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Case Study

EVALUATION OF RADIOLOGICAL VIRTOPSY AS A SUBSTITUTION METHOD FOR TRADITIONAL NECROPSIS IN CASES OF DEATH BY TRANSFIXING WOUND IN THE CRANIAL REGION, DUE TO PUNCH ING ACTION (FIREGUN PROJECTILE)

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ABSTRACT

The current medico-legal investigation has more and more at its disposal imaging exam techniques that aim to help diagnose the cause of death and its underlying pathophysiological mechanisms.

Modern forensic medical investigations increasingly utilize imaging techniques to aid in diagnosing the cause of death and the pathophysiological mechanisms involved.

However, the question raised by the use of these methods is whether they could become substitutes for conventional autopsies, or if they can only be implemented as adjuncts to them.

This study attempted to highlight the advantages and disadvantages of one of the techniques currently used, X-ray equipment, and to perform a comparative analysis of this method in the case of penetrating wounds caused by blunt force trauma from firearms in the cranial region, identifying the injured structures, as well as analyzing the benefit of less invasiveness to the human body.

Keywords: Autopsy, Virtopsy, Transfixing Wound, Firearm Projectile, Skull, Forensic Medicine

Introduction

Taking as a paradigm the moment the world went through, more precisely the coronavirus (COVID-19) pandemic, and the recommendation of the Brazilian Association of Legal Medicine and Medical Expertise (ABMLPM) [1], regarding not performing autopsies on the corpses of people who died from COVID-19, regardless of whether they were classified as investigated, probable or confirmed cases, except for well-founded clinical indications at the time, this work was developed, proving to be a relevant adjunct in the autopsies of corpses victimized by firearm projectiles (FP) that have hit the cranial region.

Since it was not possible to determine whether or not corpses of victims of penetrating-contusive trauma (PCT) were carriers of COVID-19, the prevailing thought was that they all were, and therefore, all precautionary measures should be taken by forensic experts, avoiding spreading fragments when removing, handling, or washing organs, especially lung and intestinal tissue [2].

In order to adapt and protect ourselves, it was suggested that a study be carried out in which radiographs of cadavers of victims of death by penetrating head wounds resulting from blunt force trauma (BFP) were analyzed, and their subsequent correlation with the corresponding conventional autopsy. This aimed to evaluate the usefulness of radiological virtopsy in certain cases to elucidate the cause of death and the circumstances surrounding it, without the need for the classic examination.

Imaging studies represent a powerful tool for forensic medicine; there are increasingly more cases where the application of this type of technology is necessary in the field of forensic science [3].

Virtopsy emerged with the introduction of computed tomography (CT)

and magnetic resonance imaging (MRI) in post-mortem examinations [4].

Virtopsy has a high capacity to accurately detect and locate anomalies common in forensic practice, such as hematomas, abnormal gas collections, fractures, and also metallic bodies [5], which is why it was chosen for this work.

Connected to the reasons presented above, there is also the economic factor, since it is known that there is a lack of imaging equipment in public hospitals of the SUS (Brazilian Public Health System), either due to their non-existence or lack of maintenance; in Legal Medicine services, the reality is the same, the existence of CT scanners and Magnetic Resonance Imaging equipment is an exception, with X-ray equipment being available only in some services, as is our case.

APPLICABLE LEGISLATION – BRAZILIAN LAW

Article 162 of the Code [6], of Criminal Procedure states:

" The autopsy will be performed at least six hours after death, unless the experts, based on the evidence of the signs of death, deem that it can be performed before that time, which they will state in the report.

Sole paragraph. In cases of violent death, a simple external examination of the corpse will suffice when there is no criminal offense to investigate, or when the external injuries allow the cause of death to be determined and there is no need for an internal examination to verify any relevant circumstance".

In order to understand how Article 162 of the Code of Criminal Procedure, more specifically its Sole Paragraph, justifies and supports this research work, it is necessary to comment on the Extensive Interpretation of the Law.

Extensive interpretation of the law occurs when the law lacks breadth, meaning that it does not cover what is needed to address the specific case, and the interpreter must verify the limits of the rule.

Extensive interpretation is a decision-making technique in which the applier of the law expands the meaning of the rule, causing a case that, at first glance, is not covered by it, to become covered. In this way, one can speak of the subsumption of this case to that "extensive" rule.

We cannot deny the instrumental nature of the term "extensive interpretation," otherwise it could compromise the analysis of some judgments.

For illustrative purposes, we have a norm established in the Federal Constitution that protects the home (article 5, XI) [7]. Thus, when it refers to the word "home" as the inviolable asylum of the individual, where no one may enter, it can be interpreted theologically, generating an extensive result, that is, the applier can construct an extensive interpretation in which the protection that the article allows for "homes" will extend to dental offices, law firms, and others.

This broad interpretation, in the aforementioned example, was possible thanks to the similarities with the term "house" (a privately owned, enclosed place with restricted access), and no one can enter without prior legal authorization or the owner's permission.

This differs from a broader interpretation where, if it weren't broad, "house" would be understood in a common sense and wouldn't encompass offices or consulting rooms.

Our understanding aligns with the doctrine that holds that extensive interpretation does not create new law, but only aims to identify the true content and scope of the law when it has not been sufficiently expressed in the normative text.

When, in the aforementioned Sole Paragraph, the Legislator expresses, "in verbis":

"In cases of violent death, a simple external examination of the corpse will suffice when there is no criminal offense to investigate, or when the external injuries allow the cause of death to be determined and there is no need for an internal examination to verify any relevant circumstance".

It can be concluded that, in cases of violent death, when external injuries allow... note that the legislator, when creating this rule, was unaware of the possibilities that technological advancements would achieve.

As a legal science, Law was born in an outdated way, in the sense that it has always addressed the desires that society already experienced. It is no coincidence that when we talk about the field, we immediately think of something classical, with more traditional foundations.

On the other hand, the word "technology" conveys an idea of modernity, progress, and the future.

With the impact of innovations developed in recent years, the legal field is increasingly incorporating these concepts into its image. The area is modernizing, creating new work formats and providing litigants with better solutions to disputed cases.

Given this scenario, reflecting on the relationship between law and technology becomes a relevant topic for professionals in both fields [8].

As an example of this relationship, we can cite document digitization, video calls, and electronic calendars, which are some examples of tools developed for different audiences that greatly facilitate work in the legal field.

We have moved away from the era of physical processes, where thousands of sheets of paper were printed for each petition, and entered the phase of electronic judicial proceedings, regulated by Law No. 11,419, of December 19, 2006.
With this, it is possible to access, consult, and even file petitions from anywhere in the country.

It is no longer necessary to go to the courthouse with two printed copies of the petition, wasting time and resources on travel. Now it is possible to save time and be more sustainable, as well as having access to and easy-to-follow tracking of the process.

In short, the electronic process was a milestone in the application of solutions involving law and technology.

Nowadays, with the concept of virtopsy, internal lesions can be identified with minimal chance of error, without the need for internal examination, and once again, the extensive interpretation of a norm meets the desires of a society that modernizes every minute.

Finally, in our view, classic examinations of certain injuries have no practical significance, offering little or no addition to the investigation and, on the contrary, only serve to further mutilate the corpse.

In order to demonstrate what we are stating here, we present a case in which the classic necropsy contributed nothing, either to identifying the cause of death or to gathering evidence, serving only to increase the team's exposure to biological risks and increase the degree of deformity of the corpse.

To exemplify what we are stating here, we will present a case of a penetrating wound in the cephalic region, the region that is the object of study in this work, for the application of this type of necropsy.

In the photograph provided alongside, the gunshot wound entry wound is identified, with the caveat that it shows a lesion suggestive of the muzzle and/or sight impression on the victim's skin (circled in blue).

In the photograph shown alongside, a wound with everted and irregular edges can be identified, consistent with a gunshot wound exit wound (circled in blue);

Having identified the wounds resulting from the penetrating injury caused by the firearm, a metallic stylet was introduced through the entry wound, after taking photographs that would allow for its subsequent study, and was slowly pushed towards the exit wound, in order to demonstrate the path taken.

In the photograph provided alongside, we demonstrate the presence of a metallic stylet, describing the path taken by the firearm inside the cranial cavity.

Information about the angle of incidence of the entry wound is one of the most important and necessary, as it will allow Forensic Experts to establish the trajectory of the projectile.

With this type of procedure, it is possible, without any difficulty, to identify the path taken by the FP inside the skull and, with the aid of the technique that will be presented, the subject of this work, to accurately identify the compromised structures, without the need to perform the classic technique which, as has been expressed, only serves to increase the team's exposure to biological risks and increase the degree of deformity of the cadaver.

In the photograph provided alongside, we demonstrate what was found during the classic necropsy technique.

After making the bimastoid incision and reflecting the scalp, significant hemorrhagic infiltration is observed on the deep surface of the temporal flaps and muscles; the cranial vault is completely fractured, with involvement of all three levels of the skull base; the brain is transformed into an amorphous mass.

OBJECTIVES

The objective of this study was to evaluate the correlation between radiological findings and classic autopsy findings in corpses of victims of death caused by penetrating blunt force trauma (firearm projectile (FP) in the cranial region), in which the lesions were of a transfixing nature, with no FAP remaining to be preserved for subsequent forensic study.

Utilize X-ray imaging technology to detect and document forensic evidence, improving classic observer-independent autopsies. Demonstrate that radiological virtopsy is a tool for rapid identification and examination of corpses, victims of gunshot wounds, of the penetrating type. Show its applications and objectivity in forensic autopsy conclusions [9].
Describe the quality, capacity, and efficiency that this method can bring to case resolution.

Related to the reasons presented above, there is also the economic factor, since it is well known that there is a lack of imaging equipment in public hospitals of the SUS (Brazilian Public Health System), either due to their non-existence or lack of maintenance; in Forensic Medicine services, the reality is the same, the existence of CT scanners and Magnetic Resonance Imaging equipment is an exception, with X-ray equipment being available only in some services, as is our case.

MATERIALS AND METHODS

This work has been approved by the Center for Forensic Studies and Research of the Civil Police of the State of Rio de Janeiro and has received a substantiated opinion from the Ethics Committee of the Federal University of Rio de Janeiro (UFRJ).

Between May 2021 and June 2023, we conducted radiological studies on the bodies of 20 (twenty) corpses, victims of death by penetrating wound, resulting from blunt force trauma, in the cranial region, sent to this Regional Technical- Scientific Police Post (PRPTC) of the municipality of Niterói-RJ, of the State Secretariat of Civil Police (SEPOL) of the State of Rio de Janeiro – RJ, by the Homicide Division of Niterói-São Gonçalo and Itaboraí (DHNSGI) and District Police Stations of the municipalities of Niterói and Maricá.

For this study, the cadaver is first examined, and existing wounds are assessed and photographed, identifying those with characteristics of being entry wounds, which are marked with the letter E, and those with characteristics of being exit wounds, marked with the letter S, for PAF; then, a metallic stylet is introduced through the wound identified as an entry wound, and, delicately, the path taken by the PAF is retraced by the stylet until it reaches the wound identified as an exit wound.

With the probes in place, the cadaver undergoes radiological examination to identify the path taken by the gunshot wound inside the body and, subsequently, undergoes a classic autopsy, still with the probes in place, identifying, step by step, the path and the structures involved.
.
In each case, a correlation was made between the findings from the imaging study and the cadaver study, describing the alterations and similarities found.

In the cases of wounds located in the cephalic region, the technique proved to be extremely easy to employ.

WOUND ASSESSMENT FOR IDENTIFICATION OF ENTRY AND EXIT WOUNDS FROM FIREARM INJURIES - SHOT INCIDENCE - ABRASION RIM - THE MEDICO-LEGAL IMPORTANCE OF STUDYING THE ABRASION RIM.
To identify both entry and exit wounds in firearms, we sought to identify the edges described in the forensic literature as characteristic of both entry and exit wounds.

TECHNICAL SPECIFICATION OF EQUIPMENT FOR EXPERT REPORTS ON CADAVERS THROUGH X-RAY INSPECTION

In the image provided to the side, we present the technical specifications of the equipment for forensic imaging of corpses through X-ray inspection.

EXAMPLE OF OPERATIONALITY
Currently, the Forensic Science Police of Rio de Janeiro has an X-ray machine, which allows for easier identification and location of firearm projectiles (FP) inside the body of a corpse, as well as other foreign bodies.

In the photograph on the side, taken at the Regional Technical-Scientific Police Station (PRPTC) of Niterói, we demonstrate the use of the X-ray machine during the search for FP in the corpse.

Note that there is an image in which the Expert observes the body, to choose the location he wishes to X-ray (circled in red).

METAL STYLETS – BALLISTIC ROD

To assess the correlation between radiological findings and classic autopsy findings in corpses of victims of death caused by blunt force trauma resulting from firearms, in which the lesions were transfixing and there was no firearm to be preserved for later forensic study, metallic styluses (ballistic rods) were used.

These rods were introduced through the wound identified as the entry wound, and the path taken by the firearm was delicately retraced by the stylus until it reached the wound identified as the exit wound.

To demonstrate the importance of using a ballistic rod, we will reproduce below a sequence of images, copied from the television series, shown on the "AXN" channel, called CSI (Crime Scene Investigation), Season 7, Episode 1, in which the Forensic Expert, to identify the trajectory of the firearm inside the corpse, uses the introduction of a ballistic rod for this purpose.

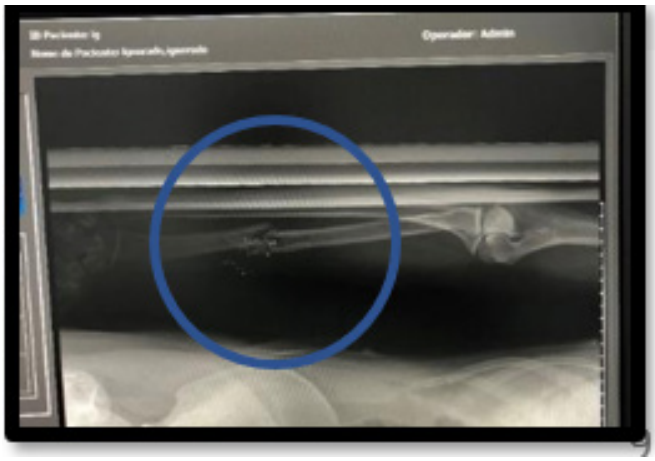
In the image provided alongside, the forensic expert can be seen inserting the rod into the corpse's body.

In the image provided alongside, the rod in the corpse's body can be identified (circled in red), indicating the path the firearm took when it pierced the body.

METALLIC DUST

Metallic dust is a radiological finding characterized by small whitish images that are related to the entry, exit, and path of the PAF (Phase-like Artificial Infiltrator).

In the image shown, we present a case of metallic dust (circled in blue) associated with a diaphyseal fracture of the radius bone, resulting from the direct impact of a firearm.



This dust can be useful when studying the trajectory of the gunshot wound, such as, in some cases, in determining the entry wound.

It is important to keep in mind that metallic dust is not always associated with an entry wound, depending on the type of gunshot wound.

In bare lead projectiles, semi-jacketed (hollow point), hollow point with a central pin, and hollow point projectiles, metallic dust may be found near the entry wound; in jacketed projectiles, it may be found near the exit wound, since the core fragments are expelled from the base of the projectile.

COMMENTS

From what can be inferred, placing a metallic probe along the path traveled by the PAF (Pulmonary Fibrillation Device) perfectly locates the anatomical structures it affects; with the use of X-ray equipment, this location becomes practically certain, confirming the hypothesis put forward for this study.

CASE PRESENTATIONS

1- Procedure no.:xxxxxxxxxxxxx
Date :xxxxxxxxxx Sex: xxxxxxxxxxxx Color: xxxxxxxxxxxxx
Cause of death: Blunt force trauma (BFP) - skull (penetrating wound) Location of wounds: on the skull.

Photograph revealing the entry wound circumscribed in red.

Photograph revealing the wounds from the gunshot wound, both from the gunshot wound, metallic fragments and bone splinters, circled in red.

In the photograph provided to the side, we present the autopsy findings from inside the cranial cavity when only the scalp was incised.

In the photograph provided below, we present the radiological examination of the skull, making it possible to identify metallic dust and fractures of all the bones of the cranial vault.

In the photograph provided below, we present a diagram of the injuries found on the corpse, with those represented by the letters E1 and S1 being of particular interest.

The relevance of this case to the work presented here is based on the fact that, with the external examination and radiological examination, there was no need for the traditional autopsy technique, since the fractures and metallic dust found already allowed us to foresee the severity of the brain lesions that would be found, as well as the trajectory of the firearm.

Since there was no FP (firearm) to be recovered, the traditional technique only exposed the brain contents, transformed into an amorphous mass, which meant nothing for the investigation of the authorship of the crime;

it only increased the working time and exposed the team to yet another unhealthy situation.

2-Procedure no:xxxxxxxxxxxxx
Date:xxxxxxxxxxx
Sex:xxxxxxxxxxxxxxxxxx
Color:xxxxxxxxxxxxxxxx

Cause of death: Blunt force trauma (BFP) - skull (penetrating wound) - face (penetrating wound) multiple penetrating wounds, one of which had the BFP lodged in the subcutaneous tissue.

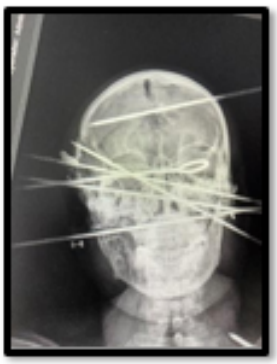
Location of wounds: on the skull and face.

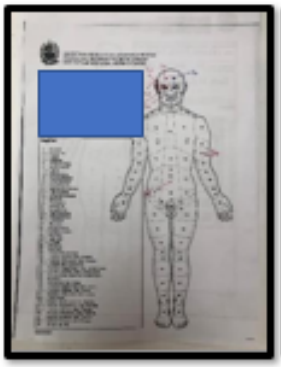
Photograph provided below, revealing the entry wounds Circled in blue

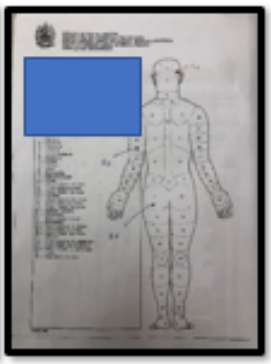
Photograph provided below revealing the entry wounds Represented in the diagram by the letters E associated with a number.

The photographs shown alongside reveal the wounds identified as exit wounds, circled in red, and entry wounds, in blue.

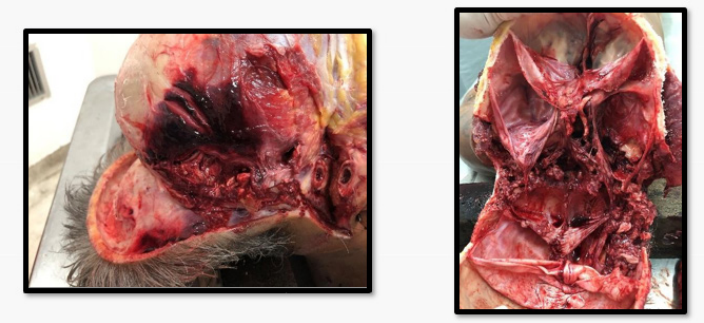
In the photographs shown alongside, we display the radiological examination, with the inserted metal probes and the diagrams used to describe the wounds.







In the photographs shown below, we present the autopsy findings when we incised the scalp; the right side of the skullcap, to the reader's left; and, after the removal of the brain, to the reader's right, showing the bone lesions already observed in the radiological views, which demonstrates the unnecessary nature of performing the classic autopsy technique.



The relevance of this case to the work presented here lies in the fact that, with the external examination and radiological examination, there was no need for the traditional autopsy technique, since the fractures and the trajectory of the gunshot wounds observed in the radiological examination already allowed us to foresee the severity of the brain injuries that would be found.

Since there was a firearm to be recovered, the traditional technique was only necessary for its removal and safekeeping.

DISCUSSION

When studying injuries caused by firearms, in addition to identifying the distance, caliber of the weapon, and the weapon itself, the incidence and angle are of paramount importance, as they allow for the reproduction of the event's dynamics.

With the study of the trajectory identified by the metallic stylus (ballistic rod), this knowledge becomes yet another piece of data in the search for the truth of the facts.

We agree with Aguiar when he expresses his observations regarding the use of X-ray equipment (FlatScan) as a substitute for traditional autopsy and, for us, in cases of transfixing wounds, produced by firearms, in the cranial region, where there is no firearm projectile (FP) to be preserved for later forensic study, the superimposition of radiological images, with styluses inserted in the trajectories developed by the FPs and, when necessary, with images obtained from 3D anatomy atlases, we believe is sufficient for the identification of the injured structures, making traditional autopsies unnecessary.

The radiological study of metallic dust remains important for identifying the entry wound, exit wound, trajectory, and resting place in cases of penetrating wounds of the pelvic organ, greatly facilitating its location inside the body of the cadaver.

This method of performing autopsies, in addition to being less invasive, also results in less exposure of the team to pathogens that inhabit the corpse, saves time in the overburdened forensic medicine services, and, in religions10 where mutilation of the corpse is prohibited, such as Judaism and Islam, avoids numerous inconveniences.

Also important, in all cases of gunshot wounds, whether penetrating or not, is the ability to accurately identify the angle and trajectory, which are extremely important for studying the dynamics of the event.

When studying gunshot wounds, in addition to identifying the distance and caliber of the weapon, the incidence and trajectory are of paramount importance, as they allow for the reproduction of the event's dynamics.

By studying the trajectory identified by the metal stylus (ballistic rod), this knowledge becomes yet another piece of information in the search for the truth of the facts.

CONCLUSIONS

Our conclusion is that Vitoppsy using X-ray equipment (FlatScan) is an innovative method compared to traditional autopsy examinations in cases of transfixing skull wounds caused by firearms, where there is no firearm projectile to be preserved for subsequent forensic study.

In cases of penetrating skull wounds, the technique can be perfectly employed, requiring only the proper use of the X-ray machine, ballistic probes and, when necessary, the use of an anatomy atlas.

Conflict of Interest Declaration

The authors declare that they have no affiliation with or involvement with any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

Each author warrants that this work contains no libelous or unlawful statements and does not infringe or violate the publicity or privacy rights of any third party, libel, slander, contain any scandalous, obscene, or negligently prepared information, or infringe or violate any other personal or proprietary rights of others. Each author warrants that the work does not contain any fraudulent, plagiarized, or incorrectly attributed material.

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