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Current State of the Art on Identification Through Fingerprints Present in Firearm Cartridge Cases - a Review

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ABSTRACT
Introduction: the present work is a review of forensic ballistics, forensic medicine, and papilloscopy. Its main focus is on the recovery of latent fingerprints in fired cartridge cases of firearms. Fundamentals of internal and intermediate ballistics are being exposed, as well as fundamentals of the anatomy of the integumentary system to explain the formation of the fingerprint. Finally, techniques of analysis of cartridge cases and the components of analysis are presented to point out the best ways to recover impressions of the shooter without, however, damaging or destroying important traces for the criminal investigation. It is important to highlight that this type of forensic methodology is practicable in the laboratory in a way that is not costly to the State and also allows quick and reliable results. Because it is a little explored topic, there was a need for this integrative review, given its importance for criminalistics and forensic sciences in general, especially forensic ballistics and forensic medicine.
Keywords: Forensic Ballistics; Forensic Medicine; Forensic Sciences; Firearms; Fingerprints.

Introduction

First, it is necessary to understand what a firearm is, the difference between unfired and fired cartridge cases, and how it works regarding the firing of a gun.

Gunpowder was a great advent in terms of artillery and could be used so that objects could be launched at great distances, being able to lethally reach distant targets in movement, as well as cross physical barriers, breaking the defense of the opponent and allowing a range of greater lethality[1]. That is, the creation of gunpowder and its use as a propellant was a determining factor for what would later be defined as a firearm. In these terms, the firearm is a complex mechanism for throwing projectiles using the expansive force of gunpowder combustion and the generation of gases that will push the projectile[1-6].

Weapons can be classified according to whether their barrel is long or short, whether they have a smooth core for those barrels where there is no need to rotate the projectile or where multiple projectiles are fired in a "single bullet" shot, as in shotguns and revolvers in which the interior of its barrels is completely smooth, without any additional contours, fed by cartridges or with a rifled core like the vast majority of firearms in which the barrel's rifling directs the direction of rotation of the projectile and still leaves marks of grooves that are identifiable in comparative tests of forensic ballistics, which compares the projectile recovered from a body or a crime scene with that of the alleged weapon who fired it. The raying system is a machined helix that crosses the inside of the barrel promoting rotation of the projectile to stabilize it during the trajectory of the shot[7].

As for portability, firearms of reduced size and weight are small arms that can be easily fired by the shooter with just one hand, as is the case with a revolver and a pistol[8]. They are portable long-barreled weapons that can be carried by one person but generally do not allow them to be fired with just one hand, requiring the support of the second hand or a shield, as in the case of shotguns, rifles, and submachine guns [8]. Finally, there exist non-portable weapons that, due to their size or high weight, require two or more people to transport them or the use of a wheeled or self-propelled vehicle to transport them, as in the case of machine guns and cannons[8].

About papilloscopy, is shown to be the primary method of identification of human beings because it is fast and has the lowest cost for its collection, analysis, research, and archiving according, for example, to the Vucetich System currently used in Brazil. In this way, papilloscopy is preferable in the analysis of crime scenes and cadaver identification, the second method being forensic dentistry, and the third, due to its complexity and high cost, DNA analysis.

Papilloscopy is divided into dactyloscopy, chiroscopy, podoscopy and poroscopy. With the aid of chemical revealing agents such as powders and

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chemical reagents or physical means such as the use of ultraviolet light or white light in an oblique position, it is possible to reveal the complete or latent fingerprint.

This work aims, through a literary review, to point out the benefits of each means of revealing and obtaining fingerprints, as well as explaining the functioning of internal and intermediate ballistics, which are the moments in which thermal changes and friction can occur that can make the work of the papilloscopist difficult.

Materials and Methods

As materials for the present work, scientific papers, monographs, and books were used for its preparation. Searches were taken in portals such as CAPES and Scielo database and leading international journals in forensic, medical, and technology sciences. The keywords used for research were "papilloscopy", "dactyloscopy", "firearm case", "latent", "cartridge case", "fingerprints" and "brass cartridge case". A total of 77,893 publications were found with the keywords above on the CAPES Journals platform, 72 were filtered and 4 were used because they fit the proposed theme, and, 451 publications were found on the Scielo database, which are filtered by the same method.

Due to the small number of works found within the keywords criteria, it was necessary to search extensively in university portals and specialized journals to find articles, books, theses, and other publications that fit the proposed topic.

Concerning cartridge cases and firearms

As for the loading system, it can be preloaded, which is defined as "weapons in which loading is carried out by the front part of the barrel, that is, by the projectile's exit end, such as blunderbusses, harquebuses, and muskets", weapons these older ones, used today mostly only for exhibitions or demonstrations, as well as retro-loading, which are "firearms whose ammunition is added to the barrel at the rear, that is, in the part closest to the shooter, such as pistols, revolvers, carbines, rifles, and shotguns"9.

As for how they work, weapons can be repeating, semi-automatic, or automatic. Repeating weapons require mechanical action from the shooter for the instrument to continue shooting. For example, a revolver needs the trigger to be pulled so that the hammer is cocked while the drum rotates, positioning the cartridge in front of the barrel, and at the end of pressing the trigger the shot is carried out, it being necessary to repeat the movement so that another cartridge moves to the firing point, and so on until the end of the charge present in the drum.

Semi-automatic weapons perform all movement automatically, requiring only one supply and every shot will be performed by pressing the trigger. This movement characterizes it, as it is necessary to press the trigger to fire, the case is ejected by the force of the gases and the mechanical action of the bolt or slide with the support of the extractor. The weapon is again fed through its magazine or another system, and for another shot to be carried out it is only necessary to press the trigger again, not requiring the loading movement popularly known as "cocking the gun", as it will be automatically ready to fire a new shot.

Finally, in automatic weapons, loading and shooting occur automatically without the need to press the trigger for each shot, just keeping it pressed is enough for the continuous operation of the weapon, being only necessary for its loading and feeding with the insertion of a new magazine when whatever is in it is empty.

As for raying, it consists of the concept of streaks as internal excavations in the barrel of the firearm using helical-shaped milling cutters to generate rotation in the projectile to maintain its stability during its trajectory[10]. The raying is produced during the manufacture of the weapon and the tool used will leave unique characteristics that will be transferred to the projectile after firing, making it unique in the eyes of the criminal expert in a ballistic comparison, thus being a kind of fingerprint of the projectile and the weapon, an effect of great importance to criminalistics[11].

However, this work focuses on cartridges, in its main models used all over the world today, mainly in the case that can be made of metallic material, in its great majority of brass easily found in the national and international industry, being the most common, there may be stainless steel, aluminum, copper-plated or nickel-plated cases (figure 1A)[12]. Brass cases are of greater interest for this research because of their large quantity on the market and nickel-plated cases because they are produced in large quantities and their color is different from the brass-plated case at the time of the papilloscopic examination.

Cases can be cylindrical, truncated-conical, or tapered with a neck, each type for its specific weapon. Cylindrical and truncated cones are more common because they are attributed to short weapons, as in the case of revolvers and pistols, and the conical ones with a neck are attributed to long weapons with high-energy projectiles, as in the case of rifles and sniper rifles.

They also have bases and breeches (figure 1B) varied according to their extraction system and fuze also varied according to the case and propelling charge, and in the most common cases they can be fuzes in the boxer, berdan, or battery model. It can also be central fire when there is a fuze in the center with an initiator mixture, this model is more common in calibers currently used, or circular fire when the initiator mixture is on the lower edges of the case, more common in .22LR caliber ammunition, for example, in which the percussion occurs at the ends of the case and not in its center as already explained in the case of central fire cartridge (figure 1C)[13].

Figure 1. A) Varieties of metal cases (from left to right): brass, stainless steel, aluminum and nickel-plated brass; B) Varieties of breeches, in order: salient breeches with circular flare, two cases of breeches without ribs, salient breeches with central flare and semi-protruding breeches; C) Examples of fuse marks, the first being a central fire and the second a circular fire; D) Top view of varied cartridges, in order: anti-riot, elastomer, bullets for sports practice, SG bullets for defense, SG bullets for defense with nickel-plated base, knock down bullet and knock M3 plus; E) Front view of cartridges; F) Fired cartridge case with latent fingerprint revealed by white developer powder; G) Fired cartridge case with latent fingerprint revealed by black developer powder.
Source: own authorship.

There are also non-metallic cases, known as cartridges, most of which are made up of a brass or nickel-plated base where the fuze is found with the initiator mixture, the propellant followed by a bushing and the projectile that can be individual or multiple, as we can see in figure 1D and figure 1E the presence of closed cartridges with multiple bullets and open ones with lead bullets, this brass or nickel base being continued by a plastic body to coat the projectile. In the past, it was common to use cardboard cartridges, but these fell into disuse because they deformed more easily and because they had less resistance to friction with other surfaces as well as humidity, problems that were overcome by polymer cartridges.

The metallic base used in cartridges is necessary to contain the ignition system and effectively seal the chamber for better combustion and use of the propellant and the gases resulting from its burning.

Papilloscopy and expert practice in collecting fingerprints from fired cartridge cases

The study of papilloscopy is a modern science, however, the use of fingerprints comes from the dawn of humanity. Archaeological studies have shown that primitive man imprinted palm drawings in the caves they inhabited and on personal ceramic objects[14]. They used natural pigments and ceramics to leave their impressions.

In ancient China it was customary to legitimize contracts with the use of the right thumbprint, however, it was a custom and it is not possible to specify whether the Chinese already knew the uniqueness of the fingerprint[14].

From the 17th century onwards, with the end of the empirical period of papilloscopy and the beginning of its scientific period, large studies began to be produced by names such as Marcelo Malpighi, William Hershel, Henry Faulds, and Francis Galton. All great collaborators of this science, however, it was with Juan Vucetich that papilloscopy took on the form it has today.

Juan Vucetich, Austrian by birth, despite his most notable achievements were in Argentina, the country where he settled, became naturalized and entered the police force, where he used papilloscopy to solve a crime, giving it notoriety and slowly started his career on identification and archiving system to the detriment of Bertilonage method, still used in most parts of the world.

First, it is necessary to understand that papilloscopy is the study of papillary impressions left as traces or for human identification. This science is divided into dactyloscopy, the study of the papillary impressions of the fingers; chiroscopy, the study of the papillary impressions of the palms; podoscopy, the study of the papillary impressions of the soles of the feet; and *poroscopy*, the study of the pores of the papillary crests, through which sweat and the natural oil of the skin known as sebum secrete, forms the means of better individualization of the human being, despite it being difficult to obtain clearly, given its small size and ease of being covered by paint or dust during collection or making the decal.

Papilloscopy has its application in the criminal sphere as an aid of police investigation, acting in the correct identification of the detained suspect, in the case of victims, mainly unknown ones or in a state of putrefaction, using necropapilloscopy in field expertise in search of the suspected of having committed the crime that led to the examination carried out[15].

The Vucetich classification method is used according to the presence or absence of the delta. When there are two deltas and a central core, there is a whorl; the presence of a delta to the left of the observer and a core opposite the delta, we have the outer loop; if the delta is on the right, there is an internal loop; and in the absence of deltas, the digital is called an arc[16].

There are statistical indications of the amount of each printing format in its base form, without including minutiae as shown in the chart below (figure 2)[17,18].

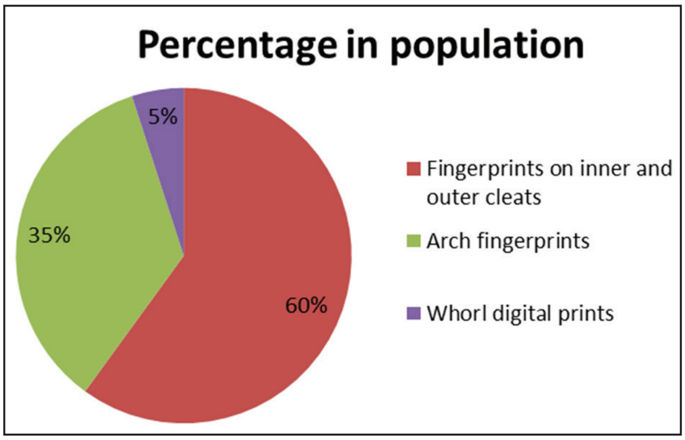

Figure 2. Percentage of fingerprints in global population.

Legal medicine literature says that "one of the most important elements of digital drawing is the delta – a small angle or triangle formed by the meeting of the three systems of lines"[19]. The delta is the fundamental characteristic of fingerprint classification, being divided into three linear systems. The nuclear system of a fingerprint, as the name implies, is between the basilar and marginal lines, with the marginal lines being superior to the nucleus and facing the ends of the fingers and the basilar lines facing the bases of the fingers, close to the interphalangeal folds[19]. The presence of one or more deltas or their absence will be the determining factor for classifying digitalis into one of the four fundamental types.

From the core, baselines, deltas, and marginal lines, it is possible to identify the digital design and compare it with another design for a confrontation that can identify an unknown corpse or a criminal. For that, detailed studies will be necessary. These details make up the digital drawing and serve as reference points for identifying a fingerprint in confrontation, for its classification, or the recovery of a latent fingerprint.

But first, it is necessary to understand what latent fingerprints and other fingerprint variables are. Through fingerprint deposition, it is possible to obtain visible, latent (or hidden), or modeled fingerprints[20]. The visible one, as the name implies, is visible to the naked eye because it has been deposited on coloring material or with the aid of ink, blood, or any other substance that allows it to be seen easily. The modeled type is left on moldable surfaces such as clay, clay, soap, or another soft surface that is easy to manipulate, but which does not deform easily. Finally, the *latents* type is invisible and transferred through the presence of sweat and fat present in human skin, and can be revealed with the aid of powders or chemical agents.

Details such as points, islands, islets, enclosures, bifurcations, beginning and end of the line are characteristic details that are sought by the criminal expert or by the police papilloscopist to identify the individual. Flaws such as scars, albodatyloscopic lines, birthmarks, or work marks can also help in this identification.

So many details would be of no use if papilloscopy did not follow the basic scientific principles that govern forensic medicine. The principles of papilloscopy are[18]:

- **Perenniality:** The digital design is formed in the sixth month of gestation and remains unchanged until the end of life in the state of putrefaction, that is, no matter the age or physical condition, the design will not change. Changes will only occur if there is a loss of part of the member or deep scars that reach the dermal layer where the dermal papillae responsible for the design are found;
- **Immutability:** The design is immutable and will only disappear with the putrefaction of the limb to which it belongs;
- **Variability or Variety:** Fingerprint designs vary from finger to finger, as well as from person to person.

There are also mentions in the literature about classifiability as "the property of fingerprints to be grouped in files that can be easily consulted"[21].

Observing these postulates, it is seen that papilloscopy is a reliable and low-cost science, since, to obtain impressions for analysis and comparison, it will often be necessary only to paint a developing powder, and a photographic camera to record the prints before they fade, thus avoiding the loss of evidence to be collected.

However, not only good quality impressions with an evident appearance live for criminal experts and police paperbacks. Most of the impressions left in crime scenes, weapons, and objects used by the suspect or where he has passed are invisible traces to the eyes, requiring the use of luminescent equipment or developer powders (these fragments of fingerprints are called latent fingerprints, as already seen here previously).

Latent prints are very common in evidence of crimes, but they are invisible to the human eye, being necessary to reveal them through optical applications such as ultraviolet light, physical applications such as powdering, or through chemical treatments according to the condition of the print impression and material that is deposited[22].

Above, in the quoted passage, it is possible to identify some of the methods used to develop latent prints, such as the application of ultraviolet light or another form of luminescence that will facilitate identification to photograph the latent print. Another means used on a large scale is the use of developer powders, which can be made up of different elements, generally predominating in white and black colors (figures 1F and 1G). However, for multicolored surfaces or of different tones, colored powders are recommended or luminescent and will react to your compatible light spectrum. Finally, ninhydrin can be used, which is toxic and not recommended for continuous use, only for specific revelations such as the development of fingerprints on paper or very old impressions, with years of deposition, and cyanoacrylate, in the same way, must be used with caution, preferably in a laboratory within a fume hood.

There is a wide variety of developer powders available in the industry with different compositions and colors (table 1)[23]. Powders composed of several elements are more satisfactory in a collection compared to powders composed only of a single substance, and amorphous powders, that is, powders that resemble wheat flour, are better used than powders made of crystalline materials[23]. It is also recommended that metallic deposition in vacuum and the use of cyanoacrylate vapor for metallic surfaces, the latter being one of the most recommended techniques for the use of latent print recovery in firearm cases[23]. The detection of latent prints is based on the interaction of substances produced by eccrine sweat glands[23].

When analyzing the sebaceous compounds left as traces, we found the following: 1) in organic eccrine compounds are found amino acids, proteins, and urea, among others; 2) in inorganic ones, there is the presence of water mineral salts, phosphate, among others[24].

It was observed that the detection in cartridge cases has some difficulties involved, such as the friction of the case with the magazine, the chamber, and other internal structures of the weapon; the high temperature reached in burning the propellant and dispersing the gases and the exposure to residues generated in the shot[25]. The use of cyanoacrylate fumigation is a way of revealing the impression in a cartridge case and other ways using liquid chemical compounds to which the case was exposed[25]. Nevertheless, it is not recommended the use of developing powders, but chemical agents in detonated cases, in which the fingerprint survives the shot[26].

A study shows positive results in the fumigation of cyanoacrylate for the identification of the author of the shot in an exploded case of a .380 AUTO caliber pistol, and with the use of the gun blue solution, it was possible to identify it through the AFIS fingerprint operating system[27].

In a similar study, the authors analyzed the union of cyanoacrylate with black developing powder applied with a marabou feather, thus obtaining the best results using this technique with oblique light in intact cases[28]. In flared kits, they used cyanoacrylate, gun blue solution, and Basic Yellow 40 (BY40), obtaining better results with this mixture[28]. Another study obtained similar results with the fumigation of cyanoacrylate and the use of gun blue in association with BY40[29].

In a gun blue electrodeposition experiment, a researcher obtained positive results in the recovery of latent fingerprints, even in corroded cases, showing that this is an efficient and inexpensive technique, with better results using the fumigation of cyanoacrylate with BY40[30].

In a large analysis with more than 700 shots, the best way of collecting fingerprints was analyzed, but only half of the samples could be used[31]. It was found

Table 1. Examples of fingerprint developing powders.

Black Powders	
Iron oxide poder	Black iron oxide, resin, carbon black and manganese dioxide
Carbon black powder	Carbon black, resin and Füller's earth
Manganese dioxide powder	Black iron oxide, resin and carbon black
Black poder	Iron oxide, quartz powder, kaolin and carbon soot
White pPowders	
Titanium oxide poder	Titanium dioxide, lead carbonate, talc, kaolin and gum arabic
White powder	Dolomite and potato starch powder

Source: Own authorship. Adapted from Figini (2003)[23].

that the use of superglue is recommended and the use of black powder after cyanoacrylate fumigation would help in the identification of latent fingerprints, as well as gun blue, which works like a generator of positive results for analysis of fired cartridge cases[31].

One study experimented with the effectiveness of using the gun blue solution on fingerprints deposited up to 30 days in advance[32]. Even in open-air conditions, the author still refers to the single-action rifle and revolver as the best to obtain positive results in this study with a focus on use from gun blue[32]. Only cyanoacrylate fumigation is positive on stainless steel, but the revelation loses clarity as time goes by, that is, the older it is, the less clear the latent fingerprint will be, and this problem can be remedied with the aid of acid acetic[33].

Another study made use of different means of obtaining impressions on metallic surfaces of different compositions and different formats[34]. Using destructive and non-destructive physical means and chemical reagents, the author concluded that chemical revelation techniques proved to be better[34]. Yet, because they have high costs, they are not practical in the day-to-day life of the forensic scientist[34]. Techniques such as palladium deposition, gun blue, and development with patina or aqueous electrolyte fluids proved to be interesting because they are cheaper and demonstrate the preservation of latent fingerprints in metals, including in fired cartridge cases[34]. Also, the author does not indicate the best according to his research, but a range of products and reagents that can be used for this purpose[34].

There is an acceptance among some authors in not having a universal method, but several methods exist for obtaining fingerprints in cartridge cases, mainly on those composed of brass[34,35]. A spectroscopic and electrochemical approach is proposed, for example, as tools for developing fingerprints through their polymerization, making it possible to observe them[36].

Using electrodeposition of PEDOT (poly-3,4-ethylenedioxythiophene) in aqueous medium, a study shows that it allowed the improvement of the contrast between the metallic surface and the sebaceous and eccrine components of the fingerprint, thus revealing good quality impressions[36]. This process proved to be advantageous due to the low toxicity of using water to form the polymer film, presenting itself as a safe and low-cost technique for developing latent fingerprints[36].

Finally, one last study highlights the use of fumigation with cyanoacrylate, and the use of gun blue and BY40 for developing prints, but reinforces that environmental factors, contact with the ground, and friction in the magazine and the firing chamber of a firearm, greatly influence the preservation or the destruction of the fingerprint left by the author on the loading of the weapon[37]. In this context, cyanoacrylate can also be used for its ease and practicality, in addition to positive results that can be improved with the use of other substances such as developer powders or other compounds as mentioned above[38].

Results and Discussion

Through reading the works selected for this review, it is observed that latent fingerprint recovery in cartridge cases is commonly possible, but not in all cases. It is up to the expert to analyze the case and the best way to recover the fingerprint in it, whether by revealing powder or with a chemical or physical agent, taking into account the environment in which the case was exposed, the time it has been in place, type of metal and what is the condition of this metal for analysis. For this purpose, the table below presents the results of the review for better elucidation (Table 2).

Based on what was said about internal ballistics, one sees the difficulty of recovering the shooter's fingerprint, since there is a series of frictions on the case with all the movement linked to the shot, as the cartridge leaves the magazine for the chamber and the chamber for being ejected to the ground.

Internal armament factors contribute to the difficulty of recovery, such as friction, heat, gas expansion, and the presence of waste from the burning of the propellant[25], and external factors such as climate, presence of liquids, dust and the action of time also contribute to the difficulty of recovery. However, this is not impossible. As seen throughout the text, it is possible to recover recent impressions or even those exposed to the weather for days with the right reagent and the right technique, leaving it to the criminal expert or to the police papilloscopist to analyze each case individually and determine the best way to recover the fingerprints left by the shooter or by the one who helped him by loading the firearm, which can be recovered completely in the body of the case or its latent in the breeches of the case, a place that generally suffers less friction during loading, firing, and ejection[32,34]. The friction of the cartridge with the chamber can influence the recovery. Yet, it is possible to recover latent fingerprints through the use of chemical and physical agents[27,28,37].

As seen, components such as cyanoacrylate, gun blue, BY40, black, white, or colored developer powder, among others, can act in a way to recover the impression in a single action or combination with chemical or physical agents, because it will be of no use to the expert to recover a latent fingerprint in which characteristic points will not appear to help him individualize it, either manually by comparison or through the AFIS system.

Sharpness is of paramount importance, as by obtaining the necessary number of characteristic points it is possible to point out a particular suspect. The number of characteristic points needed for identification may vary from nation to nation and

Table 2. Characteristics of the studies selected for the review.

Author	Year	Study Matherials & Methods	Results
Figini ARL[23]	2003	Vacuum metal deposition and fumigation of cyanoacrylate.	Positive for both, better effectiveness in deflated kits for cyanoacrylate fumigation.
Ferreira DL[25]	2014	Fumigation of cyanoacrylate and deposition by chemical reagent.	Recovery through fumigation and chemical reactions.
Girelli CMA, Segatto BR[27]	2019	Fumigation of cyanoacrylate using gun blue.	Only fumigation obtained positive results, but with the aid of gun blue it was possible to achieve better clarity for insertion in the AFIS system.
Girelli CMA *et al.*[28]	2015	Fumigation of cyanoacrylate, black developer powder, gun blue and BY40.	In intact cases, positive results were obtained with fumigation and developer powder under oblique light, however, exposed cases showed better clarity with the combination of fumigation of cyanoacrylate plus gun blue and BY40.
Sullivan KJ[29]	2018	Fumigation of cyanoacrylate, gun blue and BY40.	In flared kits, positive results were obtained with the combination of the three components.
Dove A[30]	2017	Gun blue electroplating, cyanoacrylate and BY40 fumigation.	With gun blue electrodeposition it was possible to recover fingerprints from corroded cases and after the use of cyanoacrylate and BY40 they improved their resolution.
Mantz L[31]	2021	Cyanoacrylate fumigation, black and gun blue developer powder.	Fumigation was positive with the aid of a revealing powder or the action of gun blue together.
Christofidis G *et al.*[32]	2019	Gun blue.	Using only this compound it is possible to reveal, being more efficient in cases used in rifles and revolvers.
Beresford AL, Hillman AR[33]	2010	Fumigation of cyanoacrylate and acetic acid.	In stainless steel, fumigation is positive for development, but it loses sharpness, requiring the application of acetic acid to obtain a clearer result.
Chirstofidis G *et al.*[34]	2018	Palladium deposition, gun blue and development with patina or aqueous electrolyte fluids.	Both presented compounds showed positive results in obtaining fingerprints in triggered cases.
Broncová G *et al.*[35]	2021	Spectroscopy and electrochemistry.	Fingerprint development through polymerization.
Costa CV *et al.*[36]	2020	PEDOT electroplating.	Electrodeposition of poly-3,4-ethylenedioxythiophene in an aqueous medium improved the contrast between the metal surface and the fingerprint components. Because it is in an aqueous medium, it also proved to be a low toxicity procedure.
Walkes L[37]	2021	Fumigation of cyanoacrylate, gun blue and BY40.	It mentions positive results with the application of the three components and reinforces the influence of the environment in the preservation of fingerprints.
Bumbrah GS[38]	2017	Fumigation of cyanoacrylate and developer powder.	Fumigation of cyanoacrylate together with developer powder has been shown to be effective in developing latent fingerprints.

Source: Own authorship.

even from state to state in the same nation. The most important thing is their clarity through collection procedures, and that it is done by reproducible scientific methods.

A clear fingerprint makes it possible for the criminal expert and the police papilloscopist to carry out a broad and accurate search. When the sharpness is high, to the point of observing the pores of the papillary ridges responsible for the release of sweat through the sweat glands, there is a second tool for research that can reaffirm that the suspect was present at the scene of the crime, but for that, it will be necessary a good conservation and disclosure methodology[23,24].

When the fingerprint is just a fragment, look for characteristic points such as an islet, enclosure, bifurcation and, if possible, the main one, the delta, which is the sign that serves as a guide for the papilloscopist. This sign is formed by the union of two to three basic and nuclear lines forming a design similar to a triangle, easily identified by its unique shape in the fingerprint, and can be located on the side of the finger, close to its nuclear region[19].

By finding a delta it is possible to refine the search for a possible inner loop, outer loop, or even a whorl, eliminating the arc of the search system[18]. However, not finding the delta, points like the ones described above will be very useful when comparing its shape and position concerning the design of the papillary crest.

The single-use of powder as a revealing agent and the fumigation of cyanoacrylate proved to be accessible due to its low cost and efficiency in recovery, being indicated for recent fingerprint deposition, that is, shots carried out a few hours ago or days if there was no adverse weather condition. Nevertheless, electroscopy and electrochemistry are more advantageous in older cases, and electroplating proved to be more effective even for cases already in a state of corrosion. More effective techniques, however, are more expensive compared to the first ones[28,29].

It is important to say that it is necessary to use personal protective equipment (PPE) and an adequate laboratory, with an exhaust area for toxic gases and a fumigation hood for carrying out the fumigation method and other chemical techniques exposed here, aiming at the safety of the operator and others around him while obtaining the criminal evidence.

Conclusions

In this work, it was possible to review several techniques each one with its peculiarity brought to light the fingerprint research that can be used in the fieldwork or the laboratory for the good of forensic science and criminal justice.

Of the techniques analyzed, those that proved to be more efficient and at a lower cost were those that used developer powder, cyanoacrylate, gun blue, and BY40 individually or in combination, that is, chemical and physical developers. The fumigation technique with cyanoacrylate was presented in most of the researched works and can be used with or without the support of other revealing agents such as BY40 or revealing powder and gun blue, but it will also depend on the state of conservation of the cartridge case, the climate, the environment that the case was exposed, the friction with the weapon's components and its correct handling, in other words, if no one touched it without gloves or in such a way as to destroy the latent fingerprint.

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