WEST AFRICAN JOURNAL OF ORTHODONTICS

ISSN 2315-9502

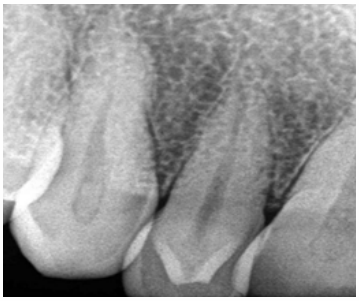
VOLUME 14, NUMBER 1

June 2025

Malocclusion, fingerprints and blood group

Cephalometric measurements and Photogrammetry

Pattern of malocclusion seen at AKTH



Artificial Intelligence in Orthodontics

Talon Cusps: Conservative management

OFFICIAL PUBLICATION OF ORTHODONTIC ASSOCIATIONS IN THE WEST AFRICAN SUB-REGION

"DENTISTRY'S FIRST SPECIALTY JOURNAL IN SUB SAHARAN AFRICA"

The Relationship Between Skeletal Malocclusions, Fingerprints and Blood Group in Patients Attending an Orthodontic Clinic in Benin City

Osemwegie C,[a] Umweni AA, [a,b] Omoregie F.O [c,d]

Abstract

Background: Documented evidence suggests a relationship between dermatoglyphic patterns, blood group system, and the development of malocclusion. The wide variations observed have been suggested to be due to genetic and environmental influences. More research to ascertain the relationship between malocclusion with fingerprints and blood group in Nigerians is essential. The objective of the study was to assess the relationship between skeletal malocclusion with fingerprints and blood group in a Nigerian population.

Methods: A total of 205 patients, aged 13-40 years, attending the Orthodontic clinic of the University of Benin Teaching Hospital, Benin City who met the inclusion criteria were selected. Their sagittal and vertical jaw relationships were determined by tracing the patients' lateral cephalometric radiograph. Fingerprints of both hands were taken using a Bio scanner, while blood samples were collected to determine their ABO blood group.

Results: More than half of the patients (55.6%) had skeletal pattern 1 malocclusion. The fingerprint pattern showed that the ulnar loop had the highest frequency across all types of skeletal malocclusion (61.8%), followed by whorl (24.5%), arch (10.2%), and radial loop (3.5 %). The fingerprint patterns of the left thumb, index finger, fifth finger, and right thumb had significant relationship with the different classes of skeletal malocclusion ($p<005$)

Conclusion: There was a relationship between dermatoglyphic pattern and skeletal malocclusion. No significant relationship was found between skeletal malocclusion and blood group. Dermatoglyphic patterns of some digits show predictive values when compared to others.

Key words: Fingerprint, blood group, malocclusion, skeletal.

Authors' affiliations

[a]Department of Orthodontics, University of Benin Teaching Hospital, Benin City, Edo State.
[b]Department of Orthodontics, University of Benin, Benin City, Edo State.
[c]Department of Oral Pathology and Oral Medicine, University of Benin, Benin City, Edo State.
[d]Department of Oral Pathology and Oral Medicine, University of Benin Teaching Hospital,
Benin City, Edo State.

Correspondence:
Osemwegie Collins
Department of Orthodontics
University of Benin,
Benin City, Edo State
Telephone Number: +2348032431452
Email Address: collinopeperano@yahoo.com
ORCID: 0009-0005-9011-0194

ORIGINAL ARTICLE

Introduction

Malocclusion may be defined as a significant deviation from what is defined as normal or ideal occlusion.[1-3] It is one of the common oral conditions that is often reported in literature.[1] The aetiology of malocclusion is multi-factorial, ranging from genetic factors to environmental factors and these factors influence the development of the jaws.[4] Skeletal malocclusion occurs as a result of the distortion of the normal maxillary and/or mandibular growth during embryonic development.[4] At present, malocclusions are ranked third in the order of priorities among the problems of dental public health worldwide.[5] It is estimated that approximately 1.2 million people in the United States have an extreme dentoskeletal anomaly.[6] Approximately 60% have a class II malocclusion, 25% have a class III malocclusion, and around 15% have a mix of dentoskeletal irregularities.[7] Class III malocclusion is thought to be one of the most complex as well as challenging orthodontic problems to deal with. The prevalence of class III malocclusion in North Indian population is up to 3.4%, while the prevalence of class III malocclusion in Caucasians varies from 0.8 to 4.0% and rises to 13% in Japanese and Chinese populaces.[7]

Skeletal malocclusion is found to show characteristic dermatoglyphic patterns as explained by embryological origin of oral and dermatoglyphic patterns.[8] Facial development begins as early as the 4th week of gestation.[1, 8] Palate begins to develop in the 6th week and is completed by the 12th week of gestation. The digital ridge patterns are indicators of growth-related developmental patterns, which start to appear during the 12th week of gestation, to be completed by 24th week, after which they remain throughout life.[9]

A relationship has also been found to exist between the ABO blood group system and some diseases and maxillofacial deformities.[10-12] The ABO blood group is genetically determined as they are inherited co-dominantly through genes on chromosome 9 from both parents.[4] A person's ABO type is determined by the inheritance of 1 of 3 alleles (A, B, or O).[10] The presence or absence of these antigens results in the four blood groups: A, B, AB, and O.[9]

Malocclusion leads to long-term complications such as temporomandibular joint (TMJ) dysfunctions, periodontal disease, obstructive sleep apnea, psychological disorders, and articulation errors.[13-15] Late diagnosis of skeletal malocclusions leads patients to orthognathic surgery,[16] therefore, the orthodontist must have sound knowledge of dental occlusion and the underlying skeletal relationship of the patient to arrive at the correct diagnosis and treatment plan for the malocclusion.[5]

Dermatoglyphic investigation is a method of exploring the genetic associations of malocclusion [17] due to the fact that there is a strong association between dermatoglyphic patterns and sagittal skeletal discrepancies.[18] A study by Reddy et al.[19] found a significant association between different malocclusions and specific types of ridge pattern.

The relationship between the ABO blood group system and some oral diseases has been one of the most important human genetic traits.[20] A relationship exists between malocclusion and ABO blood group system, and given that both are related to genetic components, it may be stated that blood groups have an association with malocclusions.[4, 10] The strongest association between ABO blood group system and malocclusion was reported to be highest in blood group B, and least in blood group AB.[4] Dermatoglyphic and ABO blood group studies done in association with malocclusion yielded diverse results, which could be due to the fact that numerous other factors such as ethnic and racial variations, congenital, environmental, and other local factors can also influence the development of malocclusions.[19,21-23] More research is essential to ascertain the relationship between malocclusion with fingerprints and the blood groups in the Nigerian population.

This study is relevant to the field of orthodontics, particularly in preventive and interceptive orthodontics, for early diagnosis and correction of deviated growth patterns of the jaws. The objective of this study is to assess the relationship between fingerprint pattern and blood group with skeletal malocclusion in Nigerians.

Materials and Methods

Study design: This was a prospective cross-sectional study.

Study population and location: Patients seeking orthodontic treatment between the ages of 13 to 40 years old who met the selection criteria. The study was carried out in the Orthodontic clinic of the Department of Orthodontics, University of Benin Teaching Hospital, Benin City.

Selection criteria:

Inclusion criteria:

1. Patients with no history of orthodontic treatment.
2. Patients aged 13 years to 40 years old.
3. All patients who attended the orthodontic clinic, and gave written informed consent to participate in the study.
4. Patients without periodontal disease that may affect the positioning of the teeth.
5. Patients with full complement of teeth, excluding third molars.
6. All subjects were of Nigerian descent.

Exclusion criteria:

1. Patients with malformation syndromes or other craniofacial abnormalities associated with maxilla and mandible, and those with facial asymmetry and acquired skeletal defects.
2. Patients with congenital or acquired deformities of the fingers and amputated fingers.
3. Patients with skin diseases, with wounds or scars on the fingers.
4. Patients with periodontal conditions that may affect the positioning of the teeth.
5. Patients with previous extraction of the teeth, particularly the first molar.

Sample size determination and selection

The sample size was calculated using quantitative data formula:

$$n = \left[z \frac{\alpha}{2} \frac{\sigma}{E} \right]^2$$

= [13.62]2 =185.55=186

Where n is the sample size, a 95% degree confidence interval corresponds to α=0.05, z the standard normal deviation, E the margin of error E=1 and standard deviation=6.95.

Materials and methods

The sagittal jaw relation was determined from the patient's lateral cephalogram with assessment of the following parameters: SNA, SNB, ANB and FMA.[18] Cephalometric norms of the Nigerian population were used to group the patients' skeletal patterns (appendix I).[24]The type of malocclusion was classified using Steiner's analysis for skeletal maloccl;usion (ANB angle) into three groups: Skeletal Class 1, Skeletal Class 2 and Skeletal Class 3.[16,25]The FMA was used to determine the vertical jaw relationship.[26]

The fingerprints recording was done by the researcher, the hands of the subjects were cleaned by the researcher with soap and water and dried with sterile gauze. The impression of individual digits was made by placing the bulb of the digits onto the surface of the bioscanner (see appendix IIa). The fingerprints were recorded with IBS software and analysed using the classification by Galton in 1892[1,23] as shown in Appendix IIIb.

The blood test of the individual was done to determine their blood group by the researcher, in conjunction with a medical laboratory scientist.[27] Antisera A, B, and D were used, with blood samples from the participants (appendix IV). The presence of agglutination with antiserum A confirmed blood group A. The presence of agglutination with antiserum B confirmed blood group B. The absence of agglutination on both antisera A and B confirmed blood group O, and the presence of agglutination on both antisera A and B confirmed blood group AB. The presence of agglutination with antiserum D confirmed Rhesus positive blood group. The absence of agglutination with antiserum D confirmed Rhesus negative blood group. The patient's blood group was determined and recorded on a data collection form (see appendix V).

Ethical considerations

Ethical approval for this study was obtained from the Ethics and Research Committee, University of Benin Teaching Hospital, Benin City, Edo State, Nigeria (protocol number: ADM/E22/A/VOL. VII/14682). Informed consent was obtained from study participants or their parents/ caregiver for minors. Each participant filled the informed consent form and the minor gave assent before they were recruited into the study.

Results

Sociodemographic characteristics

A total of 205 participants were examined, among them, 121 (59.0%) were females and 84 (41.0%) were males. The mean age was 24.86 ± 7.02 and the age ranged from 13 – 40 years, and the most common age group was 21 – 25 years (28.8%). A majority of the patients had blood group O, 143 (69.8%), the ulnar loop was the most common dermatoglyphic pattern at 1266 (61.8%), while skeletal class 1 at 114 (55.6%) was the most common skeletal malocclusion.

Table 1a: Distribution of patients' characteristics

Characteristic	Frequency N = 205	(%)
Age group (in years)		
13 – 15	16	7.8
16 – 20	46	22.4
21 – 25	59	28.8
26 – 30	41	20.0
31 – 35	19	9.3
36 – 40	24	11.7
Gender		
Male	84	41.0
Female	121	59.0
Blood group		14.1
A	29	
B	24	11.7
AB	9	4.4
O	143	69.8
Rhesus 'D' factor		
Positive	187	91.2
Negative	18	8.8
Dermatoglyphic pattern (¶*N=2,050*)		
Arch	210	10.2
Radial loop	71	3.5
Ulnar loop	1266	61.8
Whorl	503	24.5
Skeletal malocclusion pattern		
1	114	55.6
2	34	16.6
3	57	27.8

Table 1b: Vertical and sagittal skeletal measurement in degrees

ANB (Median (IQR)	3.0 (1.0 – 4.0)
FMA (Median (IQR)	22.0 (20.5 – 24.0)

Table 2: Association of dermatoglyphic patterns with skeletal malocclusion.

	Fingerprint pattern	Skeletal pattern 1 (%)	Skeletal pattern 2 (%)	Skeletal pattern 3 (%)	p-value
Left fifth finger	Arch	6 (5.3)	0 (0)	0 (0)	**<0.001**
	radial loop	2 (1.8)	0 (0)	0 (0)	
	ulnar loop	92 (80.7)	26 (76.5)	57 (100)	
	Whorl	14 (12.3)	8 (23.5)	0 (0)	
Left fourth finger	Arch	6 (5.3)	2 (5.9)	6 (10.5)	0.781
	radial loop	6 (5.3)	0 (0)	2 (3.5)	
	ulnar loop	73 (64.0)	24 (70.6)	36 (63.2)	
	Whorl	29 (25.4)	8 (23.5)	13 (22.8)	
Left index finger	Arch	20 (17.5)	1 (2.9)	11 (19.3)	**0.0345**
	radial loop	8 (7.0)	8 (23.5)	3 (5.3)	
	ulnar loop	45 (39.5)	16 (47.1)	25 (43.9)	
	Whorl	41 (36.0)	9 (26.5)	18 (31.6)	
Left middle finger	Arch	19 (16.7)	9 (26.5)	8 (14.0)	0.603
	radial loop	4 (3.5)	0 (0)	0 (0)	
	ulnar loop	68 (59.6)	19 (55.9)	38 (66.7)	
	Whorl	23 (20.2)	6 (17.6)	11 (19.3)	
Left thumb	Arch	20 (17.5)	5 (14.7)	8 (14.0)	**0.006**
	radial loop	3 (2.6)	5 (14.7)	0 (0)	
	ulnar loop	55 (48.2)	10 (29.4)	19 (33.3)	
	Whorl	36 (31.6)	14 (41.2)	30 (52.6)	
Right fifth finger	Arch	5 (4.4)	0 (0)	2 (3.5)	0.534
	radial loop	2 (1.8)	0 (0)	0 (0)	
	ulnar loop	95 (83.3)	32 (94.1)	53 (93.0)	
	Whorl	12 (10.5)	2 (5.9)	2 (3.5)	
Right fourth finger	Arch	3 (2.6)	3 (8.8)	2 (3.5)	0.207
	radial loop	0 (0)	0 (0)	2 (3.5)	
	ulnar loop	75 (65.8)	23 (67.6)	40 (70.2)	
	Whorl	36 (31.6)	8 (23.5)	13 (22.8)	
Right index finger	Arch	15 (13.2)	5 (14.7)	8 (14.0)	0.683
	radial loop	9 (7.9)	4 (11.8)	5 (8.8)	
	ulnar loop	61 (53.5)	15 (44.1)	23 (40.4)	
	Whorl	29 (25.4)	10 (29.4)	21 (36.8)	
Right middle finger	Arch	11 (9.6)	7 (20.6)	5 (8.8)	0.302
	radial loop	0 (0)	0 (0)	1 (1.8)	
	ulnar loop	87 (76.3)	25 (73.5)	43 (75.4)	
	Whorl	16 (14.0)	2 (5.9)	8 (14.0)	
Right thumb	Arch	14 (12.3)	6 (17.6)	3 (5.3)	**0.048**
	radial loop	7 (6.2)	0 (0)	0 (0)	
	ulnar loop	51 (44.7)	10 (29.4)	30 (52.6)	
	Whorl	42 (36.8)	18 (52.9)	24 (42.1)	

Fisher's exact test

The association between dermatoglyphic patterns and skeletal malocclusion is shown in Table 2. Arch was the most seen in the left thumb, index, and middle fingers of individuals with skeletal pattern I malocclusion. It was absent in the left fifth fingers of participants with skeletal patterns II and III malocclusion. Radial loop was most seen in the left index finger and right index finger of individuals with skeletal pattern II malocclusion. However, it was absent in the left fifth finger, left fourth finger, left middle finger and right fifth finger of participants with skeletal pattern II malocclusion. Ulnar loop pattern was most seen in the right and left fifth fingers of participants with skeletal pattern I malocclusion. Whorl pattern was seen more in the right thumb of individuals with skeletal pattern III and left index finger of individuals with skeletal pattern I malocclusion. But the whorl pattern was absent in the left fifth finger and right middle finger of participants with skeletal pattern III malocclusion. A significant association exists between dermatoglyphic patterns and skeletal malocclusion, with the ulnar loop patterns of left fifth finger (p = <0.001), in association with skeletal pattern III and left index finger (p = 0.035) in associated with skeletal pattern II malocclusion. The whorl pattern of the left thumb (p = 0.006) is associated with skeletal pattern III and the whorl pattern of the right thumb (p = 0.048) was found to be associated with skeletal pattern II malocclusion

Table 3: Correlation of dermatoglyphic patterns of study participants with categories of Skeletal malocclusion

Digit	Dermatoglyphic pattern	Skeletal pattern 1 *N=114* No(%)	Skeletal pattern 2 *N=34* No(%)	Skeletal pattern 3 *N=57* No(%)	Kendall's tau ($_b$)	p-value
Left Thumb	Arch	20 (17.5)	5 (14.7)	8 (14.0)		
	radial loop	3 (2.6)	5 (14.7)	0 (0)	0.136	**0.029**
	ulnar loop	55 (48.2)	10 (29.4)	19 (33.3)		
	Whorl	36 (31.6)	14 (41.2)	30 (52.6)		
Left Index finger	Arch	20 (17.5)	1 (2.9)	11 (19.3)		
	radial loop	8 (7.0)	8 (23.5)	3 (5.3)	-0.030	0.636
	ulnar loop	45 (39.5)	16 (47.1)	25 (43.9)		
	Whorl	41 (36.0)	9 (26.5)	18 (31.6)		
Left Middle finger	Arch	19 (16.7)	9 (26.5)	8 (14.0)		
	radial loop	4 (3.5)	0 (0)	0 (0)	0.013	0.835
	ulnar loop	68 (59.6)	19 (55.9)	38 (66.7)		
	Whorl	23 (20.2)	6 (17.6)	11 (19.3)		
Left Ring finger	Arch	6 (5.3)	2 (5.9)	6 (10.5)		
	radial loop	6 (5.3)	0 (0)	2 (3.5)	-0.037	0.578
	ulnar loop	73 (64.0)	24 (70.6)	36 (63.2)		
	Whorl	29 (25.4)	8 (23.5)	13 (22.8)		
Left Fifth finger	Arch	6 (5.3)	0 (0)	0 (0)		
	radial loop	2 (1.8)	0 (0)	0 (0)	-0.019	0.727
	ulnar loop	92 (80.7)	26 (76.5)	57 (100)		
	Whorl	14 (12.3)	8 (23.5)	0 (0)		
Right Thumb	Arch	14 (12.3)	6 (17.6)	3 (5.3)		
	radial loop	7 (100.0)	0 (0)	0 (0)	0.097	0.104
	ulnar loop	51 (44.7)	10 (29.4)	30 (52.6)		
	Whorl	42 (36.8)	18 (52.9)	24 (42.1)		
Right Index finger	Arch	15 (13.2)	5 (14.7)	8 (14.0)		
	radial loop	9 (7.9)	4 (11.8)	5 (8.8)	0.049	0.447
	ulnar loop	61 (53.5)	15 (44.1)	23 (40.4)		
	Whorl	29 (25.4)	10 (29.4)	21 (36.8)		

Right Middle finger	Arch	11 (9.6)	7 (20.6)	5 (8.8)		
	radial loop	0 (0)	0 (0)	1 (1.8)	-0.037	0.569
	ulnar loop	87 (76.3)	25 (73.5)	43 (75.4)		
	Whorl	16 (14.0)	2 (5.9)	8 (14.0)		
Right Ring finger	Arch	3 (2.6)	3 (8.8)	2 (3.5)		
	radial loop	0 (0)	0 (0)	2 (3.5)	-0.108	0.090
	ulnar loop	75 (65.8)	23 (67.6)	40 (70.2)		
	Whorl	36 (31.6)	8 (23.5)	13 (22.8)		
Right Fifth finger	Arch	5 (4.4)	0 (0)	2 (3.5)		
	radial loop	2 (1.8)	0 (0)	0 (0)	-0.046	0.470
	ulnar loop	95 (83.3)	32 (94.1)	53 (93.0)		
	Whorl	12 (10.5)	2 (5.9)	2 (3.5)		

Table 3 shows the distribution and relationships of the categories of skeletal malocclusion to the participants' fingerprint patterns. When considered in categories, the proportion of participants with the whorl fingerprint pattern on the left thumb appeared to increase as the class of skeletal malocclusion increased. This monotonic relationship was confirmed on Kendall's tau-b test, which demonstrated a weak positive correlation of fingerprint patterns of the left thumb with increasing classes of skeletal malocclusion, which was statistically significant ($_b$ = 0.136, p = 0.029). The ulnar loop pattern was the dominant fingerprint pattern in the left index and fifth finger, even though it did not appear to demonstrate a clear monotonic relationship with the classes of skeletal malocclusion as in the thumb. The fingerprint patterns on the other digits of the left hand were not related to the classes of skeletal malocclusion in the study participants.

On the right hand, all participants with a radial loop on their thumbs had the least class of skeletal malocclusion (100% vs 0%, p = 0.043). No clear monotonic relationship was found between participants' fingerprint patterns on any other digit and the class of skeletal malocclusion (p>0.05).

Table 4a: Relationship between participants' dermatoglyphic patterns and quantitative measures of skeletal malocclusion

Hand	Digit	Dermatoglyphic pattern	No(%)	ANB (°) Median (IQR)	p-value	FMA (°) Median (IQR)¶	p-value
		Arch	33 (16.1)	3.0 (2.0 – 4.0)		22.0 (21.1 – 24.8)	
		Radial loop	8 (3.9)	6.0 (2.0 – 9.0)		24.0 (21.3 – 28.3)	
	Thumb	Ulnar loop	84 (41.0)	2.8 (2.0 – 4.0)	0.127	22.0 (20.6 – 23.0)	0.141
		Whorl	80 (39.0)	3.0 (1.0 – 4.0)		21.8 (20.0 – 24.0)	
Left		Arch	32 (15.6)	2.0 (-0.5 – 3.0)		22.0 (20.0 – 23.9)	
		Radial loop	19 (9.3)	3.5 (2.0 – 5.0)		23.0 (22.0 – 25.0)	
	Index finger	Ulnar loop	86 (42.0)	2.5 (1.3 – 4.0)	**0.037**[a]	21.5 (20.0 – 23.0)	**0.029**[b]
		Whorl	65 (31.7)	3.0 (1.0 – 4.0)		22.0 (20.5 – 24.0)	

	Arch	36 (17.5)	3.0 (2.0 – 5.0)		22.5 (22.0 – 25.0)	
	Radial loop	4 (2.0)	2.5 (2.0 – 3.0)		21.0 (20.1 – 21.9)	
Middle finger	Ulnar loop	125 (61.0)	3.0 (1.0 – 4.0)	0.723	22.0 (20.0 – 23.0)	**0.026**[c]
	Whorl	40 (19.5)	3.0 (1.0 – 4.0)		22.8 (20.6 – 24.0)	
	Arch	14 (6.8)	2.0 (1.0 – 4.0)		22.0 (21.4 – 23.3)	
	Radial loop	8 (3.9)	2.0 (-0.3 – 2.4)		22.5 (20.1 – 23.9)	
Ring finger	Ulnar loop	133 (64.4)	3.0 (1.6 – 4.0)	0.416	22.0 (20.0 – 24.0)	0.845
	Whorl	50 (24.4)	3.0 (1.0 – 4.0)		22.0 (21.0 – 23.3)	
	Arch	6 (2.9)	2.0 (2.0 – 3.5)		26.0 (22.0 – 27.0)	
	Radial loop	2 (1.0)	NA		22.5 (22.0 – 23.0)	
Fifth finger	Ulnar loop	175 (85.4)	2.5 (1.0 – 4.0)	**0.019**[d]	22.0 (20.0 – 23.0)	**0.005**[e]
	Whorl	22 (10.7)	4.0 (2.8 – 5.0)		23.0 (21.5 – 25.0)	

Kruskal-Wallis test; NA – not applicable (both values were 3.0°)

Table 4b: Post-Hoc pairwise comparison of median values of ANB and FMA between dermatoglyphic patterns of the left hand

Hand	Digit	Paired Dermatoglyphic pattern	Test statistic (ANB)	p-value	Test statistic (FMA)	p-value
Left	**Index finger**	Arch vs Radial loop	172.0	0.009	181.0	0.016
		Arch vs Whorl	795.0	0.028	934.0	0.252
		Arch vs Ulnar loop	1113.0	0.107	1352.5	0.886
		Radial loop vs Whorl	501.5	0.133	471.5	0.071
		Ulnar loop vs Whorl	2752.0	0.527	2561.0	0.183
		Ulnar loop vs Radial loop	600.5	0.069	476.5	0.004
	Middle finger	Arch vs Radial loop	NA	NA	29.5	0.053
		Arch vs Whorl	NA	NA	611.5	0.257
		Arch vs Ulnar loop	NA	NA	1576.5	0.006
		Radial loop vs Whorl	NA	NA	49.5	0.210
		Ulnar loop vs Whorl	NA	NA	2169.5	0.206
		Ulnar loop vs Radial loop	NA	NA	188.5	0.399
	Fifth finger	Arch vs Radial loop	4.0	0.465	3.0	0.429
		Arch vs Whorl	34.5	0.071	45.5	0.247
		Arch vs Ulnar loop	499.0	0.835	199.5	0.009
		Radial loop vs Whorl	15.0	0.455	19.0	0.752
		Ulnar loop vs Whorl	1148.5	0.002	1284.0	0.010
		Ulnar loop vs Radial loop	144.0	0.664	133.0	0.557

Mann-Whitney U test; NA – Not applicable.

Table 4a: Relationship between participants' dermatoglyphic patterns and quantitative measures of skeletal malocclusion (Contd)

Hand	Digit	Dermatoglyphic pattern	No(%)	ANB (°) Median (IQR)	p-value	FMA (°) Median (IQR)¶	p-value
		Arch	23 (11.2)	3.0 (2.0 – 4.0)		22.0 (21.1 – 24.8)	
		Radial Loop	7 (3.4)	6.0 (2.0 – 9.0)		24.0 (21.3 – 28.3)	
	Thumb	Ulnar Loop	91 (44.4)	2.8 (2.0 – 4.0)	0.127	22.0 (20.6 – 23.0)	0.141
		Whorl	84 (41.0)	3.0 (1.0 – 4.0)		21.8 (20.0 – 24.0)	
		Arch	28 (13.6)	2.0 (-0.5 – 3.0)		22.0 (20.0 – 23.9)	
		Radial Loop	18 (8.8)	3.5 (2.0 – 5.0)		23.0 (22.0 – 25.0)	
Right	**Index finger**	Ulnar Loop	99 (48.3)	2.5 (1.3 – 4.0)	**0.037**[a]	21.5 (20.0 – 23.0)	**0.029**[b]
		Whorl	60 (29.3)	3.0 (1.0 – 4.0)		22.0 (20.5 – 24.0)	
		Arch	23 (11.2)	3.0 (2.0 – 5.0)		22.5 (22.0 – 25.0)	
		Radial Loop	1 (0.5)	2.5 (2.0 – 3.0)		21.0 (20.1 – 21.9)	
	Middle finger	Ulnar Loop	155 (75.6)	3.0 (1.0 – 4.0)	0.723	22.0 (20.0 – 23.0)	**0.026**[c]
		Whorl	26 (12.7)	3.0 (1.0 – 4.0)		22.8 (20.6 – 24.0)	
		Arch	8 (3.9)	2.0 (1.0 – 4.0)		22.0 (21.4 – 23.3)	
		Radial Loop	2 (1.0)	2.0 (-0.3 – 2.4)		22.5 (20.1 – 23.9)	
	Ring finger	Ulnar Loop	138 (67.3)	3.0 (1.6 – 4.0)	0.416	22.0 (20.0 – 24.0)	0.845
		Whorl	57 (27.8)	3.0 (1.0 – 4.0)		22.0 (21.0 – 23.3)	
		Arch	7 (3.4)	2.0 (2.0 – 3.5)		26.0 (22.0 – 27.0)	
		Radial Loop	2 (1.0)	NA		22.5 (22.0 – 23.0)	
	Fifth finger	Ulnar Loop	180 (87.8)	2.5 (1.0 – 4.0)	**0.019**[d]	22.0 (20.0 – 23.0)	**0.005**[e]
		Whorl	16 (7.8)	4.0 (2.8 – 5.0)		23.0 (21.5 – 25.0)	

Kruskal-Wallis test; NA[1] – Not applicable (value was -2.0); NA[2] – Not applicable (FMA value was 20.0); NA[3] – Not applicable (ANB value was 2.0).

Table 4b: Post-Hoc pairwise comparison of median values of ANB and FMA between dermatoglyphic patterns of the right hand (Contd)

Hand	Digit	Paired Dermatoglyphic pattern	Test statistic	p-value
		Arch vs Radial loop	41.5	0.053
		Arch vs Whorl	683.5	0.031
		Arch vs Ulnar loop	579.0	0.001
Right	**Thumb**	Radial loop vs Whorl	261.0	0.621
		Ulnar loop vs Whorl	3518	0.361
		Ulnar loop vs Radial loop	311.5	0.922

Mann-Whitney U test

There were statistically significant differences in the median ANB angle of the participants' fingerprint patterns within the left index and fifth fingers. These differences were noted to exist specifically between the arch and radial loop pattern (p=0.009) and the arch and whorl pattern (p=0.028) of the left index finger; and the whorl and ulnar loop of the left fifth finger (p=0.009). Using the FMA as a measure of skeletal malocclusion, there were also significant differences in the median values of the left index,

middle, and fifth fingers. The radial and ulnar loops (p=0.004) and arch and radial loops of the left index finger; the arch and ulnar loop of the left middle finger (p=0.006); and the arch and ulnar loop (p=0.009) and ulnar loop and whorl of the left fifth finger (p=0.010) all demonstrated statistically significant differences.

The median FMA of the study participants demonstrated significant differences based on their right thumbs fingerprint patterns only. This difference was particularly common among those with the arch and ulnar loop (p=0.001) and the arch and whorl (p=0.031) fingerprint patterns. The median ANB values were similar in all the study participants, irrespective of the type of fingerprint pattern they had (see Table 4 above).

Table 5: Association between ABO blood group and skeletal malocclusion

	Skeletal Pattern				
Characteristic	**Pattern 1**	**Pattern 2**	**Pattern 3**	**Total**	**p-value[1]**
Blood group A	13 (45.0%)	4 (14.0%)	12(41.0%)	29(100.0%)	
Blood group B	11 (45.8%)	2 (8.3%)	11 (45.8%)	24 (100.0%)	
Blood group AB	5 (56.0%)	2 (22.0%)	2 (22.0%)	9 (100.0%)	0.200
Blood group O	85 (59.4%)	26 (18.2%)	32(22.4%)	143 (100.0%)	
Total	114 (55.6%)	34 (16.6%)	57 (27.8%)	205 (100.0%)	

[1]Fisher's exact test

As shown in Table 5 above, most of the individuals with blood group A (45%) had skeletal pattern I malocclusion; skeletal patterns 1 and 2 were equally dominant in individuals with blood group B (46%); Also, most of the individuals with blood group AB (56%) as well as blood group O (59%) had skeletal pattern 1 malocclusion. However, there was no statistically significant association between blood group and skeletal malocclusion (p = 0.200).

Concerning the Rhesus blood group, most of the individuals who were Rhesus positive (57.0%) had skeletal pattern 1 malocclusion; skeletal pattern 1 and 3 malocclusion were equally dominant in individuals with Rhesus negative (44.4%). There was no statistically significant association between rhesus and skeletal malocclusion (p = 0.300). Table 6

Table 6: Association between Rhesus blood group and skeletal malocclusion

	Skeletal Pattern				
Characteristic	**Pattern 1**	**Pattern 2**	**Pattern 3**	**Total**	**p-value[1]**
Rhesus Blood group					0.300
Positive	106 (57.0%)	32 (17.0%)	49 (26.0%)	187(100.0%)	
Negative	8 (44.4%)	2 (11.1%)	8 (44.4%)	18 (100.0%)	
Total	114 (55.6%)	34 (16.6%)	57 (27.8%)	205(100.0%)	

[1]Fisher's exact test

Table 7: Relationship between participants' blood groups and quantitative measures of skeletal malocclusion

Blood group	No(%)	ANB (°) Median (IQR)	p-value	FMA (°) Median (IQR)¶	p-value
A	29 (14.1)	2.0 (1.0 – 3.5)		22.0 (20.5 – 23.0)	
B	24 (11.7)	1.5 (-1.0 – 4.0)	0.053	21.3 (20.0 – 23.4)	0.794
AB	9 (4.4)	3.0 (1.5 – 5.0)		22.0 (20.5 – 24.0)	
O	143 (69.8)	3.0 (2.0 – 4.0)		22.0 (20.5 – 24.0)	
Rhesus D pos	187 (91.2)	3.0 (1.5 – 4.0)	0.719§	22.0 (20.5 – 24.0)	0.872§
Rhesus D neg	18 (8.8)	3.0 (1.0 – 4.0)		21.5 (20.4 – 23.3)	

¶Kruskal-Wallis test; §Mann-Whitney U test

Table 8: Correlation of participants' blood groups with categories of skeletal malocclusion

Blood Group	Skeletal pattern 1 *N=114* No (%)	Skeletal pattern 2 *N=34* No (%)	Skeletal pattern 3 *N=57* No (%)	Kendall's tau (τ_b)	p-value
A	13 (11.4)	4 (11.8)	12 (21.1)		
B	11 (9.6)	2 (5.9)	11 (19.3)	-0.143	**0.031**
AB	5 (4.4)	2 (5.9)	2 (3.5)		
O	85 (74.6)	26 (76.5)	32 (56.1)	0.089	0.225
Rhesus D pos	106 (93.0)	32 (94.1)	49 (86.0)		
Rhesus D neg	8 (7.0)	2 (5.9)	8 (14.0)		

The median (IQR) ANB value in participants with blood group O was 3.0 (2.0 – 4.0) degrees while that of those with blood group B was 1.5 (-1.0 – 4.0). There was, overall, no significant difference between the median values of ANB across the ABO blood groups (p = 0.053). The median (IQR) FMA value was similar in the various ABO blood group types as well (p = 0.794). The same was true for the ANB and FMA values of the participants across their Rhesus antigen type (Table 7).

When considered in categories, the ABO blood groups tended to occur mostly in the skeletal pattern 1 malocclusion compared to other skeletal malocclusion patterns. The median (IQR) ANB value in participants with blood group O was 3.0 (2.0 – 4.0) degrees while that of those with blood group B was 1.5 (-1.0 – 4.0). There was overall, no significant difference between the median values of ANB across the blood groups (p = 0.053). The median (IQR) FMA value was similar in the various blood group types as well (p = 0.794). The same was true for the ANB and FMA values of the participants across their Rhesus antigen type. Skeletal malocclusion related weakly and positively with rhesus antigen positivity, though this was not statistically significant (Table 8).

Table 9: Multivariate analysis of predictors of skeletal malocclusion in study participants

Variable	Adjusted Odds Ratio	95% Confidence Interval	p-value
ABO Blood Group			
A	3.32	0.90 – 12.22	0.071
B	**9.62**	**1.24 – 74 .46**	**0.030**
AB	1.13	0.20 – 6.34	0.887
O	1.000		
Left thumb			
Arch	0.44	0.09 – 2.22	0.316
Radial loop	1.57×10^{9}	0.00 – ∞	0.999
Ulnar loop	0.71	0.23 – 2.15	0.545
Whorl	1.000		
Left index finger			
Arch	0.90	0.26 – 3.10	0.861
Radial loop	1.34	0.24 – 7.51	0.738
Ulnar loop	0.82	0.32 – 2.11	0.685
Whorl	1.000		
Left fifth finger			
Arch	0.92	0.10 – 8.50	0.941
Radial loop	0.00	0.00 – ∞	0.999
Ulnar loop	**2.53**	**1.23 – 5.23**	**0.012**
Whorl	1.000		
Right thumb			0.115
Arch	5.60	0.66 – 47.78	0.498
Radial loop	0.40	0.03 – 5.56	0.060
Ulnar loop	2.75	0.96 – 7.91	
Whorl	1.000		

Further analyses were carried out to explore prediction of skeletal malocclusion in this cohort (Table 9).

Variables that demonstrated a p-value of <0.10 in bivariate analysis were selected and put in a model to predict higher classes of skeletal malocclusion. They included the ABO blood group, left thumb, index and fifth finger and right thumb. After adjusting for confounders, blood group B and an ulnar loop fingerprint pattern on the left fifth finger independently predicted higher classes of skeletal malocclusion. Participants with blood group B compared to those with group O had about 10 times greater odds of having higher classes of skeletal malocclusion (OR – 9.6 95%CI: 1.2 – 74.5) while possessing an ulnar loop on the left fifth finger compared to possessing a whorl pattern increased the odds of a higher class of malocclusion by 1.5 times (OR – 2.5, 95%CI: 1.2 – 5.2).

Discussion

Genetic and environmental factors play a role in the development of malocclusion that can affect the general health of patients depending on its degree of severity.[28] The orofacial structures and the epidermal ridges are derivatives of ectoderm of the embryonic tissue.[28]Understanding this biology may play a role in early diagnosis and treatment plan, thereby decreasing the burden of the condition in orofacial region.[28]

This study assessed the relationship between skeletal malocclusions with fingerprints and blood group as against the background of the role of genetic and environmental factors in the development of malocclusion.

In this study, the most common skeletal pattern was skeletal pattern 1 malocclusion, followed by skeletal pattern 3 and skeletal pattern 2 malocclusion. The most common dermatoglyphic pattern seen among study participants was ulnar loop, followed by whorl, arch and radial loop and is like previous findings in Nigeria by Mohammed et al.,[29]in the Kanuri ethnic group. Also, Ujaddughe et al.,[30] in their assessment of dermatoglyphic patterns and sex distribution in Esan ethnic group of Edo state, observed that the loop pattern had the highest frequency followed by whorl, arch and double whorl.[30] These findings suggest a variable prevalence of fingerprint patterns in Nigerians. Blood group O and Rhesus positive were most predominant among the participants with AB and Rhesus negative being the least prevalent. This was in concordance with other studies done in Nigeria[31-33,] which found Blood group O to be most prevalent and AB to be the least prevalent in the ABO blood group and Rhesus positive to be most prevalent in the Rhesus blood group system.

The dermatoglyphic pattern seen in this study showed that the ulnar loop had the most dominant pattern across all types of skeletal malocclusion, with absence of arch and radial loop patterns on the left fifth fingers in skeletal class 2 and 3 malocclusions. While possessing an ulnar loop on the left fifth finger compared to having a whorl pattern increased the chances of a higher class of malocclusion by 1.5 times. The dermatoglyphic patterns of four fingers out of the ten fingers (left thumb, left index finger, left fifth finger and Right thumb) had a significant relationship with the different classes of skeletal malocclusion. The ulnar loop pattern of the left fifth finger is associated with skeletal pattern 3, and the left index finger is associated with skeletal pattern 2 malocclusion. The whorl pattern of the left thumb is associated with skeletal pattern 3 malocclusion and whorl pattern of the right thumb is found to be associated with skeletal pattern 2 malocclusion. The left hand had more digits with a significant relationship with skeletal malocclusion. This finding is comparable to that of George et al.[18] and in contrast with the findings of Kaur et al.,[34]who found no significant correlation between dermatoglyphics and different skeletal patterns. The contrasting findings may be due to differences in sample size, which was smaller, and the fingerprint method used in the study.[34] Reddy et al.,[19]also reported significant association between skeletal malocclusion and specific types of ridge patterns as seen in this study. While different researchers have reported different frequencies of occurrence of specific dermatoglyphic patterns with different classes of skeletal malocclusion. It is understandable that their divergent findings may be due to differences in population studied among other factors because the cohort in this present study consisted of those with some degree of malocclusion and a relatively uniform population.

The bivariate analysis of blood groups with skeletal malocclusion did not establish any relationship in this study. However, the multivariate analysis shows that blood group B when compared with other blood groups was found to be directly related to higher classes of skeletal malocclusion. This aligns with the findings by Gheisari et al.[35] which revealed that blood groups B and AB have an increased incidence of association with maxillofacial deformities, whereas, blood groups O and A have a lower incidence of association in Iranian populations. A contrary opinion was, however, held by Shokor et al.,[36]who reported no genetic influence of ABO blood group in relation to variations in craniofacial morphology. The reason for this may be due to the difference in the study methodologies.

The dermatoglyphic patterns of individuals remain constant throughout life, from birth till death and have

been found to have a relationship with malocclusion, although, it requires more research to be done. This easy, accessible, inexpensive, useful, reliable, and non-invasive method may be a useful tool if employed in clinical settings to aid early assessment of risk for malocclusion, along with diagnostic impression of sagittal skeletal relationships of maxilla and mandible in malocclusion. This might aid early preventive and interceptive orthodontic management of malocclusion if established, especially in developing countries with enormous populations and limited health budgets. In addition, the practice of routine recording of the fingerprints of patients in the orthodontic clinic along with other orthodontic records will go a long way in assisting forensic investigations and anthropology studies.

The sample size was a limitation, the participants were all hospital patients. No participants with normal occlusion were recruited in the study and this led to some assumptions in the regression model.

Conclusion

This study was able to show that there is a relationship between dermatoglyphic pattern with skeletal malocclusions. The possession of ulnar loop on the left fifth finger compared to the possession of whorl pattern increased the odds of a higher class of malocclusion by 1.5 times. There is a marked absence of the arch and radial loop patterns on the left fifth fingers in skeletal class 2 and 3 malocclusions. The ulnar loop patterns of left fifth finger and left index finger were associated with skeletal pattern 3 and skeletal pattern 2 malocclusion respectively. The whorl pattern of the left thumb was associated with skeletal pattern 3 malocclusion while the whorl pattern of the right thumb was found to be associated with skeletal pattern 2 malocclusion. There was no significant association between blood group and skeletal malocclusion. However, possession of blood group B, when compared with other blood groups, was found to be directly related to higher classes of skeletal malocclusion.

The dermatoglyphic patterns of some digits show predictive values, this relationship could be further studied in more races and in larger populations before being employed as a diagnostic aid for identifying malocclusion problems at an early age for timely orthodontic intervention.

Recommendation:

The dermatoglyphic patterns show the promise of being a predictive tool in skeletal malocclusion, thus, more research in different races and in larger sample populations is needed to further determine the extent of its use. The inclusion of participants with normal occlusion in future studies will aid comparison as well as test the specificity and sensitivity of dermatoglyphic patterns as a tool.

Authors' Contribution: All the authors contributed to the manuscript

Financial Support - Funded by the authors

Conflict of Interest - None to declare

References

1 Kaur J, Khokhar V and Pathak A. Dermatoglyphics-as a diagnostic tool in detection of malocclusion.Int J Rec Sci Res2016;7:12400–12404.

2 Daskalogiannakis J: Glossary of Orthodontic Terms. Publisher: Quintessence, 2000, 1st Ed.

3 Houston W, Stephens C, Tulley W. A textbook of orthodontics. Bristol: Wright Pub Co, 1992.

4 SharmaR, Preethi PN, Nagarathna C, Navin HK. "Association of ABO blood groups with malocclusion in the population of Jaipur, India: A prospective study." Int J Sci Study. 2015; 2: 45-51.

5 Rasool G, Shah SS, Adil M. Relationship of the skeletal malocclusion with dental malocclusion in the sagittal plane. JKCD 2016;6: 16 -19.

6 Nishio C, Huynh N. Skeletal Malocclusion and Genetic Expression : An Evidence- Based Review. J Dent Sleep Med 2016;3:57–63.

7 Adnan H, Koshak H. Diagnosis , Complications , And Treatment of Dentoskeletal Malocclusion ; Systematic Review.Int J Healthcare Sci2017;5:95–101.

8 Divyashree, Suhas AS, SharmadaBK,Tayeepriyanka.Dermatoglyphic Patterns and Their Correlation with Skeletal Malocclusions. J Dent Med Sci. 2016;15:101–104.
9 Achalli S, Patla M, Nayak U, Soans C R. Dermatoglyphics and orthodontics. Int J Orthod Rehabil 2016;7:144-147.
10 Gheisari R, Ghoreishian M, Movahedian B, Roozbehi A. The association between blood groups and maxillofacial deformities. Indian J PlastSurg 2008;41:138-40
11 Fathin FBAS, Wan SWR, Mohammad KA. Craniofacial morphology with genetic influence of ABO blood group in Malaysian orthodontic patients. Int J Pharm Bio Sci 2015; 6: 412- 418.
12 Gupta SP. Association of ABO Blood Groups with Occlusal Pattern among Orthodontic Patients of Kathmandu District. EC Dent Sci(2018): 17; 2119-2129.
13 Ruhl CM, Bellian KT, Van Meter BH, et al. Diagnosis, complications, and treatment of dentoskeletal malocclusion. Am J Emerg Med. 1994; 12:98-104.
14 Carvalho AC, Paiva SM, Viegas CM, Scarpelli AC, Ferreira FM, Pordeus IA. Impact of malocclusion on oral health-related quality of life among Brazilian preschool children: a population-based study. Braz Dent J 2013; 24: 655-661
15 Zere E, Chaudhari PK, Sharan J, Dhingra K, Tiwari N. Developing class iii malocclusions: challenges and solutions. Clin, Cosmetic Investig Dent 2018;10: 99–116
16 Eslami N, Jahanbin A, Ezzati A, Banihashemi E and Kianifar H: Can dermatoglyphics be used as a marker for predicting future malocclusions? Electr Physician .2016; 8:1927–1932.
17 Jindal G. A comparative evaluation of dermatoglyphics in different classes of malocclusion. Saudi Dent J [Internet]. King Saud University; 2015;27:88–92. Available from: http://dx.doi.org/10.1016/j.sdentj.2014.11.012.
18 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; 11:35 - 40.
19 Reddy BRM, Sankar SG, Roy E.T, Govulla S. A Comparative Study of Dermatoglyphics in Individuals with Normal Occlusions and Malocclusions. J Clin Diag Res: 2013; 7:3060 - 3065.
20 Al-Khatieeb MM, Al-Joubori SK and Taha SS. Association of ABO Blood Group and Rhesus Factor with Dental Malocclusion in a Population of Baghdad, Iraq. Int J Med Res Health Sci 2018, 7: 165-169
21 Bhasin MT, Bhasin P, Singh A, Bhatia N, Shewale AH, Gambhir N, et al. Dermatoglyphics and malocclusion-A forensic link. Br Biotec J, 2016;13:1–12.
22 Gravely JF and Johnson DB. Angle's Classification of Malocclusion: an Assessment of Reliability, Br J Orthod 2016; 1:3, 79-86,)
23 Lakshmi V. Dermatoglyphics and orthodontics - A review. Ann Essences Dent 2013; 4:30-33.
24 Isiekwe, MC. and Sowemimo GC. Cephalometric findings in a normal Nigerian - population sample and adult Nigerians with unrepaired clefts. Cleft Palate J 1984. 21:323–328.
25 Steiner CC. Cephalometrics for you and me. Am J Orthod, 1953;39: 729-55.
26 Proffit, W. R., Fields, H. W., and Sarver, D. M. (2007). Contemporary orthodontics (4th ed.). St. Louis, Mo.: Mosby Elsevier.
27 Harsha L, Mds GJ. Correlation of Lip Print , Fingerprint and Blood Groups in a Tamil Nadu Based Population . J. Pharm. Sci. and Res2015;7:795–799.
28 Prakash P, Sirjana D, Vivek B T, Amrita S, Prabesh S Dermatoglyphic Pattern and Types of Malocclusion among Individuals visiting A Medical Institution of Nepal. Int J Orthod Rehabil 2020;20:46-50.
29 Mohammed, BS. Garba, SH and Adeyemi LB .Digital Dermatoglyphics Patterns of the Kanuri Ethnic Group of North Eastern Nigeria. Int J Innovation and Applied Studies .2014; 9: 985-988.
30 Ujaddughe MO, Abue AD, Izunya MA, Ezeuko

VC, Eze IG. and Baxter-Grillo D. assessment of dermatoglyphic patterns and sex distribution in Esan ethnic group of Edo state, Nigeria. IJBAIR, 2015, 4: 9 - 14.

31 Enosolease ME, Bazuaye GN. Distribution of ABO and Rh-D blood groups in the Benin area of Niger-Delta: Implication for regional blood transfusion. Asian J Transfus Sci. 2008 ; 2: 3–5.

32 Odokuma EI, Okolo AC, Aloamaka PC.Distribution of ABO and rhesus blood groups in Abraka, DeltaState, Nigeria. Niger J Physiol Sci. 2007; 22:89-91.

33 Kooffreh ME, Ikpeme EV, Ekerette EE, Eyo NO. Evaluating the Prevalence of Five Genetic Traits of Simple Inheritance in Association with the Distribution Pattern of ABO and Rhesus Phenotypes among Families in Calabar, Nigeria. J Med Sci. 2015; 15: 185-191.

34 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.

35 Gheisari R, Ghoreishian M, Movahedian B, and Roozbehi A. The association between blood groups and maxillofacial deformities. Indian J Plast Surg. 2008 41: 138–140.

36 Shokor FFBA, Rahman WSWA and Alam MK craniofacial morphology with genetic influence of ABO blood group in Malaysian Orthodontic patients. Int J Pharm Bio Sci 2015 ; 6: 412- 41