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Research Article

Comparative Assessment and Correlation Between Dermatoglyphic Patterns Among Sagittal and Vertical Skeletal Discrepancies

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Abstract

Objective: The objective of this research is to compare and assess the correlation between dermatoglyphic patterns among sagittal and vertical skeletal discrepancies and to determine which among the two groups show greater significant association with fingerprints

Materials and Methods: The study included 62 subjects aged 18-40 years randomly selected from the outpatient clinic of department of orthodontics and dentofacial orthopaedics, PMS college of dental science and research trivandrum. The total sample of 62 subjects were categorized into groups of 2 as sagittal and vertical groups. These subjects were asked to clean their hands with soap and water and wipe with ethyl alcohol to remove sweat, oil and dirt from skin surface. The fingerprints were recorded using the ink stamp method. The dried distal phalanges of both hands were rolled on an ink pad and stamped on 2.5mm thick paper. The prints obtained were assessed by means of a magnifying lens for the frequency of arches, loops and whorls. The total ridge count was evaluated. Statistical analysis done.

Results: In sagittal class I and class III skeletal malocclusion, loop form of fingerprint (50% and 72.7% respectively) is more commonly seen followed by whorl (30% and 18.2% respectively) and arch forms (20% and 9.1% respectively). In class II skeletal malocclusion whorl form of fingerprint (60%) is more commonly seen followed by loop (30%) and arch forms (10%). In vertical group patients, deep bite and open bite patients were recorded with increased loop pattern (66.7% and 44% respectively), followed by whorl (20% and 42% respectively)and arch forms (13.3%and 14% respectively).

Conclusion: Results from the present study shows that comparing the sagittal and vertical skeletal discrepancies, greater correlation was observed with dermatotoglyphic patterns among patients with sagittal skeletal discrepancies as the sagittal showed significant variations in fingerprint patterns among class I class II and class III patients. Loop pattern dominated in class I (50%) class III (72%) and whorl pattern dominated in class II patients (60%).But in the case of patients with vertical discrepancies loop pattern dominated

Keywords: Dermatoglyphics; Arches; Loops; Whorls; Sagittal; Vertical

Introduction

Dermatoglyphics is the study of epidermal ridges and their configurations. It includes fingers, palms and soles. It is derived from two Greek words: derma meaning skin and glyphae meaning carve. It is assumed to be genetically controlled, and the precise mechanism of inheritance has not yet been established [1].

Several genetic disorders have been identified with abnormally rhythmic dermatoglyphic patterns. It also includes diseases which may have a direct or indirect influence on the etiology of genetic inheritence. The association of dermatoglyphics in the area of dentistry has been studied in precancerous and cancerous lesions in the oral cavity, tooth decay, cleft lip palate and Malocclusion. It's interesting to learn about the relationship between dermatoglyphics and dental anormalies. It makes sense that the development of teeth and epidermal ridges would coincide since they both occur during the same period of intrauterine life. It occurs between the 6^{th} -13^{th} week of intrauterine life [3]. It's also fascinating to consider how hereditary and maternal environmental factors can affect the formation of fingerprint patterns, which are classified into four types based on arches, loops, and whorls.

It is interesting to learn about the different classifications of arches and loops in fingerprints. Previous studies have explored the relationship between fingerprint patterns and dental malocclusions, but not much research has been done on the correlation between fingerprint patterns and growth patterns. It's fascinating to know that the study of epidermal ridges and the patterns they form is known as dermatoglyphics, a term coined by anatomist Harold Cummins of Tulane University [2].

There exist Galton's "proof of no change" rule, which suggests that a person's dermatoglyphics pattern doesn't change throughout their lifetime. These patterns are formed in the womb and remain constant except for changes in size. Fingerprint patterns are determined by multiple genes and can provide important genetic and medical information about a person. Even identical twins have different fingerprints. Dermal configuration is found to be appearing at the 12^{th} week of intrauterine life and the establishment of its configuration is found to be by around 24^{th} week. The study of fingerprints can be helpful in diagnosing and treating individuals with genetic disorders, as well as in forensic investigations.

Fingerprints have been used as a form of identification for thousands of years, dating back to the ancient Assyrians and Chinese in 7000 to 6000 BC [4]. In the early 19^{th} century, Purkinje, a professor of anatomy and physiology, proposed a system of classification for fingerprint patterns consisting of 9 basic types. William Herschel was the first to experiment with fingerprints in India in 1858, while Sir Francis Galton, a British anthropologist and cousin of Charles Darwin, began observing fingerprints as a means of identification in the 1880s [5].

In 1892, an important book was published by Sir Francis Galton titled "Fingerprints". This book established the individuality and permanence of fingerprints, and included the world's first classification system for fingerprints. Following this groundbreaking work, Sir Edward Henry published his book on "The classification and uses of fingerprints" in 1893, marking the beginning of a modern era of fingerprint identification. It's incredible to see how this form of identification has evolved and continues to be a crucial tool in forensic investigation.

Studies have conclusively shown that there exists a definitive correlation between dermatoglyphics and several medical conditions, including dental occlusion. This strong association can be attributed to the simultaneous development of teeth and dermal patterns during embryonic development. Therefore, it can be confidently stated that there is a clear link between dermatoglyphics and dental occlusion. It seems that previous studies have focused on evaluating the type of fingerprint pattern in various dental malocclusions, but have not considered certain types of growth patterns. To address this gap, the present study aims to explore the association of dermatoglyphic patterns with sagittal and vertical skeletal discrepancies. The goal is to determine whether sagittal or vertical skeletal discrepancy exhibits a more significant correlation with fingerprint patterns, and to compare the two.

Subjects and Methods

Subjects

Fingerprints were obtained from each subject under study. Lateral cephalograms of each patient was taken and obtained from Department of Orthodontics and Dentofacial Orthopaedics of PMS College of Dental Science and Research. The total sample used in this study comprise of 62 subjects categorized into 2 groups –sagittal and vertical (31 each group).

Sagittal-Ideal skeletal class I, skeletal class I with bimaxillary protrusion, skeletal class II with maxillary excess, skeletal class II with mandibular deficiency, skeletal class III with mandibular excess, skeletal class III with maxillary deficiency. Vertical-Open bite, Deep bite, Long face, Short face, Other subjects with vertical growth pattern.

The Institutional Ethical Committee approved this study and the participant or their guardians signed the informed consent. The criteria for inclusion were: systemically healthy subjects of age 18-40 years, who consented to participate in study, subjects who had not undergone any previous orthodontic treatment, subjects who had not taken undergone any oro maxillofacial surgery. The criteria for exclusion were patients with developmental anormalies, patients with any systemic disease affecting bone and general health, children and pregnant women, mentally retarded patients, patients who did not give an informed consent.

Materials and equipment

2.5mm thick paper, Ink pad, Magnifying lens

Procedure

The study was conducted on 62 subjects aged 18-40 years randomly selected from the outpatient clinic of Dept of Orthodontics and Dentofacial Orthopeadics, PMS College of Dental Science and Research Trivandrum. The total sample of 62 subjects was categorized into groups sagittal discrepancies-Ideal skeletal class I, Skeletal class I with bimaxillary protrusion, Skeletal class II with maxillary excess, Skeletal class II with mandibular deficiency, Skeletal class III with mandibular excess, Skeletal class III with maxillary deficiency.

Vertical discrepancies-Open bite, Deep bite, Long face, Short face, other subjects with vertical growth patterns

Parameter assessment for determining sagittal jaw relation

The sagittal jaw relation was determined from patients lateral cephalogram with assessment of following parameters SNA, SNB, ANB, WITS APPRAISAL, CONDYLION TO POINT A, CONDYLION TO GNATHION, ANGLE OF CONVEXITY, FACIAL ANGLE

Parameter assessment for determining vertical jaw relation

The vertical jaw relation was determined from patients lateral cephalogram with assessment of following parameters FMA, Y AXIS, SN-GoGn ANGLE, FACIAL AXIS ANGLE, JARABACKS RATIO, N-Me, S-Go

The patients were thus categorized into different groups according to skeletal relationship of maxilla and mandible.

Fingerprint recording and assessment

The subjects were asked to clean their hands with soap and water and wipe with ethyl alcohol to remove sweat, oil and dirt from skin surface. The fingerprints were recorded using the ink stamp method. The bulb of the finger was placed at right angles to the surface of the stamp pad. The dried distal phalanges were then rolled or turned until the bulb faced the opposite direction. The finger was then placed on the 2.5 mm thick white paper and it was rolled in the same manner, to obtain a clean, rolled impression of the finger pattern. In case of unsatisfactory prints, the procedure was repeated. To avoid duplication of fingerprints, fingers were numbered from 1-5 from left thumb to little finger and from 6-10 for right thumb to little finger. The prints obtained were assessed for frequency of arches, loops and whorls. The total ridge count was evaluated.

Statistical analysis

Statistical analysis was done to assess the correlation of dermatoglyphic patterns with sagittal skeletal discrepancies and vertical skeletal discrepancies separately and then comparative analysis between the 2 groups (sagittal and vertical) was also done, so as to determine if any correlation or differences exist between dematoglyphic patterns among subjects with sagittal and vertical skeletal discrepancies, and also to determine which among the 2 groups shows more significant correlation

Results

Comparison of fingerprints with sagittal and vertical skeletal discrepancies

Type	Fingerprint						Total	
	ARCH		LOOP		WHORL			
	n	%	n	%	n	%	n	%
CLASS I	2	20	5	50	3	30	10	100
CLASS II	1	10	3	30	6	60	10	100
CLASS III	1	9.1	8	72.7	2	18.2	11	100
DEEP BITE/SHORT FACE PATIENTS	2	13.3	10	66.7	3	20	15	100
OPEN BITE/LONG FACE	2	12.5	7	43.8	7	43.8	16	100
Total	8	12.9	33	53.2	21	33.9	62	100

Table 1: Descriptive statistics for fingerprint.

	χ^2	df	P
Chi-Square test	7.354	8	0.499

Table 2: Fingerprint-Chi square value.

Chi Square analysis dispalyed no statistical association between skeletal malocclusion and fingerprint P = 0.4

Correlation between finger print and sagittal skeletal malocclusion (Class I)

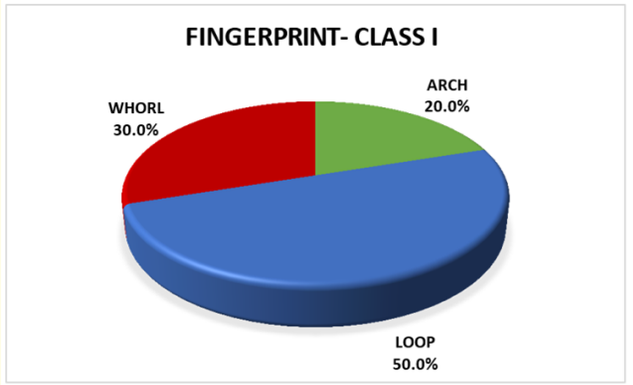

Figure 1: Fingerprint pattern class I.

Class I - Fingerprint	Frequency	Percentage
ARCH	2	20
LOOP	5	50
WHORL	3	30
Total	10	100

Table 3: Fingerprint Pattern Class I.

The class I skeletal pattern shows loop pattern dominating by 50%, followed by whorl pattern 30% and arch pattern by 20%.

Inference- skeletal class I group shows increased loop pattern

Correlation between fingerprint and sagital skeletal malocclusion (class II)

The class II skeletal pattern shows whorl pattern dominating by 60%, followed by loop pattern 30% and arch pattern by 10%

Inference- skeletal class II group shows increased whorl pattern

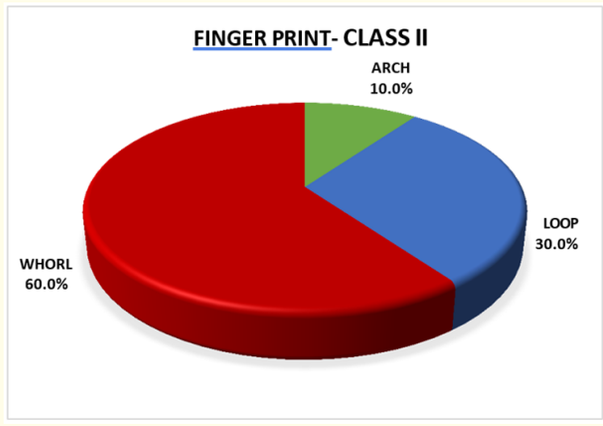

Figure 2: Finger Print Pattern Class II.

CLASS II - FINGERPRINT	Frequency	Percentage
ARCH	1	10
LOOP	3	30
WHORL	6	60
Total	10	100

Table 4: Fingerprint pattern class II.

Correlation between fingerprint and sagital skeletal malocclusion (Class III)

The class III skeletal pattern shows loop pattern dominating by 72.7%, followed by whorl pattern 18.2% and arch pattern by 9.1%

Inference- skeletal class III group shows increased loop pattern

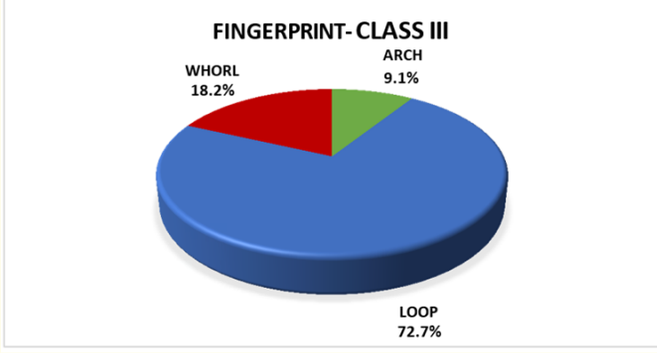

Figure 3: Finger Print Pattern Class II.

CLASS III - FINGERPRINT	Frequency	Percentage
ARCH	1	9.1
LOOP	8	72.7
WHORL	2	18.2
Total	11	100

Table 5: Fingerprint pattern class III.

Correlation between fingerprint and vertical skeletal malocclusion (deep bite)

The deep bite patient shows loop pattern dominating by 66.7%, followed by whorl pattern 20% and arch pattern by 13.3%

Inference- deep bite group shows increased loop pattern

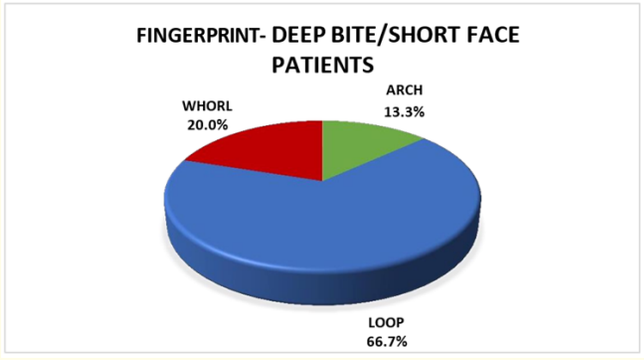

Figure 4: Fingerprint pattern deep bite.

DEEP BITE/SHORT FACE PATIENTS - FINGERPRINT	Frequency	Percentage
ARCH	2	13.3
LOOP	10	66.7
WHORL	3	20
Total	15	100

Table 6: Fingerprint pattern deep bite.

Correlation between fingerprint and vertical skeletal malocclusion (open bite)

The open bite group shows loop pattern dominating by 44%, followed by whorl pattern 42% and arch pattern by 14%

Inference- open bite group shows increased loop pattern

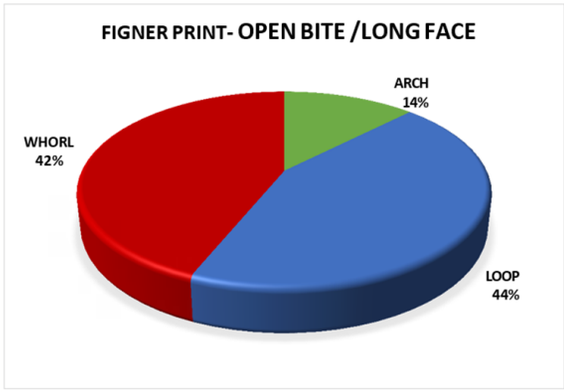

Figure 5: Fingerprint pattern open bite.

OPEN BITE/LONG FACE - FINGERPRINT	Frequency	Percentage
ARCH	2	14
LOOP	7	44
WHORL	7	42
Total	16	100

Table 7: Fingerprint pattern open bite.

Overall graphical representation

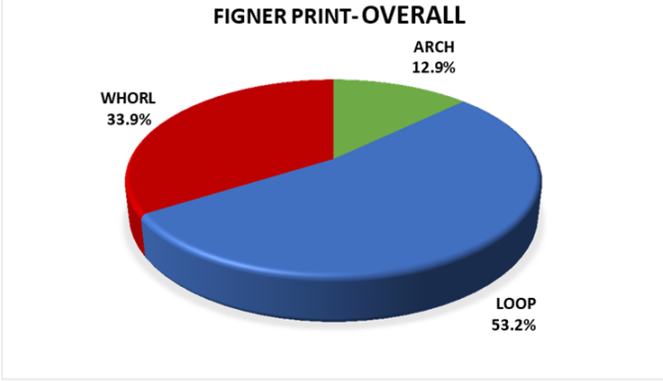

Figure 6: Fingerprint pattern overall.

Results gives us the inference that overall loop pattern dominates in the patients with both sagittal and vertical skeletal discrepancies by 53.2%, followed by whorl pattern 33.9%, and arch pattern by 12.9%

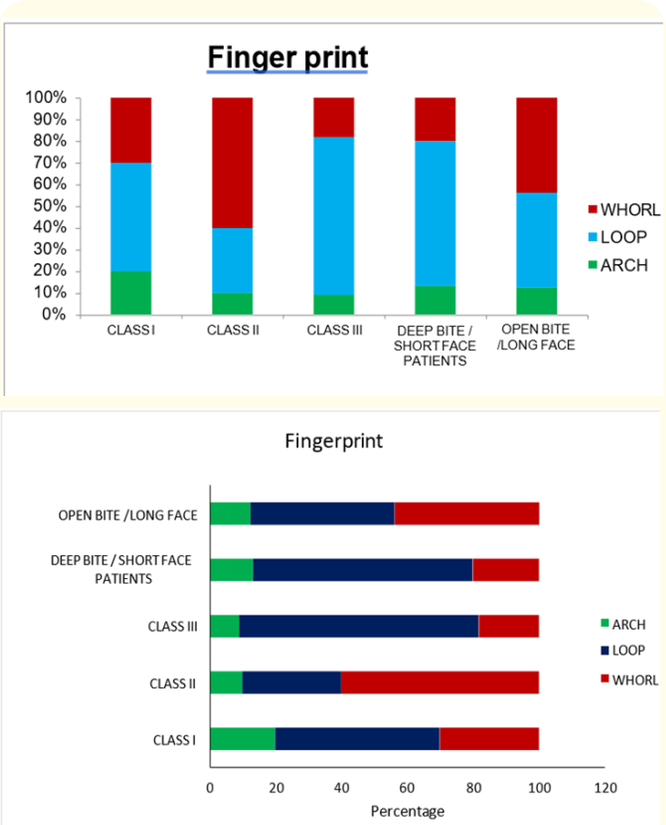

Figure 7: Correlation between finger print with sagittal and vertical skeletal discrepancies (percentage calculation).

In sagittal class I and class III skeletal malocclusion loop form of fingerprint (50% and 72.7% respectively) is more commonly seen followed by whorl (30% and 18.2% respectively) and arch forms (20% and 9.1% respectively). In class II skeletal malocclusion whorl form of fingerprint (60%) is more commonly seen followed by loop (30%) and arch forms (10%).

In vertical group patients, deep bite and open bite patients were recorded with increased loop pattern (66.7% and 44% respectively), followed by whorl (20% and 42% respectively)and arch forms (13.3%and 14% respectively).

Discussion

During the intrauterine period, embryonic tissues form both the epidermal ridges of our fingers and our facial structures, which are primarily determined by genetics. Interestingly, this has led researchers to hypothesize that hereditary and genetic factors that impact the development of the lip, alveolus, and palate may also influence fingerprint patterns.

In recent years, there has been growing interest in the field of medical dermatoglyphics due to reports highlighting the potential associations between fingerprint patterns and various health conditions, including breast cancer, autism, hypertension, and skeletal abnormalities. Additionally, researchers have recently turned their attention to dental dermatoglyphics, as irregular fingerprints have been observed in patients with certain dental issues, in periodontitis patients and congenital anomalies such as cleft lip and palate.

These new discoveries provide promising avenues for further research and potential clinical applications in the diagnosis and treatment of various health conditions. The primary objective of the study was to assess the correlation between dermatoglyphic patterns with sagittal and vertical skeletal discrepancies.

In the present study, in class I and class III skeletal malocclusion loop pattern of fingerprint (50% and 72% respectively) is more commonly seen and whorl pattern is more common in subjects with Class II malocclusion (60%). Similar results were reported by Susha Mariam George., *et al.* [20], but in their study the association of the loop pattern with skeletal class I and III malocclusion and the whorl pattern with skeletal Class II malocclusion were statistically highly significant ($p < 0.05$) whereas in the present study the association is not statistically significant ($p = 0.4$). The disparity in results could be due to variations in sample size and the involvement of different objectives as the present study is conducted on a comparatively different sample size. The difference in geographic population may have also contributed to the difference in results.

Shikha Sangal., *et al.* [36] also reported increased frequency of whorl pattern in skeletal class II subjects along with increased frequency of loop in class III subjects, but in contrast to the present study no significant correlation was observed in the case of class I skeletal pattern. In the present study class I groups were reported to have increased number of loops. The results from previous studies have varied due to a number of factors. These include differences in the way tests were designed, the lack of a precise method for evaluating Dermatoglyphics and sagittal skeletal discrepancies and oral clefts, variations in the sample size and distribution, as well as differences in the methodology, execution, and armamentarium used in the study. All of these factors have contributed to the final outcome of the study.

Smitha Sammith Shetty., *et al.* [33] has revealed a significant correlation between dermatoglyphic patterns and the type of malocclusion among Malaysian dental and medical students. The

study analyzed the fingerprints and palm prints of 104 participants to determine the pattern type. Based on the analysis, the researchers have confidently concluded that individuals with a loop ridge pattern on their left thumb are highly likely to have class I normal occlusion and class III malocclusion, while those with a whorl ridge pattern have a considerably higher incidence of class I malocclusion. The present study shows loop pattern dominance in Class I and Class III malocclusion, but the difference is observed in the case of whorl pattern dominating in class II patients unlike the above mentioned study where the whorl pattern was more in class I malocclusion. However, in the present study no statistically significant association was found. The previous study was conducted on Malaysian population whereas in the present study, the sample was derived from south Indian population. This difference in findings may be the cause of difference in statistical significance.

Charles., *et al*. [23] conducted a rigorous evaluation and comparison of dermatoglyphic patterns with various skeletal malocclusions, ultimately unveiling a clear and significant correlation between the two. Specifically, the study found that loop patterns were prevalent in individuals with class I occlusion and class III malocclusion, while whorl patterns were more commonly observed in those with class II malocclusion. These findings were robust and statistically significant with a reported significance level of $P < 0.05$. This coincides with the results obtained from the present study. Only difference is that the present study does not show statistical significance and the previous study used electric scanner for finger print evaluation.

Garima Jindal., *et al*. [14] examined the associations between dermatoglyphic features and malocclusion in Indian children. The study found that there were increased tendencies toward high frequencies of whorls in subjects with class II malocclusion and plain arches in those with class III malocclusion. Unlike the previous study, present study shows increased loop pattern in Class III and Class I patients, but coincides with whorl pattern dominance in class II patients. The previous study has not shown any correlation in the Class I cases. The variations in findings may be due to the differences in methodology and execution. Moreover, the previous study was focussing on Indian children between the age of 12- 14 yrs, whereas the present study includes age group between 18-40.

According to Jaskiran Kaur., *et al*. [16] study, those with class II malocclusion showed higher frequency of whorls in their fingerprints, while individuals with ideal occlusion tended to have ulnar loop fingertip patterns. It seems that there could be a potential correlation between dermatoglyphics and malocclusion in children aged 12- 14 years. These results coincides with our present study results, but in contrast to present study, they have not found any significance and correlation in class III patients. The variation and difference may be due to the age group difference in which the previous study was aimed at children between 12-14 yrs, unlike the present study which focussed on age group between 18-40, including differences in sample size of fingerprint (50% and 72% respectively) is more commonly seen and whorl pattern is more common in subjects with Class III malocclusion (60%). But the results reported by Achalli. S., *et al*. [22] shows association of the loop pattern with skeletal class I and II malocclusion and the whorl pattern with skeletal Class III malocclusion which were statistically highly significant ($p = .0001$) whereas in the present study the association is not statistically significant ($p = 0.11$). The disparity in results could be due to variations in sample size. The difference in geographic population may also contributed to the difference in results.

In contrast to present study, Divyashree., *et al*. [17] reported increased frequency of loops in skeletal class II subjects and increased frequency of whorls were found in skeletal class I subjects. However, in their study the comparison of dermatoglyphic data was done only between skeletal class I and class II subjects, skeletal class III subjects were not included and the sample size was less compared to the present study.

As of now no studies have been published regarding the correlation of dermatoglyphics with vertical skeletal discrepancies. The present study was also aimed at verifying the correlation of finger prints with vertical patients. Loop pattern dominated in open bite and long face patients by 43.8% whereas the same loop pattern dominated in deep bite patients by 66.7%. But the results does not show statistical significance.

Results from the present study shows that comparing the sagittal and vertical skeletal discrepancies, greater correlation was observed with dermatoglyphic patterns among patients with sagittal skeletal discrepancies as the sagittal showed significant variations in fingerprint patterns among class I class II and class III patients. Loop pattern dominated in class I (50%) class III (72%) and whorl pattern dominated in class II patients (60%). But in the case of patients with vertical discrepancies loop pattern dominated in all the study groups, which does not provide a significant correlation.

It appears that the results of the chi-square analysis conducted on the association between fingerprint patterns and malocclusion among the study subjects did not show any significant difference

between the two. This finding is consistent with the conclusions reached by Eslami., *et al*. [18], Tara V., *et al*, and Tanveer., *et al*. [28] However, other studies such as Tikare., *et al*. [10], Trehan M., *et al*. [8] and George., *et al*. have reported a significant association between dermatoglyphics and malocclusion. The reason for this disparity in results could be due to a variety of factors such as differences in sample size, variations in the protocol for recording fingerprint patterns, and ethnic and racial differences among the study subjects.

The present study shows some limitations. The study was conducted in a hospital setting, which means that the subjects were limited to those who had visited the hospital for treatment purposes. To establish a more concrete association between dermatoglyphic patterns with sagittal and vertical discrepancies, a larger sample that is representative of the whole population would be needed. Additionally, the registration of fingerprints was dependent on the pliable nature of application of fingerprint pressure, which could result in incomplete fingerprints. The ink stamp method also has its limitations, with smudged fingerprints being recorded at times. Perhaps digitalized fingerprint sensors could be a useful way to overcome these limitations in the future.

Dermatoglyphics is a highly promising screening tool for malocclusion, with several advantages. It is easily accessible, cost-effective, and non-invasive, making it an ideal marker for identifying individuals at risk of developing malocclusion. Although more studies are needed to fully understand the relationship between dermatoglyphics and malocclusion, it is clear that this technique has great potential to revolutionize preventive and interceptive orthodontics. With larger sample sizes and individuals from diverse ethnic and racial backgrounds, we can obtain a more comprehensive understanding of the link between dermatoglyphics and malocclusion, and use this information to enhance patient care and outcomes.

Conclusion

The study evaluated the relationship of fingerprint patterns with sagittal and vertical skeletal discrepancies

No statistically significant association was found between skeletal malocclusion and fingerprint

In sagittal class I and class III skeletal malocclusion loop form of fingerprint (50% and 72.7% respectively) is more commonly seen followed by whorl (30% and 18.2% respectively) and arch forms (20% and 9.1% respectively). In class II skeletal malocclusion whorl form of fingerprint (60%) is more commonly seen followed by loop (30%) and arch forms (10%).

In vertical group patients, deep bite and open bite patients were recorded with increased loop pattern (66.7% and 44% respectively), followed by whorl (20% and 42% respectively)and arch forms

(13.3%and 14% respectievely)

Results from the present study shows that comparing the sagittal and vertical skeletal discrepancies, greater correlation was observed with dermatotoglyphic patterns among patients with sagittal skeletal discrepancies as the sagittal showed significant variations in fingerprint patterns among class I class II and class III patients. Loop pattern dominated in class I (50%) class III (72%) and whorl pattern dominated in class II patients (60%).But in the case of patients with vertical discrepancies loop pattern dominated in all the study groups, which does not provide a significant correlation.

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