

# Identification of victims from two mass-graves in Serbia: A critical evaluation of classical markers of identity

Marija Djuric <sup>a,\*</sup>, Dusan Dunjic <sup>b</sup>, Danijela Djonic <sup>a</sup>, Mark Skinner <sup>c</sup>

<sup>a</sup> *Laboratory for Anthropology, Department of Anatomy, School of Medicine, University of Belgrade, 4/2 Dr Subotića, 11000 Belgrade, Serbia*

<sup>b</sup> *Institute of Forensic Medicine, School of Medicine, University of Belgrade, Serbia*

<sup>c</sup> *Department of Archaeology, Simon Fraser University, Burnaby, BC V5A 1S6, Canada*

Received 21 August 2005; received in revised form 12 August 2006; accepted 5 January 2007

Available online 1 February 2007

## Abstract

Reliable identification of victims in mass graves is of humanitarian and human rights concern. Because mass graves in the former Yugoslavia usually contain an ‘open’ population of large numbers of unknown victims and therefore ‘presumptive identifications’ based on classical markers of identity are problematic, greater reliance is now made on blind matches between victim DNA and a database of donated blood DNA samples from family members of missing persons. Nevertheless, there will always remain a legal and social need to show good correspondence between a DNA-derived identification and classical markers of identity. Moreover, pathologists and anthropologists, who must continue to rely in much of their case work on classical methods, need to evaluate on an ongoing basis the goodness of fit between the two paradigms of identification. The Institute of Forensic Medicine and Laboratory for Anthropology in Belgrade participated in 2001 in the exhumation and identification of more than 300 bodies of Kosovar Albanians interred in two mass graves at Batajnica, near Belgrade, Serbia. Of these bodies, 136 were legally identified by the end of 2003 providing an opportunity for the forensic experts to evaluate their post-mortem findings of classical markers of identity. Sex and age at death of young to middle-aged adults were reliably determined but old adults were markedly under-aged. Stature was reconstructed reliably in 77% of cases. Dental status contributed little to identification efforts. In no case did classical markers of identity require rejection of the DNA-based identification. It is concluded that: sex determination from pelvic bones is very reliable, as are age at death estimates from pelvic and rib standards for young to middle-aged adults but that uncertainty intervals for age at death in older adults be broadened or refined by creation of local osteological standards.

© 2007 Elsevier Ireland Ltd. All rights reserved.

*Keywords:* Forensic identification; Mass graves; Serbia; Kosovo

## 1. Introduction

Identification of mortal remains is required for both open and closed assemblages. In the latter situation, for example a plane crash with passenger and crew manifest, great reliance can be placed on classical markers of identity (documents, medical history, dental work and so on). In an open assemblage, for example mass graves in the former Yugoslavia, the numbers and identities are unknown and there exist few guidelines as to whom might be buried there. In this instance, a different

approach to identification has to be followed. The International Commission on Missing Persons assists governments with determining the fate of the missing in ex-Yugoslavia. Their approach is to collect several blood samples from family members of missing persons, and compare their sequenced DNA to that recovered from bone and tooth samples taken from bodies removed from mass graves. Even when a presumptive identification can be investigated a blind match is sought between the two databases of victim and family members DNA. Consequently, identification of mortal remains from mass graves is moving away from a reliance on classical markers of identity (particularly age at death, sex and stature, dental status, pathology and personal effects), as provided by anthropologists and pathologists, to a DNA-based system. Nevertheless, in order for courts and the families to accept a formal, legal decision as to identity based on biological information, even of

\* Corresponding author at: Laboratory for Anthropology, Department of Anatomy, Medical Faculty, University of Belgrade, 4/2 Dr Subotića, 11000 Belgrade, Serbia. Tel.: +381 11 686 172.

E-mail address: [marijads@eunet.yu](mailto:marijads@eunet.yu) (M. Djuric).

very high certainty as furnished by DNA, this acceptance requires that the comparability of classical markers of identity to a DNA-based identification be evaluated. The Institute of Forensic Medicine and Laboratory for Anthropology in Belgrade participated in 2001 in the exhumation and compilation of biological profiles at autopsy of more than 300 bodies of Kosovar Albanians interred in two mass graves at Batajnica, near Belgrade, Serbia. Subsequently, 136 of these bodies were identified, using DNA matches supplied by the International Commission on Missing Persons (ICMP) and biological profile of victims, thus providing an opportunity for the forensic experts to evaluate their post-mortem findings of classical markers of identity in comparison with ante-mortem information provided by other agencies. While, theoretically, there should be good correspondence between the two methods of identification, in some instances the results may differ as a function of both the quality of ante-mortem data collection and methodological weaknesses of classical markers of identity.

The investigation of mass-graves in the former Yugoslavia is conducted within a nexus of forensic, humanitarian, and political challenges [1]. Efforts by several international organizations (e.g., International Committee of the Red Cross (ICRC), International Criminal Tribunal for the former Yugoslavia (ICTY), United Nations Mission in Kosovo (UNMIK), International Commission on Missing Persons (ICMP), as well as national and international non-governmental organizations supplemented the post-mortem data collected by the Institute of Forensic Medicine with ante-mortem data; but, as can be imagined, these disparate influences impact on the process and success of identification efforts in many ways. This article evaluates the identification of victims from mass graves in Serbia in light of the complexities noted above so as to communicate to families the long and involved process, now spanning several years, of trying to bring resolution to the question of missing persons from Kosovo even as the forensic scientific methods themselves are evolving.

## 2. Material and methods

At least 305 individuals were recovered from the first two of five Batajnica sites (Table 1). This study reports only those remains from Batajnica 01 and 02 whose identifications were conducted in 2002 and 2003 by the Institute of Forensic Medicine, Belgrade with strong reliance on findings by

anthropologists and pathologists. From the beginning of the process, it was agreed that bone and tooth samples should be taken for DNA extraction. Ideally an intact molar tooth and mid-femoral plaque of bone were taken from a body. The extracted DNA is sequenced for comparison with DNA blood profiles collected by ICMP from relatives of missing persons, whenever obtainable, recognizing that DNA-based identifications are very reliable. ICMP uses a commercially available STR kit called Promega PowerPlex 16. Information about identity based on classical anthropological markers was collected to assist the identification process.

### 2.1. Ante-mortem data

Ante-mortem data were collected from relatives by UNMIK Police in Pristina using forms which recorded general data about each missing person, clothing/foot wear, personal effects/jewellery, physical description, medical conditions and dental status. These data were passed on to the identification team. In that one's genes are inherited from parents and shared with siblings and children, it is possible to conceptualize blood sets from relatives of missing persons as a form of ante-mortem information. This is the approach used by ICMP whose blood collecting teams generate sets of family blood from which DNA can be extracted for comparison with DNA derived from hard tissues obtained from mortal remains. ICMP's standard operating procedure is to release reports only for those matches in which the probability of relatedness for presumptive identities are in excess of 99.0% and for blind matches are in excess of 99.95%.

### 2.2. Post-mortem data—anthropological analysis

Autopsies by forensic pathologists provided data regarding state of decomposition, victim clothing and perimortem traumata. Anthropological post-mortem analysis included: morphological markers of sex in the pelvis and skull, age assessment, estimation of stature, dental status (including panoramic radiography), and signs of ante-mortem osteopathology. Ancestry was not evaluated in this series given the obvious source of the remains, beyond noting the consistent European-looking cranio-facial morphology. Dental status included decayed, missing and filled teeth, dental wear, alveolar bone loss, as well as dental restorations including fixed and removable prostheses. Sex determination was based

Table 1  
Nature of Batajnica sites and contents

Site	Recovery date	Condition of remains	Analysis date	Forensic team	Monitors	MNI*	DNA matched
BA01	May 2001	Bodies/parts (some burnt)	June 2002	Belgrade: six pathologists, two anthropologists, two archaeologists	ICTY: Swiss pathologist	36	12
BA02	July 2001	Bodies/parts (some burnt)	June 2003	Belgrade: seven pathologists, two anthropologists, one radiologist	ICMP: two Canadian anthropologists ICMP: one Canadian anthropologist	269	124

\* Minimum number of individuals.

on pelvic morphological features including Phenice's criteria [2]: general robusticity, preauricular sulcus, ischiopubic ramus ridge, subpubic angle, ventral arc, greater sciatic notch, and the composite arch. In cases where os coxae were absent, common sex markers of the cranium [3] were utilized: mastoid process, occipital protuberance, nuchal cresting, supraorbital margin, supraciliary arch, supramastoid ridge, robusticity of the mandible, mental eminence, and frontal tuber. The five point scale, recommended by the Workshop of European Anthropologists [4] and later in Standards for Data Collection from Human Skeletal Remains [3], was applied in scoring each trait. Stature was assessed using all limb bones with ultimate reliance being placed on femur plus tibia or fibula [5–7].

Age assessment of adults relied primarily on age-related changes in the pubic symphysis [8], costal sternal ossification [9] supplemented by experienced evaluation of dental status, ecto- and endo-cranial suture closure, and degenerative changes of articular surfaces. In non-adults we analysed dental maturation and epiphyseal fusion. For individuals younger than 30 years, the uncertainty interval for an age assignment was expressed as  $\pm 2.5$  years; for over 30 years the uncertainty interval for an age assignment was expressed as  $\pm 5$  years. Any potentially individualizing traits such as unusual dental work and healed ante-mortem trauma were highlighted. A complete ante-mortem: post-mortem review, including matched DNA profiles, was performed by the local forensic team including the authors of this study to obtain a firm and legally defensible decision as to identity.

### 3. Results

Of 305 bodies reported here from Batajnica 01 and 02, 136 (44.6%) were identified by the end of 2003. Formal, legal identification of each individual was concluded when there was sufficient congruence, in the opinion of the responsible forensic pathologist from the Institute of Forensic Medicine and forensic anthropologist from the Anatomy Department (School of Medicine, Belgrade), of post-mortem anthropological observations with ante-mortem data (including clothing and personal effects accompanied by a DNA match of victim's tissues with

family sets of blood). Table 2 shows the separate availability of ante-mortem and post-mortem data for seven identification criteria for these 136 individuals and compares the goodness of fit between ante-mortem and post-mortem data.

#### 3.1. Personal effects and medical history

Congruence of documents and personal effects such as jewellery with ante-mortem reports was found in 97.3% of cases ( $n = 111$ ). If clothing was preserved well, it was common for some of the reported garments that the victim had been wearing on the day he or she disappeared to be observed by the experts. In only a few cases were documents found on or near the exhumed body. Previous pathology was of importance in personal identification of only one individual who had sustained a bone fracture.

#### 3.2. Dental status

Comparison of ante-mortem data (obtained from UNMIK) and post-mortem dental data collected by us (53 individuals) was helpful for identification in only 43% of cases.

#### 3.3. Sex determination

Sex assessment based on the morphology of the pelvic bones showed an accuracy of 100%; noting that few females ( $n = 3$ ) were represented. Previous study of reliability of the morphological sex indicators of the skeletons from the Balkans also revealed that sex differences in pelvic morphology were sufficiently clear to allow sexing individuals with 100% accuracy; while looking at the skull alone, sex was correctly determined in 70.56% cases [10]. Our results support these experiences.

#### 3.4. Estimation of age at death

Age estimation based on pubic symphyseal morphology, sternal rib ends, dental status, suture closure and other macroscopic age indicators on skeletons demonstrated con-

Table 2

Separate ante-mortem and post-mortem data availability for seven criteria of identification (including DNA); congruence of AM-PM data for 136 legally identified individuals

Site	Source of data	Personal effect/clothing	Sex	Age	Stature	Dental	Pathology status	DNA
BA01	AM	9	12	12	10	2	0	12 sets
	PM	9	12	10	6	5	0	12 bone
	Both	4	12	10	6	1	0	12
	Congruent	4	12	8	1	1	0	12
BA02	AM	124	124	124	124	67	1	124 sets
	PM	107	124	124	118	99	1	124 bone
	Both	107	124	124	118	52	1	124
	Congruent	104	124	82	94	22	1	119 <sup>a</sup>
Total	Both	111	136	134	124	53	1	136
	Congruent	108	136	90	95	23	1	131
	Percent	97.3	100	67.2	76.6	43.4	100	97.8

<sup>a</sup> In three cases, DNA analysis indicated brothers from the same family, and was therefore not able to distinguish the victim among them.

Table 3  
Accuracy of age assessment in different age categories of individuals

Age range	Total number of individuals (N)	Observed number of individuals (n)	Missing AM or PM data	Congruence estimated vs. chronological age	Percentage of congruent
<30 ( $\pm 2.5$ )	44	42	2	34	80.95
30–50 ( $\pm 5$ )	60	59	1	46	77.97
>50 ( $\pm 5$ )	31	30	1	4	12.9

siderably less reliability (67.2%,  $n = 90$ ) than did sex markers. However, analysis of the success of the estimation in different age groups showed significant differences (Table 3). In individuals younger than 30 years (with an uncertainty interval of  $\pm 2.5$  years), our assessment demonstrated an accuracy of 80.95% ( $n = 34$ ); while, in individuals between 30 and 50 years (with an uncertainty interval of  $\pm 5$  years) our accuracy was 77.9% ( $n = 46$ ). However, for individuals older than 50 years (same uncertainty interval), our accuracy was only 12.9% ( $n = 4$ ).

### 3.5. Stature estimation

Estimation of stature, with an uncertainty interval of  $\pm 50$  mm [5], showed a reliability of 76.6% (95/124 individuals from combined sites). Similar findings have been obtained in other studies of Balkan materials necessitating new local standards [6,7].

## 4. Discussion

In no case did classical markers of identity collected at post-mortem disagree fundamentally with a DNA-based identification. Our results indicate that a DNA match is reliable, as has been found in other regions in the former Yugoslavia. For example, in Bosnia the percentage of positive identifications for 5000 bodies exhumed by the end of war in 1995 was only 3%; while, since the ICMP commenced its DNA-based identification system, more than 1200 bodies had been confidently identified by the end of 2003 [11]—the time period under consideration here. In Croatia, DNA is claimed to have identified more than 80% of missing persons from the conflict [12].

The reliability of age estimation of individuals younger than 30 years could have been more accurate (92.83%) if we had used a broader interval of  $\pm 5$  years. Our tendency to underestimate age in the group of individuals older than 50 years was obvious because all 26 individuals with an incorrect age assessment were estimated as younger than the documented age. Our rather poor estimates were based on a judgemental synthesis of several criteria; single criteria showed even worse results. When ages of 30 individuals, later determined to be older than 50 years, were estimated by the Suchey–Brooks method alone, nearly half were categorized as phase IV ( $35.2 \pm 9.4$  years). Similarly, when only Iscan and Loth's model was applied to individuals over 50 years old, half belonged to phase V (33–42 years). We conclude that it would be wise to assign broader age intervals, than we used, for older individuals until population specific standards are established.

Similar findings have been reported in previous investigations of age at death among Balkan populations: in Srebrenican

population only 42.4% of individuals were accurately aged [13]; investigation on Serbian population showed that there were significant difference between real age of the individuals and the values derived from Suchey–Brooks [14] and Iscan and Loth [15] for older age categories of both males and females. Testing on other populations [16–20] also found poor performance in aging skeletal material due presumably to inter-population variation, indicating the necessity to introduce local anthropological standards for age assessment.

Of all identification markers, dental status performed most poorly due to lack of ante-mortem data. Even in these cases there was usually no complete agreement between ante-mortem and post-mortem data, even though we regarded as congruent all cases where some outstanding features (such as gold crowns, prosthetics, missing anterior teeth, and edentulous jaws) were present in both ante-mortem and post-mortem data. Generally, ante-mortem data was incomplete and based only on interviews with family members, because dental charts were not available. Thus, our collection of very detailed dental post-mortem data (including panoramic radiography) was not particularly useful. Similar results were achieved in Croatia where dental identification was helpful in 25% of cases [21].

## 5. Conclusion

In conclusion, post-mortem anthropological observations provided the majority of classical markers of identity to the pathologists and anthropologists; and as such were very helpful in the identification challenge. In no instance did classical markers necessitate the rejection of a DNA-based identification. Dental records were weakly useful. It is recommended that: (a) more effort be expended to obtain good dental records by using local dental expertise; (b) local osteological standards for age estimation of older persons be created; (c) broader age intervals be chosen ( $\pm 5$  years in young adults and  $\pm 10$  years in adults older than 50 years).

## Acknowledgements

We thank the District Court in Belgrade, ICMP, and Professor Zoran Rakocevic (dentomaxillofacial radiologist) for their assistance with the study.

## References

- [1] E. Stover, W.D. Haglund, M. Samuels, Exhumation of mass graves in Iraq: considerations for forensic investigations, humanitarian needs, and the demands of justice, *JAMA* 290 (2003) 663–666.

- [2] T. Phenice, A newly developed visual method of sexing in the Os Pubis, *Am. J. Phys. Anthropol.* 30 (1969) 297–301.
- [3] J. Buikstra, D. Uberlaker (Eds.), *Standards for Data Collection from Human Skeletal Remains*. Arkansas Archaeological Survey Research Series No. 44, 1994, pp.16–19.
- [4] D. Ferembach, L. Schwidetzky, M. Stloukal, Recommendation for age and sex diagnoses of skeletons, *J. Hum. Evol.* 9 (1980) 517–549.
- [5] M. Trotter, G. Gleser, A re-evaluation of estimation of stature based on measurements of stature taken during life and long-bones after death, *Am. J. Phys. Anthropol.* 16 (1958) 79–123.
- [6] A. Ross, L. Konigsberg, New formulae for estimating stature in the Balkans, *J. Forensic Sci.* 47 (2002) 165–167.
- [7] N. Sarajlić, Procjena zaživotne visine na osnovu mjerenja dužine dugih kostiju donjih ekstremiteta ljudskih posmrtnih ostataka, University of Sarajevo, Master Degree Thesis, 2002.
- [8] S. Brooks, J.M. Suchey, Skeletal age determination based on the os pubis: a comparison of the Ascádi-Nemeskéri and Suchey–Brooks methods, *J. Hum. Evol.* 5 (1990) 227–238.
- [9] M.Y. Işcan, S.R. Loth, R.K. Wright, Metamorphosis at the sternal rib: a new method to estimate age at death in males, *Am. J. Phys. Anthropol.* 65 (1984) 147–156.
- [10] M. Djuric, Z. Rakocevic, D. Djonic, The reliability of sex determination of skeletons from forensic context in the Balkans, *Forensic Sci. Int.* 147 (2005) 159–164.
- [11] A. Alic, Bosnia offers Iraq its expertise in identifying bodies from mass graves. Available at: [www.fpa.org](http://www.fpa.org). Accessed July 11, 2003.
- [12] A. Marusic, DNA lab helps identify missing persons in Croatia and Bosnia and Herzegovina, *Lancet* 358 (2001) 1244.
- [13] D. Komar, Lessons from Srebrenica: the contributions and limitations of physical anthropology in identifying victims of war crimes, *J. Forensic Sci.* 48 (2003) 1–4.
- [14] M. Djuric, D. Djonic, Evaluation of Suchey–Brooks methods for aging skeletons in the Balkan, *Forensic Sci. Int.* 136 (2003) 172.
- [15] D. Djonic, M. Djuric, D. Babic, Dj. Popovic, Reliability of the individual age assessment at the time of death based on sternal rib-ends morphology in Balkan population, *Vojnosanitetski Pregled* 62 (2005) 441–446.
- [16] K. Hanihara, T. Suzuki, Estimation of the age from the pubic symphysis by means of multiple regression analyses, *Am. J. Phys. Anthropol.* 48 (1978) 233–240.
- [17] R.S. Meindel, C.O. Lovejoy, R.P. Mensforth, R.A. Walker, A revised method of age determination using the os pubis with a review and tests of accuracy of other current methods of pubic symphyseal ageing, *Am. J. Phys. Anthropol.* 68 (1985) 29–45.
- [18] J.L. Angel (Ed.), *Dating and Age Determination in Biological Materials*, Croom Helm, London, 1986.
- [19] A. Sinha, V. Gupta, A study on estimation of age from pubic symphysis, *Forensic Sci. Int.* 75 (1995) 73–78.
- [20] A. Schmitt, P. Murail, E. Cunha, D. Rouge, Variability of the pattern of aging on the human skeleton: evidence from bone indicators and implications on age at death estimation, *J. Forensic Sci.* 47 (2002) 1203–1209.
- [21] H. Brkic, D. Strinovic, M. Kubat, V. Petrovecki, Odontological identification of human remains from mass graves in Croatia, *Int. J. Legal Med.* 114 (2000) 19–22.