Evaluation of Dermatoglyphic Patterns using Digital Scanner Technique in Skeletal Malocclusion: A Descriptive Study

Abstract

**Background:** Skin is the largest human organ, which performs a dynamic role in life. The ectodermal layers of the skin found on the palm with intricate lines are stable throughout life and have grabbed scientific attention. Any disturbances during their formation might possibly have the likelihood of a person developing malocclusion. **Aims and Objectives:** The aims of this study were to evaluate and compare the dermatoglyphic pattern with various skeletal malocclusions. **Materials and Methods:** The study was carried out on 40 outpatients reported with an age group of 18–20 years divided into four groups as follows: Group: I – 10 (Class I occlusion), Group: II – 10 (skeletal Class I malocclusion), Group: III – 10 (skeletal Class II malocclusion), and Group: IV – 10 (skeletal Class III malocclusion). The fingerprints were recorded using scanner exclusively designed for diagnostic purpose of the study. The collected data were analyzed using SPSS statistics software Version 23.0 to find which groups had significant differences. **Results and Conclusion:** Increased frequency of arch pattern was present in participants with Class I malocclusion, and loop patterns were observed in those with Class I occlusion and Class III malocclusion and whorl patterns in Class II malocclusion with $P < 0.05$. Dermatoglyphic pattern remains constant throughout life and it can be used as a noninvasive aid in determining the development of malocclusion at a very early age.

**Keywords:** Dermatoglyphics, fingerprint patterns, malocclusion

Introduction

Galton in 1982[1] initiated his pioneering work to demonstrate that the development of dermatoglyphics is controlled by genetic factors. Further studies were undertaken to develop the science of dermatoglyphics, and many researchers initiated research into dermatoglyphics. Studies on the genetic inheritance of dermatoglyphic patterns to investigate the embryogenesis of dermatoglyphic patterns reported that there is genetic basis and there is no alteration in the structure of ridge patterns after birth.[2] Surprisingly, little is known about the various factors that influence a person’s fingerprint patterns. Like many other complex traits, studies suggest that both genetic and environmental factors play a role.[3]

Dermatoglyphics in human biology have a significance of their own and provide important clues of the early fetal development. Researchers always wanted to find a link between dermatoglyphics and clinical medicine. Its usefulness and limitations are to a large degree linked in diagnosis as the dermal ridge configurations are a direct consequence of the surface topography of the fetal hand during the period of dermal ridge development.[4]

Every aspect of the growth and development of a single cell to a fully formed human is directed by genetics. The capability to form friction ridges is inherent. In humans, the development of the primary palate and the lip is completed by the 7th week of intrauterine life and that of the secondary palate by the 12th week. The dermal ridges develop in relation to the volar pads, which are formed by the 6th week of gestation and reach maximum size between 12th and 13th weeks.[5]

The treatment of facial skeletal anomalies confronts the orthodontist with a special challenge of starting the treatment at the appropriate time. Dermatoglyphics can be used as a tool to identify different skeletal malocclusions. Therefore, the treatment of skeletal deviation of the
jaws can be facilitated if facial growth can be predicted using dermatoglyphic patterns. They are more relevant to orthodontics because they share the developmental time during the intrauterine period, with the development and completion of dental hard tissue and jaw bases. The genetic message in the genome, whether normal or abnormal, is deciphered during the period and reflects in the dermatoglyphic pattern. It will also help initiate treatment at the right time at an early age and to evaluate the various dermatoglyphic patterns and their association with different type of skeletal malocclusions.

Hence, this study is aimed to evaluate and compare the dermatoglyphic pattern with various skeletal malocclusions.

Materials and Methods

This study was conducted in the Department of Orthodontics, SRM Dental College, Ramapuram, Chennai. The sample size was n = 40 in the group of 18–20 years. The sample size n = 40 was calculated using the statistical sample size formulae, and the power was set at 80. They were divided into four groups each comprising ten participants: Group: I – 10 (Class I occlusion), Group II – 10 (skeletal Class I malocclusion), Group III – 10 (skeletal Class II malocclusion), and Group IV – 10 (skeletal Class III malocclusion).

The study protocol was approved by the Institutional Ethics Committee of SRM Dental College, Ramapuram, Tamil Nadu, India (SRMU/MandHS/SRMDC/2017/F/001). The procedure was explained to the patients, and a written informed consent was obtained from them with due consideration to ethical issues and confidentiality of fingerprint records. Skeletal relation was determined using patient’s lateral cephalogram with assessment of the following parameters: SNA, SNB, and ANB. Molar relation, ideal overjet and overbite, well-aligned arch – line of occlusion were used to differentiate between Class I occlusion and Class I malocclusion.

Fingerprint scanner

Fingerprint scanner with software compatibility was exclusively designed for the study using OS: Linux Language: C/C++ Processor: IMX6DQCEC-Image Processor Unit, Sensor: Fx Integrator and OEM Module.

The participants were asked to clean their hands with soap and water and wipe with ethyl alcohol to remove the sweat, oil, and dirt from the skin surface. Both the right and left distal phalanges of the digits were scanned, and the images were stored. The fingerprint image obtained was checked for clarity by zoom mode and later uploaded in the software.

Dermatoglyphic analysis

The digital prints obtained were assessed for three basic types of ridge patterns found in the distal phalanges of the digits, i.e., arch, loop, and whorl based on Galton’s classification. Figure 1 shows the scanner image and types of fingerprint patterns.

Statistical analysis

The collected data were analyzed with SPSS statistics Software Version 23.0, (IBM, Armonk, NY, United States of America). To describe about the data descriptive statistics, mean and standard deviation were used. The data obtained were tested for normality, and since the data distribution was not normal, nonparametric test, i.e. Kruskal–Wallis was used to determine if there is a significant difference between the groups used and P < 0.05 is considered statistically significant.

Results

From the present study, results show an increased prevalence of arch pattern among Class I malocclusion individuals [Table 1]. There is a predominance of whorl pattern in Class II malocclusion [Table 2]. Loop was the predominant fingerprint pattern in both Class I occlusion (Group I) and Class III malocclusion (Group IV) [Table 3].

On comparison of the fingerprint pattern between Class I occlusion and Class I malocclusion, there was a statistically significant increase in the prevalence of arch and a decrease in loop pattern in Class I malocclusion individuals compared to Class I occlusion (P < 0.05) [Table 4].

There was a statistically significant difference in loop and whorl pattern between Class II malocclusion and Class I occlusion (P < 0.05) [Table 5].

There was no statistically significant difference in the fingerprint pattern between Class III malocclusion and Class I occlusion [Table 6]. However, group comparisons showed that there was statistically significant difference in arch and whorl pattern between Class I and Class II skeletal malocclusion [Table 7].

There was statistically significant difference in arch and loop pattern between Class I and Class III malocclusion (P < 0.05) [Table 8].

Figure 1: Scanner image and types of fingerprint patterns
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There was also statistically significant difference in loop and whorl pattern between Class II and Class III malocclusion ($P < 0.05$) [Table 9].

### Table 1: Distribution of arch-type fingerprint pattern

| Group | n  | Mean  | SD   | SE   | 95% CI for mean Lower bound | Upper bound | Minimum | Maximum |
|-------|----|-------|------|------|-----------------------------|-------------|---------|---------|
| Ideal | 10 | 3.700 | 2.3594 | 0.7461 | 2.012 | 5.388 | 1.0 | 9.0 |
| Class I | 10 | 28.900 | 9.8596 | 3.1179 | 21.847 | 35.953 | 5.0 | 38.0 |
| Class II | 10 | 4.100 | 2.3310 | 0.7371 | 2.433 | 5.767 | 0.0 | 8.0 |
| Class III | 10 | 6.300 | 5.2715 | 1.6670 | 2.529 | 10.071 | 0.0 | 17.0 |
| Total | 40 | 10.750 | 12.0421 | 1.9040 | 6.899 | 14.601 | 0.0 | 38.0 |

SD=Standard deviation, SE=Standard error, CI=Confidence interval

### Table 2: Distribution of whorl-type fingerprint pattern

| Group | n  | Mean  | SD   | SE   | 95% CI for mean Lower bound | Upper bound | Minimum | Maximum |
|-------|----|-------|------|------|-----------------------------|-------------|---------|---------|
| Ideal | 10 | 22.800 | 9.5893 | 3.0324 | 15.940 | 29.660 | 5.0 | 37.0 |
| Class I | 10 | 16.300 | 8.5900 | 2.7164 | 10.155 | 22.445 | 8.0 | 38.0 |
| Class II | 10 | 39.100 | 3.9285 | 1.2423 | 36.290 | 41.910 | 34.0 | 45.0 |
| Class III | 10 | 21.000 | 7.0711 | 2.3261 | 15.942 | 26.058 | 11.0 | 34.0 |
| Total | 40 | 24.800 | 11.3594 | 1.7961 | 21.167 | 28.433 | 5.0 | 45.0 |

SD=Standard deviation, SE=Standard error, CI=Confidence interval

### Table 3: Distribution of loop-type fingerprint pattern

| Group | n  | Mean  | SD   | SE   | 95% CI for mean Lower bound | Upper bound | Minimum | Maximum |
|-------|----|-------|------|------|-----------------------------|-------------|---------|---------|
| Ideal | 10 | 37.500 | 9.9917 | 3.1596 | 30.352 | 44.648 | 22.0 | 54.0 |
| Class I | 10 | 18.800 | 3.9101 | 1.2365 | 16.003 | 21.597 | 12.0 | 24.0 |
| Class II | 10 | 20.800 | 2.1499 | 0.6799 | 19.262 | 22.338 | 17.0 | 24.0 |
| Class III | 10 | 36.700 | 8.9449 | 2.8286 | 30.301 | 43.099 | 25.0 | 50.0 |
| Total | 40 | 28.450 | 11.1101 | 1.7567 | 24.897 | 32.003 | 12.0 | 54.0 |

SD=Standard deviation, SE=Standard error, CI=Confidence interval

### Table 4: The statistical comparison between group variables - ideal and Class I skeletal malocclusion

| Patterns | Arch | Loops | Whorls |
|----------|------|-------|--------|
| Mann-Whitney U-test | 2.500 | 2.500 | 26.500 |
| Z | −3.612 | −3.596 | −1.779 |
| Asymptotic significant (two-tailed) | 0.000 | 0.000 | 0.075 |
| Exact significant (2×[one-tailed significant]) | 0.0005 | 0.0005 | 0.0750 |

### Table 5: The statistical comparison between the group variables - ideal and the Class II skeletal malocclusion

| Patterns | Arches | Loops | Whorls |
|----------|--------|-------|--------|
| Mann-Whitney U-test | 41.000 | 3.000 | 4.000 |
| Z | −0.692 | −3.562 | −3.485 |
| Asymptotic significant (two-tailed) | 0.489 | 0.000 | 0.000 |
| Exact significant (2×[one-tailed significant]) | 0.529 | 0.0005 | 0.0005 |

**Discussion**

Dermatoglyphics refers to the naturally occurring unique patterns on the epidermal ridges of hands and feet.[6,7] These dermal patterns are constant throughout life and are considered as sensitive indicator of intrauterine anomalies that occur at the same time of development.[8] The rationale behind the use of dermatoglyphics is that, in humans, the dermal ridges develop in relation to the volar pads, which are formed by the 6th week of gestation and reach maximum size between 12th and 13th weeks.[9] Hence, any concurrent anomaly of other organs developing in the same time period is reflected in the dermatoglyphic patterns.[9] The craniofacial structures develop during the second trimester of IU life; therefore, any genetic abnormality leading to malocclusion might be reflected in the dermatoglyphic patterns.[10] Skeletal malocclusion mostly requires correction by orthognathic surgeries, and an early identification of individuals prone to develop skeletal malocclusion can correct deviated jaw growth patterns with the help of interceptive orthodontics, minimizing or preventing surgeries. Dermatoglyphic patterns may serve as a noninvasive marker for identifying individuals with skeletal malocclusion at an early age; this gives an edge as skeletal malocclusion individuals generally undergo a
and dermatoglyphic patterns. The age group of the study population was between 18 and 20 years old as skeletal jaw growth is mostly completed by this time. Hence, dermatoglyphic patterns obtained from established patients might prove to be most valid marker of the deviated jaw growth pattern in younger individuals. The present study also employed the use of digital scanner for recording the fingerprint pattern. This had an advantage of accurate reproduction of dermatoglyphic patterns, with no attrition in the samples because of faulty or unrecognizable fingerprinting.

In the present study, loop was the most commonly occurring pattern among all the groups. In our study, an increased distribution of arch pattern was seen in participants with skeletal Class I while there was an increased distribution of whorls in Class II skeletal malocclusion. This finding is in concurrence to the results of the study by Jindal et al.\[11\] Where as the findings are in contrast to the results of Reddy et al.\[10\] and Trehan et al.\[12\] where Class II malocclusion was associated with increased frequency of arches and loops and decreased frequency of whorls. This could be attributed to the fact that the above studies compared dermatoglyphic patterns and dental malocclusion, unlike the present study which involves skeletal malocclusion. There is also a possibility of regional and ethnical variation between the dermatoglyphic patterns and malocclusion.

Loop was the predominant fingerprint pattern in both Class I occlusion and Class III malocclusion as it was the predominant fingerprint pattern across all the study groups. Furthermore, there was no statistically significant difference in the fingerprint pattern between Class III malocclusion and Class I occlusion.

From the present study, we infer that an increase in whorl pattern is seen in Class II malocclusion individuals. This would help us to identify individuals at the risk of developing Class II malocclusion at an early stage. The variations in the results of dermatoglyphic patterns and malocclusion as reported by various authors could be attributed to the following reasons. Variations in sample size and the prevalence of malocclusion and fingerprint patterns might differ among each study population due to their ethnic variations. The fingerprint patterns are influenced by a combination of genetic and environmental factors at the time of development.\[10\] There are an unknown number of genes which interact with each other and with the environment leading to each dermatoglyphic pattern in an individual. This provides potential for variation in the dermatoglyphic patterns between different ethnic groups.\[13\] Furthermore, in the lines of the threshold theory, abnormalities in dermatoglyphic pattern would occur only when the genetic and environmental factors cross a threshold. Hence, this threshold may not have been crossed in malocclusion, for it to be reflected clinically as an altered dermatoglyphic pattern.\[10\] Another possible

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**Table 6: The statistical comparison between the group variables - ideal and the Class III skeletal malocclusion**

| Patterns          | Arches | Loops | Whorls |
|-------------------|--------|-------|--------|
| Mann-Whitney U-test | 34.500 | 46.500 | 41.500 |
| Z                  | −1.185 | −0.266 | −0.644 |
| Asymptotic significant (two-tailed) | 0.236 | 0.791 | 0.520 |
| Exact significant (2×[one-tailed significant]) | 0.247 | 0.796 | 0.529 |

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**Table 7: The statistical comparison between the group variables - Class I and Class II skeletal malocclusion**

| Patterns          | Arches | Loops | Whorls |
|-------------------|--------|-------|--------|
| Mann-Whitney U-test | 3.000  | 35.500 | 3.500  |
| Z                  | −3.569 | −1.104 | −3.522 |
| Asymptotic significant (two-tailed) | 0.000  | 0.270  | 0.000  |
| Exact significant (2×[one-tailed significant]) | 0.005  | 0.280  | 0.005  |

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**Table 8: The statistical comparison between the group variables - Class I and Class III skeletal malocclusion**

| Patterns          | Arches | Loops | Whorls |
|-------------------|--------|-------|--------|
| Mann-Whitney U-test | 4.000  | 0.000  | 26.500 |
| Z                  | −3.485 | −3.785 | −1.780 |
| Asymptotic significant (two-tailed) | 0.000  | 0.000  | 0.075  |
| Exact significant (2×[one-tailed significant]) | 0.005  | 0.005  | 0.075  |

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**Table 9: The statistical comparison between group variables - Class II and Class III skeletal malocclusion**

| Patterns          | Arches | Loops | Whorls |
|-------------------|--------|-------|--------|
| Mann-Whitney U-test | 40.000 | 0.000  | 1.000  |
| Z                  | −0.776 | −3.791 | −3.711 |
| Asymptotic significant (two-tailed) | 0.438  | 0.000  | 0.000  |
| Exact significant (2×[one-tailed significant]) | 0.481  | 0.0005 | 0.0005 |

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long period of treatment which adds to their psychological burden along with the complexities of malocclusion. The present study was, therefore, conducted to correlate the relationship between fingerprint patterns and skeletal malocclusion. Previous studies\[11,12\] in the literature have compared dermatoglyphic patterns and malocclusion based on Angle’s classification of malocclusion which considers only the permanent first molar relationship. The present study considers skeletal malocclusion as the development of craniofacial structures takes place at the same time as the development of the ridge patterns and would, therefore, corroborate the relationship between skeletal malocclusion and dermatoglyphic patterns.
cause of variation is the diversity of the phenotype of the three basic patterns, namely, loop, whorl, and arch, making the classification and interpretation of fingerprint patterns highly subjective and inaccurate.[13] The latter parameter was overcome in the present study by the use of a fingerprint scanner over the most commonly used ink-stamp method. This was highly reproducible, sensitive, less time-consuming, and most importantly accurate. The dermatoglyphic information not only adds to strengthen the diagnosis, but a prompt diagnosis and efficient treatment planning could be used in utilizing the catch up growth.[14] We also recommend the study to be extended on a larger population that would help developing the use of dermatoglyphic patterns as an effective tool in predicting malocclusion.

Conclusion
Dermatoglyphics patterns could predict the development of skeletal problem at early age. Identifying the problems at an early age by the utilization of this dermatoglyphic information could eventually lead to formulate an efficient treatment plan. Dermatoglyphics can serve as an easy, inexpensive method of exploring the genetic association of malocclusion.

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Conflicts of interest
There are no conflicts of interest.

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