A Forensic Comparative Study of Palm Prints Similarities Among Sibling: Same Gender- Versus Opposite- Gender Analysis

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***Abstract*—Palm prints serve as a crucial biometric identifier in forensic science due to their permanence, uniqueness, and detailed ridge patterns. While palm print analysis is widely used in individual identification, limited attention has been given to similarities among genetically related individuals, particularly siblings. This study explores palm print similarities between same-gender and opposite-gender sibling pairs to evaluate the influence of genetic and biological factors on dermatoglyphic patterns. Using the traditional ink method, palm prints from selected sibling pairs were collected and analyzed based on principal lines, ridge density, ridge flow patterns, and palm morphology. The findings reveal a higher degree of similarity in palm print characteristics among same-gender siblings compared to opposite-gender siblings. Differences in ridge density and palm structure between males and females suggest that gender-related biological factors influence dermatoglyphic traits. However, despite observable similarities, individual uniqueness remains intact in all cases, reinforcing the reliability of palm prints in forensic identification. This study contributes to forensic science by highlighting the importance of considering familial similarities during palm print analysis. It also emphasizes caution in interpreting palm print evidence in kinship-related investigations and supports the integration of dermatoglyphics in forensic and biometric applications.**

***Index Terms*—Palm Prints, Dermatoglyphics, Sibling Similarity, Forensic Identification.**

I. INTRODUCTION TO FORENSIC SCIENCE AND PALM PRINT IDENTIFICATION

Forensic science plays a fundamental role in the criminal justice system by applying scientific methods to legal investigations. One of its primary objectives is accurate personal identification, which is essential in criminal cases, disaster victim identification, and missing person investigations. Over time, identification methods have evolved from simple visual recognition to advanced biometric techniques such as DNA profiling, fingerprinting, and iris scanning. Among these, palm prints have emerged as a reliable biometric tool. Unlike fingerprints, palm prints cover a larger surface area and include additional features such as principal lines, wrinkles, and ridge patterns. These characteristics provide more data points for analysis, making palm prints particularly valuable in forensic investigations. They are often found at crime scenes due to natural human interactions like touching surfaces or handling objects. Palm prints are formed during fetal development and remain unchanged throughout life, except in cases of severe injury. This permanence ensures their reliability as forensic evidence. Moreover, the uniqueness of palm prints—even among genetically identical individuals such as twins—makes them a powerful identification tool. Despite their advantages, palm prints are sometimes underutilized compared to fingerprints. This study seeks to highlight their importance, especially in complex cases involving genetically related individuals like siblings. Understanding similarities and differences among siblings is crucial for avoiding misidentification and improving forensic accuracy.

II. BIOLOGICAL BASIS AND DEVELOPMENT OF PALM PRINTS

Palm print patterns originate during early fetal development, typically between the 10th and 19th weeks of gestation. Their formation is influenced by a combination of genetic and environmental factors, including intrauterine pressure, blood flow, and maternal health. These factors interact to produce unique ridge configurations that remain stable throughout life. The biological structure of palm prints includes epidermal ridges, flexion creases, and principal lines. These features are not randomly distributed; instead, they follow specific developmental patterns regulated by genetic instructions. However, environmental variations during fetal growth introduce subtle differences, ensuring individuality.

Even identical twins, who share the same genetic material, do not have identical palm prints. This highlights the role of environmental factors in shaping dermatoglyphic patterns. At the same time, genetic influence ensures that certain traits, such as ridge density and general pattern tendencies, may be shared among family members. Understanding the biological basis of palm prints is essential for forensic analysis. It explains why similarities may occur among siblings while maintaining individual uniqueness. This dual influence of genetics and environment forms the foundation for studying familial dermatoglyphic patterns.

III. GENETICS AND FAMILIAL SIMILARITIES IN DERMATOGLYPHICS

Dermatoglyphics, the study of skin ridge patterns, has long established that genetic factors play a significant role in determining ridge characteristics. Siblings share approximately 50% of their genetic material, which can result in observable similarities in palm prints. Studies have shown that ridge counts, pattern types, and palm morphology often cluster within families. These similarities are particularly noticeable in quantitative traits such as ridge density. However, qualitative features like minutiae remain unique, ensuring individual identification.

Familial similarities are of great forensic importance. In cases where multiple suspects belong to the same family, distinguishing between individuals becomes challenging. Understanding the extent of similarity helps forensic experts interpret evidence more accurately.

At the same time, it is crucial to recognize that genetic similarity does not imply identical patterns. Each individual retains a unique dermatoglyphic identity, which prevents misidentification when proper analysis techniques are used.

IV. ROLE OF GENDER IN PALM PRINT CHARACTERISTICS

Gender plays a significant role in influencing palm print features. Biological differences between males and females affect ridge density, palm size, and overall morphology. Generally, males tend to have larger palms with lower ridge density, while females have finer ridges with higher density. These differences arise due to hormonal influences and developmental variations during growth. As a result, gender becomes an important factor when analyzing palm prints, particularly in comparative studies.

In forensic investigations, gender-based differences can aid in narrowing down suspects. However, they can also introduce variability when comparing siblings of different genders. This makes it essential to consider gender as a variable in dermatoglyphic studies. The present study emphasizes how gender influences palm print similarity among siblings, providing valuable insights for forensic applications.

V. METHODOLOGY AND ANALYTICAL FRAMEWORK

This study adopts a comparative, cross-sectional design to analyze palm print similarities among siblings. Fifteen sibling pairs were selected and categorized into same-gender and opposite-gender groups. Palm prints were collected using the traditional ink method, ensuring clarity and consistency. Various parameters were analyzed, including principal lines, ridge flow patterns, ridge density, and palm morphology. A similarity scoring system was used to quantify the degree of resemblance between sibling pairs. Statistical analysis was performed to compare results between groups and test the hypothesis. This methodological approach ensures both qualitative and quantitative evaluation, enhancing the reliability of findings.

VI. RESULTS AND COMPARATIVE ANALYSIS

The analysis revealed that same-gender siblings exhibited a higher degree of similarity in palm print features compared to opposite-gender siblings. This was particularly evident in ridge density and overall palm structure. Opposite-gender siblings showed greater variation, likely due to biological differences between males and females. However, all individuals maintained unique identifying features, confirming the individuality of palm prints. Statistical analysis supported the alternative hypothesis, indicating a significant difference between the two groups. These findings highlight the influence of both genetics and gender on palm print patterns.

VII. DISCUSSION AND FORENSIC IMPLICATIONS

The findings of this study have important implications for forensic science. While similarities among siblings are evident, they do not compromise the uniqueness of palm prints. This reinforces their reliability as an identification tool. However, forensic experts must exercise caution when analyzing palm prints in cases involving related individuals. Misinterpretation of similarities could lead to errors in identification. The study also highlights the need for advanced analytical techniques and larger datasets to improve accuracy. Future research can explore genetic markers and digital analysis methods to enhance dermatoglyphic studies.

VIII. LIMITATIONS AND FUTURE SCOPE

Despite its contributions, the study has certain limitations. The sample size is relatively small, which may affect generalizability. Additionally, the use of traditional ink methods may introduce minor inconsistencies. Future research should include larger and more diverse populations, as well as advanced digital imaging techniques. Studies can also explore genetic correlations and machine learning applications in palm print analysis. Expanding research in this field will strengthen the role of dermatoglyphics in forensic science.

IX. CONCLUSION

This study provides a comprehensive analysis of palm print similarities among siblings, focusing on the comparison between same-gender and opposite-gender pairs. The findings demonstrate that while genetic factors contribute to observable similarities, gender plays a significant moderating role in shaping dermatoglyphic characteristics. Same-gender siblings tend to exhibit greater resemblance due to shared biological traits, whereas opposite-gender siblings show more variation influenced by sexual dimorphism.

Despite these similarities, the uniqueness of palm prints remains intact across all individuals. This reinforces the reliability of palm prints as a forensic identification tool, even in complex cases involving related individuals. The study highlights the importance of integrating both genetic and biological perspectives in forensic analysis to avoid misinterpretation of evidence.

Furthermore, the research emphasizes the need for caution when dealing with familial cases in forensic investigations. It suggests that palm print analysis should be supplemented with other biometric methods to enhance accuracy. Overall, this study contributes to the growing body of knowledge in dermatoglyphics and forensic science. It opens avenues for future research, particularly in the areas of genetic analysis, digital imaging, and artificial intelligence-based identification systems.

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