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Eyewear in Forensic Investigations: Unveiling Evidence

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Abstract

Forensic investigations are essential to the criminal justice system's efforts to solve crimes and maintain the rule of law. Primarily, they depend on precise and reliable proof. One aspect of this intricate profession that is often overlooked is the significance of eyewear in the collection and interpretation of data. Glasses and customized lenses serve a variety of purposes in maintaining the objectivity of investigations and enhancing the visual analysis of crime scenes, all of which are advantageous to both parties. Eyewear is ubiquitous in today's world. Whether they are present or absent at a crime scene, glasses, contact lenses, and goggles can provide crucial information about the events that took place there. Eyeglass evidence is significant not just for its physical presence but also for its presence in the realm of traces. Particles that adhere to glasses or frames include hair, fibers, and human fluids; these particles can be crucial pieces of forensic evidence. Eyewear is utilized in forensic investigations for a variety of purposes, including both eye protection and visual enhancement. Protective eyewear, which guards against airborne contaminants, chemical spills, and bloodborne diseases, is the first line of defense for forensic investigators. Various protective eyewear styles, materials, and ergonomic designs will be explored to highlight their crucial role in ensuring the safety of investigators while preserving the integrity of the evidence. From the analysis of lens artifacts to the distinctive imprints left by eyeglasses, this study aims to give a comprehensive understanding of how eyewear can function as an essential and sometimes overlooked source of forensic evidence.

Keywords: Eyewear, Forensic evidence, Eyeglass, Contact lenses, Optometry

1. Introduction

The field of forensic science is ever-evolving, using a variety of techniques and tools to uncover the truth in criminal cases. Among the various kinds of evidence, eyeglasses have gained recognition as an essential instrument for solving crimes. Eyeglasses become an often-underappreciated yet essential instrument in the intricate realm of forensic inquiry, where every small detail matters. Apart from being useful for protection or correcting eyesight, eyewear can be applied in a multitude of ways to crime scene investigation and the subsequent interpretation of complex cases¹. Glasses and sunglasses among other eyewear have grown essential to human necessity and style. Eyewear is now considered a valuable piece of evidence in the field of forensic investigations, surpassing its original use. The investigation starts by evaluating the range of eyeglasses and their distinctive features, including frame designs, lens compositions, prescriptions, and any obvious flaws or defects². Wearing spectacles is normal in society and has both functional and aesthetic uses. This is exemplified by goggles, spectacles, and contact lenses. Because eyewear is associated with certain people, and because its surfaces may attract trace elements, it can become an important source of evidence in forensic circumstances. The examination of eyewear-related evidence has the potential to provide investigators with more insight into the events they are investigating as they work to compile information from crime scenes.

When ophthalmic materials are collected at accident or murder sites or in other situations where prescribed devices may aid to identify an individual, optometrists may be contacted by forensic investigators or law enforcement officers³. For comparative analysis, lens prescription data sets from a population can be accessed via an online service. OptoSearch is a Web-based application available to the optometric community that lets users find out how frequently a specific prescription and its components occur in a population in USA. To achieve greater statistical dependability, massive databases were used in the construction of OptoSearch⁴. To determine whether it was possible to use prescription data for personal identification, three prescription database sets were used: the Central Identification Laboratory Eyeglass Prescription Information (CILEPI) database, the National Health and Nutrition Examination Survey (NHANES)⁵ by the National Center for Health Statistics, and the Naval Ophthalmic Support and Training Activity (NOSTRA). These database sets did not contain information on age, sex, or ethnicity that could reveal the patient's identity. From the three datasets that are provided, the investigator can select data using Optosearch and compare it separately. Using objective statistics, one can determine the degree of correspondence between a person's antemortem medical/ophthalmic record and a known refractive error by counting the instances of that refractive error in the databases. OptoSearch is a web utility that may be accessed at <http://www.jpac.pacom.mil/CIL/OptoSearch.php>. There are no fees for users, passwords, or sign-in requirements³. Through the tool, investigators can choose to examine all three databases at once or just one of them. Investigators can enter a partial prescription if just that is available, or a full prescription (sphere, cylinder, axis, and add for both eyes) while searching prescription data using the application. Other features can be utilized to narrow down potential prescriptions that would meet the requirements if a certain parameter cannot be determined because of broken lens fragments recovered from the crime scene.

2. Eyeglasses in Forensic investigation

For centuries, people have worn traditional eyeglasses to correct their vision. At a crime scene, the frames and lenses of these spectacles might leave observable clues. When a suspect wearing spectacles engages in physical combat, for instance, the victim or the surrounding area may bear distinctive markings from the frames⁶. To identify the type of spectacles and maybe the wearer, forensic specialists closely inspect these imprints. In addition, substances from crime scenes, such as blood, sweat, or fibers, may still be visible on eyeglass lenses⁷. It is possible to find crucial evidence linking a suspect to the crime scene by looking through these remnants. The development of forensic technology has made it possible for investigators to remove and analyze these minute traces, contributing to the overall image of a case. Prescription eyeglass frames may have visible scuffs, scratches, or even material transfers at a crime scene. When these frames touch surfaces or objects, they may leave behind trace evidence that forensic experts might use to link a suspect to a certain spot. In certain situations, optical records may give investigators details about a patient's prescription⁸. This information may be quite useful when constructing a chronology or identifying potential suspects based on their specific visual needs. Reading glasses can leave obvious traces similar to those of conventional spectacles, which is common among patients with presbyopia. In order to piece together what transpired before a crime, it may be necessary to detect any defects on the lenses and frames. The prescription strength of the wearer's reading glasses is another forensic hint that can provide details about their age and level of vision. Smart glasses have the potential to collect crucial evidence of criminal conduct due to their capacity to store data and record both visual and audio information⁹. Biosensors integrated into some smart glasses can detect physiological changes and provide information about the wearer's health or potential involvement in specific activities. Additionally, the manner in which reading glasses are worn—such as tucked into a shirt pocket or forced up against the forehead—can leave behind noticeable patterns. Forensic experts scrutinize these patterns in great detail in the hopes of uncovering vital information regarding the activities of individuals at the murder scene, which is necessary to reconstruct the events. Sunglasses are used in forensic investigations in addition to protecting eyes from the sun's glare. The diverse shapes and hues of sunglasses lenses may leave distinct stains on different types of surfaces. It is possible to find these traces on the perpetrators, the victims, or even in close proximity to the crime scene. The type and possibly even the brand of sunglasses worn can be ascertained by forensic experts using these impressions. It might be a sign of a fight or altercation when shattered sunglasses are found at a crime scene. The lenses may break when they collide, producing fragments that might be examined for signs of proof. By examining these fragments, crucial information about the crime scene, such as the force of impact, the angle of impact, or even the sequence of events, may be uncovered. Safety goggles and glasses are frequently used in laboratory and industrial settings to protect the eyes from potentially hazardous materials. As forensic investigators handle potentially dangerous crime scenes or look through biohazardous objects, these goggles become essential. There are forensic analytical implications for safety goggles and glasses that extend beyond basic safety¹⁰. The presence of chemicals, biological agents, or poisons on the eyewear could provide crucial details regarding the type of crime that was committed. For

example, at a poisoning scene, a suspect wearing protective goggles may inadvertently bring trace chemicals that link them to the illicit.

3. Contact Lenses in forensic investigation

The history of contact lenses as we know them now is quite new. Leonardo da Vinci initially advocated the idea of directly applying a lens to the eye to improve eyesight in the early 16th century¹¹. Originally intended for vision correction, contact lenses have evolved into versatile instruments with uses outside of optometry. Contact lenses are applied directly to the eyes, as opposed to conventional spectacles. Contact lenses may be used in contemporary forensic investigations to help solve crimes or identify suspects¹². Even while contact lenses might not leave distinct, identifiable signs on their own, the information about a person's contact lenses can be useful. Information regarding a person's visual impairment can be found in their contact lens prescription. In situations when eyewitness testimony is vital, this information may be important in assisting investigators in determining the wearer's degree of vision impairment. Information may also be obtained from the kind and brand of contact lenses. Certain qualities or compositions of various brands and types of lenses may be significant to an inquiry. Contact lens wearers may have their medical records connected to them, which might help with identity verification¹³. When determining the identify of a deceased individual proves to be difficult, this information might be especially helpful. In certain instances, contact lens wear patterns may be looked at. A person's habits, way of life, or possible exposure to particular settings may be revealed by irregularities or particular wear patterns. Important biological data may be found in the tear film that develops between the cornea and the contact lens. This tear film may be examined by forensic experts to look for materials like proteins, DNA¹⁴, and other materials that could connect a suspect to a victim or crime scene. Compared to soft lenses, rigid gas permeable (RGP) lenses are more resilient and less likely to break. The existence of undamaged RGP contact lenses may reveal a wearer's capacity to withstand force in situations when there has been a struggle or physical conflict, offering information about the circumstances surrounding a crime¹⁵. Contact lenses discovered at a crime scene may be able to provide light on the culprit or help reconstruct the events in situations involving assaults or physical altercations. Smart contact lenses with tiny sensors, cameras, and other electronic components are a result of recent technical developments. By capturing visual data, smart contact lenses with integrated cameras can provide users a first-hand view of their environment. Certain smart contact lenses are equipped with biosensors¹⁶ that may track alterations in the wearer's physiological parameters, such blood sugar levels or biomarkers linked to drug usage. Reconstructing crime scenes, identifying offenders, and documenting criminal activity can all be greatly aided by this capability.

4. Forensic Virtual Reality (VR) Eyewear:

Researchers now have access to never-before-seen tools for crime scene reconstruction and evidence visualization thanks to the use of Virtual Reality (VR) technology into forensic investigations. The introduction of Virtual Reality (VR) technology has caused a revolutionary change in traditional forensic examinations. With the use of forensic virtual reality (VR) eyewear, investigators may see crime scenes from a never-before-seen perspective, improving their capacity to evaluate evidence¹⁷. Investigators may enter virtual crime scenes with the use of forensic VR eyewear, which provides an immersive visual experience. Users may explore and engage with digital reconstructions because to the gadgets' lifelike 3D worlds created by high-resolution screens and sophisticated optics. Using 3D reconstruction and photogrammetry, forensic VR eyewear creates realistic virtual worlds using crime scene data, including measurements and photos¹⁸. The accuracy and richness of crime scene depictions are improved by this procedure. It may be used to present evidence in court, providing jurors and judges with a more engaging experience than just pictures or diagrams. With VR eyewear, witnesses may reexamine and offer testimony from their point of view, possibly exposing information that was missed in the first inquiries¹⁹. Analyzing actual situations where VR eyewear has been used might shed light on its usefulness and influence on research. Case studies demonstrate how VR eyewear may be used to show evidence, solve crimes, and teach forensic experts.

5. Legal Implications and Eyewear Evidence Admissibility

One of the most important aspects of eyewear evidence's use in forensic investigations is its admissibility in court. In court cases, eyewear evidence—often in the form of video recordings from gadgets like smart glasses—has grown in popularity. The employment of this technology gives rise to several legal considerations, mostly pertaining to privacy, authenticity, and court admissibility. Potential privacy rights infringement is one of the main legal issues with eyeglasses evidence. Privacy expectations may be raised by the possibility of recording footage in public or private situations using smart glasses and other wearable devices with recording capabilities²⁰. Courts have to carefully weigh each person's right to privacy against the recordings' evidentiary value. In order to support the admission of evidence related to eyeglasses,

parties may offer expert testimony. Specialists may provide light on the dependability of the technology, the unique features of the apparatus, and the measures taken to avoid manipulation. Expert witnesses have the ability to inform jurors and judges about the limitations of technology, which aids in their comprehension of the evidence's context²¹. Legal professionals would occasionally need to hire specialists in domains like digital forensics to examine the metadata connected to the proof of eyeglasses. In order to demonstrate the reliability of the evidence, details like the recording's time and place may be included. The admissibility of eyewear evidence is contingent upon the dependability of smart glasses and other comparable recording devices. The precision of the equipment, any bugs or malfunctions, and the general reliability of the recording process are all factors that courts may take into account²². The weight given to the evidence may be impacted by flaws like low video quality, inconsistent audio, or other technological difficulties.

6. Challenges and Limitations of Eyewear as Forensic Evidence

The widespread usage of and access to standard kinds of eyeglasses is one of the main obstacles. Because of mass-produced designs, it may be challenging to positively identify a particular pair of spectacles as belonging to a single person²³. Fashion fads quickly change the designs of eyewear. This evidence's chronological relevance is limited since a person's current eyeglasses may not be represented by a pair of spectacles they wore at a certain period. Eyewear lacks the intrinsic distinctiveness required for individualization, unlike DNA or fingerprints²⁴. Despite the fact that unique frames or prescription information might help reduce the number of possible wearers, they cannot provide the same level of specificity as other forensic evidence²⁵. People might forget to wear their glasses frequently, particularly when they don't feel like it. This discrepancy can make it more difficult to create a reliable connection between a person and their eyeglasses in a variety of situations. The eyeglasses may not always be clearly visible in witness accounts or security film, especially if the event happens at a distance or in poor light. Inadequate visibility may make identification more difficult. The deliberate modification or removal of eyeglasses by criminals makes it difficult to identify them merely based on this evidence.

7. Recommendations for Improved Use of Eyewear as Forensic Evidence:

As an adjunct to other types of evidence like DNA, fingerprints, and witness testimony, eyewear should be viewed as a component of an integrated forensic approach. For a thorough investigation, cooperation between forensic specialists from different fields is necessary. Investigators may be able to identify possible matches by keeping an extensive database of prescription details and eyewear styles. Developing and maintaining a system that takes into account the always shifting world of eyewear fashion is a challenge, though. The particular case should be taken into consideration while analyzing eyewear evidence. A more accurate assessment of the evidence may be achieved by taking into account the wearer's habits, the settings, and the temporal significance of the eyewear. Technological developments in imaging and analysis may improve the examination of eyewear evidence. Other methods, such as 3D scanning and high-resolution photography, could give previously hard-to-get information. When testifying on the constraints and ambiguities surrounding the eyewear evidence, forensic optometrists should be precise and nuanced. Furthermore, it is imperative to educate the public, legal experts, and investigators on the challenges associated with utilizing eyeglasses as forensic evidence.

8. Conclusion

This thorough examination highlights the broad significance of eyewear in forensic investigations. In the pursuit of justice, eyewear serves a variety of functions that are frequently overlooked, from protecting investigators and improving accuracy through magnification to acting as independent evidence. As technology advances and forensic science continues to evolve, understanding and harnessing the potential of eyewear in investigations will be crucial. This article serves as a testament to the intricate dance between technology, psychology, and the physical world that defines the realm of forensic investigations, with eyewear at the forefront of this fascinating interplay. As technology advances, more possibilities will arise to investigate this subfield of forensic pathology. Optometrists can offer unbiased analysis and testimony in court situations about issues relating to the eyes. In situations involving poor eyesight, poor visual acuity, or other eye-related difficulties, optometrists may be asked to testify.

9. Conflict of Interest: None

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