than the arms being situated on the sides of the body, actually fell backwards behind the back prior to the fall. The metacarpals, phalanges, and wrists appear to have decomposed *in situ* behind each of the respective *os coxae*. It is therefore possible the body was interred in a way that the right arm and hand were situated just posterior to the right hip, with the left arm and hand balancing precariously atop the posterior aspect of the left abdomen and femur. The left arm subsequently fell posteriorly during decomposition but may have been held tightly together by shrouding material before the rest of the body fell atop it, thus situating the hands behind the *os coxae*. However, the general state of preservation was poor for Ent. 166, possibly due to an interaction of clayey soils and post-depositional disturbances resulting from construction, further limiting our potential. Ent. 390 (Figure 8 - Ent 390) similarly showed evidence of arms positioned dorsal to the *os coxae*, again, likely as a result of the original po-

Figure 8. Islamic burial Ent. 390. White boxes and accompanying letters correspond to zoomed-in photos. A) Note the lateral decubitus position of the cranium compared to the mandible; B) Vertebral torsion throughout the lumbar vertebrae; C) positioning of the hands behind the respective ossa coxae, in a state of disarray; D) note the position of the tibiae and fibulae compared to the feet, which are in a greater state of disarray. Photos courtesy of Câmara Municipal de Santarém.

sitioning and subsequent dorsal fall. Interestingly, L5 can still be seen in right decubitus position, but L4-L1 sequentially exhibit torsion with the dorsal fall. Unlike Ent. 166, the hand bones (and foot bones) appear in a state of disarray, possibly resulting from differential decomposition, necrodynamics, voids, or bioturbation as suggested by the presence of malacofaunal remains (terrestrial snail shells) within the burial. The posterior fall of the *os coxae* may have been the result of an original external void, whereas the left ulna displaced from the trochlea posteriorly, possibly as a result of secondary internal void following gravity (Green, 2022). The position of the mandible atop the lower cervical vertebrae in a semi-decubitus position while the cranium is situated in right decubitus position may suggest the individual fell dorsally before the temporo-mandibular articulation weakened, dislodging the mandible from the cranium in decubitus position. As mentioned briefly above, there do appear to be some prescriptions which advocated for the tethering of the mandible to the skull (Gatrad, 1994; Tritton, 2008; Petersen, 2013), which could possibly factor into this sequence, though the material used is not known. Subsequently, the cranium may have fallen back into right decubitus position at a later stage. These movements suggest some degree of original external space, either facilitated by a burial container such as a shroud which 'suspended' labile decomposing materials, or possibly even the effect of bioturbation and ground-water fluids that caused minor bones to 'float' in grave floor (Duday, 2006: 41).

Christian burials were easier to discern possible burial containers, given: 1) their extended supine position, which archaeothanatological literature has predominately focused on (Harris and Tayles, 2012; Green, 2022), 2) skeletal constriction, when observed, did not appear the product of narrow tomb architecture, unlike Islamic burials. These were often marked by the articulation of patellae, lack of external space, and a degree of constriction often confining to the body itself. Some individuals showed little movement whatsoever, with labile articulations and their associated skeletal elements (e.g., hand bones) decomposing *in situ* with minimal gravitational movement, possibly as a result of more porous soils and progressive infilling. While evidence of employment for shrouds in some Christian burials is noteworthy, it likely showcases the variable nature by which individuals were interred throughout the latter Christian Middle Ages. The discernment of burial containers from archaeothanatological evidence alone continues to be a challenging (Duday, 2009), but exciting area of inquiry. Direct evidence of textiles in Islamic funerary contexts is rare, typically involving outstanding preservation in arid contexts (Lombard, 1978; Gayraud et al., 1995; Sokoly, 1997; Gleize, 2022). Similarly, in medieval Christendom, there are few instances of burial shrouds preserving, such as those of the aforementioned St. Bees Priory in Cumberland, St. Mary Spi-

tal in London (Gilchrist and Sloane, 2005: 106). To complicate matters further, some prescriptions advocate for the loosening of the shroud after interment (el Aswad, 1987; Buturovic, 2017), though the degree to which shrouds would have been loosed is currently difficult to know via archaeothanatological evidence alone. This is compounded with the issue of textile composition, as *kafan* is traditionally made from 'Yemeni cotton' (Petersen, 2013), but to our knowledge, cotton was not grown locally within Santarém during the medieval period (Sequeira, 2014: 38, 45). By the later Christian Middle Ages (15th – 16th c. C.E.), wool and linen were produced in far greater quantities than cotton or silk, largely due to available raw materials (Sequeira, 2014: 35). Given our observations in Islamic burials, we posit that burial shrouds, if employed at all, were likely non-durable and generally loose-fitting, though some burials show archaeothanatological evidence of more tight wrapping (e.g., Ent. 166). Conversely, Christian burials appeared to have employed higher instances (22.47%) of possible tight wrappings (Score 3), given the skeletal constriction (lateralization of the clavicles, medial rotation of the humerii) and minimal post-depositional movements accompanied by the grave cut extending beyond the constriction of the body.

A cumulative 88.57% of Islamic burials analyzed showed signs of possible shrouding and/or narrow grave cuts (Scores 8 and 9), while the Christian subsample was more variable in its distribution of possible burial container typologies (Table 4). Much of our inability to confidently discern the employment of burial containers in Islamic graves stems from 1) an underrepresentation of archaeothanatological literature in Islamic contexts, and 2) the impact of narrow tomb dimensions in facilitating skeletal evidence of constriction. Christian graves were variable in burial width dimensions, ranging from 26 – 99 cm with 95% of the variation falling between 33 – 83 cm. Islamic graves were comparatively much narrower in variation, ranging between 25 – 68 cm with 95% of the variation falling between 24.5 and 52.5 cm. Not only were Islamic graves significantly narrower than their Christian counterparts, but the sample dispersion for Islamic burials was also significantly smaller, with a standard deviation of 6.30 cm compared to the Christian standard deviation of 13.43 cm (Levene's test: $F = 26.91$, $p < 0.001$). Therefore, archaeothanatological evidence of constriction — often one of the prerequisites for burial containers — in Islamic burials was difficult to discern as being the product of burial containers, narrow grave construction facilitating constrictive burial dimensions, or a combination of the two. From an ethnohistorical and legal standpoint, burial width appears to have been debated, though typically advocating for narrow tombs in accordance with Maliki jurisprudence in order to avoid post-depositional movements of the body and maintain the body in right decubitus position facing Mecca (Garcia

Gómez and Lévi-Provençal, 1998: 149; Chávet et al., 2006; Halevi, 2007). Indeed, the majority of Islamic cemeteries that have been excavated both in Iberia and in the Near East generally conform to these prescriptions (Simpson, 1995; Chávet et al., 2006; Faro Carballa et al., 2007; Murillo Fragero and Benet, 2009; Ruiz Taboada, 2015; Gonzaga, 2018; Gleize, 2022), sometimes no more than 60 cm wide (Gleize, 2022: 382). In fact, there is both ethnohistorical and archaeological evidence for the employment of mud bricks, sherds, and rocks beneath the cranium in order to maintain right decubitus position and/or give the appearance of the individual sleeping (el Aswad, 1987: 221; León Muñoz, 2008). In some cases, Islamic burials at Largo Cândido dos Reis seem to have employed similar props beneath the cranium such as limestone blocks (Matias, 2008b: 647). In many instances, it's likely that the grave was constructed just outside the confines of the cadaver, while the final positioning of skeletal elements represents movements within the internal space of the bodily confines. Altogether, the observed variance and lack of sample dispersion in burial width and depth suggest Islamic burials were in fact highly prescribed and normative (Gleize, 2022) compared to their more variable Christian counterparts. Burial construction appears more regulated in these Islamic burials, which altered the contours of archaeothanatological potentials, whereas Christian burial construction, the raw materials used for burial containers, and the degree of constriction (e.g., tight or loose) of those burial containers appear more variable based on both the burial metric and archaeothanatological evidence.

Conclusion

The application of archaeothanatology continues to experience burgeoning scholarship and attention, revealing crucial funerary rituals, burial architecture, and decomposition sequences. While the scholarship on archaeothanatological approaches to right decubitus burials in Islamic contexts is emerging (Gleize et al., 2016; Gleize, 2022), the majority of archaeothanatological investigations on burial containers have focused on extended supine burials or sitting burials, and further work is needed on lateral decubitus burials given their differential positioning and necrodynamic potential. While there is likely evidence of burial containers and shrouds employed at Largo Cândido dos Reis, tomb architecture and construction, likely in accordance with Islamic jurisprudence and funerary rites of the time, severely limited our confidence in discerning burial containers. Many burials were indeterminate in their employment of shrouds based on available *post-hoc* archaeothanatological evidence. *Post-hoc* archaeothanatological approaches are not without their shortcomings, and are heavily subjected to original documentation and photographs/drawings during excavation. However, the increasing incor-

poration of archaeothanotology in burial contexts (Knüsel and Schotsmans, 2022), paired with experimental and detailed understandings of decomposition (Dent et al., 2004; Pinheiro, 2006; Mickleburgh and Wescott, 2018; Wilson et al., 2020) have helped to document the emerging patterns of funerary rites and their consequences on human skeletal remains. The burgeoning corpus of this scholarship aids *post-hoc* approaches in providing more examples and variability of human decomposition, and the potential for *post-hoc* approaches in re-analyzing previously excavated material or even challenging previous funerary archaeological hypotheses which may have lacked biological anthropologists and/or detailed archaeothanatological understandings of decomposition (Nilsson Stutz, 2006: 218; Green, 2022).

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