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The Association of Fingerprint Patterns with Oral Potentially Malignant Disorders (OPMDS) and Oral Malignancy: A Dermatoglyphic Study

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Abstract

Introduction

Dermatoglyphics, the study of fingerprint patterns, offers significant potential for identifying genetic predispositions and detecting abnormalities. This study investigated the correlation between fingerprint patterns and oral potentially malignant disorders (OPMDs), and oral squamous cell carcinoma (OSCC).

Materials and methods

A total of 100 individuals were categorized into five groups: oral leukoplakia (OL), oral submucous fibrosis (OSMF), OSCC, individuals with tobacco habits but no lesions, and a control group. Fingerprints were recorded using mobile app named Fingerprints version 1.83.0 and analyzed for loop, whorl, and arch patterns.

Results

The loop pattern was the most commonly observed, particularly in subjects with leukoplakia, oral submucous fibrosis (OSMF), malignancy, and habits without lesions. Whorl patterns followed as the second most frequent. Composite, arch, and unclassified patterns were less common. The right-left comparison of the fingerprint patterns in all the five groups, except Group 4, showed a significant association and correlation. The Group 4 individuals were showing the least correlation between sides.

Conclusion

This study highlights dermatoglyphics as a promising adjunct tool in screening for oral health conditions.

Keywords: Association, Correlation, Dermatoglyphics, Fingerprint Patterns, Oral Leukoplakia, Oral Submucous Fibrosis, Squamous Cell Carcinoma

Introduction

Dermatoglyphics, the scientific study of ridge patterns on the hands and feet, has gained significant recognition for its applications in personal identification and understanding genetic and developmental anomalies [1]. Introduced in India by Herschel and formalized as a discipline by Galton in 1892, dermatoglyphics has stood out for its reliability due to the permanence of ridge patterns. These patterns begin forming around the sixth week of fetal development and are fully established by the 24th week, remaining unaffected by environmental or external factors throughout life. This stability makes them an invaluable tool for identifying individuals and studying population characteristics [1, 2].

Oral potentially malignant disorders (OPMDs) such as oral leukoplakia (OL), oral submucous fibrosis (OSMF), erythroplakia, lichen planus, and sideropenic dysphagia are known precursors to oral squamous cell carcinoma (OSCC) [3]. Tobacco consumption, alcohol abuse, and unhealthy lifestyles are well-documented contributors to the onset and progression of these conditions. The type, frequency, and duration of these harmful habits significantly influence the pathological transformation of oral tissues [4]. Detecting these conditions in their early stages is critical, as it allows for timely intervention and better prognosis. However, conventional diagnostic methods are often invasive, expensive, or require specialized expertise, underscoring the need for alternative screening tools [5].

Dermatoglyphics offers a non-invasive, cost-effective, and accessible method to identify individuals at risk for OPMDs and OSCC. Numerous studies have demonstrated correlations between fingerprint patterns and various genetic, syndromic, and health conditions, such as diabetes, Down syndrome, and schizophrenia [6]. The underlying principle is that ridge patterns are influenced by genetic and environmental factors during fetal development, which may reflect predispositions to certain conditions. Extending this concept to oral disorders, research is beginning to uncover potential links between specific dermatoglyphic patterns and susceptibility to OPMDs and OSCC, likely due to shared genetic and developmental pathways [7].

The potential of dermatoglyphics in this domain is immense. It could serve as an early warning system to identify individuals who might be at higher risk of developing oral lesions, enabling focused monitoring and preventive interventions [8]. Additionally, dermatoglyphic analysis could complement existing diagnostic techniques, improving the accuracy of risk assessments and reducing reliance on more invasive procedures. For populations with limited access to advanced healthcare facilities, dermatoglyphics could prove to be a practical and effective screening tool, enhancing early detection rates and ultimately reducing the burden of oral cancer [9].

As research continues, the main challenge is to develop clear guidelines for using dermatoglyphic analysis in medical practice and to confirm its usefulness through large-scale studies [8]. Even so, adding dermatoglyphics to the field of oral medicine and radiology offers exciting possibilities for easy and non-invasive diagnosis. By using its ability to predict health risks, dermatoglyphics could change how we prevent and detect oral disorders early, leading to better care and improved outcomes for patients [10].

The objective of this study was to assess and compare fingerprint patterns among individuals with oral potentially malignant disorders (PMDs), oral squamous cell carcinoma (OSCC), individuals with tobacco habits without lesions, and healthy controls. Fingerprint patterns were recorded and analyzed to determine whether specific dermatoglyphic traits could serve as early indicators or markers of susceptibility.

Materials and Methods

The study was conducted at the Oral medicine and radiology department, with prior ethical approval. A total of 100 individuals were randomly selected based on specific inclusion and exclusion criteria. Participants with a history of tobacco or areca nut usage for more than a year were included, while those with oral lesions from other causes, systemic diseases, or finger injuries were excluded.

The participants were divided into five groups:

1. Group 1: 20 subjects with OL.
2. Group 2: 20 subjects with OSMF.
3. Group 3: 20 subjects with OSCC.
4. Group 4: 20 individuals with tobacco habits but no oral lesions.
5. Group 5: 20 individuals with no history of tobacco or areca nut usage and no oral lesions (control group).

Fingerprints were collected using Fingerprints mobile app version 1.83.0. All ten fingers were analyzed qualitatively and quantitatively according to standard classification guidelines by Galton. The observed patterns—loops, whorls, and arches—were recorded and statistically analyzed using SPSS version 26.0.

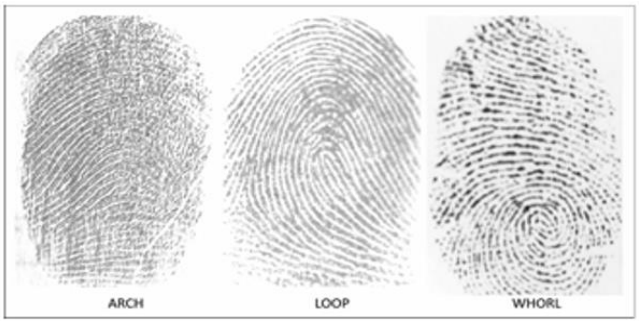


Fig 1: Types of fingerprint patterns

Results

In the present study, the **loop pattern** emerged as the predominant fingerprint pattern across all study groups. The highest frequency of loop patterns was observed in the control group (Group 5) at 69.5%, followed by the habit without lesion group (Group 4) at 68.5%, OSCC group (Group 3) at 65.5%, OL group (Group 1) at 60.5%, and the lowest in the OSMF group (Group 2) at 54.5%. However, these differences were statistically **not significant** (χ^2 = 3.354, p = 0.500).

The **whorl pattern** was most frequent in the OSMF group (42.5%) and OL group (38.5%), while it was observed least in the habit group (20.5%). The OSCC and control groups showed intermediate frequencies (33.5% and 28.5% respectively). Statistical analysis showed **no significant variation** in the distribution of whorl patterns among groups (χ^2 = 6.518, p = 0.164).

In contrast, the **arch pattern** showed statistically **significant differences** across groups (χ^2 = 18.184, p = 0.001). The habit without lesion group (Group 4) had the highest arch frequency (11.0%), compared to only 1.0% each in the OL (Group 1) and OSCC (Group 3) groups, 3.0% in the OSMF group (Group 2), and 2.0% in the control group (Group 5). This implying a possible link between arch patterns and habitual tobacco/areca nut use without clinical manifestations. These findings align with prior studies highlighting loop predominance in healthy populations and whorl enrichment in OSMF, supporting dermatoglyphics as a non-invasive marker for risk stratification.

Finger-wise analysis (Table 2) revealed that the **loop pattern** was dominant in most finger positions, especially in the middle and little fingers. The highest loop frequencies were observed in the left little finger (78.0%), right little finger (73.0%), and both middle fingers (74.0%). The **arch pattern** was primarily confined to the thumbs and index fingers, with no arches recorded in the ring or little fingers of either hand. The **whorl pattern** showed maximum occurrence in the thumbs and ring fingers.

Right–left **association and correlation** of fingerprint patterns (Table 3) were evaluated for all groups. Significant associations ($p < 0.05$) were noted in all groups except for the habit without lesion group (Group 4), where the correlation did not reach significance (p = 0.060). The highest correlation was seen in the OSMF group (Spearman's r = 0.706, p = 0.001), followed by the OL group (0.685), control group (0.611), and OSCC group (0.600).

Further finger-wise right–left **symmetry analysis** (Table 4) revealed varying degrees of correlation across fingers and groups. In Group 1 (OL), significant correlation was noted in the thumb (85% match, p = 0.001), whereas the middle finger showed poor symmetry with a negative correlation (r = -0.123). In the OSMF group, both the thumb (65%) and little finger (85%) demonstrated statistically significant correlations. Group 3 (OSCC) showed the best symmetry in the middle finger (85% match, p = 0.003). Group 4 exhibited significant right–left symmetry in the little finger (90%, p = 0.001), and Group 5 (Control) showed the **highest correlation overall** in the ring finger (90%, r = 0.787, p = 0.000).

Table 1: Frequency Distribution (%) of Fingerprint Patterns in Different Study Groups

Fingerprint Pattern	Group 1 (OL) (n=20), n (%)	Group 2 (OSMF) (n=20), n (%)	Group 3 (OSCC) (n=20), n (%)	Group 4 (Habit without Lesion) (n=20), n (%)	Group 5 (Control) (n=20), n (%)	Total (n=100), n (%)	χ^2	df	P-value
Arch	2 (1.0)	6 (3.0)	2 (1.0)	22 (11.0)	4 (2.0)	36 (3.6)	18.184	4	0.001*
Loop	121 (60.5)	109 (54.5)	131 (65.5)	137 (68.5)	139 (69.5)	637 (63.7)	3.354	4	0.500
Whorl	77 (38.5)	85 (42.5)	67 (33.5)	41 (20.5)	57 (28.5)	327 (32.7)	6.518	4	0.164

*Significant at P < 0.05.

Table 2: Frequency Distribution (%) of Fingerprint Patterns in All Fingers

Finger Position	Arch, n (%)	Loop, n (%)	Whorl, n (%)
Right Thumb n (%)	7 (7.0)	7 (7.0)	7 (7.0)
Left Thumb n (%)	5 (5.0)	5 (5.0)	5 (5.0)
Right Index n (%)	10 (10.0)	49 (49.0)	41 (41.0)
Left Index n (%)	5 (5.0)	66 (66.0)	29 (29.0)
Right Middle n (%)	2 (2.0)	74 (74.0)	24 (24.0)
Left Middle n (%)	5 (5.0)	74 (74.0)	21 (21.0)
Right Ring n (%)	0 (0.0)	70 (70.0)	30 (30.0)
Left Ring n (%)	0 (0.0)	63 (63.0)	37 (37.0)
Right Little n (%)	0 (0.0)	73 (73.0)	27 (27.0)
Left Little n (%)	0 (0.0)	78 (78.0)	22 (22.0)

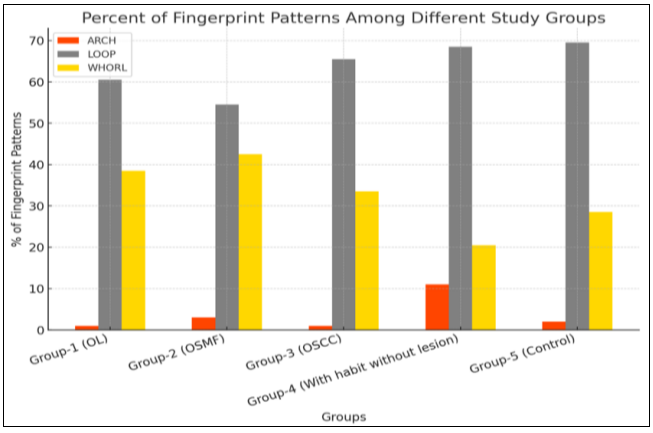
Table 3: Right-Left Association and Correlation Among Study Groups

Group	Right-Left Association (Pearson χ^2)	P-value	Right-Left Correlation (Spearman)	P-value
Group 1 (OL)	9.377	0.002*	0.685	0.001*
Group 2 (OSMF)	18.693	0.001*	0.706	0.001*
Group 3 (OSCC)	7.200	0.007*	0.600	0.005*
Group 4 (Habit)	7.688	0.104	0.443	0.060
Group 5 (Control)	7.472	0.024*	0.611	0.004*

*Significant at P < 0.05.

Table 4: Right-Left Symmetry of Fingerprint Patterns (Finger-wise Analysis)

Group (n=20)	Finger	Right-Left Symmetry (Matching Patterns), n (%)	χ^2	P-value	Spearman Correlation	P-value
Group 1 (OL)	**Thumb**	17 (85%)	9.377	0.002*	0.685	0.001*
	Index	14 (70%)	3.300	0.069	0.406	0.076
	Middle	9 (45%)	2.857	0.582	-0.123	0.604
Group 2 (OSMF)	**Thumb**	13 (65%)	18.693	0.001*	0.706	0.001*
	Little	17 (85%)	8.235	0.004*	0.642	0.002*
Group 3 (OSCC)	**Middle**	17 (85%)	7.937	0.005*	0.630	0.003*
Group 4 (Habit)	**Little**	18 (90%)	8.889	0.003*	0.667	0.001*
Group 5 (Control)	**Ring**	18 (90%)	12.381	0.000*	0.787	0.000*



Graph 1: Percent of fingerprint patterns among the different study groups

Discussion

Over the years, researchers have explored various approaches to detect oral potentially malignant disorders (OPMDs) and oral cancer, emphasizing early diagnosis and prevention [1, 2]. Dermatoglyphics, the study of fingerprint patterns, has emerged as a noninvasive and cost-effective method to analyze genetic predispositions and potential correlations with systemic conditions, including oral diseases [4, 5]. Since fingerprint patterns are formed during fetal development and remain unchanged throughout life, they may serve as markers for identifying individuals at risk for OPMDs and oral malignancies [7].

In the present study, the predominance of loop patterns across all study groups (54.5-69.5%) is consistent with established dermatoglyphic literature. This finding supports Galton's original observations that loops represent the most common fingerprint pattern in human populations. The highest loop frequency in our control group (69.5%) closely matches the 65-70% prevalence reported in previous studies of healthy Indian populations by **Dodia *et al.* (2022)** [1] and **Kulkarni *et al.* (2020)** [8]**.** The gradual decrease in loop frequency from controls through habit groups to disease states suggests a possible dose-response relationship between pathological processes and dermatoglyphic pattern alterations.

The elevated whorl pattern frequency in OSMF patients (42.5%) compared to other groups represents one of our most significant findings. This observation corroborates the work of **Kumar *et al.* (2014)** [7] who reported similar whorl predominance in OSMF subjects (45.2%). The biological basis for this association may lie in shared developmental pathways between ectodermal ridge formation and connective tissue metabolism. During embryogenesis, both fingerprint patterning and oral submucosa development occur simultaneously (weeks 6-13), potentially making them susceptible to similar genetic or environmental influences. The TGF-β pathway, known to be upregulated in OSMF, has been implicated in both fibrosis and epidermal ridge formation, suggesting a possible mechanistic link worthy of further investigation.

The arch pattern findings offer particularly intriguing clinical implications. While arches were rare overall (3.6%), their significant elevation in the habit-without-lesion group (11.0%) suggests they may represent an early marker of biological response to carcinogen exposure before clinical manifestations appear. This finding contrasts with some previous reports (e.g., **Deepa *et al.*, (2014)** [3] that found arch predominance in overt pathologies, but aligns with more recent work by **Awasthy *et al.* (2018)** [9] showing arch enrichment in high-risk habit groups. The complete absence of arches in ring and little fingers across all populations supports the concept of region-specific developmental programming in dermatoglyphic patterning.

Our bilateral symmetry analysis revealed clinically meaningful patterns. The strong right-left correlation in OSMF patients (ρ=0.706) versus the weak symmetry in habit-only individuals (ρ=0.443) suggests fundamentally different mechanisms of dermatoglyphic alteration in these groups. The OSMF findings support a systemic, possibly genetic influence on fingerprint patterning, while the habit group's asymmetry may reflect localized environmental effects. These results expand upon the symmetry work of **Dodia *et al.* (2022)** [1], providing more nuanced understanding of pattern distribution in specific oral conditions.

The finger-specific variations we observed carry important implications for clinical application. The consistent whorl predominance in thumbs (50-57%) across all groups suggests this digit may be less susceptible to pathological pattern alterations, potentially serving as an internal control in dermatoglyphic analyses. Conversely, the middle and little fingers' loop predominance (74-78%) and their symmetry disruption in disease states may make them particularly sensitive indicators of pathological processes.

Conclusion

In conclusion, this study significantly advances our understanding of dermatoglyphic patterns in oral diseases. The distinct associations we identified - particularly whorl enrichment in OSMF and arch elevation in high-risk habit groups - strengthen the evidence base for using fingerprint analysis as a cost-effective, non-invasive adjunct in oral cancer screening programs. When combined with conventional diagnostic methods, dermatoglyphics could enhance early detection, particularly in resource-limited settings where advanced diagnostic tools are unavailable.

Limitations

Several limitations must be acknowledged. Our sample size, while adequate for preliminary analysis, may limit the generalizability of findings. The cross-sectional design prevents assessment of causality or predictive value. Additionally, we did not account for potential confounding factors like duration/intensity of habits or genetic polymorphisms that might influence both dermatoglyphics and disease susceptibility.

Future Research Directions Should Include

1. Larger, multi-center studies with longitudinal follow-up to establish predictive value
2. Molecular analyses to explore genetic links between specific fingerprint patterns and disease pathways
3. Investigation of dermatoglyphic changes in relation to disease progression and treatment response
4. Development of standardized, quantitative scoring systems for clinical application.

Clinical Implications

- Dermatoglyphic screening could identify high-risk individuals before clinical manifestations appear
- Pattern-specific findings may help differentiate between various OPMDs
- The method is particularly suitable for population-level screening due to its low cost and non-invasive nature.

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