CASE REPORTS

REPORTES DE CASO

Rev. C.R. 2015 Vol.1 Suppl.1
(Jul.-Dec. 2015)
e-ISSN 2462-8522

REVISTA CASE REPORTS
SUPLEMENTO INSTITUTO NACIONAL DE MEDICINA LEGAL Y CIENCIAS FORENSES

Editora Invitada: Aida Galindo Bonilla

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UNIVERSIDAD NACIONAL DE COLOMBIA
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CASE REPORTS
REPORTES DE CASO

EDITORIAL

National Institute of Legal Medicine and Forensic Sciences, Special Edition

SPECIAL CASE REPORTS IN LEGAL MEDICINE 2015

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The main objective of the National Institute of Legal Medicine and Forensic Science (Instituto Nacional de Medicina Legal y Ciencias Forenses) is to provide scientific support to the administration of justice in Colombia, through this activity it has forged itself a remarkable reputation and has opened the door to various expressions of knowledge in the forensic field.

In over a century of practicing this specialty, the Institute has provided answers to numerous questions that have been asked by legal authorities in the clarification of criminal offenses. Over this period of time, the Institute has acquired experience in the analysis of cases of all forensic disciplines and has shared it with other national and international entities, mainly through personalized training in its laboratories and different branches.

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The Regional Office of Bogotá considers that the disemination of the knowledge acquired through the experience in analizyng cases througthout the city has a high academic and scientific value; thus it has called upon its experts to publish cases of relevance to other forensic groups.

The articles presented in this special edition of the Case Reports Journal are the product of an interest in recovering and sharing a sample of the Bogotá forensic cases from recent years, presented by several authors, many of whom received feedback and guidance in writing them with the common goal of clearly communicating, to both specialists and students, the most pertinent issues in forensic research.

We appreciate the interest and effort of every author and peer reviewer that have edited the manuscripts in great detail, because their work has allowed us to extract the most relevant aspects of forensic studies that experts face daily in their work. We would also like to thank the Vice deanship of the Center for Research and Extension of the Faculty of Medicine at the National University of Colombia, as well as Case Reports journal for their kind invitation to participate in this special edition on legal medicine and forensic sciences.

CASE REPORTS
REPORTES DE CASO

USE OF DENTAL IMPRESSION MATERIALS IN THE ANALYSIS OF TOOL MARKS TO IDENTIFY CAUSAL ELEMENTS

National Institute of Legal Medicine and Forensic Sciences, Special Edition

SUMMARY

When faced with an element which is the suspected cause of a cut or lesion, dental casting can be made to compare characteristics observed on the surface of the tool mark with those found on the bones.

There is a large variety of materials available on national and international markets to record and analyze marks or signs that an element leaves on any given surface (bite marks, tool marks on bones, finger prints, etc.), all of which are useful in forensic investigation **(1)**. However, the unconventional application of odontological techniques and the use of materials such as alginate and silicone have been found useful recovering tool marks on bones, which allows the forensic scientist to clearly establish when an element was used to cause cuts and injuries in an individual. This technique has been applied in five cases of possible homicide with the use of a cutting element and, as a result, has generated highly accurate casts. It also shows that both materials are appropriate for this purpose, and although silicone offers greater detail

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in the impression, either material can be used depending on the commercial availability.

Keywords: *Tool Marks; Forensic Odontology; Dental Impression Materials.*

INTRODUCTION

As well as the already well-documented usage in forensic odontology to identify human remains, these casting techniques can be extremely useful in the interdisciplinary analysis of tool marks in forensic cases.

Dental casting materials can be used in an unconventional way to obtain replicas of the cut surfaces on an object, facilitating the recording, observation and comparison of the element that is suspected to have caused the lesions observed on the body.

1. Tool marks: A cutting element creates a pattern on the edge of the surface that has been impacted. Due to the characteristics of bone tissue, when a cutting element hits it, all of the features of that edge are accurately preserved such as angles, striations, longitudinal and parallel lines, symmetry, depth and area (Figure 1).

2. Casting to register cut marks: The ideal materials for casting are those which have the following properties: plasticity, low viscosity, flexibility, elasticity, few dimensional changes, resistance to tearing, and compatibility with plaster materials, among others. There are two types: irreversible hydrocolloids such as alginate, and synthetic elastomers such as polysulfides, polyethers, and addition and condensation silicones **(2,3)**.

Alginate, an impression material used to make dental copies for oral prostheses, is easy deformable, requires a fast casting, contracts-rapidly, is easy to manipulate and, in Colombia, is more affordable than silicones **(4)**.

Silicones are synthetic elastomers of addition and condensation used mainly to obtain replicas for the creation of fixed prostheses and fillings in rehabilitative dental treatments. They provide a good definition of fine margins and detailed record, even in spaces that are difficult to reach; the surface of the replica is homogeneous, without irregularities nor air bubbles, with dimensional stability for an extended period of time, resistance to tearing and final rigidity —which gives stability to the cast— and with an absence of deformities in the total structure of the mold. It is a substance easy to manipulate, fast and safe **(2,4)**.

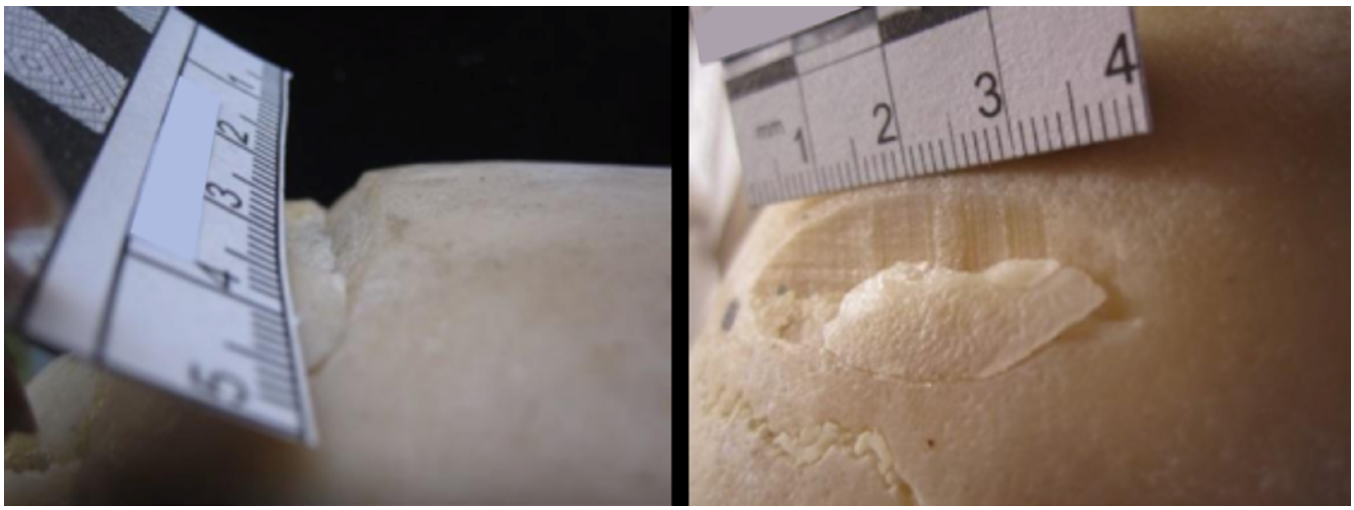

Fig 1. Detail of the mark left by a cutting tool on the skull.

Source: I. Campos.

Normally different types of plaster are used to cast and obtain the final replica, these can be differentiated by their characteristics of hardness, particle size, detail preservation and long-term final mold. The casting must be done immediately if alginate is used, while in the case of silicone, it should be done 12 to 24 hours later **(4,5)**.

METHODOLOGY

Five possible homicide cases were analyzed to determine the cause of death and up to 4 replicas (casting) were made of each bone fragment and print pattern to be analyzed, selecting those bone fragments that, according to the the anthropologist's criteria, showed more informative elements. Alginate and silicone were used to do cast.

Procedure

The bone structures were debrided using a boiling solution with lime to ensure the thorough cleaning required for the study. In highly dehydrated pieces that lacked natural fats, a thin layer of vaseline was applied as insulation to avoid the adherence of the impression material to the bone.

1. Alginate casting: Alginate was dissolved in running water at room temperature using a flexible recipient (rubber mixing bowl) to easily manipulate the material and to obtain the correct consistency (uniform and bubble-free). Preparation time was short as the correct mixture was obtained once it was uniform; it was then applied with a spatula to the areas of interest on the bone with a thickness of approximately 1 cm. No mold was required, since the mixture jellifies after 1.5 minutes, which can then be gently removed from the bone fragment. Immediately after, a type III plaster was conducted to avoid the natural distortion of the solidified alginate, which can affect the shape of the cut pattern in question (Figure 2).

2. Silicone casting: The required quantity of silicone was applied to the impression area and spread evenly using the fingers and pressed onto the bone structure. After approximately 3 to 5 minutes, the silicone was gently removed to start the plaster casting between a few hours later.

3. Plaster casting: The plaster was dissolved in running water according to the direc-

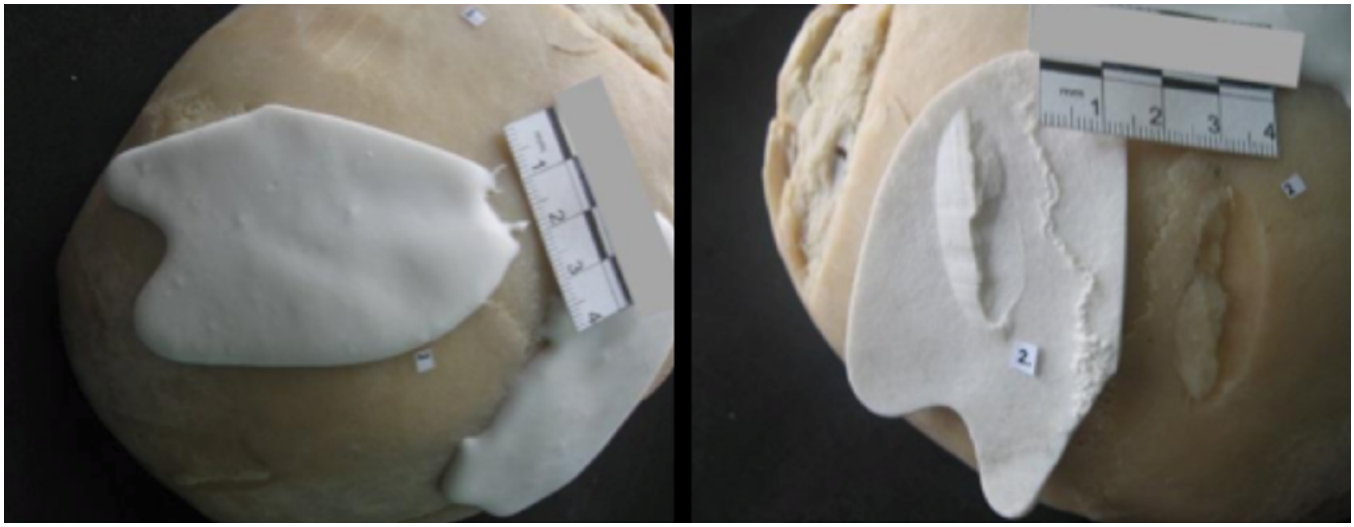

Fig 2. Alginate impression of the tool mark on the cranial surface.

Source: I. Campos.

Fig 3. Plaster casting of the tool mark on the cranial surface.

Source: I. Campos.

tions of the plaster manufacturer. It was mixed at room temperature using a flexible recipient (rubber mixing bowl) to obtain the correct consistency (uniform and bubble-free). In the case of alginate, the surface of the mold was lightly moistened; later, multiple layers of plaster were applied to the tool marks, and in both cases, vibration was used to free any air bubbles trapped in the plaster.

The plaster was gently removed without levering it after 30-45 minutes of solidifying, then the models were labeled with the information of the anatomical location of the cut (Figure 3).

RESULTS AND DISCUSSION

A cutting tool leaves a patternot striations on the bone at the time of impact. Dental casting techniques with alginates and silicones - have proven to be very useful in the study of tool marks **(6)** left in bone structures and in the interdisciplinary analysis of forensic cases, allowing for the precise identification of the tool features that caused these marks using alternative and more readily available materials **(1)**. Even though silicone allowed a more detailed recording of the tool marks morphology than the alginate, both yielded good results since the recorded characteristics were informative. The use of silicones and alginate highlight characteristics that are not easily detectable when observed directly on the tool mark of the bone. These characteristics are made even clearer with contrast by using materials of different colors. The dental technique for taking impressions is a simple and highly valuable tool in approaching forensic cases from the anthropological and odontological perspective to analyze and interpret tool marks and any other type of mark on bone structures, since it facilitates the manipulation, observation and comparison with other samples.

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CASE REPORTS
REPORTES DE CASO

CALVIN & HOBBES CHASE THE MURDERER: ATYPICAL SOLUTION TO A CASE OF TRACE EVIDENCE IN A LABORATORY. CASE REPORT

National Institute of Legal Medicine and Forensic Sciences, Special Edition

SUMMARY

This is the case of a typical request for a chemical laboratory analysis to conduct a comparison of materials or trace evidence with completely unexpected results from those obtained if established protocols had been followed.

This request involved the collation of black gunpowder, a material which is generally associated with firearms. In this case, however, the prosecutor's request was to compare the powder from two groups of paper used in tejo (a popular Colombian sport) in order to ascertain the identity of a homicide suspect at the scene of the crime.

Keywords: *Trace evidence; Scientific method; Class characteristic; Individual characteristic.*

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INTRODUCTION

Trace evidence laboratories specialize in the analysis and comparison of transferred material

according to the principle of Lockard, which includes paints, textile fibers, soil, glass fragments and fire accelerants, among others. One of the most important features of this type of work is that it is not routine, since analysts in this area of forensic sciences know that at any moment they will have to handle atypical requests or approach a case in unorthodox ways. These cases often conflict with the scientific method, but can also provide solutions to forensic problems that would otherwise be difficult or impossible to solve.

A procedure like the one presented here is a big departure from what we can consider the rigorous scientific method. However, it maintains a certain research logic that must be acknowledged when evaluating the practical results of the case.

Knowledge is a collection of information compiled and stored using a process — such as learning or experience — to fix it in the mind. The scientific method is a set of rules, organized and coherent, which allow the systematized acquisition of this knowledge, regardless of whether the truth is obtained or not; however, it is not the only way to arrive at the same objective.

There is a common "urban myth" in the judicial system that any conclusion that was formed without rigorously following the scientific method is not serious, and therefore lacks validity. In an article published in 1999, Max Houck proposed the impossibility of applying the powerful statistical tools used in the field of genetics to the world of trace evidence **(1)**; an impossibility that doesn't invalidate the results obtained by the discipline's own methods. While science searches for methods that are increasingly more reliable, humankind cannot deny the fact that we live in a universe with uncertainty at its core, which is therefore a constancy we must live with.

BACKGROUND

Tejo is a traditional sport in Colombia that dates back to pre-Colombian times. It has origins in the current regions of Boyocá and Cundinamarca, where it later extended to other corners of the country and neighboring countries such as Panama, Venezuela, Ecuador and Peru.

In very general terms, the game consists of throwing a metal disc at a board made from clay on which various pieces of paper folded into triangle shapes and filled with black gun powder (known in Spanish as mechas and referred to as such in this article) are placed; the goal is to hit and burst the largest number of these mechas to win the game.

It is rare to have this particular material sent to criminal laboratories for comparison, which is what makes the nature of this request highly atypical and interesting.

SCENARIO

In a field used to play tejo in Bogota, D.C., in 2006, an argument between two players occurred, one of whom was subsequently the victim of a homicide. The murderer fled the scene, but police located a suspect who denied having been at the scene. During this phase of the police investigation, 14 pink-colored mechas used to play tejo were found in the house of the suspect; the prosecutor assigned to the case thought that a link could be found between the detainee and the crime scene if the powders from these mechas were compared with those found in the playing field. Thus, two packages arrived at the laboratory: one containing the 14 mechas found at the suspect's home and the other with 10 mechas from the playing field.

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APPROACH TO THE CASE

Powder comparison is not a service provided by the Evidence Trace Laboratory of Legal Medicine, and in fact, in all its history, this has been the only time such a request has been made. In light of this unprecedented request, the analytical focus went beyond established procedures, but the attempt was made nonetheless to conduct a comparison without any guarantee of providing useful results to the prosecutor.

The laboratory infrastructure at that time did not have adequate technology such as scanning electron microscope, so only an infrared spectrum and elemental analysis could be obtained, which is why little can be said of the morphology of powder particles. The analysis focused instead on the possible exclusion of samples so that the laboratory could establish with certainty if the mechas were different, rather than establishing a relationship between them that could place them at the scene.

For ease in data recording, the mechas found in the home were marked with the letter H and those taken at the playing field were marked with the letter C.

Initially, a description was made of each mecha in the laboratory. These products are manufactured by hand, so the measurements of the dimensions of each mecha along with the powder content were of little use, although one of them, marked as H14, presented a pink tonality that was different than the others.

Subsequently, the infrared spectrum of the powder contained in each paper was measured using the FTIR Perkin-Elmer System 2000 spectrophotometer with a resolution of 4cm-1. The spectrum obtained was similar in all samples except, once again, H14.

The lack of any available databases or previous studies regarding the composition of

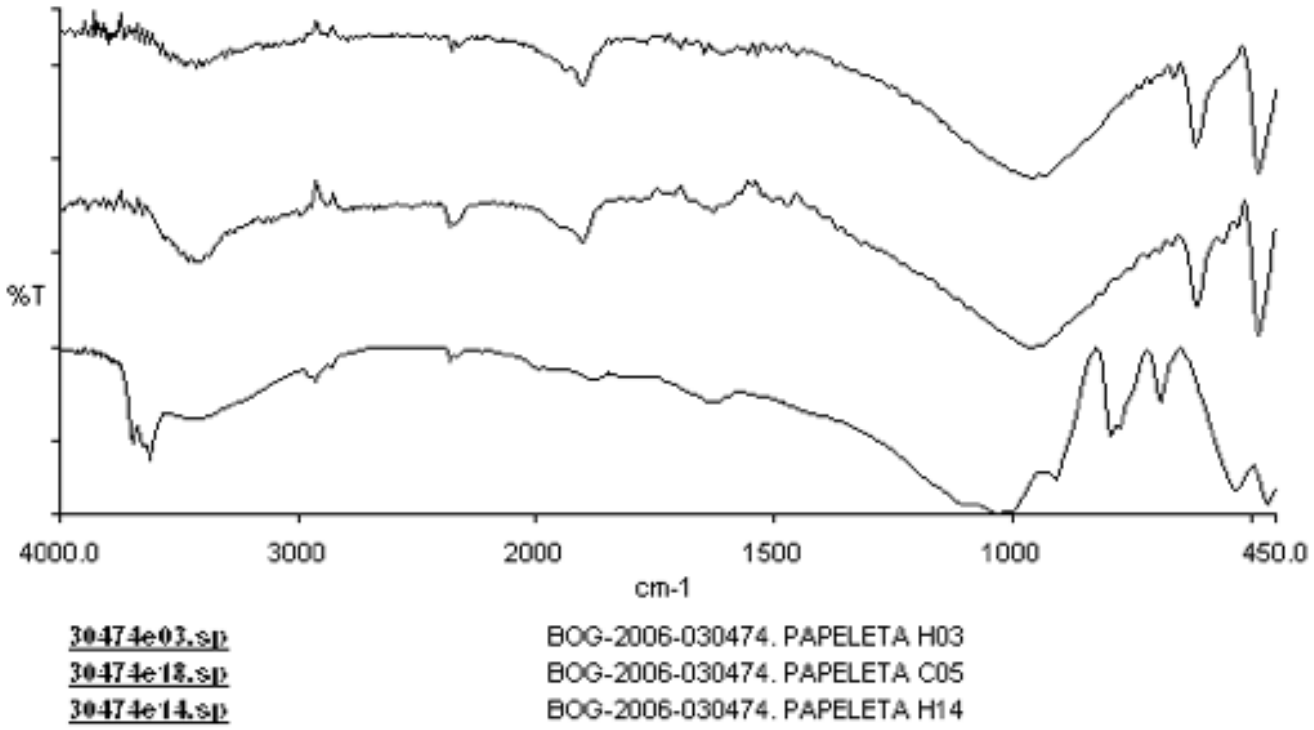

Fig 1. Infrared spectrum of material taken from mechas H-03, C-05 and H-14.

Source: I. Author.

powder used in tejo increases the difficulty in evaluating the evidential weight of this result; however, the analytical technique led to the exclusion of one of the mechas found in the suspect's home.

During the process of obtaining the content of the powder of every mecha in the laboratory, it was noted that all of them had the following architecture: an external wrapping consisting of thick printed paper with pink, red and yellow colors; some of them had incomplete words and graphics alluding to soccer as they were taken from an album of a soccer world championship. A second wrapping, containted in the previous one, which, in turn, containts the powder. in all the cases, this second wrapping consisted of newsprint. At this point the analysis experienced a surprising turn of events.

If the seized mechas had in fact come from the playing field, was it possible that all or some of them had come from the same production batch, and had therefore used the same newspaper and sports album in their production?

At this moment, the case deviated from the chemical approach and focused instead on verifying or rejecting a hypothesis that did not require any technical or scientific study.

The next step was then to completely disassemble the papers, taking care to conserve the nomenclature assigned to each of them. Then, each paper was cleaned individually and the typographic content was registered, both on the external wrapping and the pieces of newsprint.

All of the external wrappings in both H and C groups, with the exception of H14, alluded to topics of soccer (balls and players).

As for the internal wrappings, most corresponded to the section of classified ads and judicial decrees of a Bogotá newspaper. However, some select pieces of newsprint provided more promising information:

- H-03: On one side, the color print of comic character Hobbes of the comic strip Calvin and Hobbes by American cartoonist Bill Watterson. On the other side was part of a crossword with the following inscription in the central square: "Megalithic monument. Special grace" (Spanish original: Monumento megalítico. Gracia especial).
- H-10: Inscription "El Tiempo"
- H-11: Inscription "The New York Times"
- C-05: On one side, part of an illustration corresponding to a pair of feet in skates with a world map design. On the other side, with a yellow, black and blue background, the inscription "[...] The University of Melbourne [...] of May at 5pm [...] 13 nº 85-80 [...] For more information phone [...] attendance, limited availability free of charge [...] -2564309-2564552-9 65 [...] Medellín. Tel 3124 [...] naustralia.co [...] dación [...] no de Gonzál [...]" (Spanish original: "[...] The University of Melbourne [...] de mayo a las 5 pm [...] 13 nº 85-80 [...] Mayor información telefon [...] asistencia, cupo limitado sin costo [...]-2564309-2564552-9 65 [...] Medellín. Tel 3124 [...] naustralia.co [...] dación [...] no de Gonzál [...]")
- Paper C-06: Inscription "valid until [...] June 30, 2006." (Spanish original: [...] erta válida hasta [...] nio 30 de 2006")

All the previous mechas were photocopied and brought to the headquarters of the newspaper El Tiempo in Bogotá, where access to the editorial archives was requested.

H-03, containing The Calvin and Hobbes strip, was printed in color and matched a Sunday edition of the newspaper, which restricted the search to Sunday editions, within a timeframe of six months before the crime.

The search uncovered the Calvin and Hobbes strip matching H-03, published on May 21st, 2006, page 3-19 **(2)**.

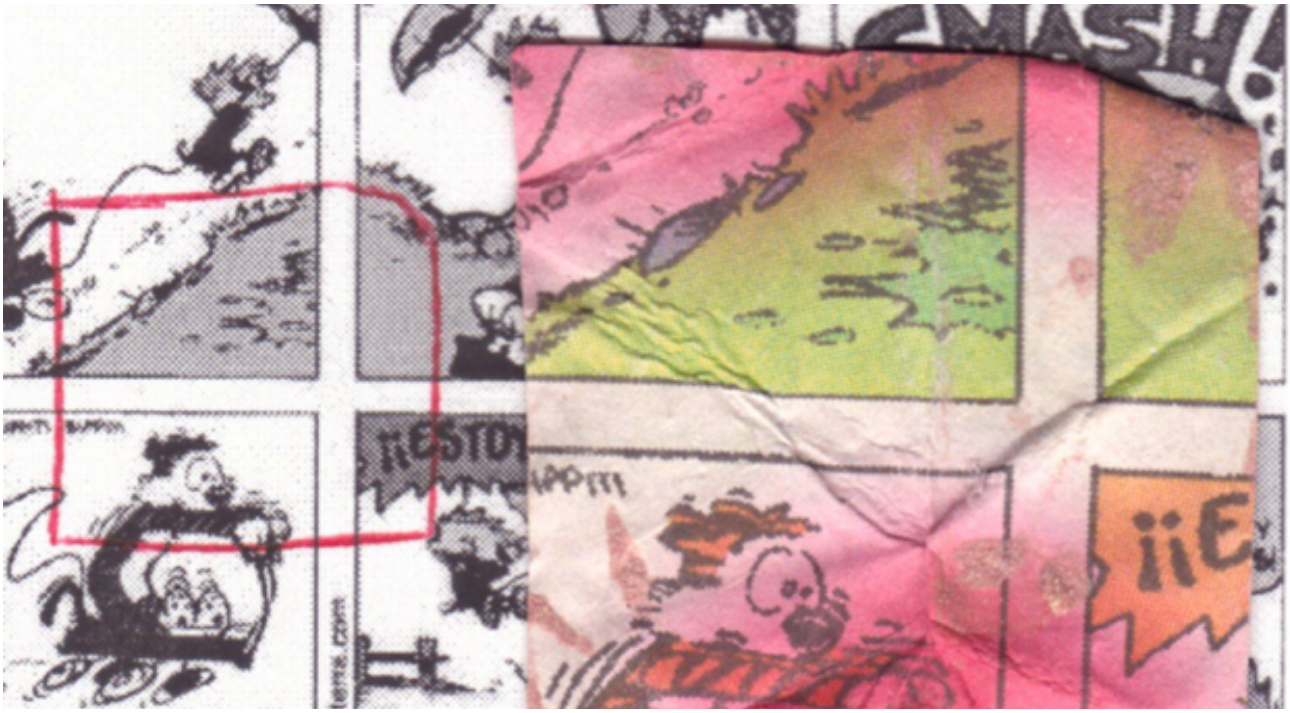

Fig 2. Newspaper fragment taken from the interior of H-03, found in the bedroom of the suspect, superimposed on a black and white copy of page 3-19 of the newspaper El Tiempo, matching the May 21st, 2006 edition.

Fig 3. Fragment of page 3-19 of El Tiempo, matching the May 21st, 2006 edition.

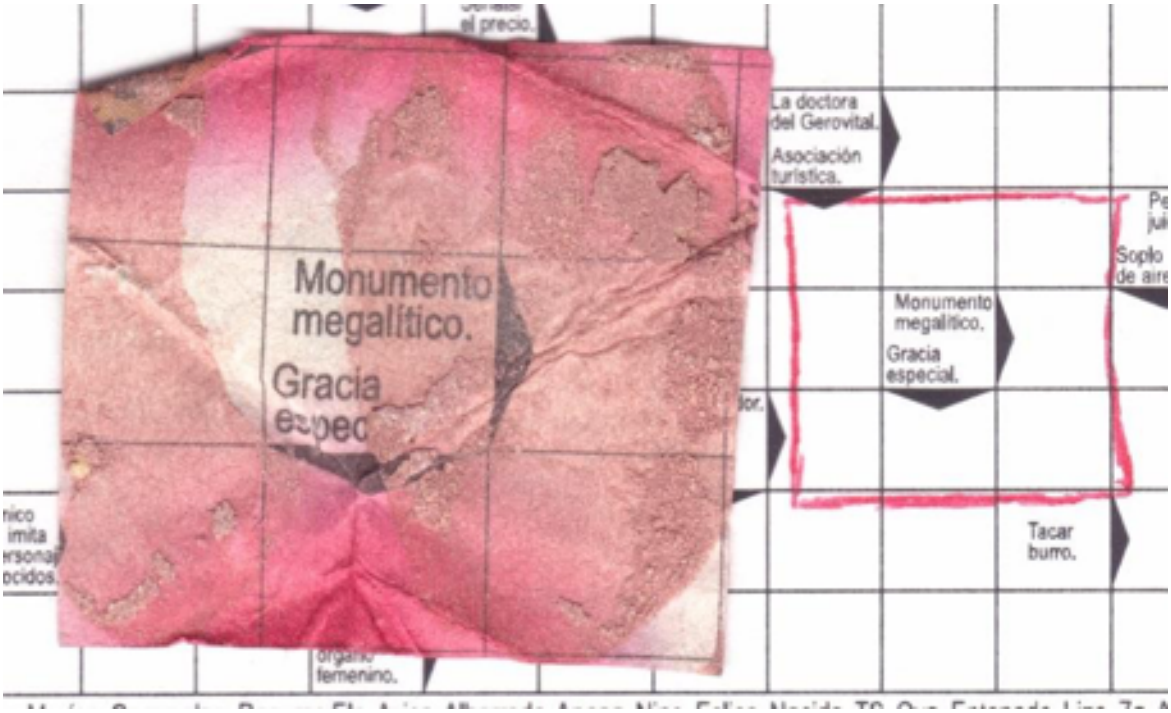

Fig 4. Newspaper fragment taken from the interior of H-03, found in the suspect's bedroom, superimposed on a copy of page 3-20 of the newspaper El Tiempo, matching the May 21st, 2006 edition.

Page 3-20, as was expected, contained the crossword evidenced on the other side of the newspaper fragment of H-03.

Searches were also conducted for the information contained on C-05 and C-09: C-05 was found in pages 3-15 and 3-16, while C-09 was

Las asociaciones de ex alumnos tienen más fuerza en las institucior
que estrechar su relación con el profesional graduado es un requisito

El punto final de la relación entre un estudiante y su universidad, generalmente, se pone el día de la entrega del diploma. Pero es allí donde inicia la tarea de las asociaciones de egresados que buscan mantener activo a ese ex alumno, que después de varios años de formación tiene mucho por recibir y por aportarle a la institución.

Aunque unas llevan medio siglo, y otras apenas comienzan, su existencia hoy es más fuerte en las instituciones privadas, donde funcionan con la misma organización de una empresa: tienen psicólogos, analistas de mercados, junta directiva y encargado de la tarea organizacional.

La importancia de los egresados, como asociación, ha tomado fuerza en los últimos tres años "desde que la relación entre universidad y ex alumno se ha vuelto un requisito para las instituciones cuando entran a procesos de certificación", afirma Carlos Montes, de la Asociación de la U. de los Andes (Uniandinos), una de las más antiguas del país, con siete mil afiliados.

Se han convertido en un importante centro de información, puesto que muchas hacen seguimiento a sus profesionales para conocer si la for-

REDES DE APOYO PARA BUSCAR EMPLEO

Es una de las actividades más importantes para estas asociaciones.

Sus redes laborales son las más organizadas y su principal función está en ayudar a sus egresados a ubicarse en el mercado laboral.

Para eso hacen alianzas con el sector empresarial, que ha encontrado en ellas una vía efectiva para buscar profesionales de nivel.

Algunas han creado sus propios observatorios. Es el caso de la U. de la Sabana que hace seguimiento a cada candidato enviado a las empresas y estudian las razones por las cuales fue o no contratado.

"En nuestro caso, hicimos el año pasado el estudio de inserción laboral de egresados de pregrado y, este año, se hará para los ex alumnos de posgrado. Estos resultados se socializan para evaluar las competencias de los estudiantes y

Fig 5. Fragment of page 3-15 of the May 21st, 2006 edition of El Tiempo.

e.
1.16

Fig 6. Newspaper fragment taken from the interior of C-05, found in the tejo playing field, superimposed on a copy of page 3-15 of the newspaper El Tiempo of the May 21st, 2006 edition.

Fig 7. Newspaper fragment taken from the interior of C-05, found in the playing field, imposed on a copy of page 3-16 of the newspaper El Tiempo of the May 21st, 2006 edition.

not found. See details of the date in Figure 6. Undoubtedly, the results obtained in this case show a link between both groups of papers studied. The suspect's story in which he was not present at the scene of the crime loses validity faced with the fact that mechas made with the same

edition of the newspapers and soccer album were found in his home and on the playing field. The mere result of the chemical analyses of the two groups of black gunpowder involved in the case would not have had the same evidential weight since the production of black gunpowder is mass manufactured by relatively few providers.

In technical terms, the information obtained through infrared spectroscopy in the present case is considered a class characteristic. This is a characteristic that does not reference a particular individual **(3)**, while information contained in the wrappings of the mechas can be considered individual characteristics because, most likely, only a small fraction of the mechas made in the city used the same two editions out of a multitude of publications circulating in the city as wrapping.

CONCLUSION

This report illustrates the fact that many forensic cases, including those of trace evidence, can be solved using a logical framework. Sometimes the framework that is chosen by the laboratory, accepted by the scientific community and submitted to quality control systems, do not yield the best results nor are they the most time-efficient. In cases such as this one, the immediacy of proof and common sense prevent the laboratory from undertaking complex, prolonged and costly verification processes in a request that could quite possibly be unique.

FINAL COMMENT

Quality management systems in forensic institutions and the legal community that benefits from these institutions need to take into account the complex nature of pieces of evidence and their relationships with a scene and / or their actors. This can determine solutions to questions generated by facts that often deviate from the officially approved and established frameworks. There should be a logic behind these alternate paths that establishes a coherence between the results obtained and the initial problem. This is a logic that guarantees that, when such a request occurs again, this analytical framework can be employed and added to the rigorous systems of laboratory quality control.

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GENDER IDENTITY WITH THE WRONG NAME

National Institute of Legal Medicine and Forensic Sciences, Special Edition

SUMMARY

This is the case of a six-year-old schoolchild —identified as J— who was born with ambiguous external genitalia. Upon medical recommendation, the child was registered as male by the parents; however, further testing (diagnostic imaging and karyotyping) showed that the child was biologically female. Based on this, the parents started the judicial process to change their child's name, and the judge ordered a forensic psychiatric evaluation to determine the child's true sex[1]. When the forensic study concluded that the child's sex was female, the result was transmitted to government authorities and the name was corrected in the child's civil registry.

Keywords: *Gender identity; Forensic psychiatry; Sexual behavior; Genital abnormalities.*

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1 Literal request from the court

INTRODUCTION

When assigning gender to a child with ambiguous genitalia there is still a controversy: while some argue that the legal sex of a newborn with phenotypically ambiguous genitalia should be assigned according to the degree of virilization **(1)**, i.e. the size of the penis, and others state that maintain that gender identity is prenatally imprinted by unknown mechanisms and that it should, therefore, not be assigned purely on anatomical morphology, but rather through a chromosomal and gonadal analysis in children under two years of age **(2,3)** and an evaluation of gender identity in older children. Other authors take this debate further and consider that the gender identity assumed by a person is more important than the one biologically assigned, whether chromosomal or gonadal aspects are considered, and that gender identity, thus, should be determined before opting for any surgical intervention. The lack of long-term studies further fuels this controversy **(6)**.

In order to assign sex in humans it is necessary to take into account multiple concepts (Table 1). Any discrepancy in gender assignment can cause problems related to sexual and gender identity.

Until june 2015 in Colombia, name changes in the civil registry were only permitted once and legal sex was impossible to change **(11)**. With the issuing of Decree 1227 in 2015 **(12)**, now those of legal age can change their name and sex in their civil registry by public deed, but minors are still submitted to a forensic psychiatric evaluation to establish a definitive gender identity to allow for a legal name change.

In 1998, a mother requested sex reassignment surgery for her daughter under a guardianship petition. However, the Constitutional Court declared a moratorium on the surgery of the minor until she could give her consent and ordered to health institutions and to the Instituto Colombiano de Bienestar Familiar (Colombian Institute of Child Welfare) to establish an interdisciplinary team of doctors, psychotherapists and social wor-

Type of designation	Main characteristic	Time of designation
Chromosome gender	Designated by chromosomes.	At conception. **(7)**
Gonadal gender	Presence of gonads. Occasional presence of an intermediate state, whereby both female and male gonads are present (ovotestis).	During gestation. **(7)**
Morphological gender	Presence or absence of a penis	At birth. **(7)**
Legal gender	Civil registry.	At the civil registry.
Gender identity	Identifying as a man or a woman.	Between 18 months and three years. **(8,9)**
Sexual orientation	Attraction or sexual leaning towards men, women or both sexes.	Controversial. **(9)**

Table 1. Definitions of gender assignment.

Source: I. Based on Oliva *et al.* **(10)**.

kers to provide medical and psychological care to the minor and establish if said minor had sufficient autonomy to provide informed consent for the surgery and hormone treatments. Despite the controversy of this decision, by ruling that children and adolescents can make health decisions before reaching legal age, the Court recognized the medical, psychological and social difficulties in these cases as well as the unpredictability and complexity of the legal consequences, leading to a follow-up by interdisciplinary teams and proposing a detailed evaluation of each individual case **(13)**.

With this in mind, it is presented the case of a school child that was born with ambiguous external genitalia who was legally registered as male by the family, but now, six years later, the child's family has requested a name change to one corresponding to the femenin gender in a correction process at the civil registry.

CASE DESCRIPTION

After studying the brief and following the guidelines of the Protocol for Basic Evaluation in Forensic Psychiatry and Psychology **(14)** of the National Institute of Legal Medicine and Forensic Sciences, an analysis was conducted. Informed consent of the mother and child were taken, along with prints of their right index fingers. Later, an interview was conducted with the minor for forensic psychiatric purposes, along with a mental examination and the Draw-a-Person test.

Study of the brief

The following aspects are highlighted:

A. **May 2008.** The summary of the clinical history on record states: "*patient of female sex that presents with an enzymatic 21-hydroxylase deficiency confirmed by clinical history as well as by hormonal and cytogenetic testing. Must continue with medical and surgical treatment, a new evaluation from urology is requested*".

B. **October 2006.** A copy of the abdominal ultrasound states: *"image that suggests the presence of a uterus"*.

C. **November 2010.** A report from the forensic clinic at the National Institute of Legal Medicine and Forensic Sciences shows that: *"[…] a 21-hydroxylase deficiency constitutes the most common form of congenital adrenal hyperplasia, which conditions the virilization of external genitalia in women. [...] a minor with female karyotype (XX) and imagining studies suggest the presence of a uterus, while the physical exam reveals ambiguous external genitalia"*.

Clinical history: summary of the interview and psychiatric evaluation

A. **Family history:** according to the information contributed by the mother, the primary family nucleus is composed of the mother and two children (the parents were separated several years ago). J is the younger child. The father is 40 years old and the mother is 26.

B. **Personal history:** The pregnancy was carried to term through vaginal birth with no complications. The child started sitting up at 6 months of age, walking and talking at 12 months of age and entered preschool at 4 years of age. The mother commented: *"I made the mistake of overprotecting her and I didn't want to send her to school since I was afraid they would mistreat her. She hasn't seen a speech therapist, occupational therapist nor a psychologist [...] when you ask her something she thinks about it a lot, three months after starting school she would pee herself, I think she was scared, she wouldn't tell anyone she had to go to the bathroom for fear that someone would see her, but now no, so I think I overprotected her [...] when I take a bath with her and she asks me why*

you are that way and why I have this (pointing to the genital area) and I explained to her that she had to get surgery so that we would be the same [...] academically she is doing well, she's very clever and often finishes her work before her classmates".

To describe herself J stated: *"I want people to call me Valeria [...] I have a friend whose name is Juan David [...] we play hide and seek [...] I like boots [...] because they have flowers on them, they're pretty and I have a doll, I like dolls [...] I don't like motorcycles, motorcycles are for boys".*

To answer the question "In what way are boys and girls different?" J stated: *"Juan David is different from me in his hands and shoes [...] my brother is different because he is big and has brown skin, and I am white [...] Bryan is a man, women have a "vagiga" (points to her belly button) [...] this is called [...] (pauses to think) vagina [...] boys run around and girls play hide and seek [...] if boys hit me, I don't hit back, I tell the teacher on them".*

The mother of the child: *"When she was born and they told me to take a good look at him and they took him away, I was looking to see if he was fine [...] I asked about my son and they talked to the doctor first and they said that they had her upstairs because she had ambiguous genitalia and a hormone problem above the kidneys. They didn't know what the sex was and that she should be kept in hospital to examine her and they were asking why she was born that way and they were going to test the karyotype. They released me and I was going to lactate her and they didn't do the karyotype test and the doctor told me that the baby was a boy and that I should register her as such at the hospital. We started medical testing and we went to the appointment and we started the process with ultrasounds, they told me that they needed to test the karyotype but the POS (Colombian obligatory health insurance plan) doesn't cover this so they made an appointment with an endocrinologist, a urologist and a geneticist; the latter told me that she was fine, but in addition to this problem she could also have other problems, so after hearing this I felt devastated, because if I didn't take care of her, they said, she could die. In urology they said that they could do the surgery with the karyotype but they wouldn't do it because of her weight and that she would have to be on medication for all of her life and continue with check-ups [...] I started the request under legal protection and at 8 months they tested the karyotype. It turned out that yes, she was a girl and that they would have to do vaginal reconstruction and get surgery but the urologists didn't want this [...] within a year she had seizures, her potassium and sodium levels were low and they put her on a diet. For me, my baby was a girl, I always knew [...] I would dress her normally, neither a boy nor as a girl, but from the moment of the karyotype test I started dressing her as a girl and the family gave her a name and we started calling her Valeria and she has been called this way ever since she can understand [...] Her father lost his job but occasionally had insurance, but the surgery still didn't happen, they told me that it was going to take place in a group belonging to the hospital of the Misericordia, but they didn't authorize it. Her father was once again unemployed and the girl was uninsured for 3 years and the process for the surgery stopped [...] I saw her as my girl, but she had some rough behavior [...] the teacher says she is strange because she chases the boys".*

C. **Specific background:** negative for any surgical, allergic, toxic, traumatic, family and psychiatric conditions. As for pathology, she presented with adrenal hyperplasia and an alpha-hydroxylase enzyme deficiency.

Mental examination

Important note: a physical examination was not conducted since this is not part of the psychiatric-forensic expertise.

J entered the exam room by herself, accompanied by her mother. Her apparent age

was chronologically consistent, and she was wearing a blouse and skirt and introduced herself as "Valeria". During the interview, it is worth noting that eye contact with the interviewer was intermittent. She seemed quiet and calm and moved around the exam room with delicate gestures. Her mood appeared to be normal, non-depressed and regulated, and her thinking, a bit slowed, tended towards concretism — findings that are consistent with her chronological age. She displayed prolonged question-answer time with no delusional ideas; her characteristics can be summarized as follows:

- Language: sharp and low tone of voice.
- Sensory-perceptive aspect: no change.
- Sensory aspect: oriented in person and space, partially disoriented in time.
- Attention: normal attention span.
- Intelligence: average.
- Judgment of reality: preserved.

Draw-a-Person test

The child viewed herself as "Valeria", which was corroborated by the Draw-a-Person test in which she drew herself as a girl and wrote the name "Valeria" to designate herself.

RESULTS

Forensic Psychiatric Analysis of the case:

J is a six-year-old girl who comes from a low socio-economic background and single-parent home described by her mother as functional. According to the facts that were gathered, she has had an adequate psychomotor development and adaptation to her family and social environment that is fitting to her social and cultural conditions. Given that the baby was born with ambiguous external genitalia but with the presence of a penis, the mother, upon medical recommendation, registered the sex as male. However, at 8 months of age, evidence was found in an abdominal ultrasound of internal female genitalia; the geneticist proved the female sex with a karyotype test and she was diagnosed with adrenal hyperplasia with a 21-hydroxylase deficiency; this deficiency is a congenital disease of genetic origin in which an enzyme of the adrenal gland is not produced, which causes adrenal hyperplasia.

The excessive production of androgenic hormones in a female fetus causes the growth of the clitoris, which can sometimes be mistaken for a penis, though genetically the fetus is female with the presence of a uterus and ovaries **(15)**. This condition must be detected early **(7)**, so as to avoid a mistaken sex assignment and to initiate treatment as soon as possible, since affected individuals often present with premature sexual development, acceleration of skeletal maturity (with the corresponding low height) and problems with electrolytes in the blood. Medical literature recommends to raise and treat a newborn child with 21-hydroxylase deficiency as a normal girl and to carry out corrective surgery as soon as possible to avoid problems with body image **(15)**.

However, other authors consider it necessary to wait to identify gender identity before proceeding with surgical intervention **(6)**. In the reported case, the delay in corrective genital surgery has generated body identity problems, since she has shown confusion about how her body is "different" from her mother's, as evidenced by the interview.

Despite the family and child not initially receiving the treatment necessary for the disease and financial difficulties with the health care system, the mother states that once the result of the karyotype was announced, before reaching a year of age, her nuclear and extended family started to call her "Valeria" and the mo-

ther started to dress her in feminine clothing. During the exam, J presented with behaviour socially considered as feminine — delicateness in her way of talking and moving— and recognized the differences between boys and girls, although she only identified the external ones. It is important to note that the girl considered herself as "Valeria", which was corroborated through the projective Draw-a-Person test in which the child drew herself as a girl and gave herself the name "Valeria". Based on everything described so far, this suggests that the person identified as J is of female gender identity.

Lastly, it is important to add that at the time of forensic evaluation, the child had gone more than three years without medical treatment for her condition, which is why the medical, surgical and psychological treatments were deemed urgent and necessary. It was also suggested that the mother attend a support group for parents with children who have 21-hydroxylase deficiency to receive the adequate psychological treatment for her anxiety in dealing with her daughter's condition.

DISCUSSION

According to international medical literature, gender identity is a psychological construct and not merely a consequence of biological factors **(16)**. As such, it is the result of complex mental processes which are developed in the first few years of life and are established around 3 years of age **(17)**. In this particular case, gender identity was consistent with the biological sex and social assignment of gender, though in some exceptional cases, the gender identity is not concordant. In other words, the individual has the perception of "being in the wrong body", and forensic psychiatry is needed to establish in the mind of the individual what gender identity they identify with, from the perspective of the individual's own perception of self, regardless of external characteristics and social influence. It is a meticulous and persistent search of the psychiatric expert within the mind of an individual to determine senses of masculinity or femininity.

In children, this legal evaluation begins by examining the name of the child—which on occasion is also ambiguous, for example "Charlie", "Mikel" or "Yin". Then, the evaluation looks for a feeling of acceptance towards this name (such as pride), or on the contrary, feelings of inadequacy, rejection, shame or rage. Later, the behavioral patterns of the child's nuclear family, the relationships with parents and siblings, play patterns, interactions with peers (classmates or neighbors of the same age), how the child exercises gender roles (their role towards others), perception of self and surroundings, and personal autonomy. Finally, body image (and any of its distortions) are evaluated. In the mental examination, behavior is analyzed for the way in which the patient enters the exam room, the attitude towards the interviewer, delicate or rough movements, ways of greeting and tone of voice, among others.

After receiving the results of the psychiatric review, the judicial authorities are able to approve the name change in the civil registry. This allows the individual to adapt his or her name to the gender identity and then adapt his or her body to the mind (and not the other way around), avoiding irreparable damages to the psyche **(18)**.

While in Argentina the change of name and sex is a simple administrative procedure that does not require medical or psychiatric diagnosis and has been permitted since 2012 **(19)**, in Colombia it has only been possible since June 2015 for children and adults to change their name and legal sex. It is highly recommendable that when children are born with ambiguous genitalia an exception to the law be considered, authorizing the name change and respecting his or her rights, based always

on a case-by-case evaluation of the true gender identity, and focusing later on legal sex when legal age is reached and the individual has the capacity to decide for him or herself.

Keeping in mind the forensic and legal rather than therapeutic nature of the study, this author does not establish a relationship with these individuals to know their subjective experience, but rather to resolve the case at the request of authorities.

ACKNOWLEDGEMENTS

Thank you to doctors Iván Perea and Adriana Bautista of the Forensic Psychiatry and Psychology Group at the National Institute of Legal Medicine and Forensic Science for their valuable collaboration in the review of this article.

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CASE REPORTS
REPORTES DE CASO

DETERMINATION OF VERAPAMIL THROUGH LC-ESI-MS/MS IN A CASE OF FATAL INTOXICATION

National Institute of Legal Medicine and Forensic Sciences, Special Edition

SUMMARY

Verapamil is a synthetic derivative of papaverine, which is used therapeutically as a hypertensive, antiarrhythmic and antianginal. This study describes an analytical method for the determination of verapamil in biological matrices of blood and urine, which consists of a liquid-liquid extraction of samples for analysis using liquid chromatography-mass spectrometry (LC-ESI-MS/MS), with flurazepam as an internal standard. The method was applied to the acute fatal intoxication of a 17-year-old young woman who consumed 170 tablets of verapamil; the concentration of this medication found in the blood was 18.261mg/L and 0.369mg/L in the urine. This study also puts forth the use of LC-ESI-MS/MS in the analysis of verapamil in biological samples for applications in forensic toxicology.

Keywords: *Verapamil; Liquid chromatography with electrospray ionization and tandem mass spectrometry (LC-ESI-MS/MS); Forensic toxicology.*

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INTRODUCTION

A large number of cases of unspecified deaths which arrive at the National Institute of Legal Medicine and Forensic Science (INMLCF for it's acronym in Spanish) in Bogotá lack adequate information to establish an apparent cause of death. Toxicological analysis is used to identify the substances of habitual consumption to assist in determining the cause of death. In the experience of the Toxicology Laboratory at the INMLCF, some suicide deaths are associated with the consumption of pest-control substances and various pharmaceutical drugs.

Verapamil is a drug that acts by inhibiting slow calcium channels, which are dependent on the voltage of cardiac muscle cells, reducing the intracellular ion concentration. This medication is classified as a calcium blocker which acts on the vascular system, heart, and conduction tissue; it has clinically useful effects in relaxing blood vessels, reducing the need for the heart to pump with such force; it also increases blood flow and oxygenation of the heart while diminishing the electrical activity to control heart rate **(1,2,3,4)**.

Verapamil is administered orally and the therapeutic dosage is determined by pharmacokinetics as well as the clinical actions and characteristics of the patient. Overdosing can be fatal, which is why the analysis to determine biological matrices is very important in forensic toxicology to establish the cause of death.

A quick and simple method was developed to determine the quantity of verapamil in blood and urine using LC-ESI-MS/MS. The analytical methodology was obtained by reviewing articles that analyze these substances **(5,6,7,8)**, which were then applied to a case of fatal intoxication presumably caused by this drug.

Presentation of the case

A young woman of 17 years of age with a 53kg weight was brought to the emergency room due to intoxication symptoms after consuming a mixture of drugs including metformin, gemfibrozil and verapamil, which produced vomiting, tonic-clonic seizures, abundant secretions from the airways and finally, a cardio-respiratory arrest.

In the medical-legal examination, the patient presented signs of minor blunt trauma in the inferior extremities with different stages of evolution. There were also nonspecific signs, both internal and external, of marked hypoxia, pulmonary oedema and cerebral and pulmonary lesions suggesting pulmonary hemorrhaging. From the medical forensic opinion, the findings were nonspecific and were not enough to determine the cause of death; therefore the toxicological analysis was necessary, considering that, along with the cadaver, 17 packs of 120mg of verapamil were found, which correspond to 170 tablets (20.4g), 3 packs of 850mg of metformin, which correspond to 30 tablets (25.5g), and 4 packs of 600mg of gemfibrozil, which correspond to 40 tablets (24g). The research was then narrowed down to verapamil since literature reports a lethal dose for this drug, in contrast with the other substances that were ingested (Table 1).

Based on the number of tablets consumed, the volume of distribution of each substance, the concentration in plasma and the weight of the deceased, theoretical values of the concentrations of each substance in the blood were calculated supposing that they were totally absorbed.

It is not known if any other attempts at disintoxication, aside from vomiting, were made in the emergency room to eliminate the absorption of the active principles in the gastric content (Table 2). These calculations allow for the establishment of an approximate value of the concentration in the blood of each drug supposing a total absorption of these substances. As the ingested dose of verapamil was so high and the lethal dose low, it is likely that a total absorption did not occur since the organs failed quickly.

e. 1.28

Substance in blood	Therapeutic concentration (µg/mL)	Toxic concentration (µg/mL)	Lethal concentration (µg/mL)
Verapamil	0.08-0.3	0.36	1
Gemfibrozilo	Not reported	Not reported	Not reported
Metformina	1-4	45-70	Not reported

Table 1. Therapeutic, toxic and lethal concentrations of the drugs in this study. Source: (9,10).

Substance in blood	Volume of distribution (L/kg)3,9	Dose taken (g)	Maximum concentration in blood (mg/L)
Verapamil	2-6	20.4	64.15
Gemfibrozil	Not reported	24.0	---
Metformin	1-4	25.5	120.28

Table 2. Volume of distribution, dose taken of each drug and maximum concentration in blood of the deceased. Source: (3).

Where $Cp\ (mg/L) = \frac{A(mg/Kg)}{Vd(L/Kg)}$

Cp (mg/L): Concentration in plasma.
A (mg/L): Dose taken over weight.
Vd (L/Kg): Volume of distribution for each active component.

METHODOLOGY

Procedure

The levels of the calibration curve were prepared in triplicate by taking 2mL of blank blood in test tubes and adding verapamil to obtain concentrations of 5, 10, 15, 20 and 25µg/mL and 0.1µg/mL of flurazepam (enriched blood). For the urine, the same preparation was done with concentrations of 0.1, 0.3, 0.5, 0.7, 1.0 and 1.5 µg/mL of verapamil and 0.1µg/mL of flurazepam (enriched). Flurazepam was added to the blood and urine samples of the cadaver as internal standard with a concentration of 0.1µg/mL.

Levels of enriched blood and urine, along with the respective samples from the cadaver, were submitted to liquid-liquid extraction to recover the verapamil by adding a pH 6 buffer of 4.0 mL of phosphates and 6.6 mL of extraction solvent (dichloromethane/isopropanol/ammonium hydroxide 80/20/2). They were then sub-

mitted to sonication for 30 minutes and centrifuged at approximately 2000 rpm. The upper organic layer was then transferred to clean and dry test tubes of 6 mL, evaporated at 60°C, and agitated to achieve an approximate volume of 0.5 mL. Maximum vacuum was applied until dry. Finally, the evaporated extracts were reconstituted with 50µL of ACN/H20 solution (50:50 v/v) with 0.1% formic acid.

Each solution of verapamil and flurazepam analytes were prepared at 1mg/mL in methanol, both reactions are standard. The reagents were at analytic grade with the exception of methanol and acetonitrile (ACN), which were at HPLC grade. Blank urine was obtained through volunteers and blank blood was obtained from a 50:50 dilution of concentrated red blood cells with deionized water.

Conditions of the liquid chromatography-mass spectrometry

PA liquid chromatography-mass spectrometry (LC-MS) of the Thermo Electron Corporation brand and Thermo Surveyor-LCQ Advantage Max model was used. The conditions were: Column HPLC Hypersil Gold PFP of (50mm X 2.1mm, 5µm); the temperature of the column was 40°C. An acetonitrile gradient was used with 0.1% formic acid and a 10 mm solution of ammonium formiate with 0.1% of formic acid at a constant flowrate of 200 µL/min. The programming was the following: 0-0.5 min 5% of ACN, 0.5-5.5 increase of 5-95%, 5.5-8.5 minutes remaining at 95% of ACN, 8.6-13 minute decrease of 95-5%. The solvents of the mobile phase had been vacuum filtered earlier using a hydrophilic polyvinylidene fluoride (PVDF) membrane with a pore size of 0.22µm. The injection volume was 10µL.

Mass spectometry was conducted in tandem with the ion trap analyzer using a product ion scan, equipped with an electrospray ionization source (ESI) in positive mode. The conditions were optimized for the verapamil through infusion to the mass spectrometer. The conditions of the main parameters were: capillary voltage 9.00V, source voltage of 5.00kV, capillary temperature of 160°C, lense voltage of 5V, flow of ionization gas of 55 units and flow of auxiliary gas of 15 units. Table 3 shows the values of ions (m/z), retention time (RT) and collision energy (CE) and the isolation width optimized for the identification of each composite.

RESULTS

The correlation coefficients for the calibration curve were 0.0047 and 0.9960 in blood and urine respectively, with a variation coefficient lower than 5% in each level. The concentration of verapamil found in the blood of the deceased was 18,26mg/L and 0.37mg/L in the urine. The

Composite	Transition (m/z)	CE (%)	isolation width	Polarity	RT (min)
Verapamil	455.1→303.2 455.1→165.1	35	1	positive	6.23
Fluazepam (SI)	388.1→315.1 388.1→317.1	35	1	positive	5.52

Table 3. Data of the LC-ESI-MS/MS

Source: Author.

chromatogram and calibration curve of the verapamil in blood are presented in Figure 1.

DISCUSSION AND CONCLUSIONS

A new method was established to determine verapamil in blood and urine through LC-ESI-MS/MS. The method presents linear results that comply with the acceptance criteria of bioanalytical guidelines **(11)**.

LC-ESI-MS/MS is a sensitive technique to detect verapamil in biological samples; the method is highly selective and allows for the unequivocal determination of the drug in question, which is a fundamental requirement of forensic toxicology.

According to information found in bibliographical references, the lethal concentra-

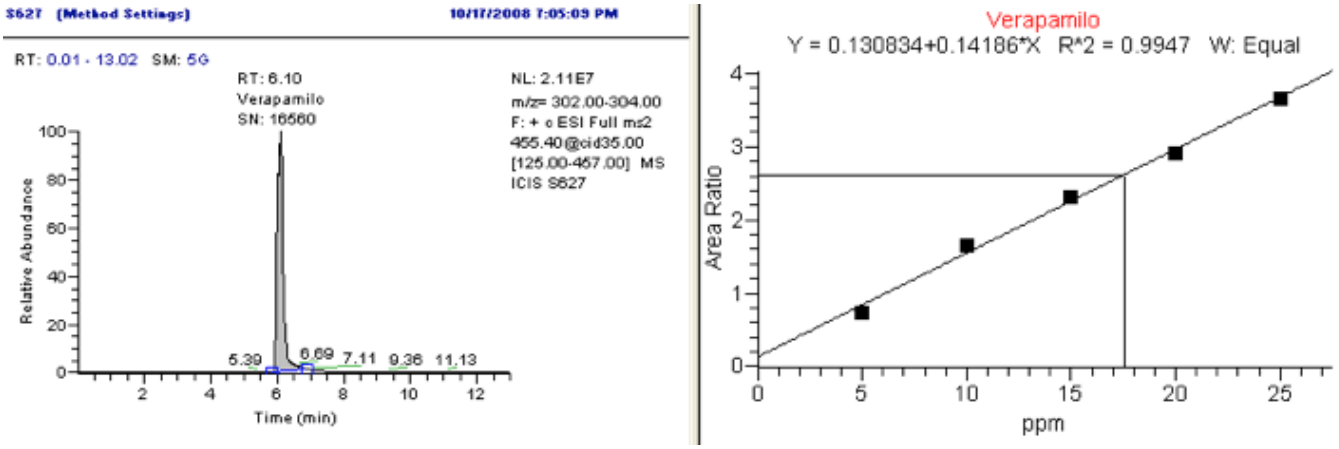

Fig 1. Chromatogram and calibration curve of the verapamil in blood (LC-MS) Source: Author.

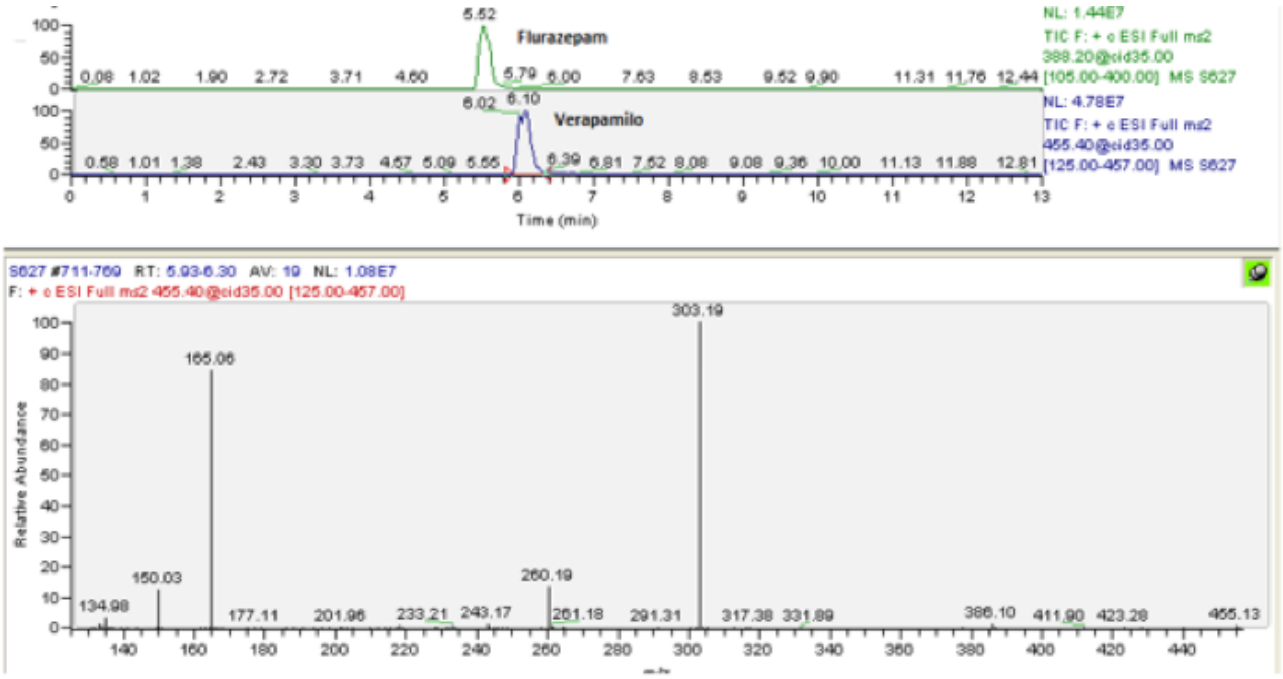

Fig 2. Chromatogram of the verapamil and flurazepam, and mass spectrum of the verapamil Source: Author.

tion of verapamil is 1μg/mL and in the results obtained, the concentration of verapamil was 18.26mg/L (18.26μg/mL) after the deceased had consumed 170 tablets of 120 mg of verapamil for a total dosage of 20.4g, which was potentially modified by vomiting. Plasma concentration levels could have theoretically reached 64.15mg/L if the drug had been completely absorbed.

The lethal dose of verapamil can be considered the cause of rapid organ failure, indicating that she suffered from an acute intoxication that led to her death.

Finally, in the forensic context, it is good practice to determine the presence of a substance with different matrices or, if there is only one sample, to undertake analyses with different techniques or assays repeated on different days **(12)**. While components are not necessarily present in all matrices (according to the variables involved in toxicokinetics), in the current case, the concentration of verapamil in blood and urine definitely proved the cause of death by intoxication with this drug.

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CASE REPORTS
REPORTES DE CASO

IDENTIFICATION PROCESS OF THE CAUSAL ELEMENT USING CUTMARK ANALYSIS IN BONE: CASE STUDY

National Institute of Legal Medicine and Forensic Sciences, Special Edition

SUMMARY

An anthropological trauma analysis was conducted on an individual killed by multiple injuries from a combined sharp and blunt mechanism using a cold weapon (machete) to the head, trunk and upper extremities. After conducting the autopsy, the cranial fragments were submitted to the anthropology laboratory for cleaning, restoration and study; later, plaster reproductions of the cutmarks with clear striations were made and a gel was developed to take impressions of the marks left by the machete recovered at the scene and submitted for study; finally, a visual comparison of the striations observed on the bone and those left by the machete in the gel was conducted.

Keywords: Tool mark analysis; Forensic anthropology; Bone trauma; chop wound; striation.

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The striation pattern left by the element in the gel was found to be random. In other words, it did not correspond to the irregular edge of the construction, but rather to a unique pattern resulting from the deformity on the cutting edge caused by the use of the tool. Considering that the same pattern of striations was observed in the cranial cutmarks, the conclusion was made that the causal element of the cuts was the same machete submitted for study.

The development of the study involved exploring odontological techniques using alginate impressions, which facilitated the analysis along with plaster molds. The development of a highly effective alternative gel for taking cutmark impressions is also reported on.

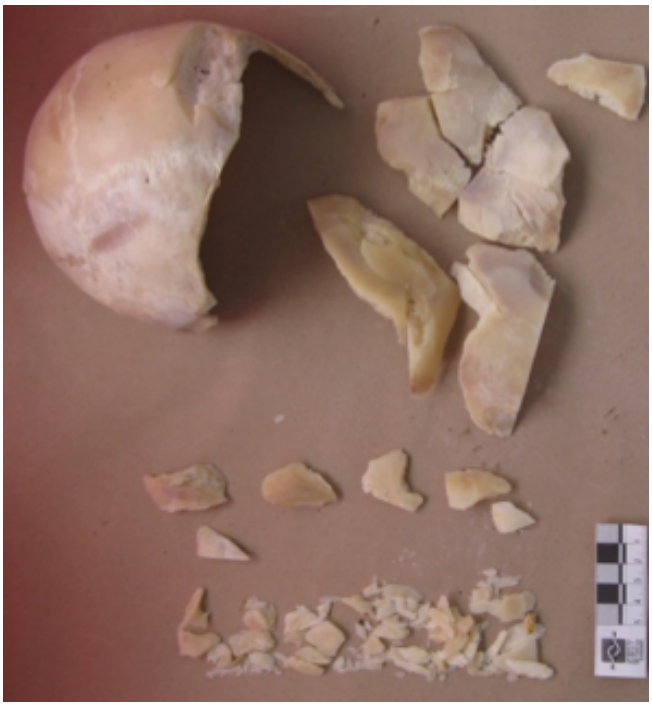

Fig 1. Bone fragments extracted from the cadaver after the cleaning procedure.
Source: I. Campos

INTRODUCTION

Fragments of the cranial vault belonging to a 38-year-old adult male who died in a public establishment and presented multiple injuries from a combine sharp and blunt mechanism to the head, trunk and upper extremities. A machete covered in blood was recovered at the scene and submitted to the Institute of Legal Medicine for a fingerprints search.

The anthropological approach was initiated during the autopsy procedure with documentation of bone injuries and their relationship to soft-tissue injuries, recovering bone fragments for further analysis (Figure 1). The presence of striations in the cutmarks was noticeable from the start, so authorization was requested from the physician responsible for the case to analyze the tool marks from the machete once lophoscopy and biological studies were completed.

METHODOLOGY

The first challenge of the case was removing the fat from the bone fragments because even though the soft tissue was removed, the bones maintained adiposity, which prevented the gluing of the fragments for the analysis, making it necessary to test various cleaning techniques.

This process required submerging the bones in boiling water. Later, water with conventional detergents was used, then calcium oxide (lime) was added. Finally, hydrogen peroxide (oxygenated water) was added until the bones were in suitable condition for restoration using a synthetic adhesive.

To carry out the analysis, the methodology proposed by Steve Symes in the short course on bone trauma he conducted at the National Institute of Legal Medicine and Forensic Sciences was applied **(1,2)**. Symes proposes matching the striations left by the blade of a tool in question in order to determine if said tool could have been used to make the cuts in the bone.

For the analysis of the machete, a high density gel with the capacity of accurately capturing the smallest irregularities of the blade was used.

While these industrial gels are widely known and used throughout the world, they are not available in Colombia, so various recipes were prepared from edible gelatin in an attempt to replace it. The first recipes had flaws such as rapid shrinking due to dehydration, the appearance of fungi and lack of consistency for the cuts. After many trials, an adequate preparation was obtained by mixing ingredients such as gelatin without flavour, sodium benzoate (food preservative) and acetic acid (commercial vinegar).

Impressions of the bone and machete cuts were taken as outlined by Buitrago **(3)**, using alginate and type 4 plaster to create the molds and final models.

After cleaning, the fragments were restored (Figure 2) paying special attention to the location of marks that presented striation, avoiding applying adhesive to those areas. After assembling the majority of fragments, the three largest surfaces with the most notable striations and the easiest to reproduce were selected; alginate molds were created and then cast with dental plaster (Figures 3 and 4).

The striations left by the blade of the machete were analyzed by dividing the blade into 12 cm-long segments and later making cuts with each one in the gelatin, taking care to number each segment and identify the location of the tip and which side of the edge left marks on the gel. After making the cuts, and faced with the difficulty of undertaking a photographic comparison due to lack of contrast with the color of the gelatin, the decision was made to make the molds out of alginate and to then take the impressions using dental plaster (Figure 5).

With the molds of the striated cutmarks of the skull and those left by the blade of the machete, a visual comparison was conducted to identify if any matches could be identified among these patterns. The comparison consisted of observing the width of the grooves and elevations as well as the side on which they were cast, considering that each striation was produced by a small crease in the edge of the element.

To facilitate the comparison, photographs were taken with metric scales, which were uploaded onto a software to edit photos and both photographs were amplified to scale.

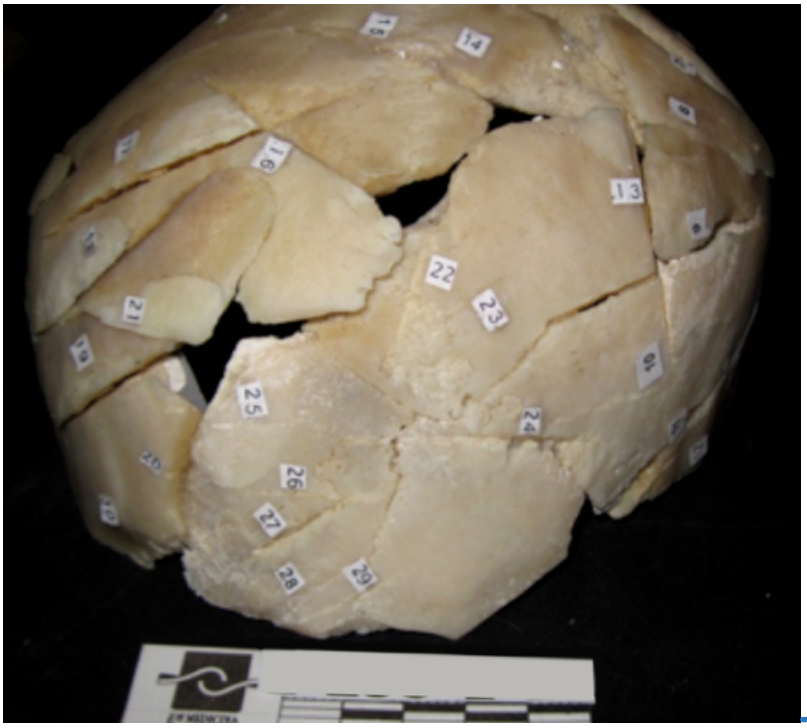

Fig 2. Bone fragments extracted from the cadaver after the cleaning procedure and restoration. The numbers denote the events caused by a combined sharp and blunt mechanism.
Source: I. Campos

Fig 3. Cranial injury caused by a combined sharp and blunt mechanism showing striations.
Source: I. Campos

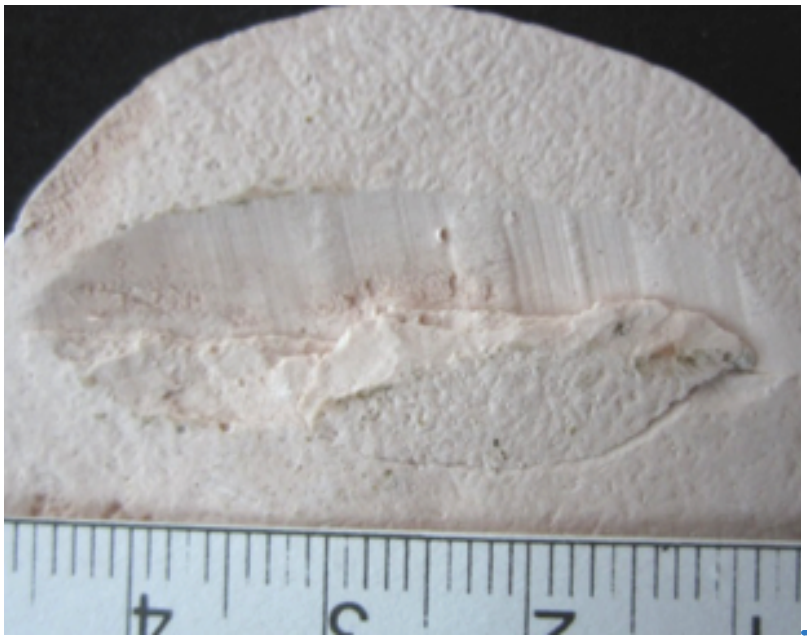

Fig 4. Plaster reproduction of skull injury due to combined sharp and blunt mechanism.
Source: I. Campos

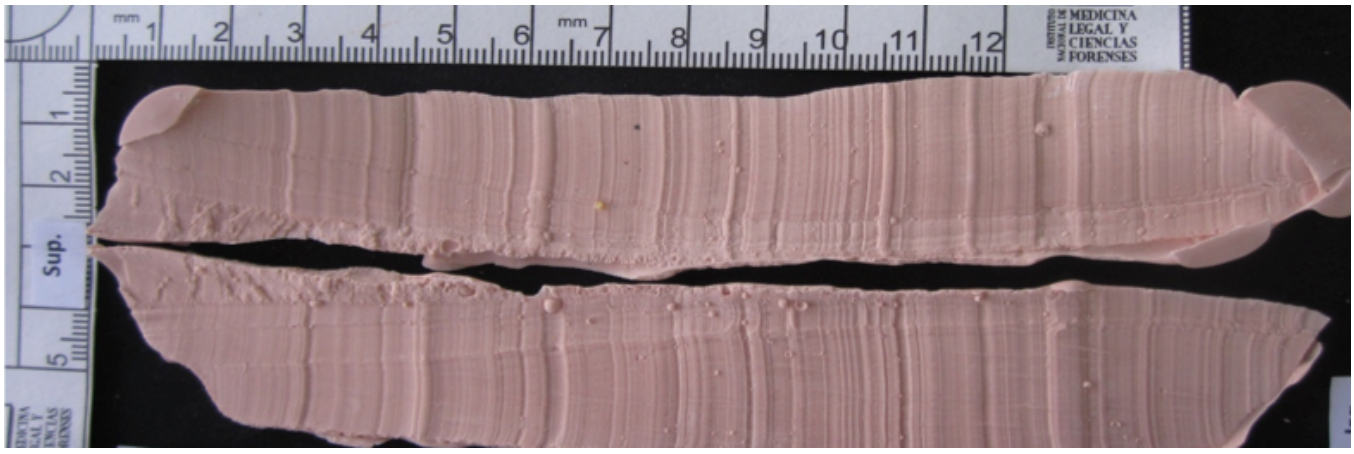

Fig 5. Model of striations left by segment of machete blade corresponding to segment 1; above, impression of the right edge and below, the left edge.
Source: I. Campos

Results

Over 30 cutmarks were found on the skull which caused its fragmentation. Although the cutmarks were all in the region of the cranial vault, they were largely concentrated in the posterior region. Three of the cuts observed presented clearly defined striations since they compromised the bone in a tangential way, only injuring the external surface.

Oxidation was found on the metal of the machete blade. The blade had irregularities on the edges - small creases towards both sides - (Figure 6), which, when making the incision, produced striations on the affected surface. Studying the impressions left by the machete demonstrated that the striations had different widths and depths that were not repeated along the entire edge.

Various segments in the bone and gel impressions can be identified that present coinciding striations in the sequence of width, depth and inclination (Figure 7, 8 and 9), which leads to the conclusion that the machete submitted for laboratory analysis is the causal element of the cutmarks, since the striation pattern is random and produced by the deterioration of the blade. It also does not correspond to a deliberate sequence used in the mass fabrication of this element.

In Figure 7, the arrows highlight the areas in the bone that have more noticeable grooves and elevations that correspond to small creases in the machete.

Upon observation, not all segments corresponded to a 100% match, which has a few different explanations. Firstly, if a gel is softer, it captures more characteristics of the element than cortical tissue, which is rigid, can. Furthermore, given that the striations were left by defects produced by the use of the machete, we deduce that the blade was deformed with each successive blow to the hard cranial surface.

DISCUSSION

When comparing tool marks in bone with suspicious elements, it is worth noting that the ideal moment for anthropologists to approach the case is in the autopsy room, since a complete observation of the cadaver —reading of the bone injury in relation to findings of soft tissues— allows them to understand the trauma that occurred and take the samples that they deem most appropriate.

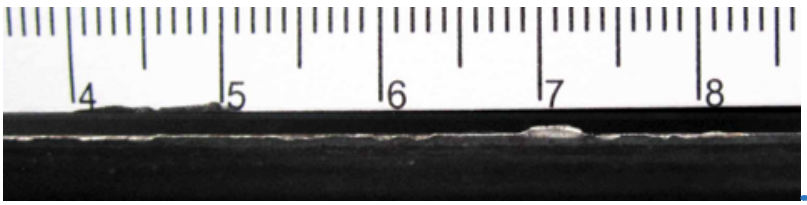

Fig 6. Detail of the blade of the machete - mid segment - which highlights the biggest irregularities. Source: I. Campos

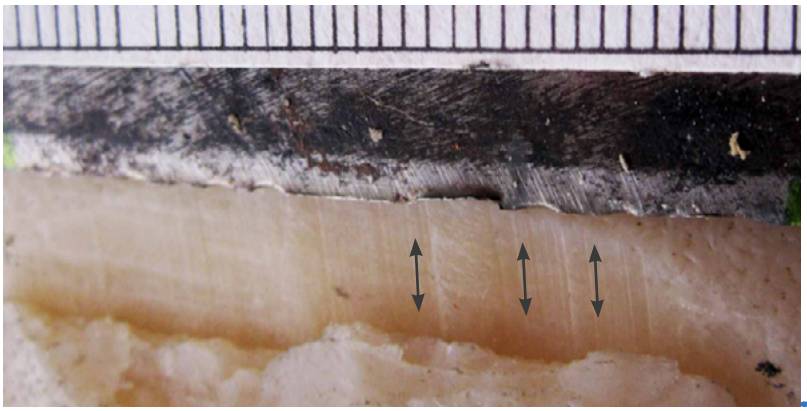

Fig 7. Detail comparison of the surface of the cut with the corresponding segment of the machete. Source: I. Campos

Fig 8. Detail assembly to scale of the cut in the frontal bone with the superimposed photograph of the cutmarks of the right edge of the machete in gel (corresponding to 200mm to 240mm of the blade measured from the tip), which shows an almost complete match of striations.

Source: I. Campos

Fig 9. Detail assembly to scale of the photograph of the chop wound located in the right parietal, with superimposed photograph of the cutmarks of the right edge of the machete in gel (corresponding to 94mm to 132 mm of the blade measured from the tip), which shows an almost complete match of striations.

Source: I. Campos

To adequately interpret bone trauma, it is necessary to know the anatomical location of the injury, which can be achieved with the exact reconstruction of the structure. Therefore, the cleaning procedure should focus on the removal of fat to enable the adhesion of fragments and the reconstruction of bone. Cleaning itself carries the risk of eroding the edges of the fragments, which should be avoided at all costs in order to keep the characteristics of the cutmarks intact.

The restoration process is long and can take several days. It consists of not only unifying all possible fragments but also of recording characteristics such as striations or inclinations of the edge on the fractures, among others, before gluing the pieces together.

The gel for taking impressions must have mechanical properties that allow for highly accurate representations of all the small details and irregularities of the cutting elements and the striations it can form on the bone. It must also be a homogenous material that does not clump. It should also be rigid enough not to deform when making the cut to prevent distorting the pattern of striations. The volume of the gel should be kept constant for the longest time possible under different environmental conditions and preservatives should be added to avoid the spread of fungi.

Creating reproductions, not only of cutmarks but also impressions in gel, significantly facilitates the photographic documentation and subsequent visual comparison of striation patterns.

Studies such as these require the multidisciplinary and collective effort of physicians, anthropologists, assistants and forensic experts, and criminal investigators, since without the recovery of elements at the scene, the request for anthropological analysis or careful handling during the extraction and processing of samples, anthropological analysis would not have been able to take place.

ACKNOWLEDGEMENTS

The study of this case would not have been possible without the decision of Dr. Mabel Zurbarán, the forensic doctor who requested the anthropological analysis in an unprecedented exploration at the Institute; the dedication of Álvaro Gutiérrez, assistant to the Pathology Group, who took great pains to recover even the smallest cranial fragment during the autopsy; the patience of Edwin Cardona, who constantly tries new techniques to improve the effectiveness of cleaning bones while conserving their characteristics; the collaboration of Sergio González, now anthropologist at the National University of Colombia, with whom a final formula for the gel was created to take impressions; finally, I am especially grateful for the work of odontologist Edna Buitrago Suárez, who created the models used in the analysis of this case.

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CASE REPORTS
REPORTES DE CASO

IDENTIFYING MISSING PEOPLE IN THE NATIONAL DATABASE OF GENETIC PROFILES FOR APPLICATION IN JUDICIAL INVESTIGATION —CODIS—: TWO CASE REPORTS

National Institute of Legal Medicine and Forensic Sciences, Special Edition

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SUMMARY

Armed conflict in Colombia has played an important role in the missing people phenomenon, in which the Government has the duty to identify, recover and investigate the crime in the process of the victims' reparation. However, identifying missing people is a complex process because of the huge amount of time it consumes and the lack of information regarding the identity of the missing people, which is the norm in most of the cases. In such cases in which there is little information on the identity of missing people (including data of their relatives), DNA analysis and databases are of key importance in the identification process. This is why we present two cases that exemplify the role of DNA databases in the successful identification of missing people.

Keywords: CODIS; Genetic Profile Databases; Database Search; Identification of Missing Persons.

INTRODUCTION

The recovery and identification of human remains found in mass graves are a key piece in the reparation process of victims. Since many missing people entailed in forced disappearance are presumed to be death, recovering and identifying human remains allow their relatives to continue in the grieving process, according to their cultural and religious beliefs in handling the death of their beloved ones. Forced disappearance has been defined as the arrest, detention or kidnapping of a person against their will by governmental agencies, organized groups or individuals with the direct or indirect support of the State, with no information of their whereabouts **(1,2)**. This is why many victims of forced disappearance never return home and their whereabouts often remain unknown, even many years after their deaths.

As a solution to uncover the identity of unidentified dead bodies, here we present two cases in which the CODIS database helped the authors to find two missing people. The CODIS database was created in 1990 in USA. The Department of Justice aimed to store human DNA profiles of convicted sex offenders in USA and Canada. However, the CODIS database was then used to identify victims of mass disasters outside USA by comparing the DNA of the victims with the DNA of their American relatives **(3, 4)**. This new use of CODIS opened additional opportunities to identify missing people.

For example, in Colombia the CODIS database may be an important means to identify missing people. Since the Colombian Plan was established in 1999, a collaborative agreement between Colombia and USA to boost peace in Colombian, the National Institute of Legal Medicine and Forensic Sciences (INMLCF, for its acronym in Spanish) acquired the CODIS platform to technologically strengthen the criminal investigations. The CODIS database changed its name to National Database of Genetic Profiles for Application in Judicial Investigation. This database stores the information provided by genetic laboratories in several cities such as Bogotá, Cali, Medellin, and Villavicencio from three govern institutions (INMLCF, Technical Team of Investigation, and the Attorney General's Office).

The database is not only used to store information of the genetic profiles of sex offenders, but it also allows searching for information with two main purposes. The first, to compare genetic profiles of the forensic evidence collected from crime scenes and victims with the information stored in the database. Such searching aims to identify the aggressor of the case or to connect related cases in serial crimes. On the other hand, the second purpose is to identify missing people. As the DNA profiles of the unidentified human remains collected from the necropsies are also stored in the database, it is possible to compare these profiles with the DNA of the relatives of missing people.

More specifically, each profile registered in the database includes Short Tandem Repeat (STR) nuclear microsatellite markers. At the beginning, the database stored 13 STR, but now it can store up to 29 STR. The DNA analyses allowed the database to store 26662 genetic profiles (2065 of human remains that were stored in the missing index and 24557 of their relatives.)

Once a match has been detected between the profiles of the suspect and those of the stored evidence (forensic module), or between an unidentified individual and their relative (identification module), the database administrator sends a report to the corresponding forensic area in the INMLCF (Pathology, Anthropology or the National Network of Missing People). These areas

analyze and exchange the information collected in the case to confirm the genetic match. Therefore, the DNA profile information stored in the database and properly indexed is useful to solve cases such as forced disappearance, identification of victims, mass disasters, sexual crimes, homicides, among others, which is very valuable for the administration of justice.

CASE REPORTS

Two cases of missing people identified by CODIS are presented. The genetic profiles of the missing people were obtained in the Genetics Laboratory of the INMLCF in Bogotá some years ago. Additionally, the database information was cross-referenced with the genetic profiles obtained from the relatives of missing people.

Case 1

Some unidentified human remains were analyzed in a bio-anthropological exam after exhumation. The results showed the remains belonged to a male individual aged 25 to 35 years. His genetic profiles were obtained from a bone sample and were stored in CODIS. In addition, genetic profiles of his possible biological father were obtained and stored in CODIS by the CTI Genetic Laboratory two years before the exhumation.

Case 2

Other unidentified human remains were also analyzed in a bioanthropological exam after exhumation. The results showed the remains belonged to a male individual aged 26 to 36 years. His genetic profiles were obtained from a bone sample and stored in CODIS. In addition, genetic profiles of his possible biological mother were obtained and stored in CODIS by the CTI Genetic Laboratory.

METHODOLOGY

Looking for missing people using CODIS

CODIS is administrated by a national casework manager who conducts a routine search in the database (version 5.7.4, Match Manager module). The searching aims to matching DNA profiles of unidentified human remains to DNA profiles of missing people's relatives. More specifically, matching is positive when 10 genetic markers in at least one allele are shared by both sources. However, the matching process takes into account the possibility that the DNA profile can include a higher number of genetic markers **(5)**.

Positive matches are then sent to the National Group of Forensic Pathology (INMLCF) where additional exams are performed to confirm the identity of the human remains. Results of these additional exams were analyzed in conjunction with the genetic data in the presented cases.

Additional genetic studies

As the identification protocols require matching more than 16 genetic markers to confirm the identity of the human remains, new analyses were conducted. The analyses included the DNA extracts of missing people's bone samples that were stored after the initial genetic analysis for including the data in CODIS. In addition, blood samples of the missing people's relatives that were initially analyzed and stored in the CTI laboratory to include the data in CODIS were requested to perform a new ge-

netic analysis. Results from both analyses were then matched in the two cases

Extraction, amplification and DNA typing

DNA of the possible father (case 1) and the possible mother (case 2) were extracted from blood samples of the FTA cards using the Chelex 100™ Resin **(6)**. On the other hand, the remaining DNA of the human remains was retaken and amplified again. To obtain the STR from these DNA samples, PCR was performed using multiple protocols including Powerplex®16 HS and PowerPlex® ESX 17 kits from Promega and the Thermal Cycle GeneAmp PCR Systems 2720 or 9700 (Applied Biosystems) to increase the DNA profile of the samples in both cases **(7,8)**.

Moreover, the PCR fragments were analyzed through capillary electrophoresis using the ABI 3130 and 3100 genetic analyzers of Applied Biosystems. By the same token, the allele assignment was done with sequenced allelic ladders associated with their respective kit, and typing the alleles was done using the program Gene Mapper, version 3.2 **(9)**.

Calculating probatility

The paternity index (PI) was determined in case 1 and the maternity index (MI) was determined in case 2, taking into account the gene frequencies of Colombian population **(10,11,12,13,14)**.

RESULTS

In the first case, DNA profiles from both the unidentified corpse and the father of a missing person shared 50% of the information for 15 markers. By the same token, DNA profiles in case 2 from both the unidentified corpse and the mother of a missing person also shared 50% of the information for 15 markers. Therefore, analyzed additional non-genetic information for both cases was collected to confirm the identity of the missing persons. Additional information was available in the National Network Information System for Missing People (SIRDEC, for its acronym in Spanish) and included places of disappearance and sex of the unidentified individuals, among other criteria.

After analyzing the information gathered, a new genetic analysis was conducted to confirm the identities. The analysis included 23 markers that indicated the non-exclusion of parenthood in both cases.

The results of additional genetic analyses were evaluated by members of the pathology group along with the ante-mortem findings described in the autopsy, the forensic anthropological study, and the information of the disappearance for each individual, which finally ended in the definitive identification of the victims, hence the bodies were delivered to their relatives.

Since there was no available information about the family members in case 1, the National Network Information System for Missing Persons at the INMLCF contacted the family by using the different available network channels of communication. In case 2, this was done through the authority in charge of the casework, and finally the bodies were delivered to their respective families.

As exemplified above, CODIS and the National Database of Genetic Profiles for Application in Judicial Investigation are an invaluable aid in the process of identifying missing people. In case 1, the sample from the unidentified corpse was entered into the database one year before the DNA profile of the biological father.

It is important to highlight the need of inclusion of more DNA profiles from both relatives of missing people and unidentified corpses in CODIS to enable matches that can lead to a positive identification, as it was the case with these two individuals, even many years after the disappearance event. This allows more families to continue with the grieving process once the identification has been made.

Considering their experience with handling the system, the DNA laboratory at the National Institute of Legal Medicine and Forensic Sciences has recommended that the number of genetic markers of a DNA profile to be included in the database contains at least 23 genetic markers, for both unidentified corpses and relatives, in order to allow matches with higher probability values that avoid further DNA analysis. This recommendation has been informed to other participating laboratories that are connected to the CODIS network.

Additionally, it is important to note that the laboratories that include DNA profiles into databases follow quality driven processes under the ISO/IEC 17025 regulations for the management and quality control of the DNA profiles. They must have different level of access and restrictions for the management of the genetic data taking into account the UNESCO declaration for the human genetic data as sensitive information that have to be properly stored in terms of confidentiality, privacy and integrity for both missing persons and relatives.

Acknowlegments

The authors would like to thank Jhon Vergel, MD, MSc. PhD., for his collaboration in proofreading the English version of this article.

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CASE REPORTS
REPORTES DE CASO

RECOVERY OF FINGERPRINTS AND IDENTIFICATION OF A DISMEMBERED BODY: A CRIME OF PASSION

National Institute of Legal Medicine and Forensic Sciences, Special Edition

SUMMARY

The body of a young woman was dismembered and placed in several plastic bags and left on a public road. Her death was the result of a crime of passion. Upon medico-legal examination, no skin was found on the palmar side of the distal and medial phalanges of all finger pads on both hands (which were also dismembered). Through the process of finger pad recovery, it was possible to find tissues that had adhered to the body and reposition the exactly on each finger to recover fingerprints. Finally, the victim was identified using the conventional fingerprinting process.

Keywords:
Finger pads; Dismemberment; Identification of bodies; Fingerprints; Dermatoglyphics.

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PRESENTATION OF THE CASE

The National Institute of Legal Medicine and Forensic Sciences (INMLCF) received various plastic bags, usually used for garbage disposal, collected from a road during the inspection of a cadaver carried out by the technical investigations team of the office of the Prosecutor General of Colombia (CTI-FGN). These bags contained the body parts of a recently deceased woman who had been dismembered. Upon preliminary medico-legal evaluation, the body was found to be dismembered at the ankles, knees, wrists, elbows, neck, lumbar spine and hands. The hands were missing sections of the skin corresponding to fingerprints (Figure 1); nine of the resected fragments were adhered to the trunk of the body and multiple cuts were observed on her face, and her nose was amputated.

METHODOLOGY

Nine small, whitish and difficult to find skin fragments belonging to the finger pads were found adhered to the trunk of the body (Figures 2 and 3) and recovered. The strips of skin were rolled up due to exposure to the environment. As such, they were rolled out proper observation.

The cut patterns on the edges of the fingerprints were carefully studied to establish a relationship between each fragment and the corresponding finger.

In order to reconstruct the whole fingerprint and thereby identify the body, different types of instant liquid adhesives were tested along with Cyanoacrylate composite (Omega-print™), used to reveal latent prints, in order to find the best adhesive result on the skin of the phalanx and thereby continue in the routine process of fingerprinting and later comparison with National Civil Registry database (Registraduría Nacional del Estado Civil) **(1-3)**.

DISCUSSION AND RESULTS

By localizing and restoring the finger pads, the correct placement of 7 fingerprints was obtained. With the finger prints, identification of the person in question was possible.

With regard to the adhesion of skin fragments to the phalanges, and after trying va-

Fig 1. View of the palm of the hands from which the skin on the fingers had previously been extracted.

Source: García & M. I. Pineda (INMLCF)

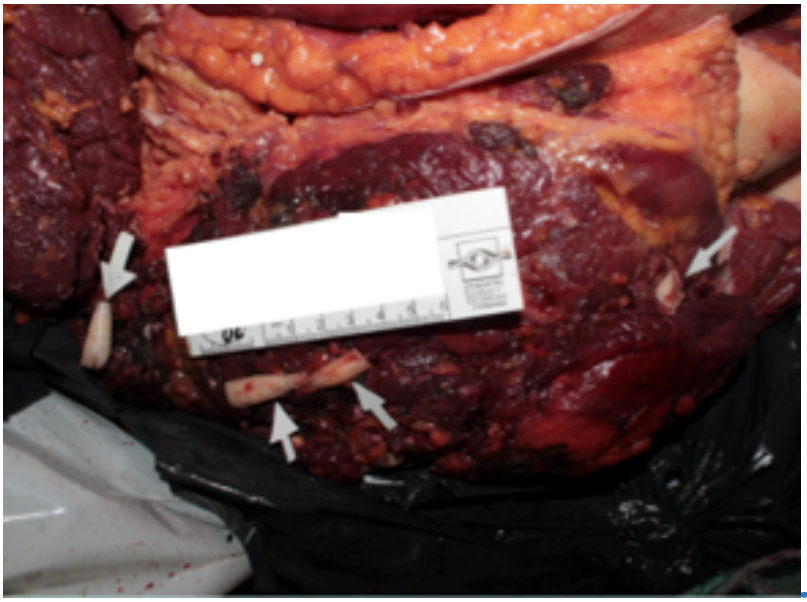

Fig 2. Vista general del tronco del cadáver con los fragmentos de pulpejos adheridos.
Fuente: García & M. I. Pineda (INMLCF)

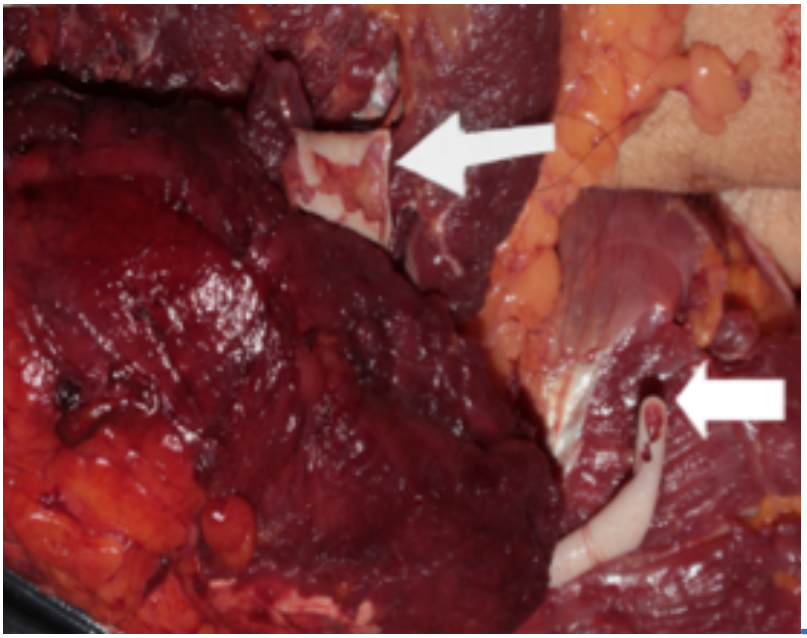

Fig 3. Vista general del tronco del cadáver con los fragmentos de pulpejos adheridos.
Fuente: García & M. I. Pineda (INMLCF)

rious liquid adhesives available on the market without achieving the expected result, the cyanoacrylate composite (Omega-Print™), often used to reveal latent fingerprints and widely known for its adhesive properties, was used **(4)**. This resin offered optimal results in terms of the adhesion of the finger pads and allowed for an appropriate fixation of each finger print on the recording strips for standard post-mortem fingerprinting (Figure 4).

The edges of the cuts in the finger pads and the marks on the fingers due to the lack of epidermic tissue had particular angular edges that completely coincided with each other and that corresponded with the the marks of the finger the fingerprints in 7 of the 9 fragments analyzed. This indicates that the injuries were caused by a cutting mechanism. In a later review of the hypothesis of the case, the suspect was found to have been employed in a job that used cutting tools, one of which had characteristics that coincided with the marks left on the victim's fingers.

Having identified the victim, and through the respective genetic study, the investigators were able to establish location of the place

Fig 4. Palmar view of the hands of the victim prepared for obtaining finger prints and matching.

Source: García & M. I. Pineda (INMLCF)

of the crime by proving that the blood at the scene belonged to the victim. This linked the suspect (her romantic partner) as the perpetrator of the crime.

Fingerprint matching was done by consulting the database of the National Civil Registry and by comparing the previously scanned images of the fingerprints in question to those of persons already entered into the software **(3)**. For identification, it is essential that the finger pads be correctly positioned. This highlights the importance of recovering the tissue and its correct placement on the corresponding body part.

While the dematoglyphic approach implies implies the development of broadly-known techniques and protocols, in the analysis of each case, the clear responsibility to recur to all possibilities for recovering the tissue is fundamental, even though conventional procedures may have yielded negative results. A great amount of creativity is required along with the occasional use of uncommon elements that allow for obtaining results that conclude —as in this case— with the identification of the victim and thereby a reconstruction of facts from evidence. In this way, it was possible to assist in the administration of justice and the clarification of the events, allowing for the delivery of the body to family members.

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CASE REPORTS
REPORTES DE CASO

WHIPLASH SYNDROME AND FORENSIC APPROACH. A CASE REPORT

National Institute of Legal Medicine and Forensic Sciences, Special Edition

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SUMMARY

The same day as being involved in a traffic incident as a pedestrian hit by a car, a middle-aged woman accessed emergency medical care and was later discharged. After two days the patient returned to emergency with complaints of neck pain. X-rays were conducted was immobilized with a cervical collar. Since the pain persisted, she was examined a few days later by physiatry, where a limitation in the arc of motion of the neck was found and whiplash was considered a possibility.

This type of cases related to chronic posttraumatic pain are relatively common in clinical consultation and represent a great challenge for physicians, mainly in the forensic field, since there are often many symptoms and very few signs to identify the damage. Therefore, a forensic doctor must recur to the clinical history and carefully examine the mechanism of injury and the

evolution of the clinical presentation, in addition to calling on other disciplines such as orthopedics, physiatry, psychiatry and pain medicine to issue a definitive concept.

Keywords: Whiplash; Clinical forensics; Traffic accident.

INTRODUCTION

Whiplash is caused by the acceleration-deceleration mechanism that transmits energy to the cervical spine **(1,2,3)**. This generally occurs in traffic collisions, which causes forced flexion and extension of the spine and can also cause forced lateral movements of the head.

The frequency of injuries produced by whiplash after traffic accidents varies from country to country (and even within regions), and depends on many factors such as the number of vehicles per inhabitant, traffic safety laws and indemnization systems, among others. It is worth noting that increasing incidence of whiplash in the United States and Western Europe over the last 30 years, along with the high financial cost, reported at 3 billion pounds annually in the UK **(1)**.

As for the type of damage, the Quebec classification **(4)**, widely accepted in literature around the world, establishes the severity of symptoms in 4 grades:

Grade 0: no symptoms in the neck or physical signs
Grade 1: neck symptoms only (pain, stiffness or pain upon palpation with no physical signs)
Grade 2: musculoskeletal signs are added
Grade 3: neurological signs are added (reduction or absence of deep tendon reflexes, weakness and sensory deficit)
Grade 4: neck symptoms and cervical fracture or dislocation

Other symptoms may be present such as dysphagia, tinnitus, temporomandibular joint symptoms, vertigo, lower back pain, dysphonia, headaches or vegetative symptoms.

CLINICAL HISTORY

A 45-year-old woman who was hit by a car when crossing the street was subsequently examined in the emergency room at a third-level clinic. She received analgesic care and was later released.

Two days later, the woman sought emergency treatment once again for severe neck pain. X-rays were conducted and the neck was immobilized with a cervical collar for 20 days. Since her injuries were caused by a traffic accident, a medical-legal evaluation was ordered.

Six days after the accident, the first medical-legal report was issued with findings of immobilization with the cervical collar and subgaleal hematoma in the occipital region. Pain in the right shoulder and left leg was also reported. Given these findings, a blunt causal mechanism was identified and provisional medical-legal incapacity was indicated for 20 days. 14 days later, a new medical evaluation was conducted in which the patient was prescribed a bone scan and management with physiotherapy.

In the second medical report, written a month after the first one, limited neck movement due to pain was observed, and it concluded in a new provisional medical-legal incapacity for 25 days. Another bone scan and neurosurgical evaluation were requested.

The following month, the patient was diagnosed with lower back pain and posttraumatic back pain, and the patient reported an improvement from the treatment (reduction especially in lower back pain, though cervicogenic pain persisted). With the cervical spine X-ray, in which no signs of fracture were observed, the bone scan revealed hypercaptation in the left sacroiliac joint

and acromioclavicular joint, without hypercaptation at the cervical or lumbar level. The patient presented with symptoms of neck pain (possibly due to whiplash) and posttraumatic lower back pain, for which she was prescribed physical therapy, analgesics and follow-up consultations the following month.

The third medical-legal report was carried out a month later. In it, evaluation from physiatry was indicated with imaging studies, with which definitive medical-legal incapacity was found necessary.

20 days later, the patient was examined by physiatry due to the persistence of cervicogenic pain. The results of the cervical X-ray showed no signs of fracture while the bone scan showed hypercaptation in the left sacroiliac joint, without hypercaptation at the cervical or lumbar level. A diagnosis was made of possible whiplash and posttraumatic lower back pain, prescribing management with analgesics and physiotherapy.

A few days later, an MRI was conducted on the patient and indicated slight chondritic changes with bulging of the annular fibers between C3 and C6 and slight changes in slight facet arthrosis in C5-C6 and C6-C7 without myopathy.

The fourth medical-legal report showed limitation to the arc of cervical motion, reporting limits to the patient's daily activities.

DISCUSSION AND CONCLUSIONS

Whiplash presents a great challenge to physicians at all levels since there is disparity between the large symptomatology and the few findings from clinical examinations that can be be supported in the results of diagnostic imaging. Therefore, it is necessary to take a comprehensive approach with all the technical and scientific tools available to objectify the complaints of the patient and make them supportable in order to rule out the possibility that the patient's symptomatology is not due to neuropsychiatric disorders or a desire for financial compensation.

In this case, a few criteria for medical-legal evaluation of whiplash were considered, as reported by Sánchez et al. **(5)**:

- Onset of symptoms in the first 72 hours.
- Presence of signs and symptoms described in medical literature.
- A mechanism of injury that can account for whiplash syndrome.
- A clinical history is very useful since it may eventually show the absence of previous neck pain, requiring evaluation by specialists to demonstrate a significant increase that could affect quality of life.
- To determine the medical-legal ramifications of the case, the presence of pain of a magnitude that obliges the patient to consult doctors frequently and receive treatment must be proven, with the concept of pain clinic being important.

After applying these criteria to the case at hand, we found that the patient had an injury that was not typical of whiplash (she was run over by a car) though it does not rule out whiplash. Within 48 hours of the traum, the patient sought medical care based the typical clinical presentation decribed in medical literature: intense cervical pain and limited cervical movement. Though X-rays of the cervical column and bone scans taken two months posterior to the accident did not show anatomical damage, this lack of findings from imaging is frequent and also described in medical literature.

Three months later an MRI was conducted that showed slight osteoarthritic changes and facet compromise, which can be associated to the trauma suffered. The patient underwent

nine medical and medical-legal evaluations in a period of three months. The patient reported limitations to carrying out daily activities and the physician continued to find limitations in the cervical arcs of motion. There is no record in the clinical history gathered of a background of cervical pain from other causes.

From the forensic point of view, and taking into these elements of judgment, it was considered that the damage is worth a 25 days final forensic inability; in addition, as a medicolegal sequel, it presents a functional disorder of the musculoskeletal system, whose temporary or permanent character will be defined through the evaluations provided by the Pain Clinic, Physiatry and neurosurgery.

We would like to thank the National University of Colombia for their support and contribution to the publication of this article.

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CASE REPORTS
REPORTES DE CASO

DESCRIPTION OF BLAST INJURIES: LITERATURE REVIEW, CASE REPORT AND PROPOSAL FOR A NEW CLASSIFICATION

Instituto Nacional de Medicina Legal y Ciencias Forenses, Suplemento

SUMMARY

After reviewing the medical literature of various classifications of blast injuries, we present a proposal called the Bogotá Classification, aimed at the study of cadavers with injuries present in cases of death caused by explosion. We also present a case that occurred in a residence in the city of Bogotá involving an improvised explosive device, resulting in three deaths.

Keywords: *blast injuries, forensic pathology, autopsy, death.*

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THEORETICAL FRAMEWORK

Classifications of blast injuries: similarities and discrepancies

Blast injuries have generally been classified in clinical terms focusing on surviving victims, such as those laid out by the National Center for Injury Prevention and Control-NCIPC (**1**), DePalma (**2**) and Wolf (**3**). Severe injuries resulting

in immediate death were also included, as laid out by Carnicero (**4**), Patiño (**5**), Crane (**6**) and Saukko (**7**).

Medico-legal autopsies examine both the injuries of those who died immediately as well as of survivors who died a short time later; it is important to categorize these deaths in order to verify the cause of death, identify related injuries, document a sequence of events and the location of people at the scene, when possible. This helps establish the cause of death in relation to the explosion.

While injuries found on the cadavers are documented in the autopsy by describing their characteristics and mechanisms, there are discrepancies in the different classifications, either because injuries are classified among the groups differently or some injuries are not included. To provide a few examples, the classifications of the NCIPC, dePalma and Wolf don't mention extensive and severe injuries such as decomposition and generalized bodily damage without disintegration. Carnicero, on the other hand, classifies burns and injuries caused by collapsed structures as secondary, while others (namely NCIPC and DePalma) describe them as tertiary.

The general mechanism for the production of blast injuries, caused by either high-order or low-order explosives, is the conversion of a solid or liquid to gas, and the rapid expansion of this gas with an increase in pressure and the formation of a blast wave that crosses through bodies and objects (**5,8**), with a subsequent blast wind displacing them. In this process, air is displaced (known as positive pressure), which forms a vacuum followed by negative pressure. This normalizes both pressures and fills the vacuum (**3**). The increase in positive pressure in particular is responsible for blast injuries. Gruss (**8**) and Marín (**9**) explain that the pressure that causes the injury is called effective pressure and that if an individual is against a wall, he or she will receive pressure both from the blast as well as that reflected off the wall, which causes a combination of pressures, or effective pressure.

Primary injuries: these have been defined by Bernal (**10**) as the most characteristic blast injuries and are a consequence of the path of the blast through the body, with disruptive effects on tissues of air/liquid or solid/liquid interfaces (**2,8**). They are also described by Shardin (**11**) and Benzinger (**12**) from 1950 as anatomical and physiological changes produced by the direct or reflected effect of impact force on the body's surface.

Primary injuries that are broadly accepted in all classifications (**1-7**) are those that occur in the organs with air/liquid interfaces and are typically described in the ears as tympanic membrane rupture and damage to the middle ear; in the lungs as hemorrhaging, pulmonary contusions, barotrauma and air embolism; and in the gastrointestinal tract as hemorrhages and perforations of the intestines, predominantly in the colon. There is also often damage to the cecum and mesentery with hemorrhage, thrombosis or rupture.

Other primary injuries are not included in all classifications. NCIP and DePalma include ocular globe injuries and cerebral concussions without physical signs of head trauma. Marín (**9**) includes the atomization of extremities due to proximity to explosion and sudden death by myocardial depression. Wolf (**3**) considers injuries due to inertia similar to those caused by a deceleration of forces in traffic accidents, physiological shock , compartmental syndrome in extremities, orbital fractures and cardiac injuries. Uribe (**13**) adds traumatic amputations and a category called immediate causes of death (aortic rupture, cardiac lacerations, massive pulmonary contusion, tracheal rupture, serious fractures, compromised column and pelvis). Carnicero and Bernal include the fragmentation and projections of the body due to the ge-

neralized blast , as well as esophagus, heart, head and eye injuries. Patiño refers to major bodily destruction, traumatic brain injury and amputations. Crane includes the total destruction of the victim and blast injuries. Saukko includes bodily destruction due to non-identifiable flying fragments through a wide area (similar to that described by Carnicero and Bernal) and flash burns. The Institute of Medicine of the National Academies (IOM) (**14**) includes cardiovascular, ocular, musculo-skeletal and central nervous system injuries. Gruss does not include other injuries.

Some authors state, without undertaking a classification of blast injuries, that some injuries should be catalogued as primary. These include fractures in extremities that compromise the diaphysis and not the joints (**15,16**), cranial fractures around paranasal sinuses (**16**), cerebral pseudoaneurysms (**17**) and in the case of pregnancy, secondary abruptio placentae (**18**).

Secondary injuries: NCPIC, Wolf, DePalma, Patiño, Uribe and Carnicero define these as injuries caused by secondary missiles originating from the bomb or surroundings. Saukko considers secondary injuries as those produced by structural collapse and places injuries caused by secondary missiles originating from the bomb or surroundings in a separate category, without specifying the method of differentiation. Furthermore, Carnicero includes thermal, chemical and nervous traumas, while Uribe includes thermal, chemical and mechanical traumas, accompanied by cerebral and neurological impact.

Tertiary injuries: These are defined by Wolf, Uribe, Patiño, the NCIPC and DePalma as a result of the displacement of the body by the blast wind. Wolf states that they are injuries of inertia and stretching that occur similarly to the deceleration effect in traffic accidents. The classifications of the NCIR and DePalma include fractures and traumatic amputations. Carnicero, Crane and Saukko do not consider them at all.

Quaternary injuries: in the classifications of the NCIPC, DePalma and Wolf, these are considered as any injuries caused by rupture and illnesses or conditions that are not described as primary, secondary or tertiary injuries. Uribe, on the other hand, calls them mixed injuries. Therefore, injuries are grouped by burns and crushing, closed and open brain injury, intoxication caused by gases, respiratory problems, angina, hyperglycemia and hypertension. Carnicero, Patiño, Crane and Saukko don't consider them at all.

For additional clarification, a synoptic and comparative chart is provided of the eight classifications:

The classifications of Crane and Saukko are not included in the table because they use a different framework described as follows:

Crane's Classification:

A. Total destruction of the victim.
B. Injuries due to explosives (body with multiple spots, abrasions and lacerations between 1 and 3 cm)
C. Injuries due to bomb fragments (secondary missiles)
D. Injuries due to the collapse of buildings or structural components.
E. Burns.
F. Blast injuries.

Saukko's Classification:

A. Effects of the blast wave.
B. Secondary projectiles of an explosive device.
C. Secondary projectiles of the surroundings.
D. Burns caused by hot gas or incandescent objects.
E. Injuries caused by fallen structures, beams and displaced furniture in an explosion

Classification/ category	NCIPC	De Palma	Wolf	Uribe	Carnicero	OIM	Patiño
Primary: gas-filled structures (lungs and Gi tract) and middle ear	Yes, and others	Yes, and others	Yes, and others	Yes, and others	Yes, and others	**Yes**	**Yes**
Secondary: secondary projectiles	Yes	Yes	Yes	Yes, and others	Yes, and others	**Yes**	**Yes**
Tertiary: displacement trauma and structural collapse	Yes, and others	Yes	Yes	Yes	No	**Yes**	**Yes**
Quaternary: injuries related to the explosion, different from aforementioned conditions.	Yes	Yes	Yes, and psychological trauma	Yes, and others	No	Yes, and others	No
Quinary	No	No	Hyperinflammatory state	No	No	**"Dirty-bombs" and others**	**No**
Burns	No	No	No	No	No		**Flash**
Crushing	No	No	No	No	No		**Yes**
Inhalation of smoke or toxic gases	No	No	No	No	No		**Yes**
Emotional shock	No	No	No	No	No		**Yes**

Table 1. Comparison of classifications. Source: I. (1-5,13,14).

DISCREPANCIES AMONG AUTHORS OF CLASSIFICATIONS

Injuries such as the amputation of extremities are not considered as primary lesions by Urbine, Hull, Cooper (**19**) and Marín, although the latter two state that traumatic amputations of the extremities are caused by shock wave. Likewise, Guermazi consider the injuries to extremities of the victims of the Boston marathon bombing in 2013 as primary injuries.

Ritenour *et al.* and Cernak (**20**) state that compartment syndrome can occur in extremities that don't appear to be injured during an explosion, raising the possibility that they are a product of the force of the shock wave, which has not been contemplated by other authors.

Villalaín (**21**) mentions an additional category characterized by the absence of external injuries but with generalized capillary hemorrhages, (in particular thoracic-abdominal, pulmonary and pleural), aortic ruptures, fat and air embolisms, and up to 70% quantity of carboxyhemoglobin. This categorization has not been considered by other authors.

Armstrong *et al.* (**22**) are the only ones that consider subarachnoid hemorrhages, edema

and diffuse axonal injury as primary injuries and explain that they are caused by the excess pressure produced by a blast wave.

Within the category of primary injuries, Carnicero includes the fragmentation and projection of the body, generalized blast and other primary injuries to hollow or solid organs; Crane and Saukko consider them as the total destruction of a victim. These injuries are not included by NCDC, Wolf, DePalma, Patiño nor Uribe.

Saukko, in his classification, separates injuries caused by secondary missiles originating from the bomb and those originating from the surroundings, without specifying the means of differentiation. The other authors do not make this difference.

As for secondary injuries, Carnicero groups together all those that are not primary, which includes the so-called mechanical, thermal, chemical and neuro-psychic injuries; this author does not include the tertiary, quaternary, and quinary categories of the other authors.

The definition of quaternary injuries used by the NCIPC, DePalma and Wolf as those that are not primary, secondary or tertiary but nonetheless related to the explosion is not considered by the other authors.

Other differences are as follows: the NCIPIC includes open or closed encephalic injuries in the category of tertiary or quaternary injuries, without establishing a clear difference between them; Patiño outlines 7 categories, with the first 3 corresponding to primary, secondary and tertiary injuries in the classifications of NCIPC, DePalma, Wolf and Uribe. The others are categories used only by this author. Crane describes a category as blast injuries not considered in other classifications; likewise, Saukko places burns in a separate category. Quinary injuries such as hyper-inflammatory reactions of survivors and injuries with multi-dimensional patterns, defined by Kluger (**23**), are only considered by Wolf and OIM.

PROPOSAL OF A NEW CLASSIFICATION FOR FORENSIC USE

We put forth a new system of classification that allows for the grouping of anatomical-pathological injuries in a systematic and documented way that will be of great use to doctors in diagnosis and evaluation in forensic pathology.

To clarify, the categories of moral, psychosocial and psychological harm have not been taken into account in this proposal because it is limited to physical bodily damage, which is the pillar of medical-forensic thought in autopsies. Therefore, no aspects related to the mental health of survivors have been included.

The Bogotá Classification categorizes injuries according to the phases of a blast: firstly, the effects of shock wave, secondly, the injuries caused by propulsion of secondary missiles, thirdly, the injuries produced by the projection of animated bodies and the collapse of non-animated bodies and fourthly, injuries that occur with later onset and injuries related to pre-existing conditions.

The proposal emphasizes the categorization of primary injuries, grouping together all the injuries caused by blast wave, which refers to both generalized body injuries and those accepted by all or only a few authors. This grouping is important since it includes injuries that explain tissue loss and other traumas that are present due to proximity to the center of the blast and the destructive power of the explosive agent.

The Bogotá Classification is organized as follows.

A. Injuries due to explosive wave (primary or blast)

Blast wave injuries are classified as those caused by the path of the wave through the body and the subsequent destruction associated with this mechanism, without any particu-

lar relation to air-liquid/solid interface. Injuries include as follows:

1. Generalized injuries described in the literature as bodily disintegration and generalized damage to the body without disintegration. These injuries cause great bodily harm and instant death (whole or partial cadavers recovered at the scene).
2. Organ injuries with air/liquid or solid/liquid interface: lungs, ears, GI tract, facial fractures affecting the paranasal sinuses and cardiac rupture.
3. Amputations and fractures of the extremities produced by blast wave (described by Uribe, Guermazi, Hull and Marían) due to proximity to the explosion.
4. Burns caused by heat or radiation, commonly known as flash burns.
5. Injuries to solid organs such as subarachnoid hemorrhages, diffuse axonal injury, contusions and hemorrhages of unrelated internal organs and external injuries with blunt or penetrating trauma. Muscular and vascular injuries are also included here with or without compartmental syndrome, as described by Wolf.

B. Secondary injuries

These are caused by secondary missiles projected by the blast wave as either bomb fragments or flying debris from the surroundings. They are generally small injuries such as abrasions, hematomas and lacerations of tissues with fragments found in the body.

C. Tertiary injuries

These injuries are related to the propulsion of the body through the air and include traumas caused by acceleration-deceleration and/or secondary crushing due to structural collapse. These consist of blunt traumas and are generally severe.

D. Quaternary injuries

These injuries are caused by events triggered by the explosion after the blast wave and destruction of bodies and objects. This category includes fires that cause burns and damage due to the inhalation of toxic gas and smoke, medical complications of injuries initially caused by the blast, the exacerbation of pre-existing conditions, and infections caused by "dirty bombs" or radiation (**24**). Quinary and multidimensional injuries are included in this category, which are identified in the clinical setting and require a period of survival.

CASE REPORT

Background

"Potato bombs", as they are commonly known in Colombia, are improvised explosive devices created with the purpose of producing a big rumbling noise, though in some cases are also used as a weapon that mutilates extremities and can be fatal (**25**). The bombs use an impact or contact mechanism and are made with potassium chloride (the combustible product), sulfur and powdered aluminium (both are inflammable solids with the capacity to produce an explosion with an increase in temperature), aluminium paper (the container), and a stone that pulverizes and sprays upon impact. Nails and knives that act as shrapnel are sometimes included.

In a neighborhood in Bogotá, in the early hours of the morning, an explosion occurred that affected 109 adults and 51 children, according to a report of the Fondo de Atención y Prevención de Emergencias (Fund for the Attendance and Prevention of Emergencies)[1] made to

1 Currently under the name IDIGER - Instituto Distrital de Gestión de Riesgos y Cambio Climático (District Institute of Risk Management and Climate Change)

the newspaper El Espectador (**26**). This report states that the incident occurred when a group of 4 students - 3 men and 1 woman between 19 and 24 years of age - were handling 10 kilos of explosives to fabricate an improvised explosive device under the influence of alcohol. There was extensive material damage, as the walls of the home where the incident occurred (on the third floor of a residential compound) collapsed and a fire broke out, which firefighters later extinguished. Structural damages were incurred to approximately 65 homes and 25 vehicles in the neighborhood (27-30); the facades of three homes were also destroyed with damages to windows and walls.

Approach

In the early morning, 3 cadavers were brought in to the National Institute of Legal Medicine and Forensic Sciences in Bogotá. According to the information available, one person died at the scene and the other three were relocated to medical centers. Two of them later died and one survived.

Before conducting an autopsy of the 3 corpses, an approach was planned based on the methodological guidelines for medico-legal autopsies in cases of death resulting from blast injuries (Guidelines for the procedures of medico-legal autopsies, second edition). The procedures for identifying corpses were also followed (Manual for the identification of cadavers in forensic practice and the Manual for the practice of medical-legal autopsies)[2], and an approach was planned for the the individualization of body parts and the collection of samples for further laboratory examination.

Detailed descriptions of the injuries of the individuals (named 1, 2, and 3) were made. The injuries were then classified according to the parameters established by the National Center for Injury Prevention and Control (NCIPC). Samples were taken and reports were written, and the injuries were subsequently reclassified according to the new classification proposal presented here and compared with classification systems of other authors.

Results

- The 3 cadavers were definitively identified using fingerprint data as a woman aged 24 and two men aged 20 and 22.
- The causes of death of the three people were found to be directly related to the explosion.
- The time of death was established as early morning, according to the available information of the incident.
- The three cadavers presented with blunt trauma caused by the blast wave and burns that compromised their bodies extensively. The injuries were characterized as typical injuries caused by explosive devices, along with explosive blast trauma, burns, and blunt and penetrating trauma.
- Cadaver 1 sustained the most burn injuries while 2 and 3 presented predominantly blast injuries and multiple blunt traumas.

Presentation of injuries involved in the case

1. Lamellar subserosal hematomas in hollow abdominal viscera (colon) in all 3 cadavers.
2. Bilateral globe rupture in two of the bodies.
3. Pulmonary hemorrhages in all 3 individuals.
4. Injury in the left forearm in individual 2 from a wooden shard measuring 2.5 x 0.5 cm as a missile or secondary projectile.

2 Guidelines, Spanish titles: Guía de procedimiento para la realización de autopsias médico legales, segunda edición, Manual de identificación de cadáveres en la práctica forense and Manual para la práctica de autopsias médico-legales.

5. Lacerations, fractures and avulsion of hand tissue.
6. Fracture compromising the paranasal sinuses: in individuals 2 and 3, fractures of the middle part of the face compromising the glabella, malar and maxillary bones, orbits and nose.
7. Jaw fracture in left horizontal line corresponding to a fracture of the lower third of the face.
8. Subarachnoid hemorrhage in patches of the surfaces of the brain.
9. Hemorrhagic contusions at the base of the frontal lobes caused by frontal cranial fossa fractures.

   The hemorrhages in Figure 10 are related to the cranial fractures in Figure 11.
10. Deceleration injuries: adventitious hematoma of the descending thoracic aorta, along with subpleural hemorrhage in the posterior wall and thoracic paravertebral space
11. Rupture of right atrium documented in individual 1.
12. Presence of flash burns in the face, neck, anterior thorax and forearms of individual 2 (female), who, at the time of the incident, was wearing a sleeveless shirt.
13. Extensive burns leading to 90% carbonization of the body.

Fig 1. Lamellar subserosal hematomas typical of blast injuries, individual 2.

Source: INML/CF.

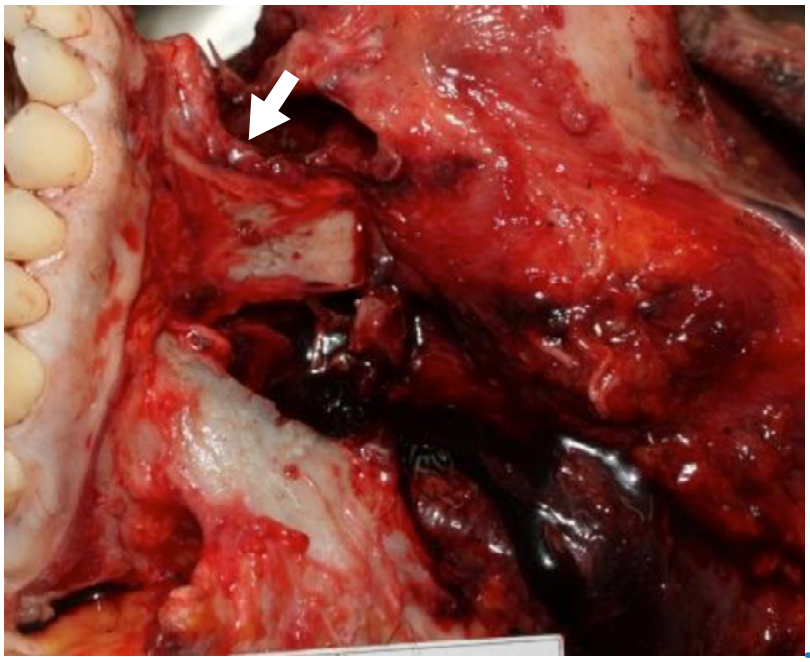

Fig 2. Bilateral globe rupture in two of the bodies.

Source: INML/CF.

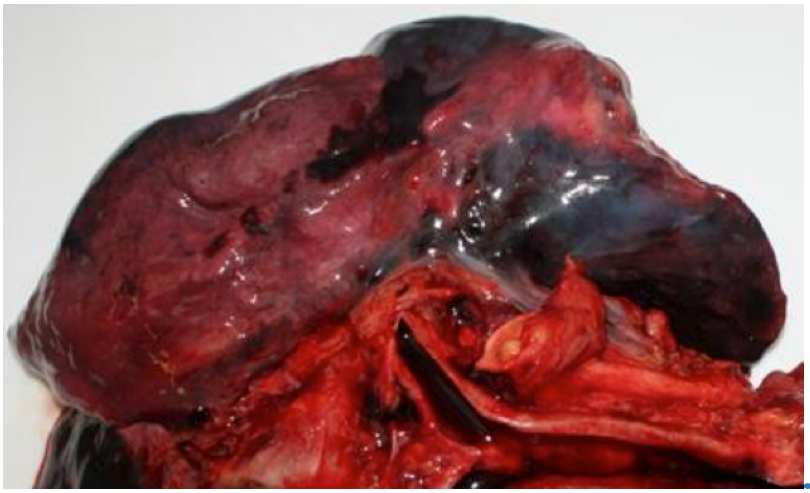

Fig 3. Pulmonary hemorrhages in subserosal and intraparenchymal areas, compromising all lobes, individual 3.

Source: INML/CF.

Fig 4. X-Ray of left superior extremity with opaque mass (see arrow) corresponding to a secondary projectile, individual 2.

Source: INML/CF.

Fig 5. Partial avulsion of the right hand, individual 2..

Source: INML/CF.

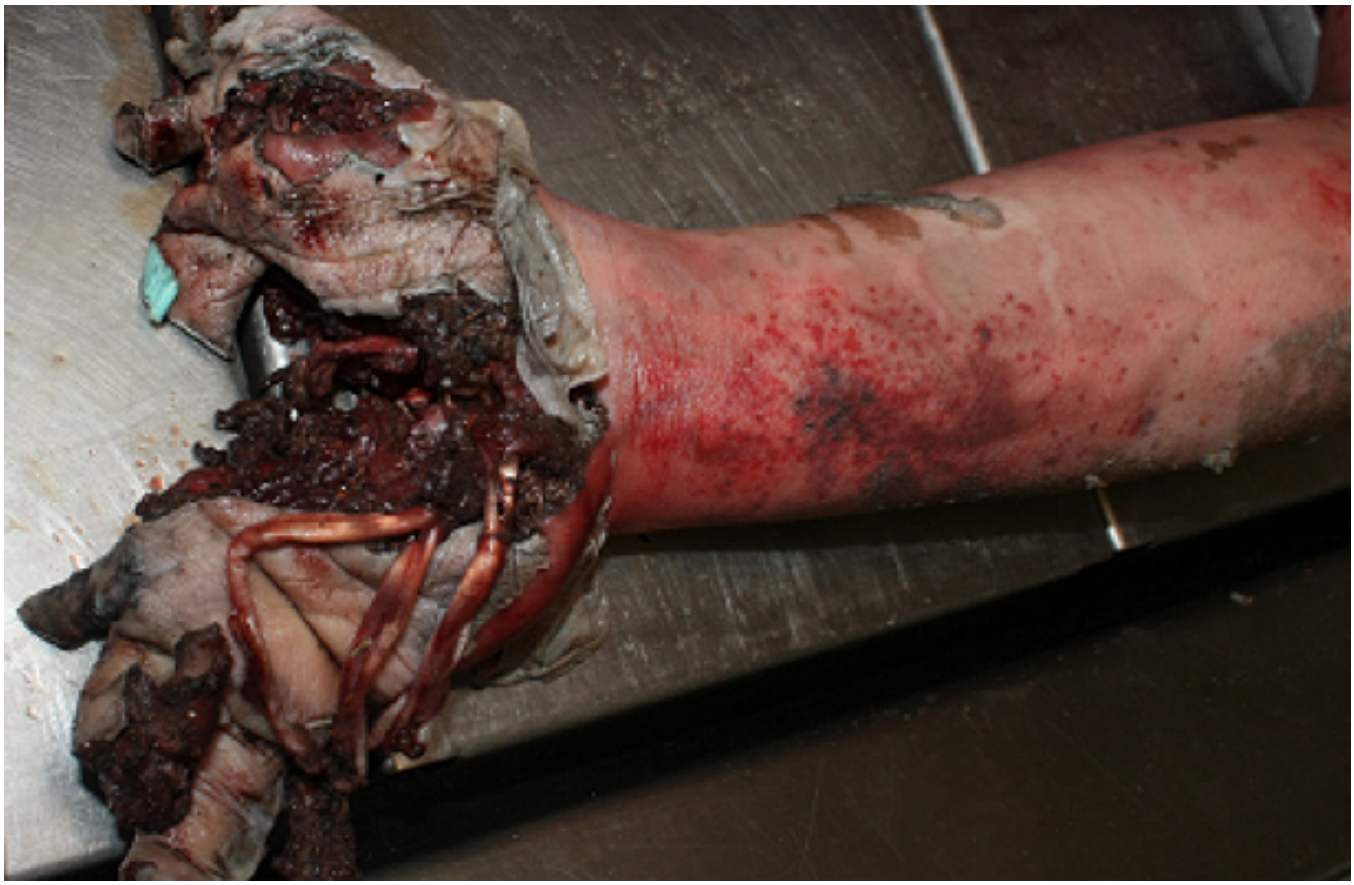

Fig 6. Partial destruction of the left hand with multiple fractures, lacerations of the skin, muscles, tendons and veins, and loss of soft tissue and bone fragments, individual 3.

Source: INML/CF.

Following this initial classification, the injuries were then categorized according to the Bogotá classification and compared with other classification systems:

This case deals with blast injuries of people in close proximity to an explosive device that was handled in a confined space. The findings of the autopsy are concordant with this view

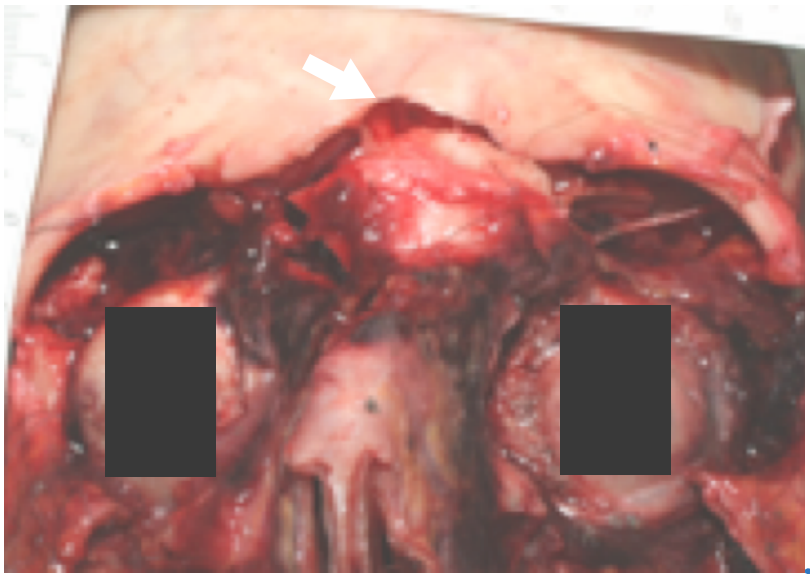

Fig 7. Dissection of the face showing total displaced fracture of the glabella and frontal and nasal bones, individual 2.

Source: INML/CF.

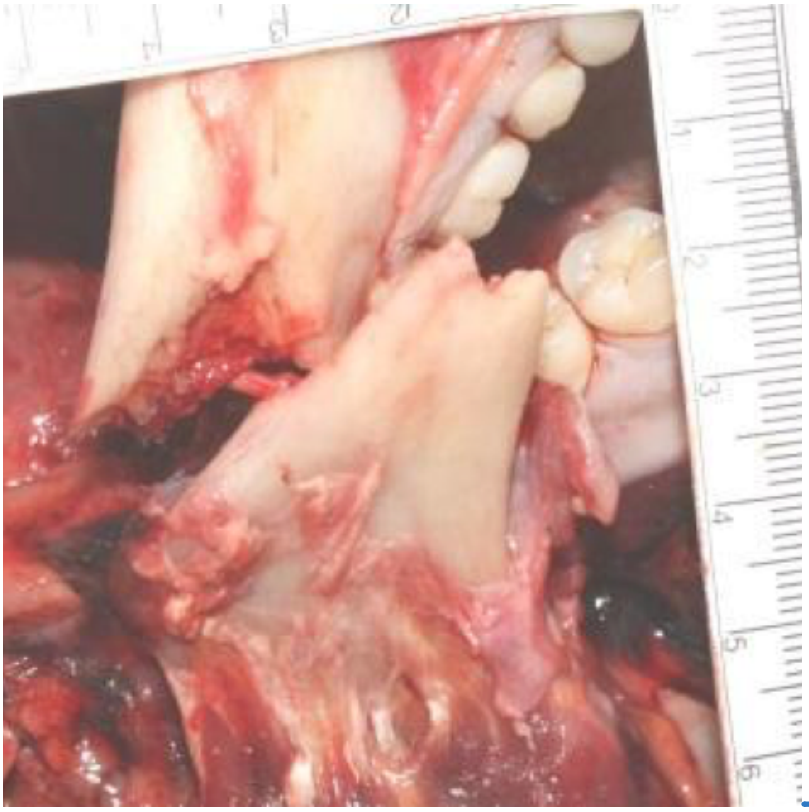

Fig 8. Total and displaced fracture of the maxillary line, individual 2.

Source: INML/CF.

since the bodies display signs of multiple primary injuries.

The hemorrhages of the lungs and colon indicate that the blast crossed through the bodies. In this case, the individuals were very

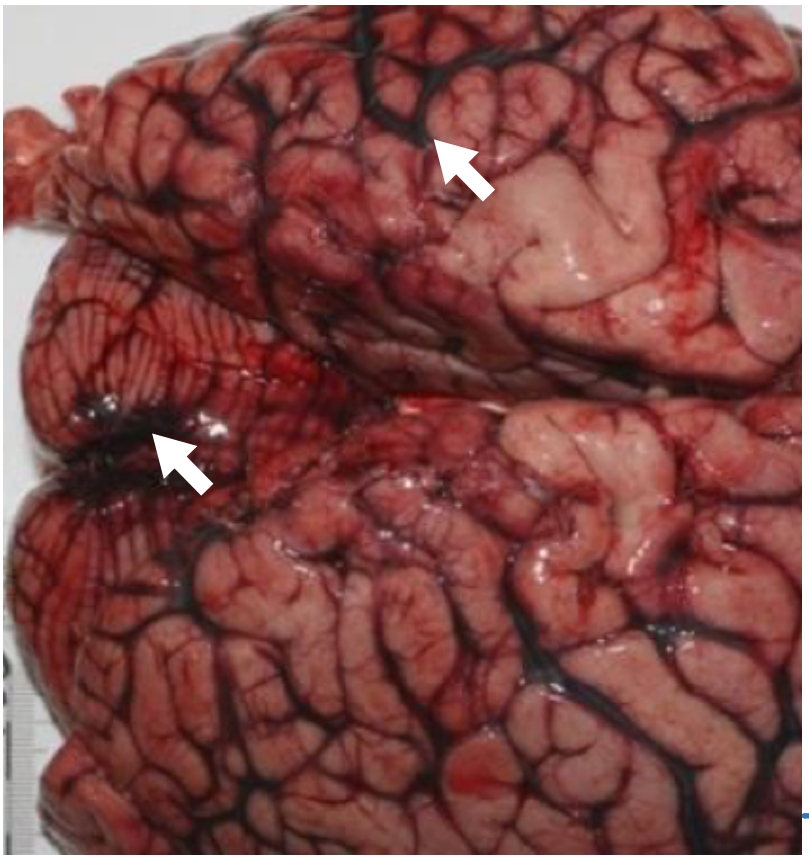

Fig 9. View of the convex surfaces of the brain hemispheres with lamellar subarachnoid hemorrhages most prominent in the left occipital lobe and in the juncture of cerebellar lobes (see arrows), individual 3.

Source: INML/CF.

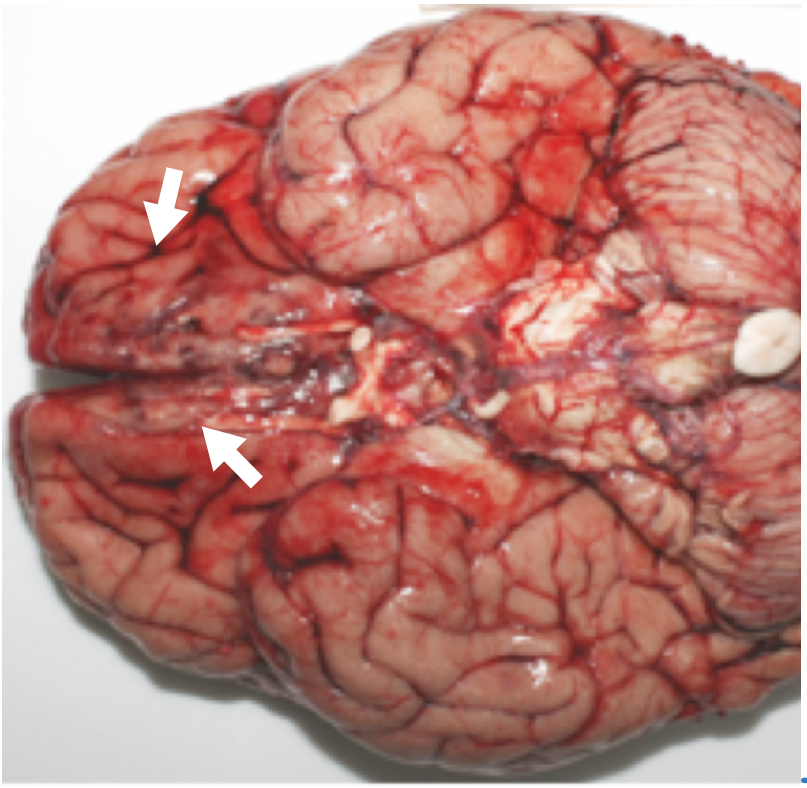

Fig 10. View of the base of the brain with hemorrhagic contusions in medial areas at the base of frontal lobes (see arrows), individual 2.

Source: INML/CF.

near to the center of explosion and being in a confined space, received both the expansion blast and the reflected blast. Wolf explains that abdominal injuries are more common in explosions under water or in confined spaces.

Fig 11. Cranial base with total and displaced fractures in the frontal fossa, individual 2.

Source: INML/CF.

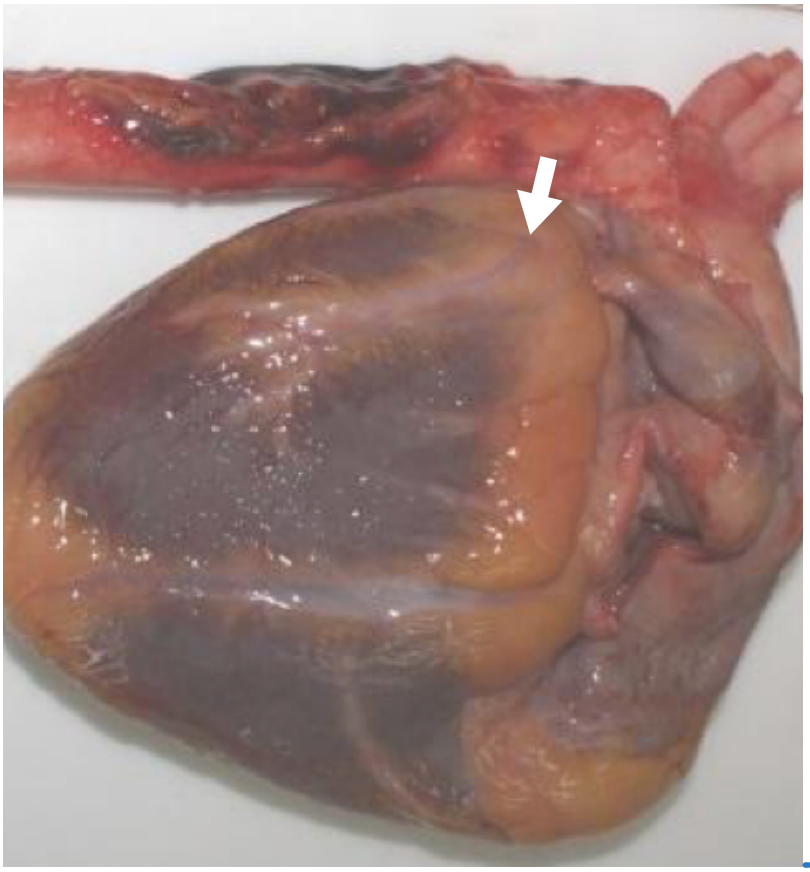

Fig 12. Posterior view of the heart with aortic arch and descending aorta, showing a hemorrhage in the location where the aorta attaches onto the spinal column, individual 2.

Source: INML/CF.

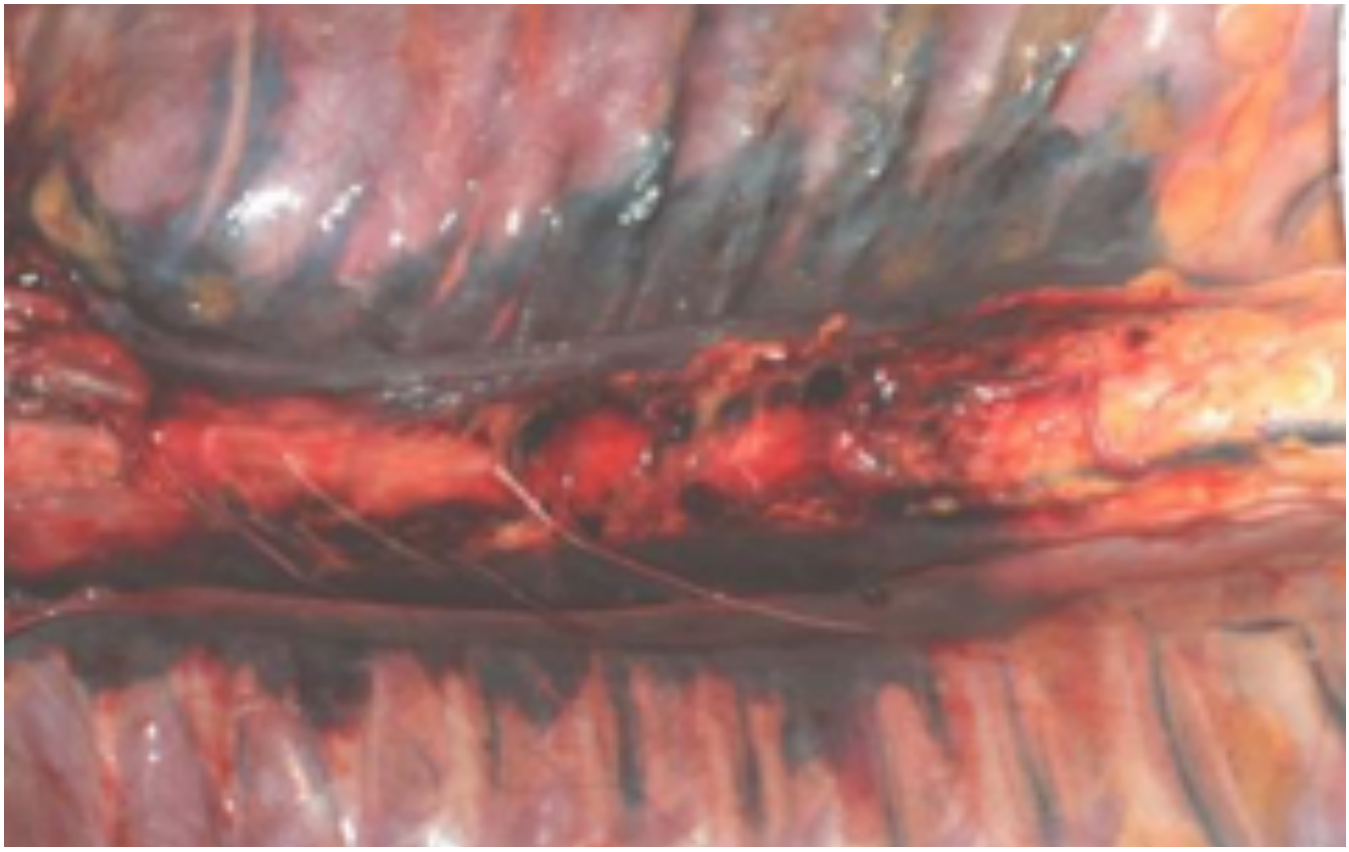

Fig 13. Thoracic cavity with lamellar subpleural hemorrhage in paravertebral areas, adjacent to the descending aorta, individual 2.

Source: INML/CF.

Fig 14. Lateral view of the upper third and face, showing uniform second-degree burns, mainly in areas that were not covered by clothing, individual 2.

Source: INML/CF.

Fig 15. Changes to the skin incurred by carbonization, hyperextension and disruption (see arrows), individual 1.

Source: INML/CF.

Likewise, flash burns can be explained by the proximity to the center of the blast; Saukko mentions that this type of burn only affects people in proximity, unless the device is massive.

The avulsion of hand tissue indicates proximity to the explosive device.

CONCLUSION

The study of this case led to a literature review, searching for a classification system that would allow for the organization and approach of blast injury cases. It was found that the clas-

INJURY	Bogotá	NC PIC	De Palma	Wolf	Uribe	Carnicero	OIM	Patiño	Crane	Saukko
Subserosal hematomas of the colon	1st	1st	1st	1st	1st	1st	1st	1st	*Blast*	*Blast*
Globe rupture	1st	1st	1st	1st	3rd	1st	3rd	3rd	-	-
Pulmonary hemorrhage	1st	1st	1st	1st	1st	1st	1st	1st	*Blast*	*Blast*
Secondary projectile	2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd	Other	Other
Hand avulsion	1st	3rd	3rd	1st	3rd	2nd	1st	1st	-	*Blast*
Paranasal sinus fracture	1st	3rd	3rd	1st	3rd	2nd	1st	3rd	-	-
Mandibular fracture	3rd	3rd	3rd	3rd	3rd	2nd	3rd	3rd	Other	Other
Subarachnoid hemorrhage	1st	3rd/ 4th	3rd	3rd	3rd	2nd	3rd	1st	-	-
Cerebral contusion	3rd	3rd/ 4th	3rd	3rd	3rd	2nd	3rd	1st	Other	Other
Deceleration injury	3rd	3rd	3rd	3rd	3rd	2nd	3rd	3rd	Other	-
Rupture of right atrium	1st	3rd	3rd	1st	3rd	2nd	3rd	3rd	-	-
Flash burn	1st	4th	4th	1st	4th	2nd	4th	Other	Other	Blast
Carbonization	4th	4th	4th	4th	4th	2nd	4th	-	-	Other

Table 2. Injuries according to the classifications. Source: Authors.

sifications in question either frame the study in clinical terms focusing on surviving patients or present injuries of both survivors and the deceased in a non-systematic way. This lack of homogeneity made it difficult to name the injuries found in the forensic case presented, which in turn led to the necessity of creating a new classification proposal to classify injuries of cadavers in an organized way.

The severity of blast injuries varies in relation to the power and quantity of the explosive, open or confined space, and the proximity of the victim to the center of explosion. Given these characteristics, it is important to have a classification that highlights the groupings of all the documented injuries as primary to direct them towards a correlation with the scene and center of explosion

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CASE REPORTS
REPORTES DE CASO

PROCEDIMIENTO ALTERNATIVO DE RECUPERACIÓN DE TEJIDOS DACTILARES E IDENTIFICACIÓN DE UN CUERPO CON EXPOSICIÓN PROLONGADA AL FUEGO. REPORTE DE CASO

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RESUMEN

Se presenta un procedimiento alternativo empleado en la recuperación de tejidos blandos de los dedos (pulpejos) de un cuerpo en condición de no identificado que fue largamente expuesto al fuego, de tal forma que los procedimientos de identificación dactilar de rutina no fueron aplicables.
Un largo proceso de hidratación mediante soluciones de yodopovidona y Complucad® permitió el restablecimiento de los tejidos y la identificación positiva por huellas dactilares del fallecido.

Palabras clave: Huella dactilar; Identificación; Exposición al fuego.

INTRODUCCIÓN

El cadáver es encontrado en una zona despoblada de Bogotá, D.C. sobre unas llantas de caucho abandonadas. El cuerpo presentó calcinación

e incineración, tenía las manos reducidas a la mitad de su tamaño por causa de la exposición a altas temperaturas y los dedos empuñados en postura de 'púgil'. Los tejidos blandos sufrieron alta friabilidad debido a la deshidratación severa, lo que dificultó la recuperación directa de pulpejos para identificación mediante cotejo dactilar de rutina **(1-3)**. Con la ayuda del médico y con el fin de evaluar un proceso alternativo para la recuperación de las huellas dactilares forense se preservaron varios dedos de ambas manos en solución de yodo.

METODOLOGÍA

El proceso de hidratación requirió dos fases.

Primera fase

Las falanges fueron sometidas a hidratación en solución de yodopovidona en agua corriente (1:1) desde el momento de la toma de muestra y por un tiempo aproximado de 3 meses, preservando además el tejido de la descomposición. Este compuesto se emplea de rutina para la limpieza de heridas, bloqueando la actividad bacteriana, y facilita la hidratación de tejidos para estudio lofoscópico.

Segunda fase

Las falanges se sumergieron durante 5 días en la solución Complucad®, sustancia fijadora de tejidos e hidratante con funciones de protección y preservación ampliamente usada en histotecnología y tanatopraxia, con lo que finalmente se logró recuperar elasticidad suficiente de los tejidos blandos para posteriormente aplicar tinta a los pulpejos e imprimir las huellas dactilares del cadáver. Estas impresiones fueron escaneadas para consulta en el Sistema Automatizado de Identificación Dactilar de la Registraduría Nacional del Estado Civil (AFIS por sus siglas en inglés).

Al tiempo que se acercaron familiares al Grupo de Identificación y Personas Desaparecidas del Instituto Nacional de Medicina Legal y Ciencias Forenses en busca de sus seres queridos, se filtró esta información y se comparó con la del Sistema de Información de la Red de Desaparecidos y Cadáveres (SIRDEC) del INMLCF para finalmente seleccionar aquellos casos cuyas fechas de desaparición coincidieran con una ventana de tiempo razonable en relación con la fecha del hallazgo del cuerpo.

Teniendo la identificación positiva del cuerpo mediante el procedimiento alternativo de cotejo dactiloscópico acá descrito, se cruzó esta con la información de los casos seleccionados de la base de datos SIRDEC a partir de los registros, para así poder comunicar a la familia y hacer la posterior entrega de la persona desaparecida.

DISCUSIÓN Y CONCLUSIONES

Los cuerpos calcinados representan gran complejidad para el abordaje de casos en los que se requiere la identificación de los individuos. En la recuperación de tejidos blandos para análisis dactiloscópico es crítico encontrar el procedimiento adecuado para la hidratación y preservación de los mismos y que también evite al máximo la degradación y deterioro por manipulación.

El éxito en la identificación de este cuerpo es producto de años de concienzuda observación y análisis de los tejidos blandos en sus diferentes estados de preservación o exposición a una amplia gama de sustancias químicas. A lo largo de los años de experiencia del laboratorio se han probado diferentes estrategias con la finalidad esencial de hidratar y preservar los tejidos de la descomposición, con tan

diversos productos que van desde compuestos químicos, como el hidróxido de potasio, hasta el agua caliente, el jabón detergente convencional, la glicerina, la lanolina, entre otros.

Ante la complejidad de muchos casos y la carrera contra el tiempo en la preservación de los tejidos, el lofoscopista podría desistir en el camino, pero la perseverancia debe ser la constante en este trabajo para lograr la identificación de un cuerpo sin importar el estado en el que se encuentre.

AGRADECIMIENTOS

A los coordinadores del Laboratorio de Lofoscopia de Bogotá y a los directores regionales del INMDCF en los últimos 6 años, que han permitido la experimentación en diferentes casos, aun a expensas de exceder los tiempos establecidos de respuesta, y con esto apoyaron el logro de identificaciones positivas.

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