Original Article

Assessment of correlation between dermatoglyphics of individuals with different skeletal growth

ABSTRACT

Introduction: Dermatoglyphics refers to the study of the intricate dermal ridge configuration on the skin covering the palmar and planter surfaces of the hands and feet. Dermal ridges are usually established by the 24th week of intrauterine life, which remains constant throughout the life. The development of dentition and palate occurs during the same period and also genetically determined as dermatoglyphics. Hence, it can be assumed that hereditary and environmental factors leading to malocclusion may also influence normal fingerprint pattern. Thus, it was decided to assess the correlation between dermatoglyphics patterns and growth patterns in individuals with Skeletal Class I and Skeletal Class II malocclusion.

Materials and Methods: Ninety individuals aged between 18 and 28 years were divided into Skeletal Class I (Group I *n* = 45) and Skeletal Class II (Group II *n* = 45) based on Tweed's and Steiner's analysis. Both the groups were further subdivided according to their growth pattern and named as A, B, and C, respectively, for horizontal, average, and vertical. Fingerprints of both hands were taken by the ink and stamp method. The patterns of Arches, Loops, and Whorls in fingerprints were assessed. The data collected were then statistically evaluated using the Chi-square test.

Observations: In Skeletal Class I subjects, there was increased frequency of occurrence of whorl-pattern in thumb, plain-arches in little, index, and ring finger, and ulnar-loops in middle finger, whereas in Skeletal Class II subjects, radial-loops were more in number in ring and index finger, plain-arches in little finger, ulnar-loops in the middle finger, and whorl-pattern in the thumb same as Skeletal Class I.

Conclusion: No significant correlation was observed between dermatoglyphics and various growth patterns. However, further studies must be conducted on large sample size to validate the findings.

Keywords: Dermatoglyphics, growth pattern, skeletal Class I, skeletal Class II

INTRODUCTION

Dermatoglyphics refers to the study of the intricate dermal ridge configuration on the skin covering the palmar and planter surfaces of the hands and feet.[1] The dermal ridges are usually laid down between the 10th and 18th weeks of intrauterine life, and they are established by the 24th week.[2] Once laid down, they remain unchanged except for the change in size.[2] Dermatoglyphics is assumed to be genetically controlled, and the exact mechanism of inheritance is still unknown. Abnormal dermatoglyphic patterns have been seen in several genetic disorders and other diseases whose etiology may be influenced directly

Harmeet Kaur, Tripti Tikku, Rohit Khanna, Rana Pratap Maurya, Snehlata Verma, Kamna Srivastava, Anshul Srivastava

Department of Orthodontics and Dentofacial Orthopedics, Babu Banarasi Das College of Dental Sciences, Lucknow, Uttar Pradesh, India

Address for correspondence: Dr. Harmeet Kaur, Department of Orthodontics and Dentofacial Orthopedics, Babu Banarasi Das College of Dental Sciences, Lucknow, Uttar Pradesh, India.
E-mail: harmeet.rini@gmail.com

Received: 28-Feb-2020 **Revised:** 31-May-2020
Accepted: 05-Jun-2020 **Published:** 09-Jul-2020

Access this article online	
Website: www.orthodrehab.org	Quick Response Code
DOI: 10.4103/2349-5243.289249	

How to cite this article: Kaur H, Tikku T, Khanna R, Maurya RP, Verma S, Srivastava K, *et al*. Assessment of correlation between dermatoglyphics of individuals with different skeletal growth. Int J Orthod Rehabil 2020;11:69-75.

or indirectly by genetic inheritance.[2] Dermatoglyphics has been reported to be associated with a number of conditions such as dental caries, oral cancer, bruxism, anomalies of teeth, cleft lip, cleft palate, periodontal diseases, and dental fluorosis.[2] Among these conditions, dental occlusion is closely associated with dermatoglyphics, due to the fact that the development of dentition and the palate occurs during the same period when dermal pattern develops.[2] Hereditary and prenatal environmental factors leading to malocclusion may also influence fingerprint patterns which are classified into four types – arches, loops, whorls, and composite. The arches can be further classified into simple and tented and loops can be radial or ulnar.[2,3]

Many of the previous studies have evaluated the type of finger print pattern in different types of skeletal malocclusion, but these studies have not evaluated finger print pattern in different types of growth pattern. Considering this, the present study was conducted to explore the associations between dermatoglyphics patterns and its association with different growth patterns in individuals with Class I and Class II malocclusion.

MATERIALS AND METHODS

Place of the study

This study was conducted at the Department of Orthodontics and Dentofacial Orthopedics, Babu Banarasi das College of Dental Sciences, Lucknow, Uttar Pradesh, India.

i. Sample and collection method

Sample consisted of 90 participants (42 males and 48 females) with skeletal Class I and Class II malocclusion in the age range of 18–28 years.

a. Selection of sample

The sample was selected from the participants who were already undergoing fixed orthodontic treatment in the department. The type of skeletal malocclusion and growth pattern in the participants were ascertained based on the mean values of different parameters from various cephalometric analysis documented in the case records. The parameters used for sagittal dysplasia were ANB angle and WITS Appraisal and the parameters used to ascertain growth patterns were FMA and SN to Go-Gn [Tables 1 and 2].

b. Inclusion criteria

Patient with no history of orthodontic treatment, age of the patient between 18 and 28 years, and patients with no related medical or dental history.

c. Exclusion criteria

Subjects with facial asymmetry, acquired skeletal defects, congenital or acquired deformities of the fingers and palm, amputated fingers, patients with skin diseases, with wound or scars on the fingers were excluded from the study.

d. Ethical committee approval

Approval was obtained from the Ethical and Research Committee of Babu Banarasi Das College of Dental Sciences, BBDU, Lucknow. Signed informed consent was obtained from each patient undergoing the treatment as per the guidelines of the University.

e. Distribution of sample

Sample was divided into two groups: Group I with Class I malocclusion (45 subjects) and Group II with Class II malocclusion (45 subjects), which were further subdivided into three subgroups based on growth pattern and named as A, B, and C, respectively, for horizontal, average, and vertical growth pattern [Table 3].

The procedure and purpose of the study were explained to all the participants and consent forms were obtained at the institutional level.

ii. Armamentarium

- Planmeca Proline XC cephalostat (Finland machine)
- Ink (manufactured by Soni polymers, India)
- Magnifying lens
- A4 size blank white sheet
- Soap
- Microgen hand antiseptic
- Cotton.

Finger prints of all the participants were recorded by the following method:

- The participants were asked to clean their hands with soap and water

Table 1: Range of ANB angle and WITS appraisal to be considered for different malocclusion groups ($n=90$)

	Skeletal Class I	Skeletal Class II
ANB range	1-4	>4
WITS appraisal range	0-2	>2

Table 2: Range of FMA and SN to Go-Gn to be considered for different growth pattern ($n=90$)

	Horizontal growth pattern	Average growth pattern	Vertical growth pattern
FMA	<20	20-30	>30
SN to Go-Gn	<27	27-32	>32

Table 3: Distribution of sample

Groups	Subgroups		
	Horizontal growth pattern	Average growth pattern	Vertical growth pattern
Group I Skeletal Class I ($n=45$)	I A ($n=15$)	I B ($n=15$)	I C ($n=15$)
Group II Skeletal Class II ($n=45$)	II A ($n=15$)	II B ($n=15$)	II C ($n=15$)

- Hands were wiped with hand antiseptic to remove the sweat, oil, and dirt from the skin surface
- For recording finger prints using ink and stamp method, blue duplicating ink was applied on the pulp of all the ten fingers
- Impression of all the fingers was taken on a nonblotting A4 size blank white sheet
- Finger prints were visualized to check the clarity of the finger print patterns and repeated if the finger print impression was not satisfactory
- Data collected were analyzed for various dermatoglyphic patterns.

RESULTS

Analysis of finger prints

The finger prints were then visualized with the help of a magnifying lens in the Department of Oral Pathology, BBDCODS for various dermatoglyphic patterns such as Arches, Loops, and Whorls [Figure 1],[4] to determine its association with different growth patterns in individuals with Class I and Class II malocclusion. The study was completed in 6 months of duration. The dermatoglyphic patterns for the ten fingers of all the participants were recorded using the ink stamp method. The finger prints were observed and identified into arches, loops, and whorls. The results were entered and calculated for each subject. The frequency distribution of the different dermatoglyphic patterns on the right and left hands of all the participants in different groups and subgroups were assessed. It was observed that out of ten fingers of each subject analyzed, no significant difference for dermatoglyphic pattern was present on the left and right side. For further evaluation, mean values of right and left side dermatoglyphic pattern were taken.

A total of 90 subjects were analyzed which were divided into two groups, Group I (Skeletal Class I, $n = 45$) and Group II (Skeletal Class II, $n = 45$) based on sagittal dysplasia and growth pattern.

Both the groups were further divided into subgroups based on their growth pattern as IA and II A (Horizontal, $n = 15$), IB and II B (Average $n = 15$), IC and II C (Vertical $n = 15$).

Data were analyzed using the Statistical Package for the Social Sciences SPSS 21, Package (IBM Corp., 2015, Virginia, US). The values obtained were statistically analyzed using the Chi-square test for the finger print patterns with skeletal Class I and Class II malocclusion were taken according to their growth pattern for right and left hand separately.

The results of both the study are summarized in the following tables [Tables 4 and 5].

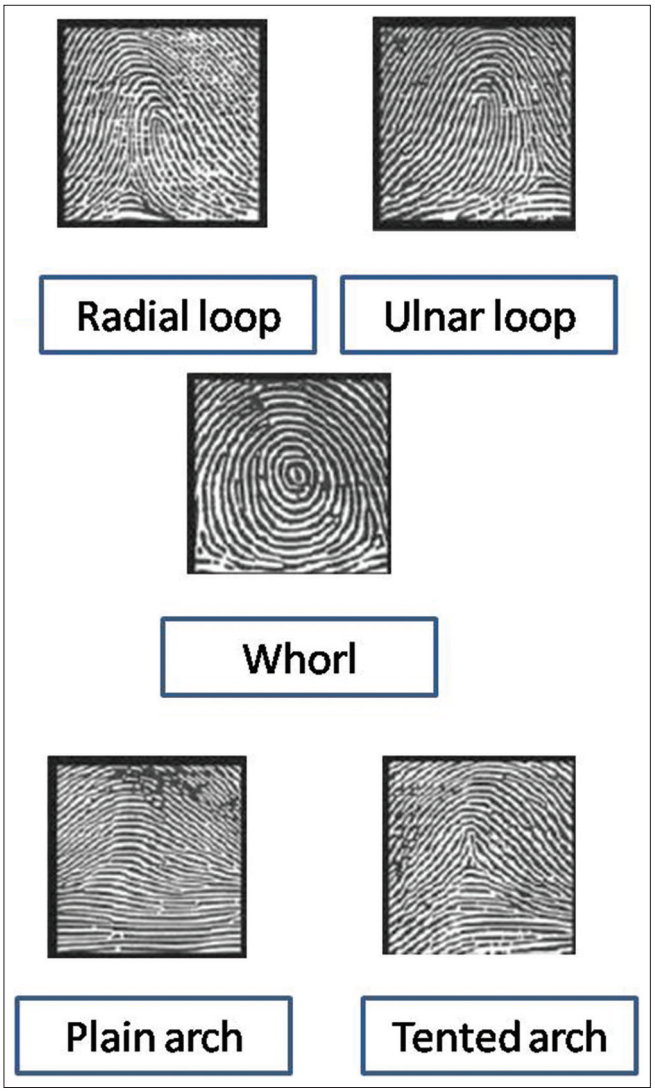

Figure 1: Types of finger print patterns

No significant statistical difference was found for dermatoglyphic pattern between left and right hands both for Class I and Class II malocclusion for each growth pattern.

Hence, mean values of the right and left hand were taken for comparison between different growth pattern for Class I and Class II malocclusion separately [Tables 6 and 7].

Arch pattern was found more frequently followed by loop and whorl pattern was minimum in all the groups. There was an increased distribution of loop pattern in skeletal class I, horizontal growth pattern than in average and vertical growth pattern.

DISCUSSION

Dermatoglyphic patterns are genetically determined, and their inheritance is considered to follow a classic polygenic

Table 4: Frequency distribution of right and left hand of different dermatoglyphic patterns in skeletal Class I malocclusion

Patterns	Skeletal Class I malocclusion								
	Sub Group IA Horizontal growth pattern ($n=15$)			Sub Group IB Average growth pattern ($n=15$)			Sub Group IC Vertical growth pattern ($n=15$)		
	Left	Right	*P*	Left	Right	*P*	Left	Right	*P*
Little finger									
Ulnar loop	3	3	0.96	3	2	0.88	1	2	1.06
Radial loop	1	3	1.12	2	3	0.88	4	3	0.81
Whorl	5	3	0.73	3	2	0.88	3	2	0.88
Plain arch	5	2	0.61	6	2	0.62	5	6	0.52
Tented arch	1	4	0.82	1	6	0.63	2	2	1.16
Ring finger									
Ulnar loop	2	2	1.16	3	1	1.12	1	1	1.27
Radial loop	3	3	0.96	2	3	0.88	5	3	0.73
Whorl	3	4	0.81	3	2	0.88	2	3	0.88
Plain arch	3	3	0.81	5	2	0.61	3	4	0.81
Tented arch	5	3	0.73	2	7	0.67	4	4	0.76
Middle finger									
Ulnar loop	5	4	0.67	2	3	0.88	4	4	0.76
Radial loop	3	3	0.96	3	5	0.73	2	3	0.88
Whorl	2	2	1.16	3	1	1.12	2	2	1.16
Plain arch	2	2	1.16	3	4	0.81	4	3	0.81
Tented arch	3	4	0.81	4	2	0.85	3	3	0.96
Index finger									
Ulnar loop	3	3	0.96	3	3	0.96	3	4	0.96
Radial loop	2	4	0.85	2	3	0.88	3	4	0.96
Whorl	3	2	0.88	4	2	0.85	3	2	0.88
Plain arch	4	2	0.85	3	5	0.73	4	3	0.81
Tented arch	3	4	0.81	3	2	0.88	2	2	1.16
Thumb									
Ulnar loop	3	1	1.12	1	2	1.06	3	2	1.16
Radial loop	3	3	0.96	3	3	0.96	0	3	1.12
Whorl	6	6	0.51	6	4	0.66	6	6	0.51
Plain arch	1	3	1.12	2	2	1.16	3	1	1.12
Tented arch	2	2	1.16	3	4	0.81	3	3	0.96

model which has proved useful to study many genetic disorders. Dermatoglyphic investigation being unique to each individual had been used extremely in the field of forensic sciences.

In 1892,[5] Sir Francis Galton classified the basic characteristic pattern of fingerprint into three types: Arches, loops, and whorls. This was mainly based on the degree of curvature of the ridges. Arches may be simple or tented, loops may be described as radial or ulnar, and whorls may be spirals or double loop.

Previous studies[1-7] demonstrated that type of finger print pattern was generally variable on different fingers, though a person may have same pattern on all the ten fingers. Loops were, however, the most common pattern on the fingertips. Whorls were most likely to be found on the thumb and the ring finger while radial loops and arches were most common on the index finger. On the little finger, the most frequent pattern was an ulnar loop.

In an another study by Kanematsu *et al*.,[6] dermatoglyphic patterns of 311 children of the cleft lip, alveolus, and palate without any external malformations were compared with those of the normal children. They found that the appearance of finger and palm prints were significantly different from normal children.

Lakshmi *et al*.,[7] conducted a study, where they found more frequent whorls and arch patterns as compared to that of the loop patterns in individuals with hypodontia than to normal subjects.

In studies done by Kharbanda *et al*.,[8] Reddy *et al*.,[9] and Jindal *et al*.,[10] finger print pattern varied significantly between different malocclusion groups. However, previous

Table 5: Frequency distribution of right and left hand of different dermatoglyphic patterns in Skeletal Class II malocclusion

Patterns	Skeletal Class II malocclusion								
	Sub Group IA Horizontal growth pattern (n=15)			Sub Group IB Average growth pattern (n=15)			Sub Group IC Vertical growth pattern (n=15)		
	Left	Right	*P*	Left	Right	*P*	Left	Right	*P*
Little finger									
Ulnar loop	3	3	0.96	3	2	0.88	2	2	1.16
Radial loop	4	4	0.76	3	3	0.96	3	3	0.96
Whorl	2	2	1.16	5	2	0.61	3	2	0.88
Plain arch	3	3	0.96	2	5	0.61	4	4	0.76
Tented arch	3	3	0.96	2	3	0.88	3	4	0.81
Ring finger									
Ulnar loop	2	2	1.16	3	2	0.88	3	3	0.96
Radial loop	6	5	0.52	3	3	0.96	2	4	0.85
Whorl	2	3	0.88	3	2	0.88	3	3	0.96
Plain arch	4	4	0.76	3	5	0.73	4	2	0.85
Tented arch	1	1	1.27	3	3	0.96	4	3	0.81
Middle finger									
Ulnar loop	5	4	0.67	2	5	0.61	3	3	0.96
Radial loop	3	2	0.88	3	2	0.88	3	3	0.96
Whorl	2	2	1.16	4	2	0.85	0	2	1.27
Plain arch	3	4	0.81	4	4	0.76	2	4	0.85
Tented arch	2	3	0.88	2	2	1.16	2	3	0.88
Index finger									
Ulnar loop	3	3	0.96	3	4	0.81	2	2	1.16
Radial loop	5	4	0.67	2	2	1.16	4	3	0.81
Whorl	3	4	0.81	2	2	1.16	3	2	0.88
Plain arch	2	2	1.16	4	2	0.85	3	4	0.81
Tented arch	1	2	1.06	4	3	0.81	3	4	0.81
Thumb									
Ulnar loop	2	2	1.16	2	2	1.16	2	2	1.16
Radial loop	3	3	0.96	3	3	0.96	2	3	0.88
Whorl	4	5	0.67	6	5	0.52	6	5	0.52
Plain arch	2	2	1.16	3	2	0.88	2	3	0.88
Tented arch	4	3	0.81	1	3	1.12	3	2	0.88

studies did not consider growth pattern. The present study was conducted to assess the correlation between dermatoglyphics patterns and growth patterns in individuals with Skeletal Class I and Skeletal Class II malocclusion.

In our study, on the thumb Whorls were most likely to be found in both the groups. Arches were the most common pattern on the fingertips. Plain arches were most common on the little finger and ring finger in skeletal class I group and only on little finger in skeletal class II group. Middle finger had most common occurrence of ulnar loop in both skeletal class I and class II and radial loops was found to be most common on ring finger of skeletal class II group. No significant difference between different growth patterns in both the groups was found.

Kharbanda *et al*.[8] (1982) compared the dermatoglyphic findings of individuals with Class I to those with Class III malocclusion. They found that skeletal Class III pattern was associated with an increase in arches and ulnar loops at the expense of whorls on all digits except digit II, there was an increased frequency of whorls and radial loops, and an increased frequency of carpel loops on interdigital area of palm in comparison to Class I malocclusion. We did not included skeletal Class III malocclusion in our study; hence, comparison was not possible.

A study was conducted by Reddy *et al*.[9] in 2013 in an attempt to compare the dermatoglyphic patterns of individuals with normal occlusion and various classes of malocclusions. Particular predictive occurrence of patterns was not found to be associated with each group, but some of the fingerprint patterns such as twinned loops were seen with an increased frequency in Class II malocclusions and ulnar loop were most prevalent in skeletal Class I pattern group.

Table 6: Comparison of dermatoglyphic pattern between different growth pattern in Skeletal Class I malocclusion

Group I		Skeletal Class I ($n=45$)			*P*		
	Patterns	Sub Group IA Horizontal growth pattern ($n=15$)	Sub Group IB Average growth pattern ($n=15$)	Sub Group IC Vertical growth pattern ($n=15$)	Horizontal versus average	Average versus vertical	Horizontal versus vertical
Little finger	Ulnar loop	3	2.5	1.5	0.7401	0.4652	0.6353
	Radial loop	2	2.5	3.5	0.6353	0.5582	0.3031
	Whorl	4	2.5	2.5	0.9282	1	0.9282
	Plain arch	3.5	4	5.5	0.876	0.1978	0.2796
	Tented arch	2.5	3.5	2	0.7934	0.2008	0.3428
Ring finger	Ulnar loop	2	2	1	0.4652	0.5403	1
	Radial loop	3	2.5	4	0.7401	0.4285	0.64
	Whorl	3.5	2.5	2.5	0.5582	0.5271	0.9212
	Plain arch	3	3.5	3.5	0.4285	0.2801	0.7968
	Tented arch	4	4.5	4	0.09213	0.2316	0.6143
Middle finger	Ulnar loop	4.5	2.5	4	0.577	0.7249	0.8188
	Radial loop	3	4	2	0.64	0.9282	0.7401
	Whorl	2	2	2	0.4652	0.4652	1
	Plain arch	2	3.5	3.5	0.819	0.593	0.819
	Tented arch	3.5	3	3	0.3906	0.5582	0.7968
Index finger	Ulnar loop	3	3	3.5	1	0.7968	0.7968
	Radial loop	3	2.5	3.5	0.819	0.9212	0.7249
	Whorl	2.5	3	2.5	0.819	0.819	1
	Plain arch	3	4	3.5	0.2801	0.4468	0.7249
	Tented arch	3.5	2.5	2	0.5582	0.7642	0.819
Thumb	Ulnar loop	2	1.5	2.5	0.2703	0.4652	0.6353
	Radial loop	3	3	1.5	1	0.1336	0.1336
	Whorl	6	5	6	0.639	0.639	1
	Plain arch	2	2	2	0.4652	0.4652	0.1573
	Tented arch	2	3.5	3	0.819	0.7968	1

Jindal *et al*.[10] (2015) found that the prevalence of ulnar loop was maximum in skeletal Class I group. malocclusion group followed by whorls, then plain arches and last was radial loop. However, in the present study, ulnar loop was most prevalent in the middle finger only both in skeletal Class I and Class II malocclusion.

Divyashree *et al*.[1] found that there was increased frequency of whorls both in right and left hands in skeletal class I group and skeletal Class II group has maximum ulnar loops in the right hand. However, in the present study, whorl pattern was found to be maximum only in thumb of both right and left hands.

George *et al*.[4] found that loop and whorl patterns were more than arch pattern. There was an increased distribution of loop pattern in skeletal Class I group and skeletal Class II has increased frequency of whorl pattern except in left fifth finger, right thumb, and right middle finger which had loop pattern in maximum. Arch pattern was least found in skeletal Class I group.

Within the limitation of the study, it can be stated that growth pattern did not influence the type of finger print pattern in skeletal Class I and Class II malocclusion group. However, further studies must be conducted on large sample size to validate the findings. Software can be used for accurate analysis of the finger print. The variability in finger print pattern in Class I and Class II malocclusion group as seen in other studies was also found in the present study. The assessment of the type of malocclusion based on dermatoglyphic pattern can help in sorting out subjects in mass disaster or criminal investigation. It can also be used for early prediction of malocclusion.

CONCLUSION

1. The variability in finger print pattern in Class I and Class II malocclusion was seen, but there was no significant correlation between dermatoglyphics and different growth pattern
2. Arch pattern was found more frequently followed by loop and whorl pattern was minimum in all the groups
3. There was an increased distribution of loop pattern in skeletal class I, horizontal growth pattern than in average and vertical growth pattern.

Table 7: Comparison of dermatoglyphic pattern between different growth pattern in Skeletal Class II malocclusion

Group II		Skeletal Class II ($n=45$)			*P*		
	Patterns	Sub Group IA Horizontal growth pattern ($n=15$)	Sub Group IB Average growth pattern ($n=15$)	Sub Group IC Vertical growth pattern ($n=15$)	Horizontal versus average	Average versus vertical	Horizontal versus vertical
Little finger	Ulnar loop	3	2.5	2	0.7401	0.7642	1
	Radial loop	4	3	3	1	1	1
	Whorl	2	3.5	2.5	0.4773	0.6788	0.7642
	Plain arch	3	3.5	4	0.4285	0.398	1
	Tented arch	3	2.5	3.5	0.7401	0.9212	0.7968
Ring finger	Ulnar loop	2	2.5	3	0.7642	0.7401	1
	Radial loop	5.5	2.5	3	0.8576	0.5582	0.4024
	Whorl	2.5	2.5	3	0.5271	0.7401	0.7401
	Plain arch	4	4	2.5	0.6143	0.4285	0.7249
	Tented arch	1	3	3.5	1	0.7968	0.8577
Middle finger	Ulnar loop	4.5	3.5	3	0.2804	0.4285	0.8327
	Radial loop	2.5	2.5	3	1	0.7401	0.7401
	Whorl	2	3	3.5	0.5982	0.8529	0.4773
	Plain arch	3.5	4	3	0.7821	0.5329	0.7249
	Tented arch	2.5	2	2.5	0.7642	0.7642	1
Index finger	Ulnar loop	3	3.5	2	0.7968	0.819	1
	Radial loop	4.5	3	3.5	0.398	0.3906	0.9494
	Whorl	3.5	2	2.5	0.819	0.7642	0.5582
	Plain arch	2	3	3.5	0.5982	0.3906	0.819
	Tented arch	2	3.5	3.5	0.819	0.593	0.819
Thumb	Ulnar loop	2	2	2	1	1	1
	Radial loop	3	3	2.5	1	0.7401	0.7401
	Whorl	4.5	5.5	5.5	0.6531	1	0.6531
	Plain arch	2	2.5	2.5	0.7642	0.5271	0.7642
	Tented arch	3.5	2	2.5	0.3031	0.2937	0.9212

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Divyashree S, Sharmada AS, Tayeepriyanka BK. Dermatoglyphic patterns and their co-relation with skeletal malocclusions. OSR J Dent Med Sci 2016;15:101-4.
2. Bhasin MT, Bhasin P, Singh A, Bhatia N, Shewale AH, Gambhir N. Dermatoglyphics and malocclusion-a forensic link. Br Biotechnol J 2016;13:1-12.
3. Baswaraj H, Lalakiya H, Mashru K, Modi H, Patel U, Ramani A. Dermatoglyphics and malocclusion. JIOH 2016;8:865-9.
4. George SM, Philip B, Madathody D, Mathew M, Paul J, Dlima JP. An assessment of correlation between dermatoglyphic patterns and sagittal skeletal discrepancies. J Clin Diagn Res 2017;11:ZC35-40.
5. Galton F. Finger Prints. 1892 Macmillan, London as cited in Henry, Sir Edwardcsi, Classification and Uses of Finger Prints. 6th ed. London: University of California, George Routledge and Sons Ltd.; 2007.
6. Kanematsu N, Yoshida Y, Kishi N, Kawata K, Kaku M, Maeda K, *et al*. Study on abnormalities in the appearance of finger and palm prints in children with cleft lip, alveolus, and palate. J Maxillofac Surg 1986;14:74-82.
7. Lakshmi V. Dermatoglyphics and orthodontics – A review. Ann Essences Dent 2013;5:30-3.
8. Kharbanda OP, Sharma VP, Gupta DS. Dermatoglyphic evaluation of mandibular prognathism. J Indian Dent Assoc 1982;54:179-86.
9. Reddy BR, Sankar SG, Roy ET, Govulla S. A comparative study of dermatoglyphics in individuals with normal occlusions and malocclusions. J Clin Diagn Res 2013;7:306-15.
10. Jindal G, Pandey RK, Gupta S, Sandhu M. A comparative evaluation of dermatoglyphics in different classes of malocclusion. Saudi Dent J 2015;27:88-92.