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Identifying missing people: the contribution of forensic dentistry and DNA

Identificação de desaparecidos: a contribuição da perícia em odontologia forense e do exame de DNA

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Resumo

Introdução: A identificação humana é uma das principais etapas referentes às questões relacionadas à pessoa desaparecida. **Objetivo:** O presente estudo visou avaliar a efetividade da identificação humana pelas perícias odontolegais realizadas no Serviço de Antropologia Forense de Belo Horizonte-Minas Gerais, comparando-as com as realizadas por DNA. **Metodologia:** Estudo transversal, utilizando dados secundários registrados no arquivo do Setor de Antropologia Forense, considerando o período de 2008 a 2014, referente às perícias de identificação odontolegais e DNA. **Resultado:** Analisando-se apenas as perícias de interesse deste estudo (241), a análise de DNA foi o método utilizado para identificação em 79,3% dos casos e exame odontolegal, 20,7%. Quanto ao tipo de material biológico encaminhado para análise, os cadáveres desconhecidos totalizaram 131 (53,9%), as ossadas 109 (44,9%) e segmentos corporais 3 (1,2%). A análise do tempo efetivamente despendido para a conclusão dos exames mostrou que os realizados pela Odontologia foram mais rápidos que os de DNA. No exame odontolegal, o tempo gasto independe do tipo de documentação odontológica avaliada. **Conclusão:** A análise dos resultados do presente estudo mostrou que a identificação humana pela técnica odontolegal é eficaz, mais ágil e menos onerosa, contribuindo para uma maior celeridade na resolução de questões envolvidas na localização de pessoas desaparecidas.

Descritores: Antropologia forense; odontologia legal; genética forense; identificação biométrica.

Abstract

Introduction: Human identification is considered one of the major steps concerning missing people. The Forensic Anthropology Sector of Legal Medical Institutes identifies corpses. Forensic dentistry and DNA tests stand out among the existing standard tests. **Objective:** This article aimed to evaluate human identification effectiveness through forensic dental examination performed in the forensic anthropology sector in a Forensic Medical Institute, comparing them with DNA analyses. **Methodology:** This is a cross-sectional study using secondary data available in the department´s database, from 2008 to 2014, concerning identification procedures using forensic dentistry and DNA techniques. **Result:** The analysis of the examinations eligible to this study (241) showed that DNA analysis was the method used for identification in 79.3% of the cases and forensic dental examinations were used in 20.7% of the cases. As for the type of biological material used during these examinations, unidentified corpses corresponded to 131 cases (53.9%), skeleton structures corresponded to 109 cases (44.9%) and there were 3 cases of body segments (1.2%). When analyzing the time spent to complete the tests, dental examinations were faster than DNA tests. The time spent for forensic dental examination does not depend on the type of dental documentation evaluated. **Conclusion:** The analysis of the results in this study showed that human identification through forensic dentistry is effective, rapid and less costly, contributing to greater agility in solving issues related to locating missing people.

Descriptors: Forensic anthropology; forensic dentistry; forensic genetics; biometric identification.

INTRODUCTION

Human identification is considered one of the key steps concerning missing people. Legal, humanitarian and social reasons are involved in the whole context of the identification, underpinning the entire structure related to such procedure[1]. Forensic human identification consists of a series of steps with the purpose of finding unique particularities of individuals to establish their identity[2]. Among these characteristics, fingerprints, genetic profile and medical and dental data are considered as the most

scientifically trustful information[1]. Data can be civil or criminal. The first concerns the daily identification of the citizen, such as name, marital status, filiation, age, nationality, social status, profession and others. When civil identification in the forensic sphere is not possible, criminal identification is performed, either in living or dead persons[3]. Multidisciplinary action in forensic identification has become increasingly efficient and reliable, producing extremely satisfactory results in human qualification[4].

The prerogative of searching for missing persons is the responsibility of the State, through the Law Enforcement Agencies[5]. The Police Agency responsible for identification tests of unidentified corpses in the city of Belo Horizonte is the Legal Medical Institute (LMI-BH), which performs routine procedures for this purpose such as anthropological, dental, papillary and DNA tests[1,2]. The latter are performed at the Criminal Institute, by the Technical Sector of Biology and Legal Bacteriology.

After all relevant data for medical-legal identification is analyzed and recorded, these are compared to available antemortem records for the deceased person[1,6], in the hypothesis that the person is missing. Forensic dentistry and DNA tests stand out among the legal medical examinations carried out for identification

Forensic odontologists have a remarkable participation in Forensic Anthropology[7] and provide effective, scientifically reliable, agile and low-cost results[8] and more with rapid resolution of issues involving location of missing persons. DNA tests also play an important role in forensic identification[9]. However, genetic research for this purpose uses a methodological protocol that requires a laboratory equipped with specific technology to ensure effectiveness, and therefore becoming a time-consuming and costly procedure[10].

The present study aimed to evaluate the effectiveness of forensic dental human identification performed at the LMI/BH Forensic Anthropology Service, comparing them with those performed by DNA test.

METHODOLOGY

This is a cross-sectional study using secondary data from the Legal Medical Institute of Belo Horizonte (LMI/BH), considering the period from 2008 to 2014.

All the data related to human identification resulting from forensic dental and DNA examination were initially considered through consultation of records of the Forensic Anthropology Sector of the Legal Medical Institute of Belo Horizonte/MG (FAS/LMI/BH).

A total of 1,257 requests for examinations were found in the FAS/LMI/BH in the defined period. Examinations generated by procedures for Adaptation of Biological Material for DNA tests (ABMDT) were excluded, that is, biological material sent by the criminal institute to be used in the technical methodology of DNA test; exhumations of already identified corpses, and examinations carried out on Human Conception Products (HCP), or fetuses. A total of 599 examinations were excluded.

Thus, 658 examinations for identification of deceased persons were selected, of which 305 reached conclusive positive results (46.3%). From the total of 305, 191 (62.6%) were completed by DNA tests, 50 (16.4%) by forensic dental examination, 35 (11.4%) by fingerprint examination, 09 (2.9%) by combined DNA and forensic dental examinations, 08 (2.6%) by anthropological examinations, 07 (2.3%) by complementary medical examinations, such as imaging tests (paranasal sinuses x-rays and computed tomography); and 05 (1.6%) by family recognition. Thus, the final sample selected for this study was 241 cases of positive complete identification by forensic dentistry (50) and DNA examination (191).

Data were collected by a single researcher and stored in a database prepared for this study. A descriptive analysis was performed, followed by an association test (Pearson's X^2 test), at the level of significance of 95% and error of 5%, considering the time of the test as dependent variable and the human material to be identified, type of examination performed and additional examinations required in the forensic dental examination as independent variables.

The time corresponded to the time elapsed from the beginning of the examination until its conclusion, represented by the issuance of the expert's report. The time was then categorized into three groups based on quartiles: group 1 = quartile 1; group 2 = quartiles 2 and 3 and group 3 = quartile 4. This categorization was related to the fact that there is a relationship between stress and waiting time, especially considering the events known as "independent stressing life events", that is, events that are out of control of the individual and independent from his participation; depending on the individual's ability to cope with the situation of disappearance missing/deceased relative, these events may trigger psychic disorders such as major depression[11]. The categorization also allows organize the variability of time lengths found in the study (1 to 273 days).

This study was approved by the Ethics Committee of the Federal University of Minas Gerais CAAE - 55009916.9.0000.5149

RESULT

The investigation of the FAS/LMI/BH examinations of interest for the present study (241) revealed that DNA analysis was the method used for identification in 79.3% of the cases and forensic dental analysis in 20.7% of the cases. As to the type of biological material sent to these tests, unknown corpses totaled 131 (53.9%), bones 109 (44.9%) and body segments 3 (1.2%).

The time was distributed into three groups. The group 1, represented by quartile 1, i.e. less waiting time to obtain the result, consisted of 69 examinations lasting 1-15 days, with a mean 10.93 ± 3.52 days. The Group 2, intermediate, consisted of 112 examinations completed within time intervals of 16-48 days, with a mean of 27.47 ± 8.28 days. The Group 3 was composed of 59 examinations completed within ≥ 49 days, with a mean of 93.32 ± 53.32 days.

As for the type of biological material sent for examination, a statistically significant difference was observed, with a level of significance of 0.5%, regarding the time spent for identification,

regardless of the type of examination performed. Corpses took on average 130 days to be identified; bones, 108 days and body segments, 03 days. Intermediate time of identification was more frequent in the case of corpses and bones (Table 1). As only three cases of body segments were included in this analysis, the results regarding identification time should be considered with caution.

The time required for forensic dental examination was not associated with the type of biological material examined. The state of presentation of the corpses did not influence the time spent to complete the examination.

When analyzing the time effectively taken to complete the positive identification by forensic dental and DNA examination, it was observed that the first was predominantly in time 1 (46.0%), that is, the exams were completed within 1 to 15 days. As for the DNA method, only 25.1% were performed at that time, being this difference statistically significant (Table 2). A greater number of DNA tests can be observed at time 3 (≥ 49 days), which shows that the forensic dental examination was faster than the DNA method.

In the tests in which the identification was made through forensic dental examination, no statistically significant difference was found related to the type of parameter used, i.e. the time spent does not depend on the type of dental documentation evaluated (Table 3), which may mean that all the exams used presented similar relevance in the examination.

Table 1. Time spent and type of biological material sent for identification, FAS/LMI/BH, 2015

	Time							
	1		2		3		Total	
	N	%	N	%	N	%	N	%
Corpse	49	37.7	54	41.5	27	20.0	130	100
Bone	20	18.5	56	51.9	32	29.0	108	100
Body segment	2	66.7	1	33.3	0	0	3	100
TOTAL	71	---	111	---	59	---	241	100

X^2 p=0.012.

Table 2. Time required to complete the identification by forensic dental and DNA examination, FAS/LMI/BH, 2015

		Time							
		1		2		3		TOTAL	
		N	%	N	%	N	%	N	%
Type of test	DNA	48	25.1	90	47.1	53	27.7	191	100
	DENTISTRY	23	46.0	21	42.0	6	12.0	50	100
TOTAL	TOTAL	71	29.5	111	46.1	59	24.5	241	100

X^2 p = 0.006.

Table 3. Time required for completion of identification and parameters used by forensic dental examination, FAS/LMI/BH, 2015

		Time							
		1		2		3		TOTAL	
		N	%	N	%	N	%	N	%
	Radio	20	64.5	10	32.3	1	3.2	31	100
Type of parameter	Radio + picture	2	100	0	0	0	0	2	100
	Radio + Medical record	8	72.7	3	27.3	0	0	11	100
	Medical record	4	66.6	2	33.3	0	0	6	100
	TOTAL	34	66.0	15	32.0	1	2	50	100

X^2 p = 0.242.

DISCUSSION

The Forensic Anthropology Sector of the Legal Medical Institute of Belo Horizonte (FAS/LMI/BH) performs medical legal examination with the main objective of identification.

Besides expert reports, the FAS/LMI/BH receives relatives of missing persons in order to collect, through interviews, anthropometric or anthropological, personal data and other pertinent information, such as clothing and belongings at the time of the disappearance, for comparisons with information collected in the medical legal examinations.

Contact with the relatives of the missing persons is one of the greatest challenges of the whole identification procedure, because this gives rise to the main information that will lead to the effective judgment of the identity of the unknown corpse. There is also the prerogative of the commitment of the whole staff in this work, not only in the technical context, but also in the assistance to the relatives, in what concerns the resolution of the identification[6].

In the period from 2008 to 2014, the three most used identification methods in the forensic procedures of the FAS/LMI/BH were DNA, forensic dental and fingerprint exams. Although not part of the subject of this study, fingerprints were the third most frequent type of exam. Although important in the identification of people, fingerprints are not commonly used in forensic anthropology due to the state of conservation of the examined bodies that makes it impossible to use this method[3].

In the same period, 241 identification requests were positively completed through forensic dentistry and DNA exams. DNA tests were successful in 191 cases, and the forensic dental examination in 50 cases, representing, respectively, 79.3% and 20.7% of the cases (Table 2).

Regarding the type of material available for the examination, unknown corpses were featureless, that is, without apparent data that allowed their individual qualification. They represent advanced putrefactive and carbonized material that, in this study, totaled 131 cases (53.9%); fragments or body segments corresponded to three cases (1.2%); and bones corresponded to 109 cases (44.9%), as described in Table 1. The state of preservation of the corpse, upon registration in the LMI, explains the time spent to perform the examinations, requiring adequate preparation of the mortal remains for accurate examination. Thus, carbonized corpses in and those in advanced state of decomposition, with remnant soft tissues, require greater time for anthropological examinations because of the type needed for preparation and cleaning, such as maceration to facilitate the dissection of such tissues.

However, in cases of corpses without parameters for medical/dental confrontation, DNA testing is the only method available for identification. In this case, the preparation time may be shorter; the sample needed for genetic profile testing may be derived from body fluids, or muscular or visceral tissues, which require less preparation time compared to bone tissues and teeth[10].

This may explain the fact that the total number of cases positively completed within 1-15 days was higher in relation to corpses and body segments, with a percentage of 37.7% and 66.7%, respectively, against 18.5% in the case of bones (Table 1).

Waiting to identify a missing relative may be a stressor for family members. Therefore, the time for completion of an examination is an important factor to be considered in the evaluation of a method[1].

The period described as examination (DNA or Forensic Dentistry) was not the period comprised by the actual comparative work, but rather the time demanded by each method from the moment the material was obtained to complete the identification.

A lower number of cases were found to be positively completed by forensic dental examination compared to DNA tests (Table 2). It should be emphasized that this finding did not indicate a lower effectiveness of forensic dental examination in the positive result of the first. In all cases, for the purpose of identification, the material is referred to the FAS/LMI/BH to se submitted to forensic dental examinations, when information such as presence of restorations, missing teeth, endodontic treatments, age estimation, among others, is collected. However, when there is no material to be compared, it is necessary to use other identification techniques. There are cases where the DNA test was requested because of absence of the skull and face. Otherwise, the requisition of DNA tests was based on the absence of pre-existing dental records, or even due to insufficient information of the documents made available for forensic dental comparisons, thus making it impossible of the precise identification by this technique[1,12].

Among the means used for the comparative study of data collected in forensic dental examinations are the information contained in dental records, images of complementary exams (radiographic and intraoral photographs), and associations between information in dental records and images observed in the complementary documentation.

The study showed that there was no statistically significant difference between the type of dental document used for comparisons and the number of cases positively completed. Individual dental records, with detailed documentation, are therefore fundamental for the success of this expert procedure[13].

The most frequent parameter for forensic dental comparative study was radiographic comparison. Radiological analysis makes it possible to verify the compatibility of radiographic images related to the morphology of anatomical structures and therapeutic restorative interventions in the teeth[14].

Thus, the morphology of the anatomical structures, the compatibility of the morphological and anatomical contour of the paranasal sinuses, especially the frontal and maxillary sinuses[15,16], are widely used in the comparative study, with aid of antemortem and postmortem radiological images.

Another relevance of the radiological study is the use for the analysis of teeth with the purpose of determining the age of the deceased person, especially in the age group where dental development takes place, in the mineralization phase of the teeth[17]. This analysis allows determining the exact stage of development of the tooth germs, evidencing the rhizogenesis of the evaluated teeth.

Medical records, precisely the orthodontic ones, were also used in forensic dental comparisons. This demonstrates the relevance

of orthodontic documentation to forensic dentistry[8,13]. Thus, the importance of an individual's dental records through detailed documentation contributes to a greater effectiveness and agility of the forensic dental reports with positive identification[1].

It should be noted that, despite the current literature shows the existence of advanced technologies such as three-dimensional (3D) records of palatal roughness[18], microscopic analysis of incremental lines of dental cement[19] and the use of *softwares* for morphometric measurements of dental pulps[20], and a careful forensic dental examination associated with previous data in dental records, are sufficient to contemplate, with precision and rapidity, the success of the identification procedures, without need of further tests for human identification[13].

Regarding DNA, it should be noted that the shortest time demanded by some cases was due to the preservation of soft tissues or blood of the material to be identified. The extraction of biological material for the study of DNA is faster when compared to extraction from bones and teeth[21].

DNA tests used for identification are surrounded by many questionings about the results by statistical probabilities. DNA analysis does not identify a unique individual but provides the statistical probability of including or excluding this individual within a restricted universe[22]; that is, it shows the frequency in the population in which the genetic profile of a given individual can be included or excluded as a possible relative of the genetic profile provided for the comparative study. Thus, it is not possible to affirm that the analyzed material belongs to a single individual.

However, in spite of this discussion, DNA exams are widely accepted in judicial and criminal proceedings and serve as reason for conviction in the view of judges, prosecutors, law authorities and lawyers in criminal proceedings, especially with regard to the issue of human identification[22].

The method of identification through dental characteristics is a very effective, safe, reliable, low-cost method, mainly based on scientific quality criteria[8,13,21]. DNA identification is the most modern technique and the most useful in cases where corpses or remains are in an advanced state of decomposition. However, DNA identification requires more time, effort, financial resources and qualified staff[10] (Chart 1).

The use of DNA tests is often supported by arguments related to what is called "technological fetish". The latest technology becomes the best solution for any case, also further supporting analysis have not yet been produced. According to Fonseca[23], there is a risk that, despite the acknowledged limitations, DNA testing be considered as capable of promoting the well-being of all, promoting an automatic association between technological science and justice. This association should be carefully considered so as not to run the risk of "elitism of forensic expertise", when several financial resources are available and directed to few cases of greater repercussion[23].

Chart 1. Comparison between identification techniques: Forensic dentistry and DNA

DENTISTRY	DNA
Simpler technique	More complex technique
Lower technological density	Higher technological density
Shorter time to complete	Longest time to complete
Low cost	High cost

As accurate as it may seem, a new technology cannot be exclusively assessed by scientific and technological criteria. There are other dimensions that should be part of this analysis such as economic, socio-cultural, political and ecological aspects. For each problem, several technological solutions may compete. It is necessary to evaluate the technology and identify the best option for each case[24].

CONCLUSION

The analysis of the results of the present study indicate that human identification, in the forensic context, must occur following a reliable and fast methodology, contemplating the necessary legal, humanitarian and social reasons so that the due assistance to families of missing persons, in the moment they are given as dead through forensic identification, be satisfactory with respect to the valuation of the individual as a person.

Forensic dentistry has proven to be a very effective, safe, reliable, low technological density, low cost and less time-consuming method, resulting in a greater agility of the identification process.

The successful resolution of examinations in forensic dentistry was explained by the availability of concrete dental data through dental documentation made available for comparisons, especially imaging tests.

The present work was based on a retrospective analysis of the database of the sectors involved, what represents a limitation of the results. Therefore, further studies with the objective of comparing, in the specific case, the time, feasibility and even the cost of the different identification tests are important for the knowledge of the different indications and limitations.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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