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Dentistry

# EVALUATION OF DERMATOGLYPHIC PATTERNS AND THEIR CORRELATION WITH SKELETAL MALOCCLUSIONS

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## ABSTRACT

**Background and Objectives:** Dermatoglyphics deals with the study of the epidermal ridges and their configurations on the fingers, palms and soles. Epidermal ridge patterns form early in fetal development and remain unchanged throughout life and play a significant role in the diagnosis of many disorders with genetic background. As the primary palate, lip and dermal ridges develop during the same period of intrauterine life, the genetic message contained in the genome - normal or abnormal, is deciphered during this period and is also reflected by dermatoglyphics. The present study was undertaken to evaluate the different dermatoglyphic patterns and their correlation with skeletal malocclusions. **Methods:** The study was conducted on 90 individuals divided into 3 equal groups- skeletal class I, II and III. Dermatoglyphic patterns were recorded using ink method following rolling impression technique. The dermatoglyphic data was assessed for different finger ridge patterns and total ridge count (TRC). **Results:** On comparison skeletal class I group showed markedly decreased number of loops and increased total ridge count (TRC). Skeletal class II showed markedly increased number of loops and markedly decreased TRC. Skeletal class III showed markedly decreased number of arches and increased TRC. Loops were found to be the most predominant pattern in skeletal class II and III groups. The mean TRC was found to be increased in skeletal class III group and markedly decreased in skeletal class II group which was statistically significant. **Conclusion:** Dermatoglyphics can be used as a screening tool and for early prediction of skeletal malocclusion at a younger age group. Dermatoglyphics have important practical and clinical implications which can be applied for preventive and interceptive orthodontics among paediatric patients and also for parent counseling.

**KEYWORDS :** dermatoglyphics; total ridge count; skeletal malocclusion.

## INTRODUCTION

Dermatoglyphics refers to the study of the intricate dermal ridge configurations on the skin covering the palmar and plantar surfaces of hands and feet.[1] The word dermatoglyph means 'a skin carving 'coined by the anatomist Harold Cummins and Midlo in 1926.[1,2]

The pattern of dermal ridges has fascinated many researchers and dermatoglyphics has been investigated in various fields such as forensic medicine, genetics and anthropology.[3] The dermatoglyphics are genetically controlled characteristics and any deviation in dermatoglyphic features indicates a genetic difference between the controls and abnormal population.[4]

A pattern of epidermal ridges characteristic of a given individual occurs at the site of certain mounds of skin appearing during fetal life. It appears first during the early months of fetal development during the third and fourth months of intrauterine life.[2] The finger, palm prints, lip, alveolus and palate develop during the same embryonic period.[1] As a result, certain disturbances of fetal growth during this period whether due to hereditary or environmental factors are faithfully recorded by modifications in the ridge configurations.[2]

Thus any factor causing changes in the lip, alveolus and palate may also cause peculiarities in the appearance of finger and palmprints.[1] The dermatoglyphicpatterns once established in intrauterine life never alters except in overall size.[2] The development of the primary palate and the lip is completed by the 7th week of intra uterine life and that of secondary palate by 12th week. The dermal ridges reach maximum size between 12th and 13th weeks. During this period the genetic message contained in the genome, normal or abnormal is deciphered and the same is reflected by dermatoglyphics.[4]

Dermatoglyphics have been studied in various malformations such as those caused by autosomal aberrations (Down's syndrome, Patau's syndrome and Edward syndrome), sex chromosomal aberrations (Turner's syndrome and Klinefelter's syndrome), inherited or genetic malformations (hypohydrotic ectodermal dysplasia, schizophrenia, psychosis, autism, carcinoma of breast, leukemia, congenital heart disease and psoriasis), systemic disorders (Diabetes Mellitus, Hypertension and Rheumatoid arthritis) and others.[2,5,6,7,8,9,10,11,12,13] In dentistry, dermatoglyphics has been studied in cleft lip and palate, hereditary gingival fibromatosis, periodontal diseases, dental caries, dental malocclusions and potentially malignant and malignant disorders (oral submucous fibrosis, leukoplakia, oral cancer) of the oral cavity.[1,4,14,15,16,17]

There are a multitude of deformities in the dentofacial area. Malocclusion is by far the most common deformity, probably involves greatest variation and number of etiologic factors and its high prevalence is thought to be related to a host of genetic and environmental factors.[18,19] Genetic expression is the basis for craniofacial development and is known to be responsible for skeletal malocclusions.[20] It is recognized that the antero-posterior relationship of the maxilla and mandible to each other and to the cranial base is of vital concern. Skeletal malocclusions involve all three dimensions like saggital, vertical and transverse planes and have profound influence on the ultimate therapeutic achievements.[21]

With this background this study was undertaken to evaluate the different dermatoglyphic patterns and their correlation with skeletal malocclusions which in turn can be applied in preventive and interceptive orthodontics to the high risk groups and also for parent education and counselling.

## AIMS AND OBJECTIVES

The study was designed with the following aims and objectives:

- To record and evaluate fingerprint patterns in skeletal class I subjects (control group).
- To record and evaluate fingerprint patterns in subjects with skeletal class II and class III malocclusions.
- To assess the relationship between fingerprint patterns and the type of malocclusion.
- To ascertain the reliability of dermatoglyphic patterns to detect early skeletal malocclusion.

## METHODOLOGY

This study consisted of 90 healthy subjects including diagnosed cases of skeletal malocclusion age ranging from 20 to 30 years inclusive of both the genders. Subjects were selected from those visiting the Department of Oral Medicine and Radiology and also diagnosed skeletal malocclusion cases from the Department of Orthodontics, M.R. Ambedkar Dental College and Hospital, Bangalore.

The study was conducted after the approval by ethical committee of the institution and the participants were enrolled after an informed consent.

The study sample contained:

- 30 cases of skeletal class I (Control Group)
- 30 cases of skeletal class II
- 30 cases of skeletal class III

### Exclusion Criteria:

1. Malformation syndromes associated with maxilla and mandible,
2. Patients who have undergone orthognathic surgery of maxilla or mandible,
3. Subjects with facial asymmetry and acquired skeletal defects,
4. Subjects with inherited and systemic disorders like diabetes, hypertension rheumatoid arthritis, psychosis etc.
5. Subjects with polydactyly or syndactyly, congenital or acquired deformities of the fingers and skin diseases affecting the fingers,
6. Subjects with wounds, scars, amputated and artificial prosthesis of fingers,
7. Subjects allergic to duplicating ink.

Selected subjects were made to sit comfortably on the dental chair. Detailed case history was recorded in a designed proforma and complete intraoral examination was carried out under artificial illumination. The subjects were then subjected to lateral cephalogram using the KODAK-8000C Digital Panoramic and Cephalometric system following radiation protection protocol. The exposure parameters used were 78kVp, 12mA, 1sec. The recorded images were traced digitally for the measurements of cephalometric landmarks using Windows Trophy Dicom software.

Skeletal malocclusion was assessed by tracing following parameters:

### SNA -

It is the angle formed by the intersection of SN plane and a line joining nasion and point A. This angle indicates relative antero- posterior positioning of the maxilla in relation to the cranial base. Normal SNA 82+/-2

### SNB -

It is the angle between the SN plane and a line joining nasion to point B. This angle indicates the antero-posterior positioning of the mandible in relation to the cranial base. Normal SNB-78+/-2

### ANB -

Angle formed by the intersection of lines joining nasion to point A and nasion to point B. It denotes relative position of the maxilla and mandible to each other.

Normal ANB- 0.1-4, Skeletal Class II- ANB > 4 Skeletal Class III- ANB <0

## DOWN'S ANALYSIS:

### Facial Angle -

It is the inside inferior angle formed by the intersection of nasion pogonion plane and Frankfort Horizontal plane. This angle gives an indication of antero-posterior positioning of the mandible inrelation to the upper face. Normal Facial angle: 82-95

FIGUREI: LATERAL CEPHALOGRAM OF THE PATIENT


FIGUREII: SKELETAL CLASS I: CEPHALOMETRIC ANALYSIS

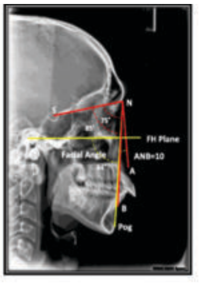



FIGURE III: SKELETAL CLASS II:CEPHALOMETRIC ANALYSIS

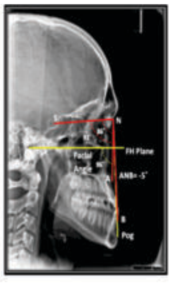



FIGURE IV: SKELETAL CLASS III: CEPHALOMETRIC ANALYSIS

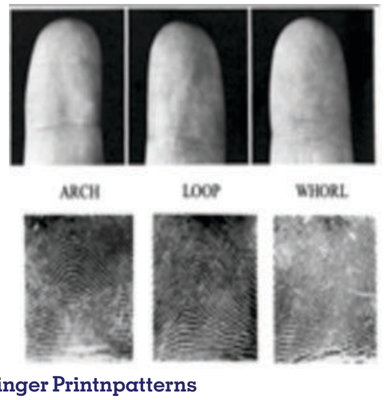



**Figure V: Finger Printnpatterns**

### Procedure for Obtaining Dermatoglyphic Prints:

The selected study subjects 'hands were washed with soap and water to remove dirt and oil from the ridged skin surface and to improve the quality of the dermatoglyphic prints.

Duplicating ink was applied on all the fingers of left and right hand using preformed cotton rolls. The fingerprint patterns were then recorded on a non-blotting A3 size blank white recording sheets using rolling impression technique. The collected data was analysed for various qualitative and quantitative dermatoglyphic patterns.

**Qualitative Dermatoglyphic Analysis:**
Fingerprints were studied for qualitative analysis as under:

**1. Loops (L):**
A loop is that type of fingerprint pattern in which one or more of the ridges enter on either side of the impression, recurve, touch or pass an imaginary line drawn from the delta to the core, and terminate or tend to terminate on or toward the same side of the impression from whence such ridge or ridges entered.

**2. Arches (A):**
An arch is that type of pattern in which the ridges enter on one side of the impression and flow or tend to flow out the other with a rise or wave in the center.

**3. Whorls (W):**
The whorl is that type of pattern in which at least two deltas are present with a recurve in front in each.

The recorded patterns were assessed for increase or decrease in mean frequencies between the groups.

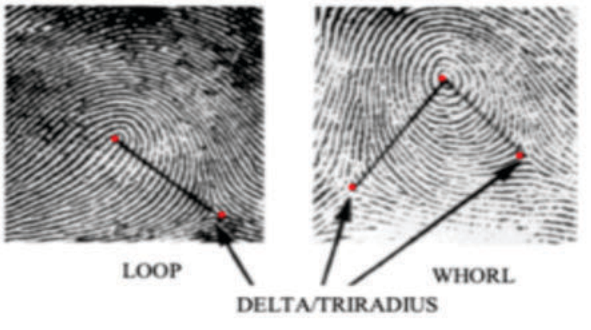



**Figure VI: Total Ridge Count**

**Qualitative Dermatoglyphic Analysis:**
**Total Ridge Count (TRC):**
A ridge-count is determined by drawing a straight line from the core or centre of a fingerprint pattern to its triradius and counting the number of ridge transected or touched by this line, the triradius and core not being included in the count. The TRC was then calculated by adding the larger of the two ridge counts for each finger, and the ridge counts were added over all the 10 fingers. It was assessed for increase or decrease in mean frequencies between the groups.

**Triradius/Delta:**
A triradius is the meeting place of three systems of ridges whose elements lie approximately parallel to one another at this point.

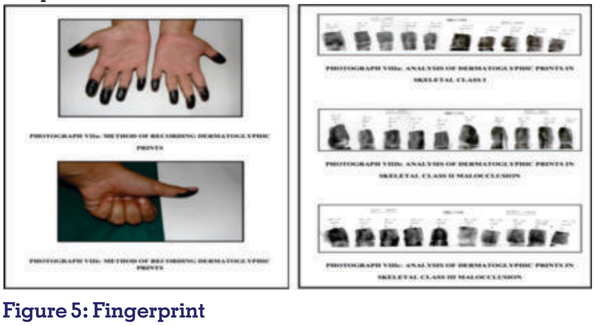


**Figure 5: Fingerprint**

Thus, there is no triradius in an arch, one in a loop, and two or more in a whorl.

Comparison of dermatoglyphic data was done between: Skeletal class I (control), class II and class III groups.

**Statistical Analysis:**
The obtained data was calculated and subjected to relevant statistical analysis using Analysis of Variance (ANOVA)/ Kruskal-Wallis test and Chi-Square Test.

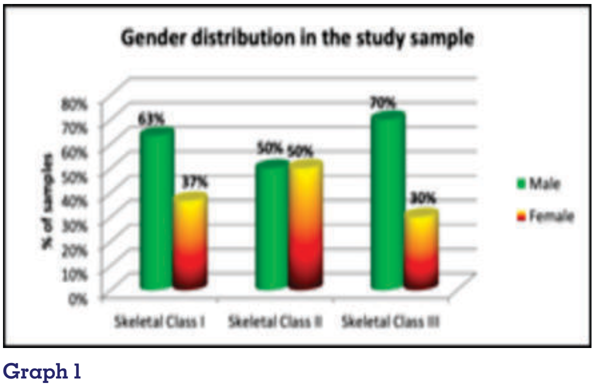
## RESULTS AND DISCUSSION:

The study of pattern of dermal ridges has long fascinated men through the ages and attempts have been made to predict the future of individuals based on the ridge patterns. After Galton's rule called 'proof of no change', many researchers have investigated dermatoglyphics in various fields such as forensic medicine, genetics and anthropology.[22]

**Age:**
The mean age of skeletal class I subjects was 23.67 years± 2.04 SD (standard deviation), that of skeletal class II was 22.53 years ±2.57 SD and that of skeletal class III subjects was 24.50 years ±3.47 SD.This age group was selected as the growth of maxilla and mandible gets completed by the age of 17-18 years and any growth deviation, from the normal may be completely established by then. During this age, there is a good level of awareness among all the patients demanding treatment.

**Gender:**
Among skeletal class I, 19 subjects (63%) were males and 11 (37%) were females. In skeletal class II, 15 subjects (50%) were males and 15 (50%) were females.In skeletal class III, 21subjects (70%) were males and 9 (30%) were females. In the total sample 55 (61%) were males and 35 (39%) were females.

We observed male preponderance over females with a ratio of 1.57:1. This finding is consistent with studies by Oluranti ODC et al[23] and Boeck EM et al [24] who observed a high male to female ratio with respect to dental and skeletal malocclusions at the time of diagnosis respectively.




**Graph 1**

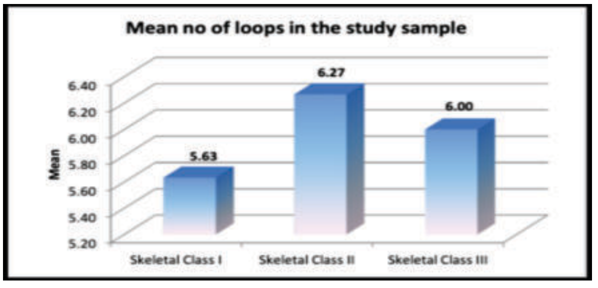
**Comparison Of Finger Ridge Patterns And Total Ridge Count Between Skeletal Class I, Ii And Iii Groups:**
**I. Finger Ridge Patterns:**
Each finger ridge pattern was assessed separately for left and right hands and compared between skeletal class I, II and III groups.

**Loops:**
The mean number of loops was found to be markedly increased in skeletal class II group, followed by class III group. However, skeletal class I group showed markedly decreased number of loops. No significant difference was observed among the groups with respect to the mean number of loops (P>0.05).

This is in agreement with studies by Reddy S et al1 who found that the dental class II div.1, div.2 pattern was associated with increased frequency of ulnar loops. Trehan M et al[3] also noted an increased frequency of radial loops in dental class-II div.1 malocclusions. Increased number of loops in the experimental group could be due to the fact that ridge configurations are very variable and are determined partly by genetic and partly by other factors such as stress and tension in the growth of the part during fetal life.[2,24]

**Table 1: Comparison of Loops in the Study Sample**

| Group | Mean | Std dev | SE of Mean | 95% CI for Mean | | Min | Max | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound | | | |
| Skeletal Class I | 5.63 | 2.85 | 0.52 | 4.57 | 6.70 | 0 | 10 | 0.623 |
| Skeletal Class II | 6.27 | 2.39 | 0.44 | 5.37 | 7.16 | 2 | 10 | |
| Skeletal Class III | 6.00 | 2.30 | 0.42 | 5.14 | 6.86 | 1 | 10 | |



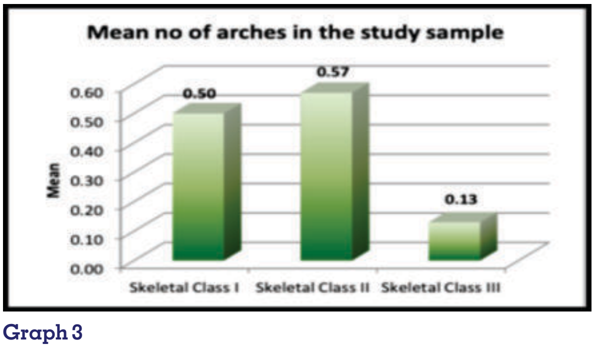

**Graph 2**

**Arches:**
The mean number of arches was found to be increased in skeletal class II group, followed by class I group. Skeletal class III group showed markedly decreased number of arches. No significant difference was observed among the groups with respect to the mean number of arches (P>0.05).

This finding is consistent with Trehan M et al[3] and Reddy S et al[1] who observed increased number of arches in dental class I and class II div. 1 malocclusions. The increased number of arches in skeletal class II and class I groups may be due to X linked inheritance.[1, 25] There is wide agreement that the mechanism of inheritance of many dermatoglyphic features conforms to a polygenic system with each gene contributing a small additive effect.

**Table 2: Comparison of Arches in the Study Sample**

| Group | Mean | Std dev | SE of Mean | 95% CI for Mean | | Min | Max | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound | | | |
| Skeletal Class I | 0.50 | 1.01 | 0.18 | 0.12 | 0.88 | 0 | 4 | 0.266 |
| Skeletal Class II | 0.57 | 1.17 | 0.21 | 0.13 | 1.00 | 0 | 5 | |
| Skeletal Class III | 0.13 | 0.35 | 0.06 | 0.00 | 0.26 | 0 | 1 | |




**Graph 3**

**Whorls:**
The mean number of whorls was increased in both skeletal class I and III groups. Skeletal class II group showed decreased number of whorls. No significant difference was observed among the groups with respect to the mean number of whorls (P>0.05).

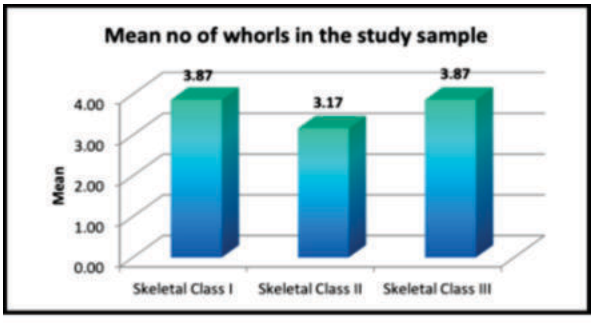
This finding was in accordance with Trehan M et al[3] and Reddy S et al[1] who observed that when compared with normal occlusion, dental class-I and class-III malocclusions were associated with an increased frequency of whorls, which is attributed to X linked inheritance.

With regard to the timing of development of patterns, whorls are the first to develop in the distal digit segment, followed by loops and arches are associated with later development. A dominant mode of inheritance has been postulated for the total number of whorls.[26]

Increased number of whorls in skeletal class III could be due to the morphological changes in jaw size and facial profile from class III to class I, which could have been changed from early human evolution. This could suggest that these forms of prognathism are correlated characterised by a process of joint and integrated change from a more prognathic to a more orthognathic facial morphology.[27]

**Table 3: Comparison of Whorls in the Study Sample**

| Group | Mean | Std dev | SE of Mean | 95% CI for Mean | | Min | Max | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound | | | |
| Skeletal Class I | 3.87 | 3.08 | 0.56 | 2.72 | 5.02 | 0 | 10 | 0.505 |
| Skeletal Class II | 3.17 | 2.44 | 0.44 | 2.26 | 4.08 | 0 | 8 | |
| Skeletal Class III | 3.87 | 2.43 | 0.44 | 2.96 | 4.77 | 0 | 9 | |



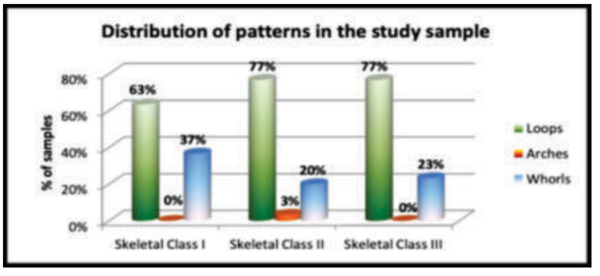

**Graph 4**

**Predominant Pattern In The Study Sample:**
In the present study, loops were found to be the predominant pattern followed by whorls and arches. Loops were found to be the most predominant pattern and were markedly increased in skeletal class II and III groups. Arches were least in number among the compared patterns. Whorls were increased in skeletal class I group, followed by skeletal class III group. No significant association was observed between the groups and the predominant pattern (P>0.05).

This finding is in contrast with a study by Tikare S et al[22] who noticed that whorl patterns were significantly associated with dental class I and II malocclusions. Increased number of loops in skeletal class II and class III and decreased in class I (control group) may be due to the presence of extra genetic material which may increase or decrease the number of loops. This finding is also confirmed by Kharbanda et al.[25] Increased number of loops is associated with a decreased number of whorls and arches which is also similar to the observation made by Holt and Shiono.[28]

**Table 4: Predominant Pattern in the Study Sample:**

| Predominant Pattern | Skeletal Class I | | Skeletal Class II | | Skeletal Class III | | $\chi^2$ | P-Value |
|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | | |
| Loops | 19 | 63% | 23 | 77% | 23 | 77% | 4.242 | 0.374 |
| Arches | 0 | 0% | 1 | 3% | 0 | 0% | | |
| Whorls | 11 | 37% | 6 | 20% | 7 | 23% | | |
| Total | 30 | 100% | 30 | 100% | 30 | 100% | | |




**Graph 5**

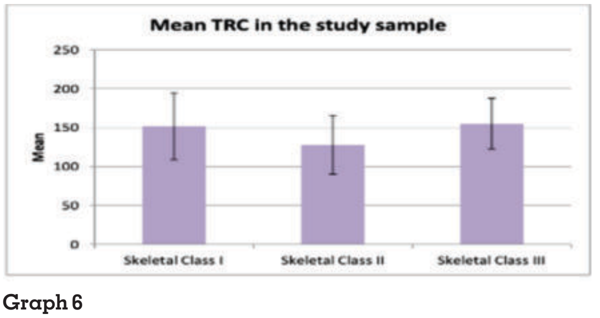
**II. Total Ridge Count:**

The mean TRC was found to be increased in skeletal class III group followed by class I group. Skeletal class II group showed markedly decreased mean TRC. This difference in mean TRC between skeletal class I, II and III was found to be statistically significant ($P<0.05$). Further, pair-wise comparisons using Bonferroni test resulted in a statistically significant difference between skeletal class II and Class III groups ($P<0.05$). This finding is in agreement with Trehan M et al[3] who observed that the total ridge count was increased in dental class III and control group. Reddy S et al[1] observed that the total finger ridge count decreased in all experimental groups (class II div. 1, div.2 and class III) when compared to control group, which is in contrast with the present study.

The mean number of total finger ridge count increased in skeletal class III and class I group because it is entirely determined by additive or co-dominant genes and also the total finger ridge count follows a polygenic mode of inheritance. Similar findings were reported by Penrose and Losch[29] and Holt.[30] Whorls in general have high ridge counts as compared to loops and arches. Ridge count for an arch is taken as zero.

**Table 5: Comparison of Total Ridge Count in the Sample**

| Group | Mean | Std dev | SE of Mean | 95% CI for Mean | | Min | Max | P-Value | Sig diff between |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound | | | | |
| Skeletal Class I | 151.67 | 43.06 | 7.86 | 135.59 | 167.75 | 49 | 244 | 0.014 | II vs III |
| Skeletal Class II | 128.00 | 37.68 | 6.88 | 113.93 | 142.07 | 26 | 184 | | |
| Skeletal Class III | 155.10 | 32.51 | 5.94 | 142.96 | 167.24 | 88 | 224 | | |




**Graph 6**

It is widely acknowledged that most malocclusions have a genetic component and show polygenic inheritance of craniofacial and dental characteristics or traits. Hence, dermatoglyphics are a useful research tool which can be used to strengthen a diagnostic impression or to select persons for additional diagnostic studies.

Due to the great natural variations in print patterns, no single dermatoglyphic trait can be associated with a specific disease. Prediction of malocclusion based on the values in this study cannot be substantiated, as it is multifactorial, number of factors like congenital, genetic, environmental, local factors etc influence the malocclusion.

## CONCLUSION:

In our study, we found that total finger ridge-count was the most consistent and reliable parameter for familial investigations and is an inherited metrical character which can be used as a sensitive screening indicator for early detection of skeletal malocclusion. Hence, we can recommend the use of total ridge count (TRC) along with other dermatoglyphic parameters to predict skeletal malocclusion at a younger age group as a risk assessment strategy, so as to provide early treatment, to reduce cost, time of treatment and later complications.The goal of early treatment is to minimize, eliminate or correct existing or developing skeletal, dentoalveolar and muscular imbalances to improve the environment before the eruption of the permanent dentition is complete.

Dermatoglyphics have important practical and clinical implications which can be applied for preventive and interceptive orthodontics among pediatric patients and also for parent counselling. We suggest that the fingerprints can be recorded with the inkless biometric method which captures a better print with no deterioration over a period of time.

From our observations, we found that dermatoglyphics have many distinctive advantages as a screening tool which is an easily accessible, economical and non invasive marker for malocclusion. Dermatoglyphics opens new avenues for research with different parameters and further studies on larger samples are required to shed more light on the relationship between dermatoglyphics and skeletal malocclusion.

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