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Dermatoglyphics and its correlation with salivary pH and saliva buffering capacity- A 'Handy' tool for dental caries prediction

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Abstract

Aim: The aim of the study was to find a correlation between salivary pH & saliva buffering capacity with dermatoglyphic patterns in children, aged 6-15 years, with and without dental caries.

Materials And Methods: A total of 60 children, aged 6-15 years, were divided into three groups of 20 each, based on the child's caries experience: Group I, II and III with DMFT/dft score = 0, <5 and ≥5 respectively. Fingerprint pattern of the subjects was recorded with digital photographs. Salivary pH and saliva buffering capacity was recorded using GC Saliva-Check Buffer kit. Number of triradii, total finger ridge count (TFRC) and absolute finger ridge count (AFRC) were analyzed using Ridgecounter software.

Results: Whorl pattern showed significantly lesser mean DMFT and dft scores. Mean TFRC, AFRC, salivary pH and saliva buffering capacity in children of group I was significantly higher than groups II and III.

Conclusion: The present study found a significant association between dental caries, dermatoglyphics, salivary pH and saliva buffering capacity confirming the role of genetic and environmental factors in the causation of dental caries. Therefore, dermatoglyphics and chairside salivary diagnostics can be used as effective tools in developing a new field for dental caries prediction and prevention.

Keywords: Dental caries; Dermatoglyphics; Saliva buffering capacity; Salivary pH

Introduction

The modern-day study of the hand is far cut off from the popular image of the soothsaying hand reader uttering perplexing incantations in a mysterious language. Through decades of scientific research, dermatoglyphic analysis has been recognized as an effective tool in the preliminary diagnosis of psychological, medical and genetic conditions. [1,2]

The word “dermatoglyphics” originated from two Ancient Greek words “derma” which means skin and “glyphics” which means carving. It is a science dedicated to the study of ridges and their configurations on the skin and has been applied in the fields of criminology, personal identification, embryology, comparative anatomy, physical anthropology, genetics and medicine. [3]

Widespread medical interest in dermatoglyphics developed only in the last few decades and promises to provide a simple and cost-effective method to determine whether a given patient could have a particular chromosomal aberration. [4]

Dermatoglyphics has drawn attention in the field of dentistry and has been used to unveil forensic odontology and oral diseases like dental caries, oral cancer, bruxism, malocclusion, anomalies of teeth, cleft lip, cleft palate, periodontal disease, dental fluorosis. [5]

There is a striking similarity in timing between the development of dentition & palate and development of dermal patterns. The epithelium of primary palate and finger buds are both ectodermal in origin. The dermal ridges take their origin from the fetal volar pads that appear in the 6th -7th week of embryonic life, i.e. at the same time as that of tooth formation in intraembryonic life. [6]

Factors that affect dental caries such as heredity, host, agent and environment, might cause peculiarities in dermal ridge patterns also. Hence, the recording of fingerprint patterns in the first dental visit can be useful in predicting caries at an early age, thereby preventing children from its harmful effects.

Saliva is vital to the integrity of teeth and soft tissues and contains biomarkers that serve as an early predictor for disease, contributing to its effective prevention and treatment. The causation cascade of dental caries includes demineralization of dental enamel which depends on host factors such as salivary pH and saliva buffering capacity. The overall goal of Point-of-care (POC) testing is to move salivary diagnostics out of the laboratory and into chairside clinical practice to allow for more timely diagnosis of the disease. [7] Thus, dermatoglyphics & chairside salivary diagnostics can be used for early detection and prevention of caries in children, thereby saving the child from undergoing invasive or restorative treatment at an early age.

The conventional method of dermatoglyphic analysis is the ink method that has a lot of drawbacks, which is the main barrier for its wide use. A new stain less, strain less, user and subject friendly method called the photographic method was implemented in the present study. [8] The

quantitative analysis of the dermatoglyphic samples obtained was done using a freely available 'Ridgecounter' software to avoid further errors.

The present study was designed to evaluate the correlation between dermatoglyphic patterns, dental caries, salivary pH and saliva buffering capacity.

Materials and methods

This randomized, cross-sectional, analytical study was conducted in schools of East Bangalore city, Karnataka after obtaining approval from the Institutional Review Board and Ethics Committee (IRB Number: MRADC/ECIRB/2017-18) and written informed consent from the head of the schools, parents and assent from the children, along with a video recording of the same. A sample size of 45 was estimated using PASS Statistical Software, assuming 90% power and 5% level of significance. The test statistics used was the two-sided two sample test. In the present study, we considered a sample size of 60 children, aged 6 to 15 years, with equal distribution in both genders.

Inclusion criteria

1. Children aged 6 to 15 years with good to fair simplified oral hygiene index (OHI-S) or Miglani's modification of OHI-S (OHIS-M) scores.
2. Children who gave their assent and whose parents gave written consent to be part of study.
3. Children belonging to middle socioeconomic class based on B.G. Prasad's social classification to categorize children based on per capita income. [9]
4. Cases were selected based on the following clinical criteria for dental caries
   a) White spots
   b) Discoloration of the tooth
   c) Definite catch
   d) Definite cavitation
   e) Softness of the base

Age and sex matched controls were selected.

Exclusion criteria

1. Children with other disorders, i.e. mentally or physically handicapped children.
2. Children with skin disorders or trauma to the fingertips (adermatoglyphia, psoriasis, atopic eczema, verruca vulgaris, pulpitis sicca and Naegeli–Franceschetti–Jadassohn syndrome).
3. Uncooperative children (rating 1: definitely negative according to Frankl Behavior Rating Scale).
4. Children whose parents/guardians did not give consent.

Using simple random sampling technique (drawing of lots), 60 samples were selected from the 200 children examined from schools in East Bangalore. Selected children were equally distributed into three groups of 20 each, based on the child's caries experience; Group I, II and III with DMFT/dft score = 0, <5 and ≥5 respectively. All three groups had equal distribution of males (n=10) and females (n=10) with 20 samples overall in each group. A digital photograph of the subject's fingerprints, of both hands, was taken using Canon EOS 1300D DSLR Camera, Canon India., 18 Megapixel, 35x optical zoom. The camera was held at a fixed distance of 30 centimeters from the subject's finger, to get the best image quality. [10] Recording of salivary pH and saliva buffering capacity was done using GC Saliva-Check Buffer kit (GC Asia Dental Pte Ltd, Singapore) and according to the manufacturer's instructions.

Fingerprint pattern was classified into whorls, loops and arches using Cummins and Midlo method. [3] The number of triradii, total finger ridge count (TFRC) and absolute

finger ridge count (AFRC) was analyzed using Ridgecounter software. [11]

The data collected was tabulated and subjected to the following statistical analyses performed using Statistical Package for Social Sciences (SPSS) for Windows, Version 22.0. Released 2013. Armonk, NY: IBM Corp.

- Comparison of mean DMFT and dft scores between three groups and mean DMFT and dft scores between predominant finger print patterns was done using Kruskal Wallis test followed by Mann Whitney post hoc test.
- Comparison of different types of fingerprint patterns between three groups on right- and left-hand fingers and predominant fingerprint patterns with frequency between three groups was determined using Chi square test.
- Comparison of mean Total Finger Ridge Count [TFRC], Absolute Finger Ridge Count [AFRC], salivary pH and saliva buffering capacity between three groups was done using One-way ANOVA test followed by Tukey's post hoc test.
- Gender-wise comparison of fingerprint patterns within each study group was done using Chi square test.
- Gender-wise comparison of mean values of different study variables in different groups was done using Independent Student t test / Mann Whitney test.

The level of significance [P-Value] was set at $P < 0.05$.

Results

The differences seen in the mean DMFT and dft scores between groups I, II and III were statistically significant as shown in Table 1.

Whorl pattern showed significantly lesser mean DMFT and dft scores as compared to other patterns as shown in Fig. 1(a) and Fig. 1(b) respectively.

Children in group I showed more whorl and less ulnar loop fingerprint pattern than the other two groups. Children in group II showed more ulnar loop and less radial loop and whorl fingerprint pattern than the other two groups. Children in group III showed more radial loop and whorl fingerprint pattern than group II and equal amount of ulnar loop pattern as group I as shown in Fig. 2.

Radial loop fingerprint pattern was predominant on the right-hand digits while ulnar loop fingerprint pattern was predominant on the left-hand digits. While analyzing the fingerprint patterns on individual digits, children in group I showed increased frequency of whorl fingerprint pattern on right and left thumbs whereas children in groups II and III showed increased frequency of radial loop fingerprint pattern on right middle and little digits and ulnar loop fingerprint pattern on left middle and little digits as shown in Fig. 3(a) and Fig. 3(b).

Mean total finger ridge count (TFRC), Absolute Finger Ridge Count (AFRC), salivary pH, and saliva buffering capacity in children of group I were significantly higher than groups II and III as shown in Table 2.

Gender-wise diversity:

A. In group I, males showed more whorl fingerprint pattern whereas females showed more radial loop fingerprint pattern. While in groups II and III, males showed more ulnar loop and arch fingerprint patterns whereas females showed more radial loop fingerprint pattern as shown in Fig. 4.
B. In groups I and III, the mean TFRC and AFRC is slightly higher in males than in females. In group II, the mean TFRC and AFRC is significantly higher in females than in males. In all three groups, the mean salivary pH and saliva buffering capacity is slightly higher in females when compared to males as shown in Table 3.

Discussion

Although there is an increased focus on preventive methods, dental caries still emerges to be the major cause of tooth loss in children.

The etiopathogenesis of dental caries is multifactorial. In the present study two important factors have been correlated- one genetic component i.e. Dermatoglyphics in terms of loops, arches and whorls fingerprint patterns and other being the oral environmental factor i.e. salivary pH and saliva buffering capacity.

Fingerprints serve as an accurate, long-term record as they are unique and unalterable and are based on the genetic constitution of each individual. Once formed, they remain constant throughout life. Recording of fingerprints can be accomplished rapidly, inexpensively and without causing any trauma to the patient.

The epidermal ridges of the fingers, palms and facial structures such as lip, alveolus, palate and tooth buds are formed from the same embryonic tissue i.e. ectomesenchyme and during the same embryonic period i.e. 6-9 weeks. The genetic message in the genome, whether normal or abnormal, is decoded during this period and is reflected by dermatoglyphics. Thus, with genetic susceptibility and added environmental factors, the proneness for dental caries due to alterations in the dental hard tissues, tooth eruption and development may be reflected in the fingerprint patterns. [1] Hence, a study to correlate dermatoglyphics and dental caries is helpful for prediction of caries at an early age, thereby preventing children from its deleterious effects.

The conventional method of recording dermatoglyphics is the ink method that has a lot of drawbacks, which is the main barrier for its wide use. It is not subject and user friendly as the ink is not washable creating a lot of chaos over the hands of the subject and embarrassment to the user with errors arising from fingerprint collection, which include smudging and omitting areas of the print. [11]

In order to overcome this chaos and barrier, the photographic method was implemented in the present study that is convenient, easy, less time consuming, effective, economical and provides better clarity and perfect calibration. [8] A Canon EOS 1300D DSLR camera was used to record the digital photograph of the subject's 10 fingerprints. The camera was held at a fixed distance of 30 centimeters from the subject's finger, to get the best image quality.

Many dermatoglyphic characteristics can be described quantitatively by counting the number of triradii or ridges within a pattern. Manual ridge counting process and pattern analysis requires prolonged concentration and a magnifying hand lens, especially if large samples are analyzed. This increases the strain on the eyes and likelihood of errors. With advances in technology, easier methods to carry out quantitative analysis of dermatoglyphics have been introduced and in the present study it was done using a freely available 'Ridgecounter' software that yields semi-automated ridge counts and logs the location of the user-selected core and delta points. [11]

Saliva, a source to monitor both oral and systemic health of an individual, contains biomarkers that serve as an early predictor for disease. [7] Incorporating POC or chairside salivary tests into the dental office will significantly change the dentist's role in risk assessment, prevention and disease management and will render improved access and health-care outcomes for patients. The etiopathogenesis of dental caries includes demineralization of dental enamel which depends on host factors such as salivary pH and saliva buffering capacity. A study correlating dental caries and salivary pH and saliva buffering capacity can benefit the pediatric dentist from enhanced diagnostics, early detection of problems, improved patient and parent communication and motivation and an increased dental

awareness for patients and parents. In the present study we utilized GC saliva check buffer kit as a chairside salivary diagnostic aid to record the salivary pH and saliva buffering capacity. Other researchers have utilized the same kit to assess salivary characteristics in their studies and have obtained optimal results. [12-15]

The recording of photographs of fingerprints, salivary pH, saliva buffering capacity and the analysis of the various data obtained from the study was done by a single, trained investigator to avoid any inter-observer variation/bias.

In the present study, we included subjects within 6-15 years of age, wherein environmental factors such as salivary pH and saliva buffering capacity act predominantly along with genetic factors in the causation of dental caries.

In the present study, to avoid bias, equal number of males and females were included in all the three groups.

Children with similar environmental factors (subjects with only good to fair oral hygiene) and similar socioeconomic status (availability and use of oral health care services) were considered.

The three study groups, differentiated based on the severity of dental caries as assessed using DMFT or dft indices, were individually analyzed, to endorse the role of the genetic component.

Children in group I showed more whorl and less ulnar loop fingerprint pattern. These observations are in agreement with previous studies that have reported an increased frequency of loop fingerprint pattern in children with dental caries. [16-20] The results of the present study are in contrast with previous studies that have reported an increased frequency of whorl fingerprint pattern in children with dental caries. [21-24] Shaik MA et al [25] and Gomez MS et al [26] have reported contradictory findings of an increased frequency of arch fingerprint pattern in children with dental caries. The result of the present study is also in disagreement with studies done by Sharma A et al who have reported a decreased frequency of loop pattern in children with dental caries. [27]

Children in group I showed a significantly higher mean total finger ridge count (TFRC). This is in agreement with previous studies [22,28,29] and contradictory to studies done by Tegginmani Veeresh et al [16] and Elkwatehy WM et al. [30]

Children in group I showed a significantly higher mean absolute finger ridge count (AFRC). The paucity in literature regarding assessment of this component of dermatoglyphics, makes it a more significant parameter to be compared and analyzed in the present study.

A significantly higher mean salivary pH was seen in children of group I which is in agreement with previous studies. [12-17]

A significantly higher mean salivary saliva buffering capacity was seen in children of group I which is in agreement with previous studies. [12-15] The dearth in literature regarding assessment of saliva buffering capacity in pediatric population and its correlation with dermatoglyphics, makes it a valuable component of the present study.

The gender-wise diversity observed in dermatoglyphic traits is as follows. Males in group I showed more whorl fingerprint pattern whereas females showed more radial loop fingerprint pattern. While males in groups II and III showed more ulnar loop and arch fingerprint patterns whereas females showed more radial loop fingerprint pattern. This is in agreement with previous studies [20] while it is in contrast with studies done by Asif SM et al [22] and Madan N et al. [29]

Gender-wise diversity of different study variables such as TFRC, AFRC, salivary pH and saliva buffering capacity was analyzed due to scarcity of literature regarding the same and is as follows. Males in groups I and III showed

slightly higher mean TFRC and AFRC. This is contradictory to the study done by Madan N et al who observed lower TFRC, especially in male children with dental caries. [29] Females in group II showed significantly higher mean TFRC and AFRC. In all three groups, the mean salivary pH and saliva buffering capacity is slightly higher in females when compared to males.

The multifactorial etiology of dental caries is thus provable, and all factors should be kept in mind by the clinician during diagnostic and preventive procedures in dental caries management.

Conclusion

The present study reaffirms the role of genetic and environmental factors in the causation of dental caries and is unique in the way that three prudent parameters viz. caries, dermatoglyphics and salivary characteristics were linked together, which can open a new realm for characterization of dental caries.

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Tables and Figures

Table 1: Comparison of mean DMFT and dft scores between three groups

Variables	Groups	N	Mean	SD	Min	Max	P-Value[a]	Significant difference	P-Value[b]
DMFT scores	Group 1	20	0.00	0.00	0	0	<0.001*	G1 Vs G2	<0.001*
	Group 2	14	2.93	1.14	1	4		G1 Vs G3	<0.001*
	Group 3	20	5.40	3.28	1	12		G2 Vs G3	0.004*
dft scores	Group 1	10	0.00	0.00	0	0	<0.001*	G1 Vs G2	0.008*
	Group 2	6	2.00	0.89	1	3		G1 Vs G3	<0.001*
	Group 3	11	5.09	1.70	2	8		G2 Vs G3	0.004*

* - Statistically significant

Note: a. P-value derived by Kruskal Wallis test, b. P-value derived by Mann Whitney post hoc test

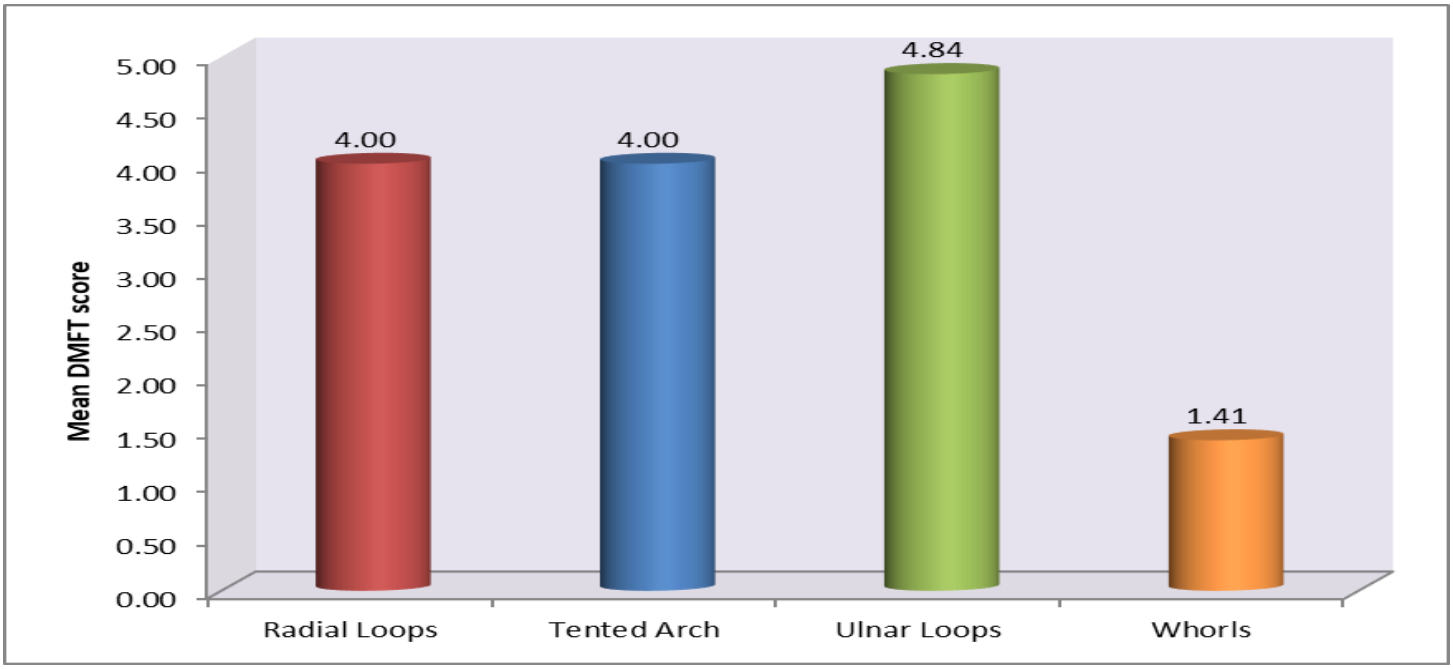

Fig. 1(a): Comparison of mean DMFT scores between predominant finger print patterns

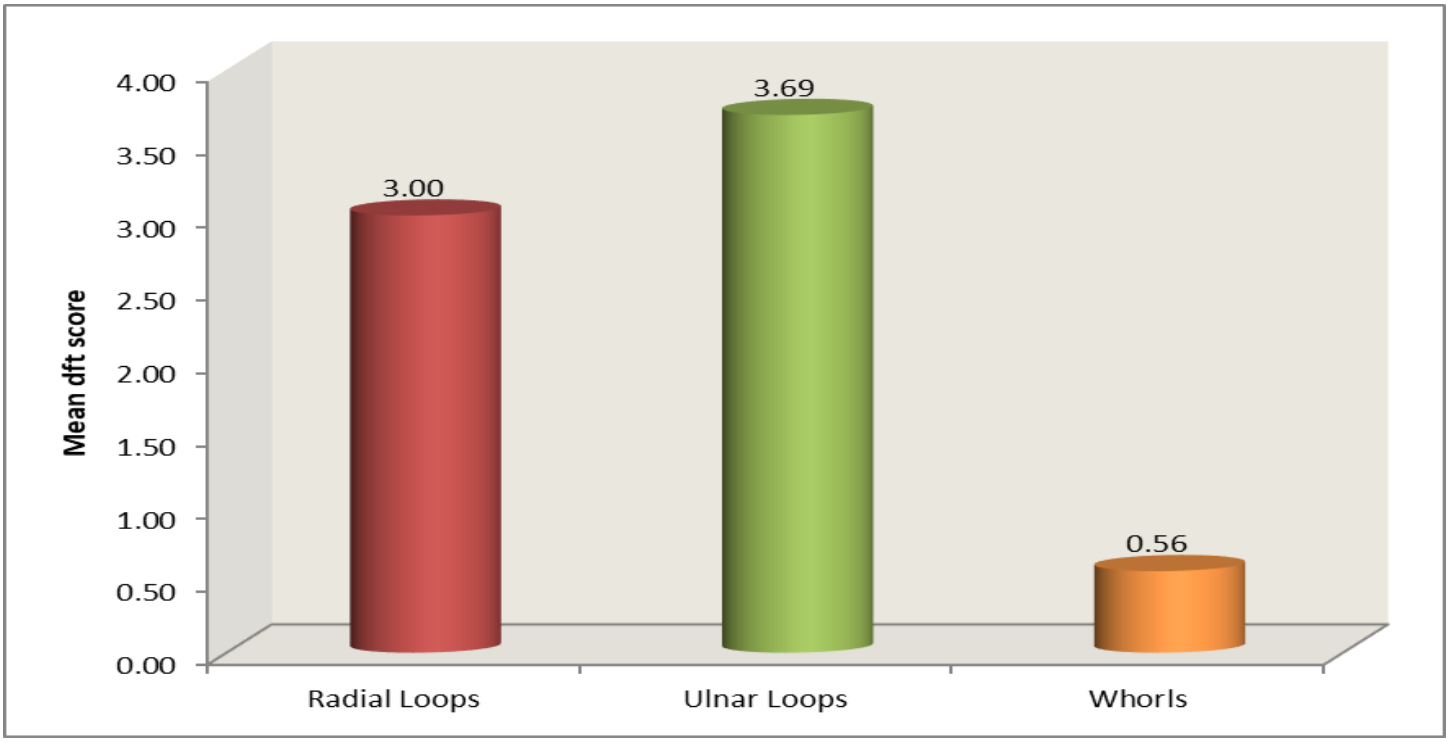

Fig. 1(b): Comparison of mean dft scores between predominant finger print patterns

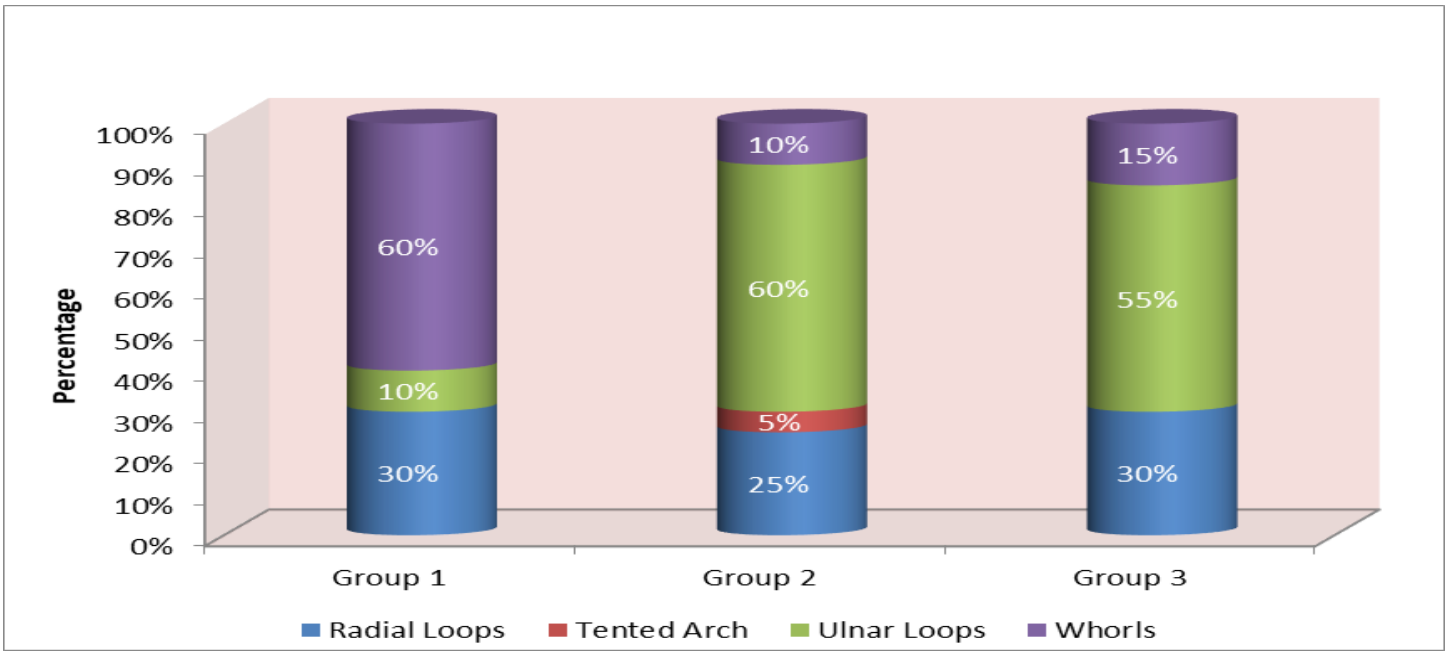

Fig. 2: Comparison of predominant fingerprint patterns between three groups

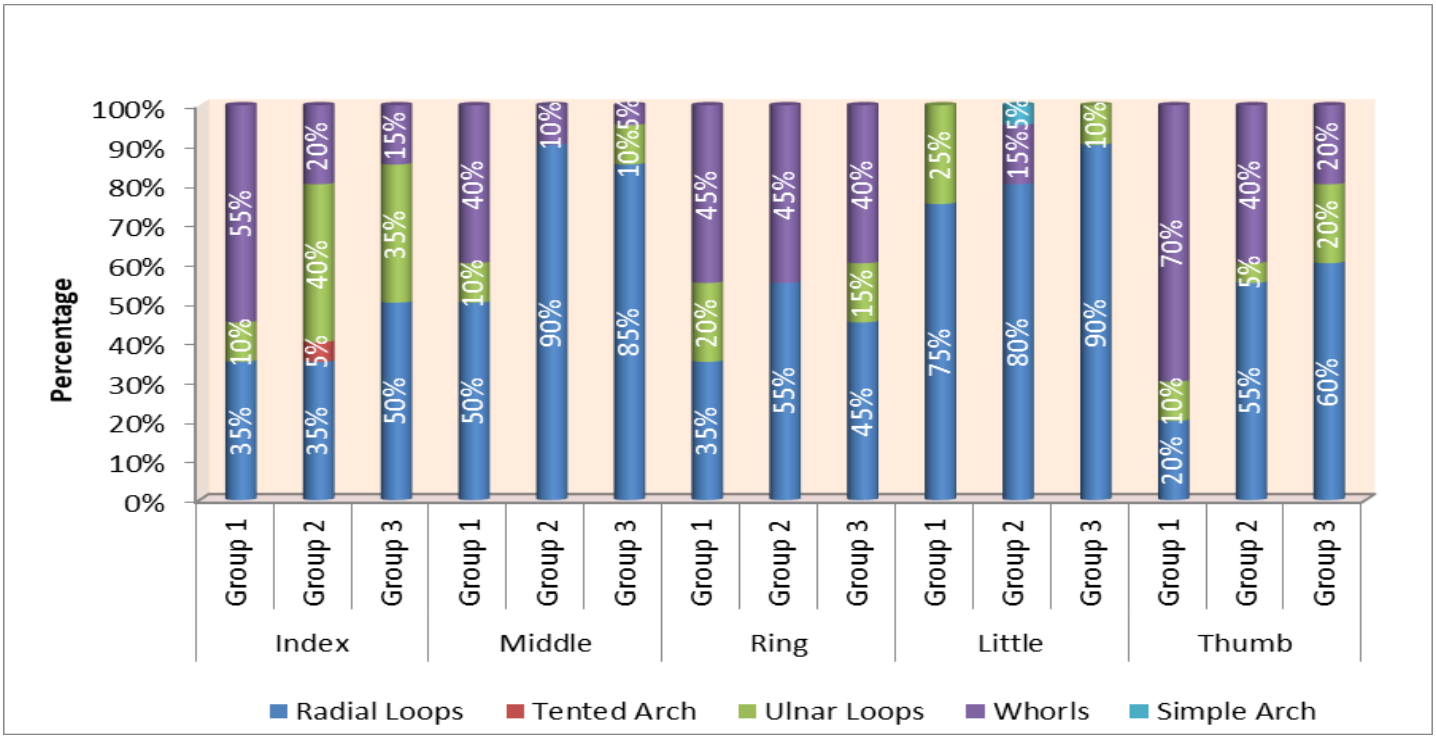

Fig. 3(a): Distribution of fingerprint patterns between three groups on right-hand fingers

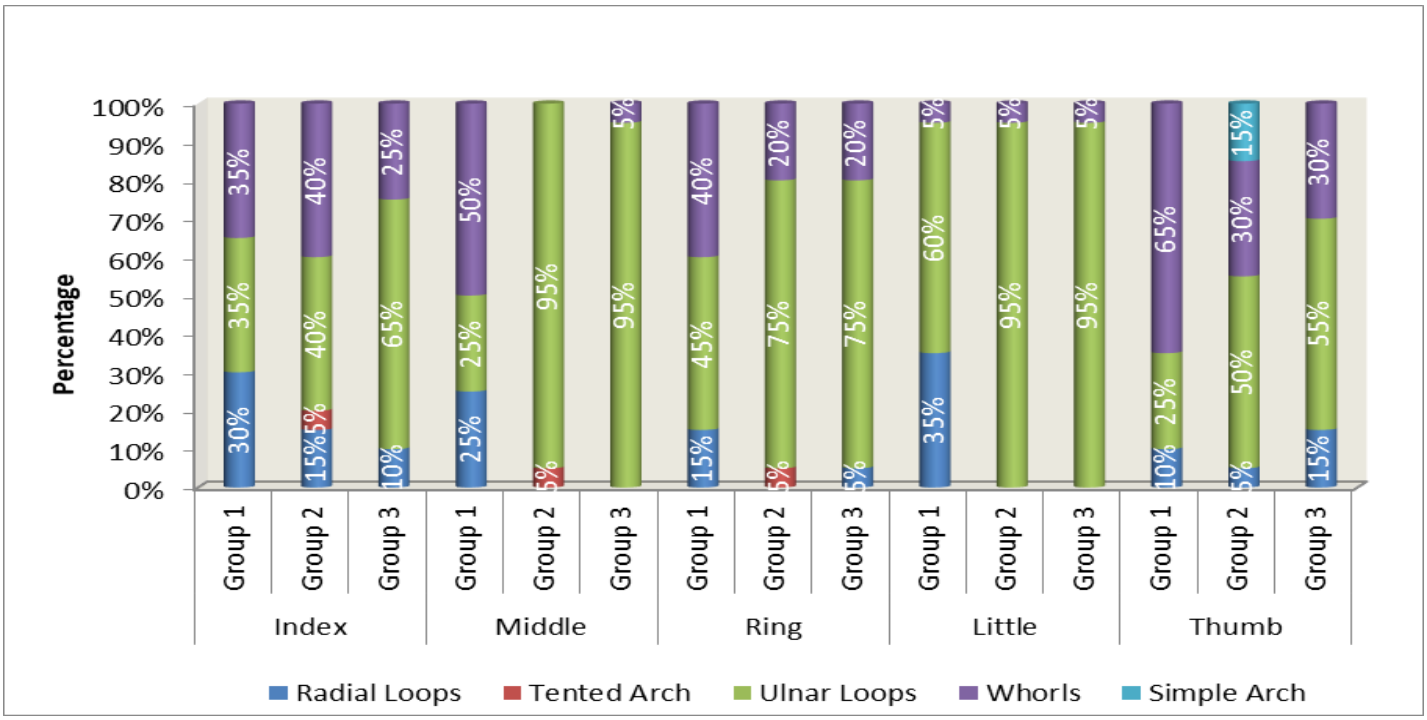

Fig. 3(b): Distribution of fingerprint patterns between three groups on left-hand fingers

Table 2: Comparison of mean Total Finger Ridge Count [TFRC], absolute finger ridge count (AFRC), salivary pH, and saliva buffering capacity between three groups

Variables	Groups	N	Mean	SD	Min	Max	P-Value[a]	Significant difference	P-Value[b]
TFRC	Group 1	20	326.05	79.21	222	480	0.002*	G1 Vs G2	0.005*
	Group 2	20	246.45	75.46	102	352		G1 Vs G3	0.005*
	Group 3	20	246.15	77.83	132	480		G2 Vs G3	1.00
AFRC	Group 1	20	449.50	138.42	257	632	<0.001*	G1 Vs G2	<0.001*
	Group 2	20	291.30	89.94	102	424		G1 Vs G3	<0.001*
	Group 3	20	283.30	100.22	132	510		G2 Vs G3	0.97
Salivary pH	Group 1	20	7.48	0.19	7.2	7.8	<0.001*	G1 Vs G2	<0.001*
	Group 2	20	6.68	0.22	6.4	7.0		G1 Vs G3	<0.001*
	Group 3	20	5.95	0.26	5.6	6.4		G2 Vs G3	<0.001*
Saliva buffering capacity	Group 1	20	10.80	0.77	10.0	12.0	<0.001*	G1 Vs G2	<0.001*
	Group 2	20	7.15	1.04	6.0	9.0		G1 Vs G3	<0.001*
	Group 3	20	3.75	1.29	2.0	6.0		G2 Vs G3	<0.001*

* - Statistically significant

Note: a. P-value derived by One-way ANOVA test, b. P-value derived by Tukey's post hoc test

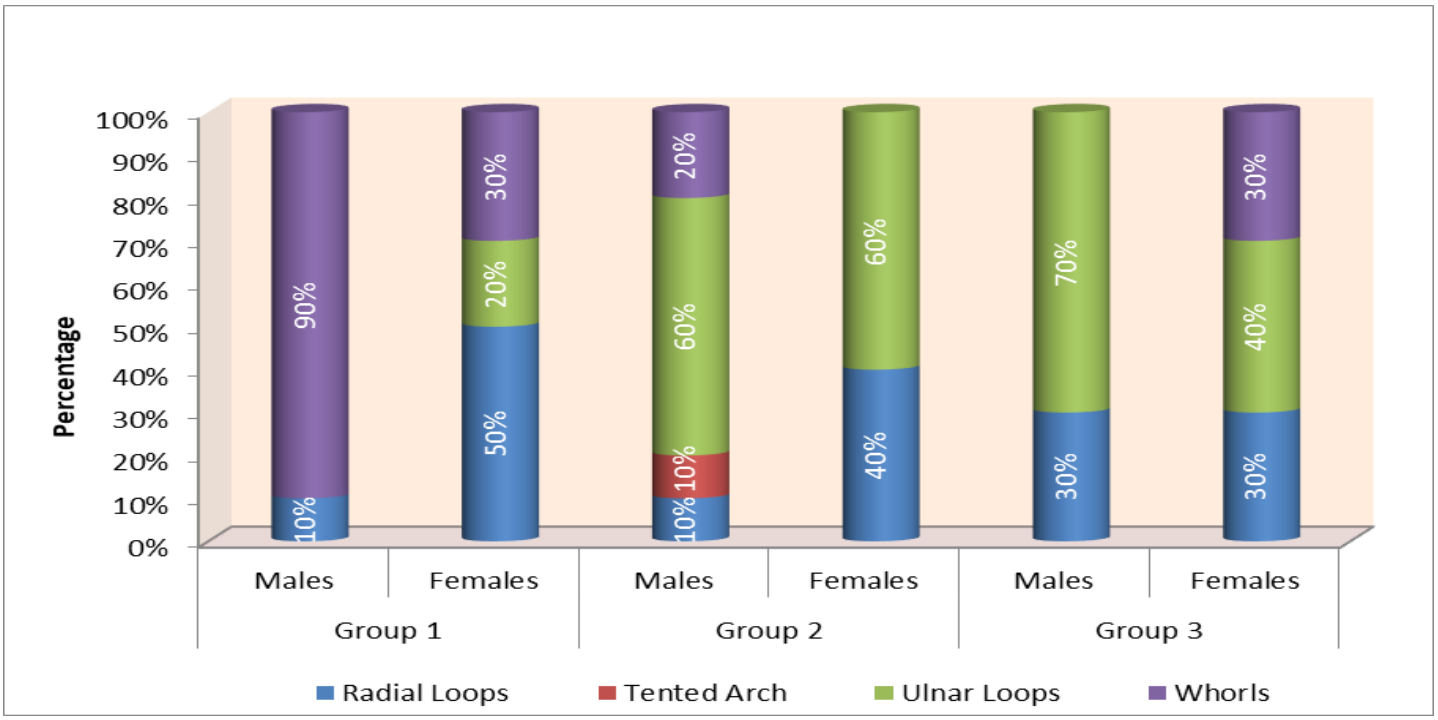

Fig. 4: Gender-wise comparison of fingerprint patterns within each study group

Table 3: Gender-wise comparison of mean values of different study variables in three groups

Groups	Variables	Sex	N	Mean	SD	Mean difference	P-Value
Group 1	TFRC[a]	Males	10	335.70	79.54	19.30	0.60
		Females	10	316.40	81.92		
	AFRC[a]	Males	10	493.90	122.94	88.80	0.16
		Females	10	405.10	144.76		
	Salivary pH[b]	Males	10	7.46	0.21	-0.04	0.65
		Females	10	7.50	0.17		
	Saliva buffering capacity[b]	Males	10	10.60	0.84	-0.40	0.26
		Females	10	11.00	0.67		
Group 2	TFRC[a]	Males	10	210.00	63.04	-72.90	0.03*
		Females	10	282.90	71.38		
	AFRC[a]	Males	10	248.50	80.42	-85.60	0.01*
		Females	10	334.10	80.87		
	Salivary pH[b]	Males	10	6.56	0.21	-0.24	0.14
		Females	10	6.80	0.16		
	Saliva buffering capacity[b]	Males	10	6.80	1.03	-0.70	0.08
		Females	10	7.50	0.97		
Group 3	TFRC[a]	Males	10	277.70	85.42	63.10	0.31
		Females	10	214.60	57.27		
	AFRC[a]	Males	10	306.60	74.41	46.60	0.24
		Females	10	260.00	120.25		
	Salivary pH[b]	Males	10	5.88	0.22	-0.14	0.24
		Females	10	6.02	0.29		
	Saliva buffering capacity[b]	Males	10	3.40	1.08	-0.70	0.17
		Females	10	4.10	1.45		

* - Statistically Significant

Note: a. Mann Whitney test b. Independent Student t test