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Eyes on the Scene: Forensic Optometry Role in Decoding the Visual Clues at Crime Scenes

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ABSTRACT

Forensic optometry is a specialized field that utilizes ophthalmic expertise in the context of criminal and legal inquiries. This review article investigates the diverse applications of optometry within the realm of forensic science, encompassing the assessment of visual deficiencies, analysis of spectacle lenses, and interpretation of optical evidence at crime scenes. This review highlights the instances in which forensic optometry has proven pivotal in the identification of suspects, the reconstruction of incidents, and the provision of expert testimony during judicial proceedings. Furthermore, it examines emerging technologies such as biometric identification and sophisticated imaging methodologies, which are augmenting the precision and breadth of forensic investigations. The significance of forensic optometrists engaging in interdisciplinary collaboration with law enforcement, forensic specialists, and legal practitioners is accentuated as an essential element in the pursuit of justice within the contemporary legal framework.

Keywords: *Contact Lens, DNA Recovery, Forensic Optometry, Optical Evidence, Visual Clues*

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1. INTRODUCTION

Optometry constitutes a distinct healthcare discipline characterized by autonomy, rigorous education, and regulatory oversight (licensed/registered), wherein optometrists serve as the principal healthcare providers for the ocular and visual systems, delivering extensive eye and vision care services. These services include refraction and dispensing, the identification, diagnosis, and management of ocular diseases; and the rehabilitation of various conditions affecting the visual system.[Error! Reference source not found.] Forensic optometry uses cutting-edge technologies and ocular evidence to play a c ritical role in crime investigation. This multidisciplinary profession integrates forensic science with optometry to offer insights into different facets of criminal investigations.[Error! Reference source not found.] Visual evidence, which is especially i mportant in identifying suspects, confirming witness accounts, and examining crime scenes, is the focus of this branch of forensic science. This study aims to investigate the ways in which forensic optometry aids in the investigation of crime scenes, with a particular emphasis on the recognition, interpretation, and use of visual cues in legal situations.

2. METHODS

This study was approved by the Institutional Review Board of the university. This study was conducted in accordance with the principles of the Declaration of Helsinki. Using the PubMed/MEDLINE, Web of Science and Google Scholar databases, a thorough literature search was performed for indexing phrases and keywords. The following terms were used while searching for articles: Forensic optometry, Crime Investigation, Tear investigation, Optical Evidence, contact lens, spectacle, and eyewear. All the relevant articles published in English language and the referenced articles were included in the study.

3. DISCUSSION

I. Identification of visual evidence

Analyzing Optical Evidence: The incorporation of visual evidence into more comprehensive forensic practices improves the reliability of investigations and promotes the general goal of justice.[Error! Reference source not found.] A prescription eyewear i s a valuable investigative tool in forensic science as contact lenses and spectacles are typical personal things that individual might lose at a crime scene. A web-based tool has been designed to evaluate the frequency of prescriptions for spectacles, allowing forensic specialists to offer statistical proof on the possibility of a match between a suspect's eyeglasses and the prescription retrieved at a crime scene.[**Error! Reference source not found.**] Also, the identification of contact l ens type, brand, and prescription details play a crucial role in investigation.

According to a research, refractive error metrics had an accuracy of 81.4% in predicting an individual's age. This can be useful in reducing the number of potential suspects based on age-related changes in vision.[Error! Reference source not found.]

In order to avoid false identification, clear vision free from illness is crucial for forensic investigations. Although forensic optometry is a viable approach to identifying suspects, it is crucial to take into account the limits of eyewitness testimony, especially in situations when ocular abnormalities might potentially impede vision and compromise the accuracy of the identification such as glaucoma and depth variation.[Error! Reference source not found.] Also analysis of lenses (scratches, marking o r damage) may be useful in the reconstruction of event at the crime scene.

II TRACE EVIDENCE

Fibers and Residues: Analyzing fibres or residues on eyewear that might identify a suspect or point them towards a particular person or place is one use of forensic optometry. Studies reveal that individual fibre identification may be possible using stochastic fluctuations in optical fibre Rayleigh backscattering, implying a technique for examining residues on eyeglasses.[Error! Reference source not found.]

DNA Recovery from Contact Lenses: Suspects or victims can be identified using contact lenses that have been left at crime scenes as a source of DNA which can be extracted from the tear embedded in contact lenses. Studies show that it is possible to successfully separate nuclear and mitochondrial DNA from these lenses, offering a beneficial method for forensic DNA analysis.[Error! Reference source not found.]

DNA Recovery from tears: Tears are released in reaction to any emotional or stressful circumstances and might end up on bedding, tissue paper, or other surfaces. By analyzing the biochemistry and molecular components to produce a complete DNA profile, can result in personal identification.[Error! Reference source not found.]

III. Reconstruction of crime scenes

Line of Sight Analysis: Methods include tracking eye movements in order to examine gaze patterns. One technique to identify line-of-sight is a method that correlates pupil position with face orientation to predict the direction of an individual's gaze.[Error! Reference source not found.] Analyzing variables like illumination, distance, and viewing angles is part of this process. F orensic optometrists might replicate certain circumstances, such as when a witness reports seeing a suspect at night, in order to assess the plausibility of the sighting. Systems that track variations in gaze speed and frequency can provide insights into participants' psychological states throughout an event.[Error! Reference source not found.]

Visual Acuity/Field Examination: Inspection of the visual field of a suspect or witness to identify any blind spots or visual field limitation that may have existed during the crime. This may entail determining viewing angles, assessing illumination, and taking into account the consequences of vision impairments like myopia or cataracts. The authenticity of witnesses' and suspects' statements can be strongly impacted by their visual acuity. Experts in forensic optometry evaluate factors like night vision, distance vision, and the existence of visual impairments like astigmatism or myopia. Through this evaluation, it will be possible to ascertain if a person may have correctly detected crucial information about the crime, including identifying suspect or recognizing particular things. Motor vehicle accidents are often associated with alcohol/drug consumption, speeding, risky overtaking, etc.

IV. Comparison and matching techniques

Spectacle Impressions: Spectacles are important in forensic investigations because they might contain traces of DNA. According to a study, recovering DNA from eyeglasses with a 70% ethylated swab produces greater amounts than with

conventional techniques.[**Error! Reference source not found.**] In some cases, the condition of the eyewear, such as d amage patterns or wear marks, can provide additional clues about the events leading up to the crime.

Lens Fragments: The manuscript elucidates a particular instance of homicidal stabbing that culminated in bilateral penetrating ocular injuries, thereby unveiling an atypical mechanism of mortality associated with such traumas. The manifestation of arrhythmias, inclusive of asystole, can be correlated with the oculocardiac or trigeminocardiac reflexes. This reflex constitutes a physiological reaction that may precipitate abrupt alterations in cardiac rhythm upon injury to the eye or adjacent regions. The oculocardiac reflex ought to be contemplated as a plausible mechanism of demise within forensic examinations, especially in scenarios entailing craniofacial trauma.[**Error! Reference source not found.**]

V. Estimating time of death

The post-mortem interval (PMI) may be determined by eye tests with excellent accuracy; half-hour accuracy can be attained immediately after death. This is achieved by evaluating morphological alterations and metabolic processes inside the ocular system.[**Error! Reference source not found.**]

Tears and other ocular secretions can aid in crime scene investigations by providing more biological evidence for examination.[**Error! Reference source not found.**] Vitreous humour is a better method for estimating PMI than blood or CSF. Linear i ncreases in postmortem vitreous humour are observed for both potassium and hypoxanthine.

VI. Potential cause of death

TSD (Time Since Death) may be determined with sensitivity of 36 hours and accuracy of 15 minutes by analyzing the polycrystalline structure of vitreous body using polarization microscopic tomography. The study revealed notable variations in the fibrillar collagen networks' optical anisotropy within the vitreous body layers, which are correlated with different TSD.[**Error! Reference source not found.**]

Time since death can be estimated with the use of post-mortem alterations in the iris, lens, retina, and vitreous humour, in addition to external eye abnormalities such as tache noire and corneal haziness. Iris and retinal scans, or ocular biometrics, might make identification easier. Age-related changes in the eyes might provide information. The eye provides hints about a person's characteristics (trichotillomania, corneal tattooing) and cause of death (abusive head trauma, retinal haemorrhages, petechiae). Both underlying eye diseases and ocular trauma may be obvious. The toxicology of vitreous humour can identify toxins and medicines. Post-mortem exams have importance because the eye assists with pathology interpretations by providing a window into systemic illness and age-related alterations.[**Error! Reference source not found.**]

The determination of chemical abnormalities in the vitreous humor can be crucial for establishing the cause of death, especially when autopsy findings are inconclusive or when an autopsy cannot be performed. Blood chemical studies have demonstrated that some anomalies, such as those in creatinine, urea nitrogen, calcium, protein, and bilirubin, can reveal information about conditions that existed before to death.[**Error! Reference source not found.**] Iris features from a deceased person c an be matched for up to 407 hours. It has been proposed that near-infrared light improves cadaver eye imaging.[**Error! Reference source not found.**]

4. CASE STUDIES

The presence of aphakic eyes identified on Postmortem computed tomography (PMCT) verified the identity of a deceased man. When a decomposing body was discovered inside a home, it was thought to be that of a man in his 40s who lived alone. Pontine haemorrhage was found to be the cause of death during the autopsy. The homeowner's dental records were no longer in storage, despite obvious indications of prior dental care. He didn't have any family member whose DNA may be used for identification. Aphakia was found using postmortem computed tomography prior to autopsy, which may indicate prior ocular surgery. According to his medical records, he had aphakia after ocular surgery for secondary glaucoma brought on by uveitis. Identification of body of the deceased was confirmed by an exact match between the findings in his medical records and the scar from the peripheral iridectomy.[**Error! Reference source not found.**]

2. A alleged homicide instance involved the finding of intact spermatozoa in the deceased's mouth, detected forty days following his disappearance. In January, the victim's partially frozen corpse was spotted outside in an upstate New York rural region. Bloodstains and broken eyeglass lenses were found in the suspect's home and car during a subsequent inquiry. Bloodstains and broken eyeglass lenses found in the suspect's home and car indicate a clear connection between the suspect and the murder scene. The lens fragments were examined for chemical and optical investigations, which are crucial for identifying the components and perhaps establishing a connection with the suspect.[**Error! Reference source not found.**]

5. CONCLUSION

Forensic optometry offers unique insights through the analysis of visual evidence that are useful in criminal investigations. Forensic optometrists can help with the identification and interpretation of visual evidence that are useful in recreating events, establishing the credibility of witness testimony, and connecting suspects to crime locations. The area of forensic optometry is expected to grow as technology and methods progress and play a bigger part in criminal investigations. But

the future of this field will depend on how well it handles the issues of standardization and the subjectivity of visual perception.

REFERENCES

[1] WCO's Concept of Optometry - World Council of Optometry . Accessed: September 02,2024: https://worldcouncilofoptometry.info/concept-of-optometry/.

[2] Iorliam A.: Subdivisions of forensic science. Fundamental Computing Forensics for Africa: A Case Study of the Science in Nigeria. Springer, Cham, 2018. 17-56. 10.1007/978-3-319-94499-9_3

[3] Dharmendra SC: The Role of Forensic Evidence in Criminal Investigations in India. International Journal for Research in Applied Science and Engineering Technology. Oct 2023, 11:760-765. 10.22214/ijraset.2023.56099

[4] Collins RS, Berg GE: Forensic application of optical correction . Optometry. 2008, 79:203-207. 10.1016/J.OPTM.2007.10.014

[5] Moustafa MA, Ghitani SA, Kholief MA, Abulnoor BAE, Attia MH: Prescription eyeglasses as a forensic physical evidence: Prediction of age based on refractive error measures using machine learning algorithm. Journal of Forensic Sciences. 2024, 69:765-783. 10.1111/1556-4029.15493

[6] Das S, Selvaraji K, Dutta M, Isa MZ, Moorthy TN.: A pilot study on glaucoma and depth variation, A factor that affect the accuracy of eyewitness identification. International Journal of Medical Toxicology & Legal Medicine. 2018, 21:239-242. 10.5958/0974-4614.2018.00077.3

[7] Brodsky M, Oh J, Tur M, Henry PS. : Rayleigh backscattering from optical fibers-could it be used to identify individual fibers?. Frontiers in Optics. 2010, FMC3. 10.1364/FIO.2010.FMC3

[8] C. Zapico S, Crucet K, Antevska A, et al.: From your eyes only: Efficiency of nuclear and mitochondrial DNA isolation from contact lenses at crime scenes. Electrophoresis . 2021, 42:122-5. 10.1002/ELPS.202000140

[9] Aparna R, Iyer RS: Tears and eyewear in forensic investigation—A review. Forensic science international. 2020, 306:110055. 10.1016/j.forsciint.2019.110055

[10] Miki, Matsuoka., Atsushi, Irie: Line of sight detecting device and method . Washington, DC: U.S. Patent and Trademark Office; 9 Oct. 2012.

[11] Sakaino, Hidetomo: Line of sight analyzer . 1995.

[12] Nzilibili SM, Putra MA, Yudianto A: 70 persentase Ethylated and Non-Ethylated Swab: A Trace Evidence Recovery Method and Usefulness in Spectacles Forensic Evidence. Proceedings of the 2nd International Conference Postgraduate School (ICPS 2018) . Science and Technology Publications, Lda., Surabaya; 2018. 312-316. 10.5220/0007541903120316

[13] Lynch MJ, Parker H: Forensic aspects of ocular injury . American Journal of Forensic Medicine and Pathology. 2000, 21:124-126. 10.1097/00000433-200006000-00006

[14] van der Veer J, Rzepczyk S, Żaba C : Keep an eye on the crime - a new look at the forensic use of post-mortem eye examination to estimate time of death. Journal of Medical Science. 2023, 92: e753. 10.20883/medical.e753

[15] Singh J, Kaur E, Dhiman S, et al.: Eye Optics: A Unique Blink in Forensic Identification. International Journal of Health Sciences. 2022, 4188-200.. 10.53730/ijhs.v6ns3.6763

[16] Sarkisova Y, Bachynskiy V, Palamar A, Palibroda N, Patratii M: Diagnostic possibilities of analysis of the map of linear birefringence of the crystal fraction of vitreous body for accurate determination of the time since death. Proceedings of CBU in Medicine and Pharmacy. 2020, 1:82. 10.12955/PMP.V1.103

[17] Atreya A, Ateriya N, Menezes RG : The eye in forensic practice: In the dead. Medico-Legal Journal. 2024, 00258172241230210. 10.1177/00258172241230210

[18] Coe JI: Use of chemical determinations on vitreous humor in forensic pathology. Journal of Forensic Sciences. 1972, 17:541-6. 10.1520/JFS10142J

[19] Trokielewicz M, Czajka A, Maciejewicz P : Post-mortem Iris Decomposition and its Dynamics in Morgue Conditions. Journal of Forensic Sciences. 2020, 65:1530-8. 10.1111/1556-4029.14488

[20] Oshima T, Yoshikawa H, Yoshitomi T, Ohtani M, Mimasaka S: A Case of Personal Identification Via Postmortem Computed Tomography Confirmation of Aphakic Eyes. The American Journal of Forensic Medicine and Pathology . 2020, 41:60-3. 10.1097/PAF.0000000000000534

[21] Schwartz EA, Vallaro KE, Pool TM, Adamo RA, Taff ML, Boglioli LR: Optical Analyses of Eyeglass Lens Fragments and the Unexpected Detection of Oral Sperm in a Homicide Case. Journal of Forensic Sciences .

1995, 40:306-9. 10.1520/JFS15364J