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Case report

Identification process in mass graves from the Spanish Civil War I

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ABSTRACT

The identification process of human skeletal remains exhumed from a mass grave from the Spanish Civil War (1936–1939) is presented. Information regarding the presumptive location of the grave and the presumptive number and identities of the persons buried in the grave was collected from interviews and written records from relatives and witnesses, as well as from research at the penitentiary archive. Antemortem individual data were collected from testimonies, and from research from penitentiary, army and civil archives. The consistency between data obtained from testimonies, archives, archeology and osteology allowed a targeted approach to DNA typing based on the assumption of the finding of a closed synchronic group. Two were the first genetic studies requested: the first study focused in the identification of a family group presumptively buried in the grave, compatible with a group of four skeletons that were associated on the basis of dental non-metric traits; the second study focused on the identification of the youngest person presumptively buried at the grave, compatible with the biologically youngest skeleton exhumed. A complete match between 16 Y-STR loci was observed for the four skeletons, as well as a match between mtDNA profiles of the biologically youngest skeleton and the sister of the youngest person presumptively known to be buried in the grave. These results, together with the accumulated evidence, led to propose the identification of these five persons. To date, identifications have been proposed for 17 out of 46 skeletons exhumed from the grave.

1. Introduction

The identification of human remains in massive contexts is a complex process whose success depends on different factors, as it has been described by professionals working in mass graves resulting from human rights violations in Croatia, Kosovo and Serbia [1–4], or in natural disasters such as the Asian tsunami [5]. Besides time and infrastructure constraints, the most important factors are the number of victims; the preservation of the remains and associated personal objects [3,6]; the availability of appropriate methods and reference samples for the anthropological study and for an adequate presentation of the results [7–9]; the quantity and quality of the antemortem information from relatives, witnesses and diverse documentary sources [5,10,11]; the availability of financial support, living relatives and adequate statistical methods to conduct DNA analyses when possible (for a recent review of different mass disasters see Alonso et al. [12]).

In the last decade the study of DNA has been incorporated, systematically or as pilot projects, to the identification process of victims of human rights violations and war casualties, and the implementation of genetic data bases has allowed the identification of a larger number of human remains exhumed from mass graves [13–19]. However, the comparability of classical markers of identity (anthropological findings) to a DNA-based identification is still required, since in cases of limited or non-definitive DNA data, these findings can be important for positive identification [20,21], or individual body identification [22]. On the other hand, positive identifications based solely on the findings from the anthropological study of skeletal remains face different problems and limitations. As mentioned before, an emphasis on appropriate statistical analysis and presentation of the data for sex, age and stature estimation has been recently requested [7], and caution has been advised about identifications based on the comparison between morphological features and antemortem data, as explained by Komar and Lathrop [23]. Underlying these problems of identifications based on osteological analysis in mass graves is the lack or limitation of adequate antemortem information. For instance, this lack of antemortem data can hamper the dental identification rates [24,25], or directly precludes any identification due to generalized absence or low comparability of medical records for the nature of

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local target population of the mass disaster, such as the Thai victims of the tsunami [5], or main target population of the human rights violations, such as the Peruvian rural population [10].

All these considerations apply to the identification process of human skeletal remains exhumed from mass graves and cemeteries from the Spanish Civil War (1936–1939) and postwar years. It has been estimated that more than 150,000 people were killed away from the battlefields during the Spanish Civil War (1936–1939), and the first decade of Franco's dictatorship (1939–1950) [26]. Through the initiatives of relative associations and other groups, since 2000, diverse mass graves and cemeteries dating from the civil war and postwar years have been located, exhumed, and the human remains reburied in a legal and dignified place [27]. In some cases, the identification of the human remains has been requested by the relatives. This paper is the first of a series of articles, where the main goal is to expose, through case-studies, the different sources of information that can be used in the identification process in the specific context of the Spanish Civil War mass graves and cemeteries, as well as the contributions and limitations of the osteological study for the identification process. In the present work we present the identification process of 46 individuals exhumed from the same grave.

2. Materials and methods

2.1. Testimonies from relatives and witnesses

The exhumation was carried out at the request of people whose relatives were killed after the 18th July 1936 military coup. Relatives and witnesses' relatives were interviewed by volunteers from the *Asociación para la Recuperación de la Memoria Histórica* (ARMH), including one of the present authors (J.I.C.) and by a social anthropologist, who recorded and later transcribed the interviews [28]. From the interviews it was known that written testimonies of the killing event existed, in the form of autobiographical accounts of some witnesses. Using all these sources the team obtained the presumptive location of the grave, the number and identities of the people killed and presumptively buried in the mass grave, and for some of the victims, antemortem information such as physical complexion and photographs.

2.2. Location and exhumation of the grave

In the summer of 2004, 46 skeletons were exhumed from a mass grave located near the town of Villamayor de los Montes, province of Burgos. The location of the grave was indicated by some relatives and witnesses of this and other nearby towns. Relatives and volunteers from the ARMH took charge of most of the logistic of the exhumation in terms of lodging and accommodation for the archaeological team, which consisted of volunteer archaeologist and anthropologist from different universities and institutions coordinated by archaeologist Angel Fuentes from Universidad Autónoma de Madrid. The main finding reported by the archaeological team was that 46 skeletons were found at the same grave but in two spatially separated groups of 21 and 25 skeletons. This fact was interpreted as evidence of two temporally separated events. The skeletons were delivered for study to the Unit of Anthropology at the Universidad Autónoma de Madrid, where one of the present authors (L.R.) was in charge of the osteological study.

2.3. Osteological study

The state of preservation of the remains was moderate to good. Sex was estimated by observation of the pelvis and cranium, following recommendations of diverse authors [29,30]. When epiphyseal activity was observed, age at death was extrapolated from studies of bone maturation [31–34]. If bone maturation was complete, broad age ranges were assigned after seriation and scoring of the pubic symphysis [35] and auricular surface [36]. For the pubic symphysis casts were used when possible [37]. Other ageing methods, such as the observation and scoring of the sternal end of the fourth rib and the so-called Lamendin technique, will not be discussed here since they could be applied only in a limited number of skeletons. When preservation allowed it, stature was estimated by the modification of the anatomical method proposed by Raxter et al. [38,39], otherwise, stature was estimated by applying the formulae for maximum length of femur developed using a modern Portuguese sample [40]. An easily observable list of non-metric traits (cranial, postcranial and dental), evidence of pathological conditions and morphological features were recorded for each skeleton [23].

2.4. Archival information

Three archives were researched by one of the authors (J.I.C.) in order to locate relevant information regarding the people presumptively buried at the Villamayor de los Montes grave. These archives included the *Archivo del Centro Penitenciario de Burgos* (Archive of the Penitentiary Center of Burgos), the *Archivo General Militar de Guadalajara* (Army General Archive at Guadalajara), and the archives of the municipalities. At the penitentiary archive, documentary information is kept regarding all the people arrested and released from prison in the province of Burgos since the XIX century. Two kinds of documents were looked for at the prison archive: documents regarding the release of groups of persons following the July 1936 military coup, and the mandatory individual files drawn up when a person is imprisoned. At the army archive, the individual files of all the Spanish recruits since the XIX century are kept, organized by military province, year of recruitment and surname. The mandatory individual files of those men recruited for the army service were looked for. Finally, the section *Actas de Reclutamiento y Reemplazo, Sección Quintas* (Conscription and Replacement Records), were consulted in the archives of different municipalities. In the individual files from the three archives, information can be found regarding date and place of birth, occupation, stature, and individual physical features. Copies were made of all relevant documents.

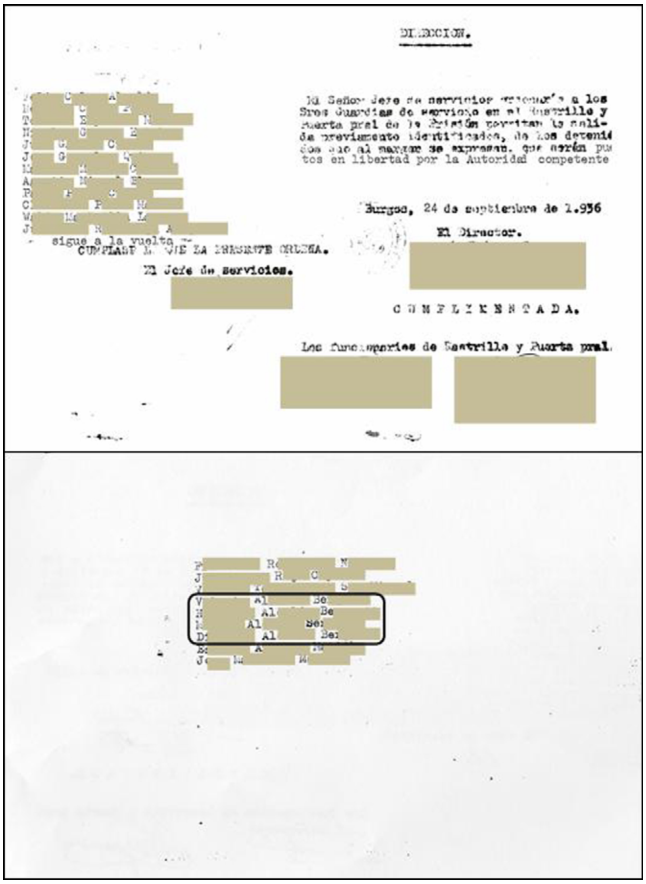
3. Results and discussion

3.1. Testimonies and archival information

The relatives interviewed included some brothers and sisters, sons and daughters, and numerous grandchildren of the deceased. The older generation of relatives had been informed that after the 18th July 1936 military coup, their relatives were arrested, imprisoned, released from jail, killed and subsequently buried in a mass grave near the town of Villamayor de los Montes. The location of the grave was provided by the grandson of one of the victims and the written testimony of a deceased witness, who indicated that the grave was placed near the working hut of his father, a "*peón caminero*" (road maintenance worker responsible for care of a specific section of road). According to the witness testimony, the killings and the burial took place at the same place. The archaeological team located the grave at the place indicated by both testimonies.

A preliminary list of persons presumptively buried in the grave was compiled from the interviews of relatives and witnesses' relatives, and from personal written testimonies. The search of the penitentiary archive resulted in two official documents that corroborated the names of 19 men from this preliminary list. Document 1, presented in Fig. 1, was of special relevance. It can be observed that 21 names are listed in this signed and stamped document of release from jail dated on 24th September 1936. Of these 21 men, 14 were in the aforementioned preliminary list. On this document it is important to note the presence of two familial groups: a father and his son, and a father and his three sons. From testimonies it was suggested that the men whose names were included in this document were killed and buried together the night of September 24th. The release of groups of people from prison, who were subsequently delivered to, and killed by, paramilitary garrisons, was a widespread *modus operandi* in the province of Burgos as well as in other Spanish provinces during the first months of the armed confrontation that followed the military coup. The group of people released to be killed received the name of *saca*, from the Spanish verb *sacar* (to take out).

Five additional names from the preliminary list were found in other signed and stamped document of release from jail dated on 13th September 1936, which included the names of 14 men from the towns of Lerma and Villalmanzo (document 2, not shown). From diverse testimonies it was also suggested that two groups of four men each were arrested on 12th September 1936. One of the groups comes from Villamayor de los Montes and the other one from a nearby town, Madrigal del Monte. It was hypothesized that once in jail, these 8 men were released together with the 14 men listed in document 2, and the group of 22 men were killed and buried at the Villamayor de los Montes' grave the night of 13th September. This hypothesis has been supported by a document dated on 2nd September 1939 recently found at the municipality of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El Señor Jefe de servicios ... a los
Sres Guardias de servicio en el ... y
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sigue a la vuelta

Burgos, 24 de septiembre de 1.936

El Director.

[redacted]

El Jefe de servicios.

[redacted]

CUMPLIMENTADA.

Los funcionarios de Rastrillo y Puerta pral.

[redacted]

[redacted]

Fig. 1. Document of release from jail of 21 men, dated on 24th September 1936. The presence of a familiar group is indicated.

Villamayor de los Montes, where it is stated that a neighbor of this town "disappeared from his house the 12th September 1936, 21:00 h, brought by several armed and unidentified individuals" (document 3, not shown). This neighbor was F.A.G., one of the four men from Villamayor de los Montes presumptively buried at the grave.

When all this information from the testimonies and from the penitentiary archive was combined, a larger list of persons presumptively buried at the Villamayor de los Montes' grave was conformed. This list was completed with the information recovered from testimonies and from the individual penitentiary, army and civil files, and a definitive list was elaborated as shown in Table 1.

3.2. Osteological analysis

The osteological study proceeded separately and independently from the archival and testimonial research. The findings from the osteological study were organized in two separated reports, regarding the group of 21 and 25 skeletons. Here we will only discuss in detail the data from the group of 21 skeletons. The main findings are organized and discussed in two blocks of information: first, the sex, age and stature distribution estimated from the remains, together with signs of pathology and morphological features potentially relevant for the identification process; second, the presumptive finding of a familiar group conformed by four skeletons.

3.2.1. Sex, age and stature distribution: group of 21 skeletons

The study of pelvis and cranium unequivocally indicated that all the skeletons were males. Next, age ranges were estimated from the degree of fusion of diverse epiphyses and from adult ageing methods. The scoring of epiphyseal activity is usually a straightforward task, and the age ranges estimated from the stage of epiphyseal fusion are usually narrower than those obtained from other adult ageing methods. Nevertheless, two questions are broadly discussed regarding age estimation from bone maturation: the presence and extent of the differences between populations in bone maturation, and the genetic or environmental causes of the observed differences. Some authors have suggested that genetic factors can play an important role in the explanation of the differences observed between populations [33]. Other authors have shown the significant impact on bone maturation of environmental factors such as nutrition or the average socio-economic status [41,42]. The rural population of Burgos from the first half of the last century is geographically and temporally distant from most of the samples from where the most widely applied references have been developed (e.g. Korean War casualties, Spitalfields, contemporary Bosnians), with the possible exception of the recently available data from XX century Lisbon [34]. There is also ample evidence of the depressed growth environment for the rural population from Burgos: linear enamel hypoplasias were found on almost all the 46 skeletons; the average estimated stature was 161.23 cm ($N = 46$, mathematical method); and the mean stature from the 27 documented heights was 159.05 cm. These data are compatible with the data found by anthropometric historians in larger samples from the same province [43], and indicate the lower biological living standard of this population. But as stated by Cardoso [44], whatever the causes of the differences observed between populations, the overall pattern when comparing different references seems to be similar, and population-specific data will prove more useful when advanced statistical analysis is utilized [33]. In practical terms, our approach was conservative in that we decided to obtain the widest age range for every bone used to estimate age by combining the available references. With this premise, we obtain three main conclusions: an estimated age below 30 years was based on the state of maturation of the medial end of the clavicle for 11 skeletons, five out of these 11 skeletons were estimated to be below 25 years based on the state of maturation of other bones (ribs, vertebrae, iliac crest, ischial tuberosity), and finally, for one out of these five skeletons a range of 16–21 years was suggested based on the state of maturation of the epiphyses from limb long bones (unfused epiphyses of left and right distal ulna and radius, unfused distal epiphysis from left femur).

Age estimation of the 10 fully mature remaining skeletons was more problematic. In comparison with age estimation from bone maturation, the classical adult ageing methods rely on more complex and more subjective scoring systems [45], and present wider age ranges and diverging accuracies depending on the age group studied [46,47]. Furthermore, caution has been warned when the method applied has been developed in a different population from the case or sample under study, due to possible population differences in the ageing process [48], or due to differences in age structures of both the reference and study samples [49,50]. We first seriated the available pubic symphyses and auricular surfaces (including the 11 skeletons from the young adult group) following written descriptions, and compared the pubic bones with casts [35–37]. Only six pubic bones from the fully mature group were preserved for scoring, and the assigned phases ranged from III to VI. With regard to the auricular surface, by applying the method of Buckberry and Chamberlain [36], the stages ranged from IV to VI. If the pubic symphysis was preserved, the age assigned to the skeleton was the mean age and 95% range associated with its Suchey–Brooks phase [35]. We consider these age assignments as tentative, since it has been shown that the Suchey–Brooks method for age estimation works better for phases

Table 1
List of men presumptively buried at the grave obtained from testimonies and archival data.

Penitentiary document/testimonies	Name	Age	Height (cm)	Testimonies and archives	Family group
21 men presumptively killed and buried together the night of September 24th					
Released from jail 24th September 1936	J.J.R.A.	18	–		Son
(Document 1, penitentiary archive)	U.M.L.	20	–		
	H.A.B.	21	151.2		Brother
	N.C.P.	22	169		
	C.P.M.	23	166.8		
	V.T.S.	23	165.3		
	A.M.B.	23	160.9		
	F.J.C.A.	24	169		
	D.A.B.	24	158.9		Brother
	V.A.B.	26	155.7		Brother
	J.G.Q.	27	–		
	N.G.E.	36	–		
	J.M.M.	42	160		
	M.M.C.	42	158.8		
	E.A.M.	47	–		
	P.P.C.	48	159.9		
	J.R.C.	50	158		
	F.R.N.	50	–		Father
	O.E.M.	54	–	Very tall[a]	
	J.G.C.	55	–		
	M.A.S.	61	154.5		Brother's father
22 men presumptively killed and buried together the night of September 13th					
Released from jail 13th September 1936	P.P.G.	22	154		
(document 2, penitentiary archive)	J.F.G.	23	169		
	G.N.C.	25	157.5		Brother
	H.A.D.	27	159.5		
	C.N.A.	27	158.7		
	C.S.G.	27	161.1		
	A.N.C.	28	157.5		Brother
	L.G.G.	28	–		
	V.G.M.	30	154		
	L.L.R.	32	155		
	J.L.A.	34	–		
	A.M.G.	36	155.8		
	P.P.A.	38	–	Very short[b]	
	G.G.A.	42	–		
Villamayor de los Montes,	V.D.V.	27	160		
released from jail 13th September	F.A.G.	40	154.3		
1936 (testimonies and civil record for F.A.G.)	B.G.J.	49	–		
	Z.D.O.	57	157.8		
Madrigal del Monte, released from jail	P.A.B.	35	–		
13th September 1936 (testimonies)	E.C.C.	39	152		
	N.A.M.	35	–		
	L.O.	–	–		

[a] A full-body photograph was provided by the relatives, together with the testimony that this man was very robust and was one of the tallest in town.
[b] A full-body photograph was provided by the relatives, together with the testimony that this man was one of the shortest in town.

I, II and III [37,46,51], and since it has been observed that it may be not adequate to estimate age from the mean and 95% range for each phase from the Suchey–Brooks system [50]. If the symphysis was not preserved, the age assigned was based on the scoring of auricular surface following the age ranges offered by Buckberry and Chamberlain [36].

With regard to stature estimation, its role in the identification process in mass burials has been of limited value for various reasons [10,11]. First, diverse factors determine the appropriateness of the formulae selected for estimating stature, mainly the presence of inter-population variation in size and body proportions. Second, once we have an estimated stature, the next problem is the validity of the comparison between this estimate, and the available antemortem records and accounts from relatives and witnesses, which may vary considerably in their accuracy. The questions of the quality of the antemortem statures from the archives and the development of population-specific formulae, are both currently under research. In order to avoid the problem of differences in body proportions, the anatomical method was applied when possible [38,39]. Also, the formulae developed from maximum length of the femur in a modern cadaveric Portuguese population were used [40]. Statures estimated by the anatomical method ranged from 151.3 cm to 169.7 cm, and those estimated from maximum length of the femur ranged from 153.4 cm to 171.7 cm.

All data regarding the group of the young adult skeletons are summarized in Table 2. Skeletons were ordered based on estimated age from bone maturation and then by stature estimation. As indicated, besides the basic biological profile (sex, age, stature), from our analysis only four skeletons presented some feature potentially relevant for the identification process (skeletons 7, 8, 10, and 20). All the other data regarding the group of the ten fully mature skeletons are summarized in Table 3. Skeletons were ordered based on age estimations using pubic symphysis when available, then the auricular surface. As indicated, besides the basic biological profile (sex, age, stature) from our analysis only four skeletons presented some feature potentially relevant for the identification process (skeletons 5, 6, 9, and 16).

Table 2
Osteological findings of the young adult group.

No.	Age estimation		Stature (cm)	Other potentially relevant findings
	Bone maturation	Age range		
2	Long bones	16–21	164.1[a]	
20		17–25	151.3[b]	Tuberculum dentale and shoveling upper incisors.
12		17–25	160.3[a]	
10	Vertebrae	17–25	166.5[a]	Klippel–Feil at C7-T1 with associated scoliosis of the neck.
14	Ribs	17–25	169.7[b]	
15	Ischion	17–25	171[a]	
7	Clavicle	21–30	156.9[b]	Tuberculum dentale and shoveling upper incisors.
26		21–30	158.3[b]	
8		21–30	159.2[a]	Tuberculum dentale and shoveling upper incisors.
4		21–30	169.3[b]	
19		21–30	169.5[b]	

[a] Stature estimated from maximum femur length (de Mendonça [40]).
[b] Stature estimated from anatomical method (Raxter et al. [38,39]).

3.2.2. Presumptive finding of a familiar group: group of 21 skeletons

A presumptive identification as a familiar group was suggested for skeletons 7, 8, 16 and 20 based on the observation of two dental non-metric traits: the tuberculum dentale on the upper central incisors, and shoveling on the upper lateral incisors. These traits were recorded applying the criteria of the ASU DAS (Arizona State University Dental Anthropology System), as detailed by Turner et al. [52]. The tuberculum dentale is described as "*This feature can take the form of ridges on the lingual surface (referred to as mediolingual ridges) or various degrees of expresión of a cusp (known on the canine as the canine tubercle)*" [52: 16], and the scoring scale ranges from 0 (absence) to 6 (strong cusp with a free apex). On the other hand, shoveling is described as "*The presence of lingual marginal ridges*" [52: 14], and the scoring scale ranges from 0 (absence) to 7 (exceeding grade 6, which is defined as the contact of the mesial and distal ridges at the cingulum). After evaluation of the dentitions, we decided to score the tuberculum dentale as follows (Fig. 2): skeletons 16 and 8 were unequivocally scored as grade 6 (cusp with free apex), while skeleton 7 were scored as grade 5 (weakly developed cuspule with or without a free apex), and skeleton 20, initially scored as grade 5 was finally and conservatively scored as grade 4. Shoveling was observed in the upper lateral incisors, and skeletons 7, 8 and 20 were scored as grades 5–6 (strong development of the ridges with contact at the cingulum), while skeleton 16 was scored as grade 4.

In order to be useful to identify a family group, a non-metric skeletal or dental variant should fulfill various conditions [53]. Mainly, the frequency of the trait in the population to which the skeletons belong should be low, and there should be some evidence regarding the genetic inheritance of the trait. With regard to the first condition, there is no data about the frequency of the different grades of expression of tuberculum dentale and shoveling in the rural population of the first third of the last century from the province of Burgos. However, in a recent research, the frequency of a diverse list of dental non-metric traits was recorded in a modern living sample of 245 Spanish people following the ASU recommendations [54]. With regard to the tuberculum dentale, the frequency of expression of grade 6 in the upper central incisors was 0%, and the frequency of expression of grade 5 was 2.04%. Low frequencies have been also reported by Bailey [55], who only found two cases out of 1649 dentitions observed. With regard to shoveling, grades 5, 6 and 7 were not observed in the modern Spanish simple [54]. So, if we assume the validity of the comparison between both samples, we can consider that the condition of low frequency of the trait in the population under study is satisfied by both dental traits.

Table 3
Osteological findings of the fully mature group of skeletons.

No.	Age estimation		Stature (cm)	Other potentially relevant findings
	Phase	Root* translucency		
13	III[P.S.] 28.7 (21-46)	–	169.1[a]	
3	IV[P.S.] 35.2 (23–57)	36.4–48.1 (4)	164.2[b]	
9	V[P.S.]	36.4 (1)	165.9[b]	Degenerative disease at right elbow, extension limited.
16	45.6 (27–66)	47.9–54.9 (3)	151.3[b]	Tuberculum dentale and shoveling upper incisors.
6		–	160.3[b]	Healing fracture at first left rib.
23		–	162.5[a]	
5	IV[A.S.] 51.41 (29–81)	35.7–46.2 (4)	153.5[b]	Klippel–Feil at C2–C3.
11	V[A.S.] 59.9 (29–88)	–	159.8[b]	
33	VI[A.S.]	36.08–38.2 (2)	161.2[b]	
1	66.71 (39–91)	–	157.7[a]	

P.S.: (pubic symphysis), A.S.: (auricular surface). Mean age and age range (brackets) of each phase in years.
* Age range defined by the lowest and highest estimation from available teeth, number of teeth in brackets.
[a] Stature estimated from maximum femur length (de Mendonça [40]).
[b] Stature estimated from anatomical method (Raxter et al. [38,39]).

Fig. 2. Palatal view of the upper anterior dentition of skeletons 7, 8, 16 and 20.

With regard to the second condition, evidence of genetic inheritance, shoveling has been studied in Japanese, Chilean, and Pima Indian samples, and based on intrafamilial correlations it has been stated that the heredability of this trait is approximately 0.70 [56]. It is important to note that heritability is a population concept, referring to the degree of genetic contribution to observed variation between individuals in a population, not to the trait as it develops in an individual [57]. However, as stated by Scott and Turner [56], it is telling that different sets of researchers studying familial groups from three different populations arrived at similar heritability estimates. No similar systematic research has been undertaken on the tuberculum dentale, and the only available data are the bibliographical review and the study of some family groups by Bailey [55], who suggests a complex hereditary base for the traits of the anterior upper dentition, including tuberculum dentale. In Fig. 3 we can observe the presence of tuberculum dentale in the dentition of a family group, a father and his three young daughters who kindly agreed to collaborate in a study of dental variation carried out in our University. The interindividual and intraindividual differences observed in these four cases can be considered as an indication of the complex hereditary base suggested by Bailey [55]. Clearly, a systematic study on a sample of significant size is needed to reach any sound conclusion regarding the inheritance of the tuberculum dentale. To summarize, with regard to the second condition, evidence of the genetic inheritance of the trait, for shoveling different studies indicate the inheritance of this trait, and for the tuberculum dentale the limited evidence indicate the possibility of at least a partial genetic inheritance of the trait.

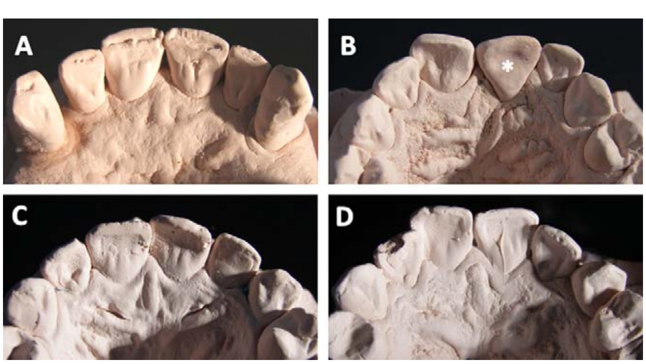

Fig. 3. Palatal view of the upper anterior dentition of dental casts from a family group. (A) Father; (B–D) daughters. For the central incisors, we can observe that cases A, B and C present a tuberculum dentale in the form of two well defined ridges on the lingual surface (grade of expression 3 for cases A and B, grade 2 for case C), while case D only present a faint ridging (grade 1). *A prosthetic tooth.

In order to formalize these observations, we followed the approach used by Alt et al. [53]. We defined a null hypothesis, to be contrasted by statistical tests, stating that the four skeletons are randomly chosen from the reference population and do not represent a family group. Therefore, both observed traits should occur independently among the four skeletons and with a probability equal to the relative frequency of the specific trait in the reference population. Considering only those skeletons with grade 5 or 6 (cases 7, 8 and 16) on the tuberculum dentale, the binomial law can be used to calculate this probability. First, calculate the probability that a randomly chosen individual in the reference sample of Moreno [54] presents grade 5 or more, which is 0.0204 (2.04%). Second, we can estimate the 95% confidence interval for this probability, which gives the result of [0.0027, 0.0381], indicating that with this level of confidence, the percentage of grade 5 or more in the population ranges from 0.27% to 3.81%. Next, we calculate the probability that three individuals with grade 5 or more could be found between 21 individuals randomly chosen in the reference population, for which we use the binomial distribution. In order to follow a conservative approach, we chose the upper limit of the confidence interval as the p value for the calculation ($p = 0.0381$):

$$P(X = k) = \binom{n}{k} p^k (1 - p)^{n-k} = 0.0366 \quad k = 3, n = 21, p = 0.0381$$

The probability that three individuals present grade 5 or more in the reference population is 0.0366. Although this probability is higher than those found in other kin studies [53], it seems reasonable to suggest that whether the skeletal forensic sample does not belong to the reference population, or the three individuals who present this grade of expression (plus the skeleton conservatively scored as grade 4) are genetically related, or both possibilities. Based on these findings, we suggested that the four skeletons were genetically related.

3.2.3. Identifications

Once the osteological and archival study were completed, all the information was gathered and, as indicated in Fig. 4, it was observed that data from four different sources were consistent: testimonies, archaeology, archives, and osteology. This corroboration of evidence led us to the crucial step of formulating a working hypothesis where the identification proceeds in what Baraybar [10] would define as a closed synchronic system, and other authors would name as closed assemblages [4]. In other words, based on the previous information we assume that the 21 skeletons correspond to the 21 men listed in the document. The group of 21 skeletons found at the grave of Villamayor de Los Montes would constitute a closed system since the documentary data indicate that there is a finite number of people whose identities are known, at least in terms of name and age at death. And it would constitute a synchronic system since these persons were killed in the same event. The designation as a closed system is of primary importance as it considerably simplifies the identification process, depending of the number of persons involved, which then resembles the identification process in for instance some bus accident, where the identities of all the victims are known [58].

The age and stature estimations for skeletons 7, 8, 16 and 20 were compatible with the documented age and stature of the father and his three sons, and therefore a presumptive identification was proposed for this kin group (Table 4). The documented ages at death of the father and his three sons together with the age

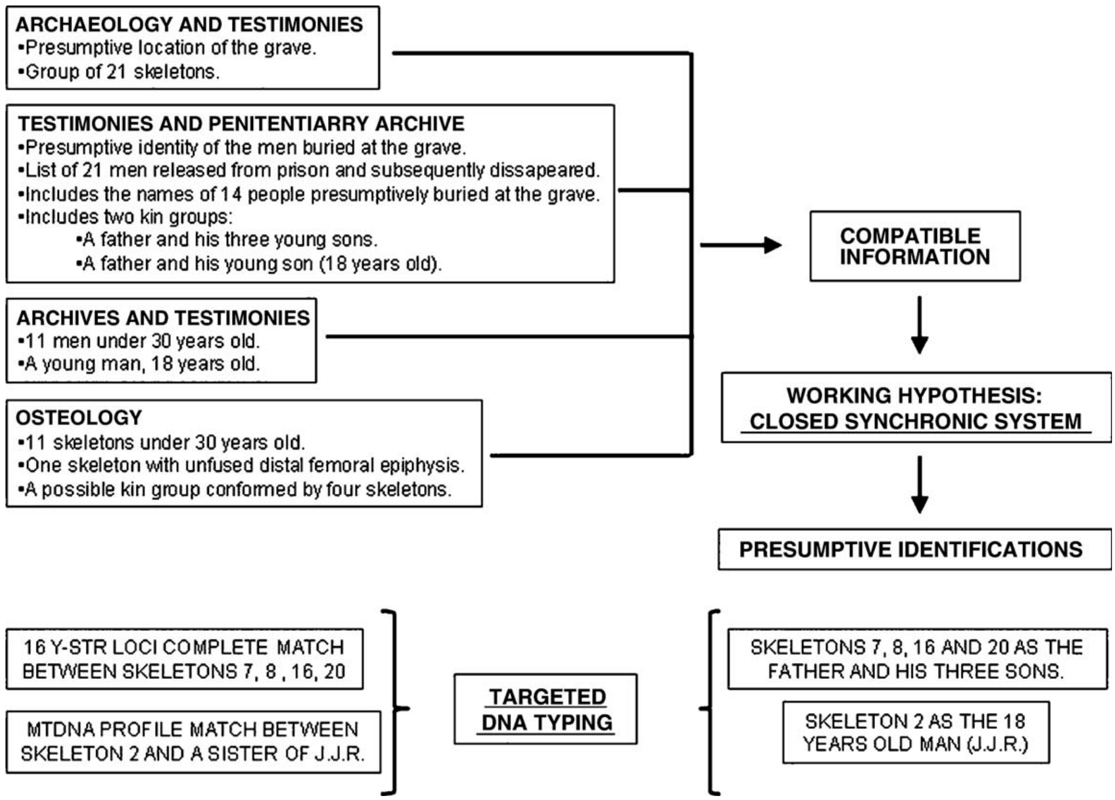

Fig. 4. Consistency of different sources of information and targeted DNA typing.

estimations allowed assigning a presumptive identity for skeleton 20 as H.A.B., and for skeleton 16 as M.A.S. The compatibility of information from four different sources and the assumption of group identification allowed suggesting the presumptive identification of skeleton 2 as the 18 years old young male based solely on the estimated age range (Table 4). The accumulated evidence allowed a targeted approach to DNA typing: the first DNA tests requested were those related to skeletons 7, 8, 16 and 20 (the presumptive family group) and skeleton 2. No relatives were found for the family group, but the study of 16 Y-STR loci indicated a complete match between skeletons 7, 8, 16 and 20 (Table 5). A sister of J.J.R. (the 18 years old young man) was alive, and her mtDNA matched with that from skeleton 2 (Table 6). Based on the accumulated evidence we considered that the family group and J.J.R. had been identified. The working hypothesis that the 21 skeletons correspond to the 21 men listed in the document shown in Fig. 1 was partially confirmed.

But we would like to stress that no conclusive results were obtained from the osteological study regarding the group of 25 skeletons. Based on the information summarized in Table 1, it was suggested that the 22 men supposedly killed together the night of September 13th were among the 25 skeletons. Based on this assumption, different hypotheses were elaborated about the identity of the three remaining men needed to complete the number of 25 skeletons, but in no case there was complete information even regarding the age at death of these three unknown men. This lack of exact corroboration between the documentary, testimonial and archeological findings precluded us from developing the working hypothesis of a closed synchronic system. Although a family group of two brothers was presumptively present among the 25 skeletons (Table 1), and five skeletons presented some morphological feature potentially useful for the identification process (depressed fractures at the cranial vault in two cases, antemortem fractures affecting two ribs, first right metacarpal and 4th left metatarsal respectively in the other three cases), we were unable to suggest any presumptive identification.

Table 4
Compatibility between the antemortem data and the osteological findings for the five presumptive identifications proposed.

Antemortem			Proposed identification	Osteology		
Name	Age	Height		Skeleton	Age	Height
J.J.R.	18	–	2	2	16–21	164.1[a]
H.A.B.	21	151.2[b]	20	20	17–25	151.27[b]
D.A.B.	24	158.9[b]	7, 8	7	21–30	156.9[b]
V.A.B.	26	155.7[b]		8	21–30	159.2[a]
M.A.S.	61	154.5[b]	16	16	45.6 (27–66)	151.3[a]

[a] Stature estimated from maximum femur length (de Mendonça [40]).
[b] Stature estimated from anatomical method (Raxter et al. [38,39]).

Table 5
Complete match between 16 Y-STR loci for skeletons 7, 8, 16 and 20.

Y-STR	16	20	7	8
DYS456	15	15	15	15
DYS3891	14	14	14	14
DYS390	24	24	24	24
DYS38911	28	28	28	28
DYS458	15	15	15	15
DYS19	14	14	14	14
DYS385	11/14	11/14	11/14	11/14
DYS393	13	13	13	13
DYS391	10	10	10	10
DYS439	13	13	13	13
DYS635	23	23	23	23
DYS392	13	13	13	13
Y-GATA-H4	11	11	11	11
DYS437	14	14	14	14
DYS438	12	12	12	12
DYS448	18	18	18	18

Table 6
Match between mtDNA profiles of the biologically youngest skeleton found at the grave and the sister of the youngest person presumptively known to be buried in the grave.

	HVI	HVII
S.R.	16311C	263G; 315.C
2	16311C	263G; 315.C

Therefore, the contributions of the skeletal analysis to the identification process were limited to two general conclusions. First, the sex, age and stature distribution estimated from the 25 remains was compatible with the antemortem sex, age and stature distribution of the 22 men. Consequently, at the group level, the osteological report did not exclude the possibility that the group of 22 men presumptively buried at the grave, plus an unknown group of three other men, corresponded to the group of 25 skeletons exhumed. Second, a table of compatible identities based on age estimations and documented ages at death was elaborated that could serve as a guide for a partially targeted DNA typing.

Based on these findings the decision was made by the relatives and the ARMH to ask for financial support to the Government in order to complete the DNA study of the 46 skeletons. The project was approved and to date 17 genetic identifications have been obtained, as indicated in Table 7. In all cases, the genetic identification was compatible with the age group assigned by the osteological study. Eight identifications, plus the familial group of the parent and his three sons, correspond to the group of 21 skeletons. Five identifications correspond to the group of 25 skeletons. In this case it is important to note that at least one person from each of the three presumptive groups of men supposedly killed and buried together the night of September 13th (Table 1), has been identified, leading support to the hypothesis that the 22 men searched were buried at the Villamayor de los Montes grave. Nevertheless, although we still keep the hypothesis that the other 16 men looked for at this grave are among the unidentified 20 skeletal remains, we have to be cautious about any statement regarding the identification of a group of people presumptively buried together once an identification for one of the persons of the group have been achieved, especially when the information from testimonies, archives and archaeology do not coincide, as in this case. It is also important to note that the identification of human remains through DNA analysis in cases of human rights violations and mass fatalities has recently received more attention, as caution has been warned due to the finding of false positives in non-targeted DNA typing [21,59,60]. We expect to present the DNA data from five graves and one cemetery in a future paper.

Table 7
Summary of the DNA findings for the 17 identifications achieved to date.

Identification	Method	Observations
Group of 21 skeletons		
H.A.B.	16 Y-STR (age range)	Brother
D.A.B.	16 Y-STR	Brother
V.A.B.	16 Y-STR	Brother
M.A.S.	16 Y-STR (age range)	Father
J.J.R.	mtDNA	Son
F.R.N.	mtDNA	Father
J.G.C.	10 Y-STR	
P.P.C.	16 Y-STR, mtDNA	
E.A.M.	9 Autosomal-STR	
O.E.M.	15 Y-STR	
C.P.M.	mtDNA	
J.R.C.	12 Y-STR	
Group of 25 skeletons		
P.A.B. (M.M.)	mtDNA	From the group of Madrigal del Monte.
E.C.C. (M.M.)	mtDNA	
V.D.V. (V.d.l.M.)	mtDNA	From the group of Villamayor de los Montes.
F.A.G. (V.d.l.M.)	14 Y-STR	
J.L.A. (document 2)	12 Y-STR	From the group listed in Document 2.

4. Conclusion

Due to testimonies from relatives and witnesses, as well as the diverse sources of documentary information, some mass graves and cemeteries from the Spanish Civil War and postwar years represent a favourable situation for the forensic investigator when facing the identification of human skeletal remains. When available and compatible with the archaeological and osteological findings, the main implication of this information is that it allows us to formulate a working hypothesis, where the identification proceeds assuming the presence of a closed synchronic system or closed assemblage [4,10]. The designation as a closed system is relevant for the identification process as discussed for example by Steadman et al. [7]. These authors emphasize the definition of appropriate "reference samples" and of the "population at large," indicating conceptual differences between both definitions in the context of Bayesian analysis. For a specific case, the population at large, or population cohort, was defined by these authors "...a priori as those individuals who could have ended up as this case," and by Rogers and Allard [61] as the "identification universe." In the case of the group of 21 skeletons, the population cohort or identification universe is presumptively defined by documentary data from the penitentiary, military and civil archives as 21 men with known ages at death, including two kin groups and stature data for 13 of them. For instance, if there was no available information regarding groups of people released and that disappeared the same day, the population at large or identification universe for the skeletons exhumed at Villamayor de los Montes' grave would be formed by the approximate minimum of 2500 people killed away from the battlefields in the province or Burgos during the war [[62] and research in progress], increasing considerably the difficulties of the identification process. The application of new quantitative methods for presentation of data regarding forensic identification of human skeletal remains is worth applying to the exhumations from Spanish Civil War and postwar mass graves and cemeteries, but it is beyond the scope of this paper and we expect to treat this topic in another article.

In the case of the Spanish Civil War and postwar mass graves and cemeteries, the designation as a closed system depends on two assumptions. First, the assumption of completeness and accuracy of the documents found at the archives. Beyond preservation problems, an exhaustive search at the archives by experienced personal can determine the completeness of the information. The issue of the validity of the documentation is important, since it could be possible that the authorities responsible for these killings may have altered documentary information and physical evidence in order to mislead or hamper searches after the fact. To date, there is no data that lead us to think that the authorities responsible of the archival and penitentiary files systematically altered the recorded information, although at least one case of false information has been detected regarding the cause of death of one postwar prisoner [63]. The second assumption is that of the continuity between the number of people released from jail (as stated by the documents), or kidnapped from towns (as stated by testimonies), and the number of skeletons found at the graves. Various events may have transpired between the release from jail or kidnapping from towns, and the assassination of these people in the countryside, as is possibly the case for the group of 22 men mentioned above (Table 1). Therefore, we want to make explicit that we construct our working hypothesis, and suggest presumptive identifications, based on these assumptions, which in some cases cannot be fulfilled due to lack or incompleteness of documentary or testimonial information.

For the specific case of Spanish Civil War mass graves and cemeteries, the implementation of a multidisciplinary approach for the identification process is needed. This approach should include an exhaustive research at the different archives (penitentiary, army, civil), where information can be found regarding groups of people imprisoned and released from jail, as well as individual antemortem data. People trained in conducting interviews (e.g. social anthropologists) should be incorporated to the team to take fulltime responsibility to gather and compile information from relatives, witnesses and witnesses' relatives. These persons can offer key information regarding presumptive location of the grave, presumptive identity of the persons buried in the grave, and antemortem information regarding physical complexion, morphological features, photographs, and personal objects. In addition to other data, archaeological findings can provide key information regarding the presence of multiple but separate burials of groups of skeletons, help reconstruct the chronology of events, and detect natural and artificial alterations of the grave site. The osteological study provides information regarding the basic biological profile of the skeletons (sex, age, stature), as well as information regarding the presence of pathological conditions, morphological features, and anatomical variants (see above) that are potentially useful for the identification process. In the best situation, the joint analysis of the information provided from these different sources can simplify the identification process through the informed assumption of having found a closed system. Depending on the details of the case under study, a list of compatible identities can be compiled and sometimes a small number of presumptive identifications can be suggested. Moreover, this information can be useful to organize a targeted approach to DNA analysis, as well as act as a control mechanism when there are no conclusive results from the DNA study. An example of available information from different sources and its compatibility and coincidence is represented by the group of 21 skeletons exhumed at Villamayor de los Montes' grave. On the other hand, the example of the group of 25 skeletons exhumed from the same grave indicates the complexity of the identification process in contexts of massive human rights violations, even in those cases where there is information from different sources regarding grave location and identity of the people buried.

To conclude, these results, together with those obtained from other groups working with mass graves from the Spanish Civil War [64,65], indicate that the task of identify the human skeletal remains from those graves can be accomplished through a systematic research. Finally, although in this and other cases the identification process is partially supported by Government funding, with the strong disapproval of the main opposing party, a considerable part of the research is undertaken by volunteers. If the adequate resources were provided by the local and national competent authorities, the results could be obtained faster, an imperative for the oldest people who have requested the identification of their relatives.

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