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A Study of Blood Deposition Pattern on Various Surfaces: Analysing the Impact of Different Application over Time

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Abstract: Forensic bloodstain pattern analysis (BPA) is essential in crime scene reconstruction, offering insights into the cause, nature, and timing of blood deposition. This study examines how blood interacts with different surfaces—glass, tile, cloth, wood, and paper—using application methods such as dripping, splattering, and pooling. Fresh pig blood was used due to its similarity to human blood. Blood samples were deposited on selected surfaces and documented over 24 hours. Imagej software was used for grayscale conversion and edge detection, enhancing forensic interpretation. Results showed that non-porous surfaces (glass, tile) maintained welldefined stains, making time estimation more accurate, while porous surfaces (cloth, paper, wood) led to diffusion and absorption, complicating analysis. Time-dependent changes such as shrinkage, darkening, and coagulation were more evident on non-porous surfaces, reinforcing their forensic reliability. Findings confirm that surface characteristics and application methods significantly impact bloodstain patterns. Digital imaging enhances interpretation, improving forensic accuracy. This study refines BPA methodologies, aiding in crime scene reconstruction and legal evaluation of blood evidence. Future research should explore additional surfaces and integrate advanced imaging techniques to further enhance forensic reliability.

Keywords: *Blood Spatter Analysis, Pooling, Splashing, Dripping, Time Since Deposition.*

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I. INTRODUCTION

Forensic science integrates scientific principles with legal processes to analyze physical evidence, with bloodstain pattern analysis (BPA) playing a crucial role in reconstructing crime scenes by examining blood deposition patterns to determine force type, movement, and event sequence. This study analyzes bloodstain patterns on five surfaces— glass, tile, cloth, wood, and paper—using dripping, splattering, and pooling methods, considering factors like absorbency, texture, and porosity. Fresh pig blood, chosen for its similarity to human blood, was used for ethical feasibility. A structured experimental approach documented stain changes over 24 hours, utilizing ImageJ software for grayscale conversion and edge detection to enhance forensic accuracy. Findings indicate that nonporous surfaces retain well-defined stains, aiding time estimation, while porous materials cause diffusion, complicating analysis. By refining BPA methodologies, this research enhances crime scene reconstruction and forensic reliability, with future studies encouraged to incorporate advanced imaging techniques and a broader range of surfaces to strengthen forensic applications.

➢ *Objectives*

- To investigate the effects of different surfaces (e.g., glass, paper, wood, cloth, tile) on blood deposition patterns.
- To examine the influence of various blood application methods (e.g., dripping, splashing, pooling) on blood deposition patterns.
- To analyze the changes in blood deposition patterns over time (e.g., initial, 6, 12, 18, 24 hours).
- To compare the blood deposition patterns on different surfaces with various application methods

➢ *Hypothesis*

- Different surfaces and blood application methods will produce distinct blood deposition patterns,
- Blood deposition patterns will change over time based on surface type and application method.

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II. MATERIALS AND METHODS

This study investigates blood deposition patterns on different surfaces over time using various application methods. Blood samples were applied to glass, tile, wood, cloth, and paper through dripping, splattering, and pooling techniques. Fresh pig blood was used due to its similarity to human blood. To systematically analyse stain evolution, photographs were taken at specific time intervals (0, 6, 18, and 24 hours). ImageJ software was employed for grayscale conversion and edge detection to enhance stain visibility and pattern analysis.

III. RESULTS

Fig 1 Tile Pool Pattern 10am Initial

Fig 2 Grey Scale of Tile Pool Pattern

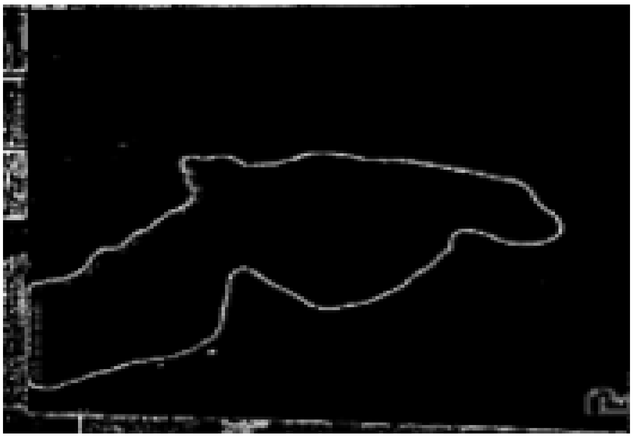

Fig 3 Edge Detection of Tile Pool Pattern

Fig 4 Tile Pool Pattern 4pm 6 Hours

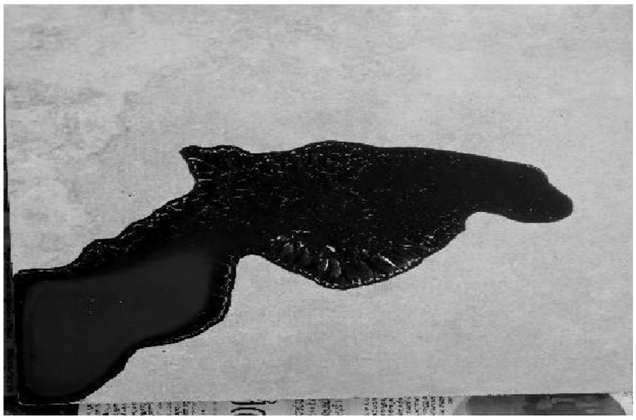

Fig 5 Grey Scale of Tile Pool Pattern

Fig 6 Edge Detection of Tile Pool Pattern

A controlled experimental setup ensured consistency, with surfaces cleaned before application to prevent contamination.

Environmental factors, such as light and insect interference, were minimized. Data collection focused on observing morphological changes in stain spread, absorption, and edge definition across different surfaces. The results were systematically documented to understand how blood behaves under varying conditions, providing insights relevant to forensic investigations.

This structured approach refines bloodstain pattern analysis (BPA), aiding crime scene reconstruction and enhancing forensic methodologies. Future research could incorporate advanced imaging techniques and additional surface materials to improve forensic applications.

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Fig 7 Tile Pool Pattern 10 am 24 Hours

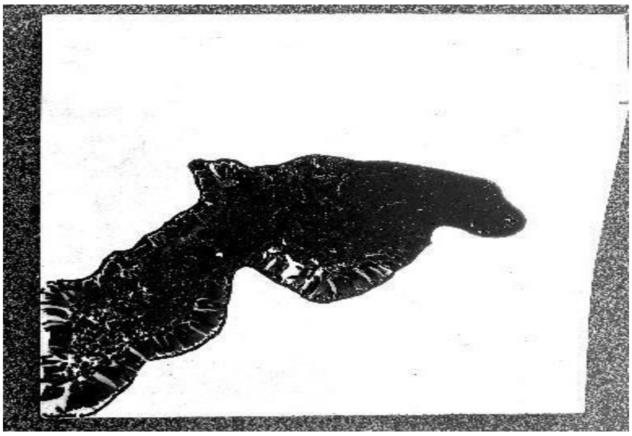

Fig 8 Grey Scale of Tile Pool Pattern

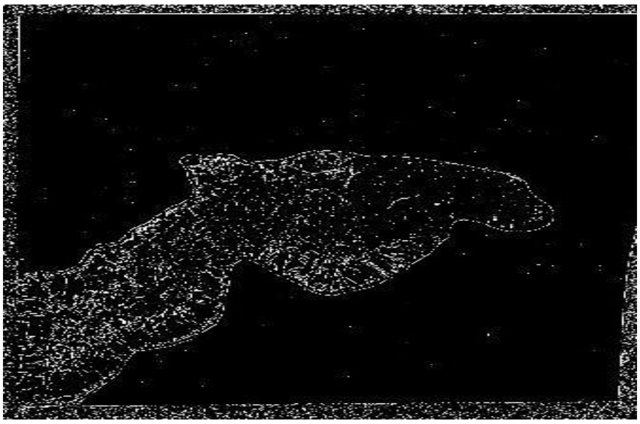

Fig 9 Edge Detection of Tile Pool Pattern

Fig 10 Glass Pool Pattern 10 am Initial

Fig 11 Grey Scale of Glass Pool Pattern

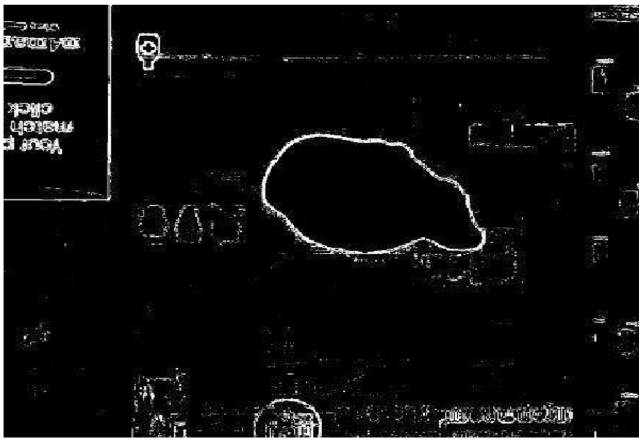

Fig 12 Edge Detection of Glass Pool Pattern

Fig 13 Glass Pool Pattern 4pm 6 Hours

Fig 14 Grey Scale of Glass Pool Pattern

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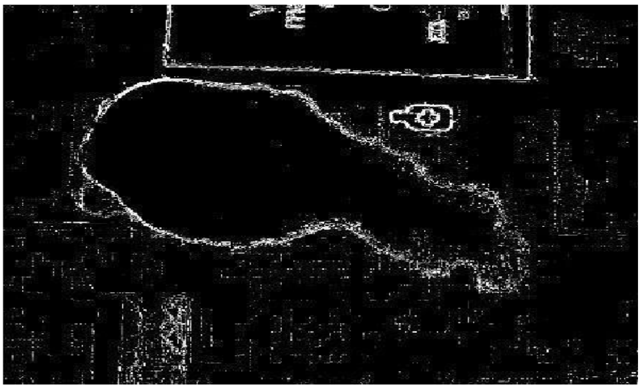

Fig 15 Edge Detection Of Glass Pool Pattern

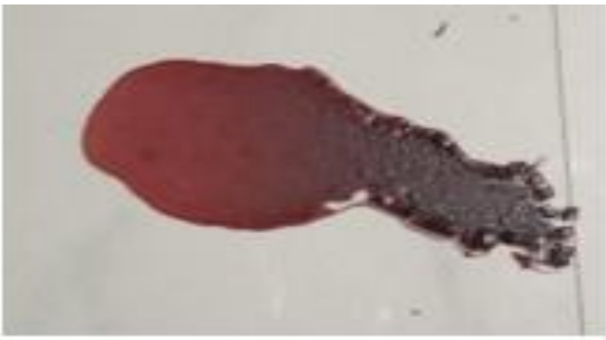

Fig1 6 Glass Pool Pattern 10 Am 24 Hours

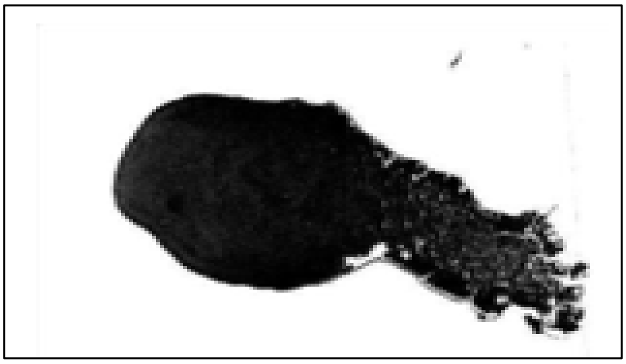

Fig 17 Grey Scale of Glass Pool Pattern

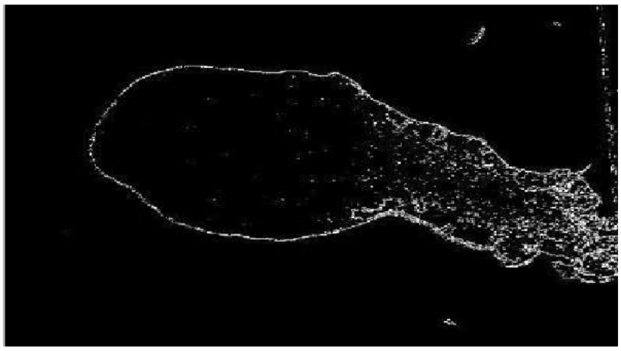

Fig.18 Edge Detection of Glass Pool Pattern

IV. HYPOTHESIS BASED INTEPRETATION

The study confirms that different surfaces and application methods produce distinct blood deposition patterns. Surface properties such as porosity, texture, and absorbency significantly influence stain morphology. Non-porous surfaces like tile and glass retained well-defined edges with minimal absorption, while porous materials like cloth and paper facilitated diffusion and wicking, altering stain patterns. Application methods also affected stain formation—pooling created larger, concentrated stains, splashing resulted in irregular droplets, and dripping produced well-defined circular stains. These variations highlight the critical role of surface type and deposition method in forensic bloodstain analysis.

Additionally, blood deposition patterns change over time based on surface type and application method. Over six hours, observable alterations occurred, with non-porous surfaces showing shrinkage, darkening, and coagulation, leading to distinct edge formation. Conversely, porous surfaces exhibited increased absorption, causing stains to spread and diffuse. Newspaper posed additional challenges due to printed text interference. Digital analysis using grayscale conversion and edge detection confirmed that bloodstains undergo dynamic transformations influenced by surface interaction and time. These findings reinforce the importance of considering both factors when analyzing bloodstains in forensic investigations.

V. CONCLUSION

This study systematically examined blood deposition patterns on different surfaces using various application methods over time, providing critical insights into forensic bloodstain pattern analysis (BPA). The findings confirmed that surface characteristics—such as porosity, texture, and absorbency—significantly influence bloodstain morphology. Nonporous surfaces like glass and tile retained well-defined stains, making them ideal for time estimation, whereas porous materials such as cloth and paper caused diffusion and absorption, complicating forensic interpretation. Additionally, the method of blood application—whether dripping, splattering, or pooling—resulted in distinct stain patterns, reinforcing the importance of deposition technique in crime scene analysis.

Time-dependent changes in bloodstains were also observed, supporting the hypothesis that blood patterns evolve based on surface type and application method. Over different intervals, stains exhibited shrinkage, darkening, and coagulation on non-porous surfaces, while porous materials continued to absorb and spread the blood, altering stain morphology. The use of grayscale conversion and edge detection software further validated these findings, demonstrating the value of digital analysis in forensic investigations.

Despite minor limitations such as environmental interference and imaging constraints, this study provides a strong foundation for future research. Expanding surface variety, refining experimental conditions, and incorporating advanced imaging techniques could further enhance forensic BPA methodologies. By improving crime scene reconstruction and legal evaluations, this research contributes to the accuracy and reliability of forensic investigations, strengthening the role of BPA in the justice system.

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