Section A-Research paper

Analysis of lipprints, fingerprints and intercommissural distance as gender predicator among maharashtrian population: A Forensic study

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Abstract

Introduction: In the digital era, where there is exponential growth, a need for definite mode of identification which is accurate is the need of the hour. Lip print and finger print analysis in the forensic scene may help in the personal identification and in criminal investigations.

Aim: The aim of this study was to determine the co-relation of finger prints, lip prints & inter commissural distance (ICD) in gender determination among maharashtrian population.

Materials&methods: In this study method this cross-sectional study sample comprised 200 individuals (100 males &100 females) aged between 18-30 years. Finger, lip prints & inter commissural distance were recorded. Statistical analysis was done for this study using Chi-square test. A correlation of lip prints with finger print and gender variation was analysed by Pearson correlation test.

Results: The study observed high prevalence of type I (vertical)lip print pattern and arch pattern of finger print in the overall population. Inter commissural Distance in males was found to be 52.6+/- 3.2 and in females was found to be 46.4+/-2.9. Type I lip print (68.5%) and Arch type finger print pattern (63.5%) was more common among males in our study, however there was a weak co-relation between lip &finger print pattern and statistically insignificant (P= 0.780) in males. Type I lip print pattern

(72%) with arch pattern of finger pattern(56.2%) was the most common finding in females however the co-relation showed weaker co-relation with P=0.047 which was approachable significance

Conclusion: Type I lip print and Arch type finger print pattern was more common among males as well as in females in our study. However, the results were statistically non-significant and a weak correlation was exhibited in our present study.

Key-words: Lip prints, Inter commissural distance (ICD), Forensic.

INTRODUCTION

Identification of an individual is a crucial and an exigent task in forensic investigation. To accurately identify an individual, the association between two variables in the forensic science is of utmost importance as it can possibly be a supplementary tool along with routinely used methods. The analysis of finger prints as a form of identification dates back to pre- historic times. Fingerprints of an individual have been used as one of the vital parts of identification in both civil & criminal cases because of unique properties of absolute identity. [1]

Based on **Locard's exchange principle**, when two objects come into contact, there is always a transfer of material from one to the other. The fingerprints, lip prints and blood remains are evidence left at the crime scene which can be utilized for forensic identification purpose based on the same principle [2]

Lips surround the oral orifice and are covered by mucosa and by skin. When identification is concerned , the mucosal area is important, which is called **Klein's Zone**, covered with wrinkles and grooves on the labial mucosa forming characteristic patterns called lip prints.[3]

The flow or the ridges, the features present along the ridges, and their sequences are the information collected from the finger prints. The comparable technology can very well be applied to the lip prints as well. The practical application of lip prints for 'verification' lacks convincing accurate methods, unlike the currently recognised identification methods. While for the 'identification' purpose, the advantages of the uniqueness of the lip prints need to be raised.

Lip prints are being studied in the aspects such as the ability to recover back to the original pattern after injury by trauma or infection, the similarities between siblings and families, and about the gender variation. [4,5]

Sir Francis Galton first identified the fingerprint patterns, and the characteristic of the fingerprints are named as "**Galton prints" or "minutiae**" after him. Every individual has a unique fingerprint pattern, and based on genetic characters of each individual, it remains unchanged throughout life.

The literature reported varied results and in small numbers of groups, few proved that lip prints are fundamentally similar to the fingerprint. The current study was designed to find the most common lip and fingerprint and their correlation and intercommissural distance among the genders.

MATERIAL AND METHODS

Selection of participants and method of collection

The sample was composed of 200 students within age group of 18-24yrs (male=100, female=100). The university ethical committee had approved the study ((EC/NEW/INST/2019/329). The participants were explained about the study and the informed consent of the included participants was taken and signed.Lip print impressions were made by uniform application of dark coloured lipstick on the lips. The glued portion of cellophane tape was subsequently dabbed on lips, first in the centre and then pressed uniformly over the corner of lips. Lip prints were traced in normal rest position of lips. A minimal pressure was maintained while making lip impression. Cellophane tape was then stuck to a white chart sheet for permanent record purpose. These lip prints were examined using magnifying glass, classified and analysed according to **Suzuki and Tsuchihashi in 1970** as: [6]Shown in **FIGURE 1A**. **Type I- Clear cut vertical grooves that run across the entire lip, Type II- Branched grooves (Y shaped pattern), Type III-Intersecting, Type IV- Crisscross patterns, reticular grooves, and Type V- Undetermined.** Fingerprint impression was made using left thumb. Individuals were asked to wash their hand to remove any dirt and oil. The imprint of thumb was made on a white chart sheet using a blue ink stamp pad and was visualized using magnifying lens. Fingerprints were analysed by following the classification given by **Kuchen as loop, arch and whorl pattern**[7]shown in **FIGURE 1B**. Individuals with competent lips and intact fingerprints were included in the study. Individuals with diseases of dermis, burns, and cuts on finger, incompetent lips such as inflammation, trauma, deformity, and surgical scars were excluded from the study. The ICD in relaxed state was measured between the corners of the mouth. It corresponds to the width of maxillary anterior teeth and can be used as a guide for selection of maxillary dental prosthesis. ICD could be utilised in forensic odontology for the identification of a person or a denture wearer. The collected data was analysed by two observers after certain amount of agreement between the observer's analyses with statistical confirmation. Data obtained was compiled on a excel sheet (v 2019, Microsoft Redmond Campus, Redmond, Washington, United States). The statistical analyses were performed using SPSS version 26.0, IBM. Intergroup comparison (2 groups) was done using t test. Comparison of frequencies of categories of variables with groups was done using chi square test. Agreement between observer 1 and 2 was done using Kappa statistics. Comparison of lip print patterns, finger print patterns in males and

females was done using Chi-square test.Correlation between lip print patterns, finger print patterns and ICD was done using Spearman 'r' correlation test.

RESULTS

The analysis of lip print patterns revealed that no two lip prints matched with each other as well no two finger print matched, thus assuring the uniqueness of the lip print and finger print in each individual. A total of two hundred participants (100 male + 100 female) were included in the study. The mean age of 21.56 year was observed in this study among the participants.

Distribution of lip print pattern -

The most predominant lip print pattern was type I (72%) followed by type II (26%),type IV (4%),type III (0.5%). These findings were **statistically significant** (P< 0.001). Type I (vertical) lip pattern was found more commonly in females (73%) as compared to males (64%).(**TABLE 1, CHART I).** Type II (branched) lip pattern was found more commonly in males (31%) as compared to females (21%). Type IV (reticular) was found more commonly in females (5%) compared to males (3%). Type III was equally found in both the genders. However these findings were **not statistically significant**.

Distribution of finger print pattern- The most predominant finger pattern was Arch pattern (64%) followed by Loop (30%) and then whorl pattern (7%). These findings were **statistically highly significant**. Arch pattern of finger print was seen frequently in 67% of males and 60 % females, Loop pattern was seen in 26% of males and 33% in females and whorl pattern was seen in equal number in both the genders that is 7% in both males & females**. (TABLE 2, CHART 2)**The most predominant finger pattern was arch type seen in 67% followed by loop pattern seen in 30 % and whorl was seen only in 7% of the male participants. The most predominant finger pattern was arch type seen in 60% followed by loop pattern seen in 33 % and whorl was seen only in 7% of the female participants. However these findings were **notstatistically significant**. The predominant pattern in males was Arch type whereas the predominant pattern in females was loop type and whorl was equally distributed among both the genders.

Correlation between lip pattern and finger print pattern-Type I lip print (65%) and arch finger print pattern (67%) was more common among males in our study, however there was a weak co-relation between lip &finger print pattern and **statistically insignificant** (P= 0.780) in males. Type I lip print pattern (74%) with arch pattern of finger pattern(75.6%) was also the most common finding in females however the co-relation showed weaker co-relation with P=0.047 which was **approachable significance(TABLE 3 & 4, CHART 3,4)**

Inter commissural distance ICD in mm - The minimum ICD is 39.3 & max is 59.6mm with S.D 4.40 among subjects. The mean ICD in males was 52.63+2.23 and in females 46.41+2.98**. (TABLE 5a & 5b, (CHART 5).** The maximum ICD was observed in type II (branched) pattern of lip print among the participants. There was **statistically highly significant** difference seen for the values between the groups (P< 0.01) with higher values in males than in female participants.There were **two observers** for the study wherein there was a moderate agreement (KAPPA VALUE -0.41-0.6) between observer1 Vs. 2 both for lip print analysis and substantial agreement (KAPPA VALUE 0.21-0.4) between observer1 Vs. 2 for finger print analysis.

Table 1 - Comparison of frequencies of lip print between males & females

		sex				
		F	M	Total	Chi square value	p value
Lip print	type 1	73	64	137		
	type 2	21	31	52	4.014	0.404#
	type 3	0	1	1		
	type 4	5	3	8		
	Total	100	100	200		

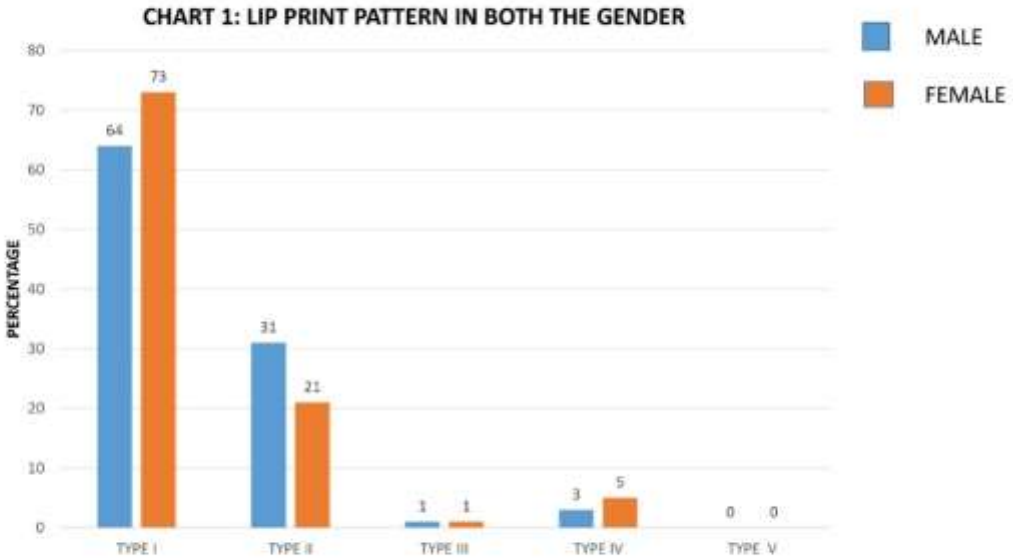

Table 2-Comparison of frequencies of finger print between males & females

		sex				
		F	M	Total	Chi square value	p value
Finger print	Arch	60	67	127	1.216	0.544#
	loop	33	30	59		
	whorl	7	7	14		
	Total	100	100	200		

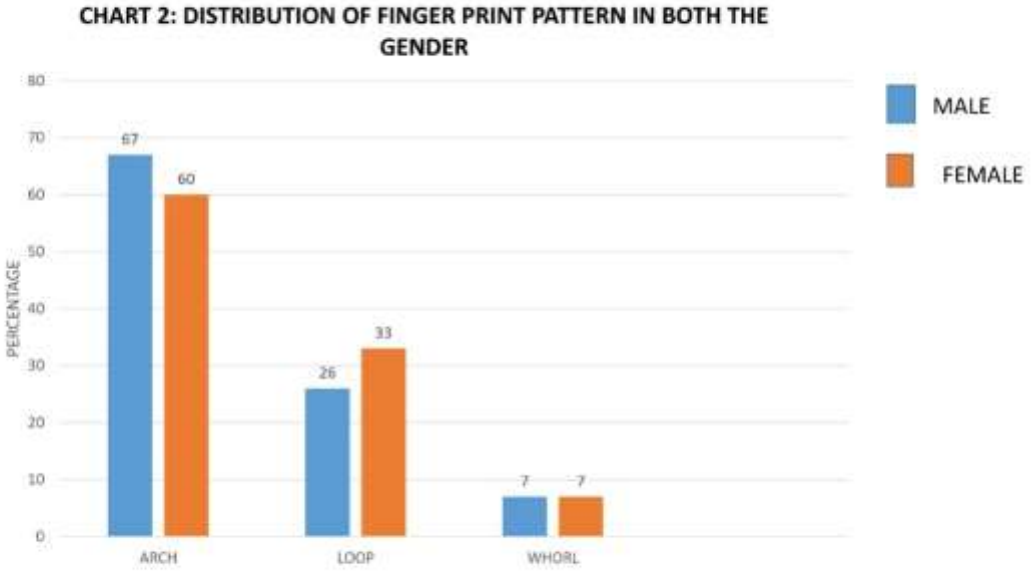

Table 3 -comparison and correlation of finger print patterns and lip print patterns in male study participants

Males	Arches n (%)	Loop n(%)	Whorls n (%)
Type I(n=65)	44(67%)	11(16%)	10(15%)
Type II(n=31)	17(54.83%)	13(41.9%)	1(3.2%)

Type III(n=1)	**1(100%)**	**0 (0%)**	**0 (0%)**
Type IV(n=3)	**2 (66.6%)**	**1(33.3%)**	**0 (0%)**
Type V(n=0)	**0 (0%)**	**0 (0%)**	**0 (0%)**
	Chi square test =4.791, p =0.780Pearsoncorrelation'r'value= 0.033,p=0.668		

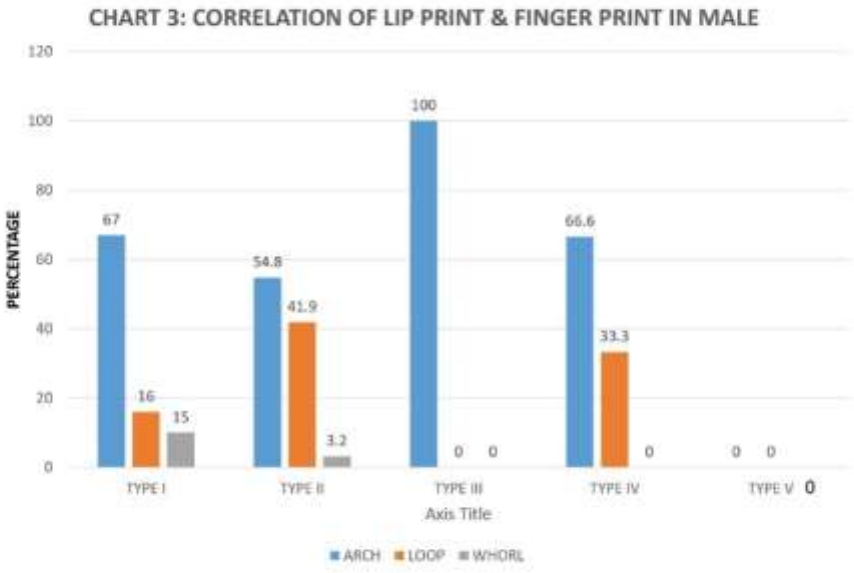

Table 4 -comparison and correlation of finger print patterns and lip print patterns in female study participants

Females	Arches n (%)	Loop n(%)	Whorls n (%)
Type I(n=74)	**56(75.6%)**	**12 (16.2%)**	**4 (5.4%)**
Type II(n=21)	**14(66.6%)**	**4(19.04%)**	**3 (14.2%)**

Type III(n=0)	**0 (0%)**	**0 (0%)**	**0(100%)**
Type IV(n=5)	**4 (80 %)**	**0 (0%)**	**1(20%)**
Type V(n=0)	**0 (0%)**	**0 (0%)**	**0 (0%)**
	Chi square test =15.723, p =0.047*Pearsoncorrelation'r'value= -0.078,p=0.075		

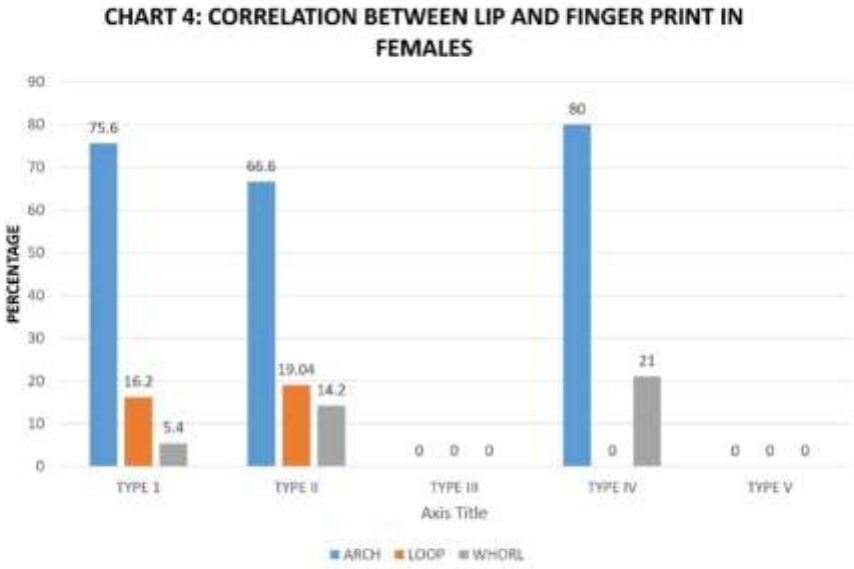

Table 5a- Mean ICD mm of the subjects

	N	Minimum	Maximum	Mean	Std. Deviation
ICD mm	200	39.3300	59.6200	49.524350	4.4043134

Table 5b- Inter group comparison (M vs F) of ICD mm

	sex	Mean	Std. Deviation	Std. Error Mean	T value	p value of t test
ICD mm	M	52.637600	3.2364534	.3236453	14.132	.000**
	F	46.411100	2.9894491	.2989449		

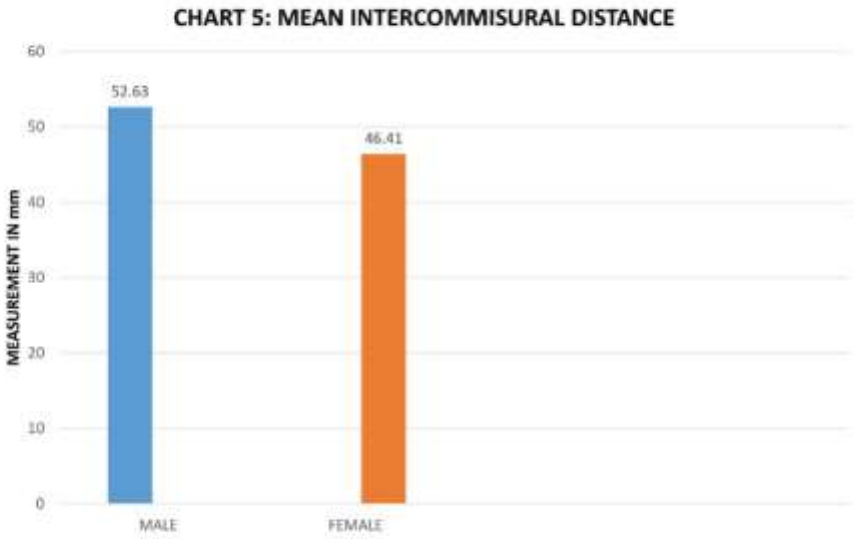

FIGURE 1 : Suzuki and Tsuchihashi (1970) classification of lip prints

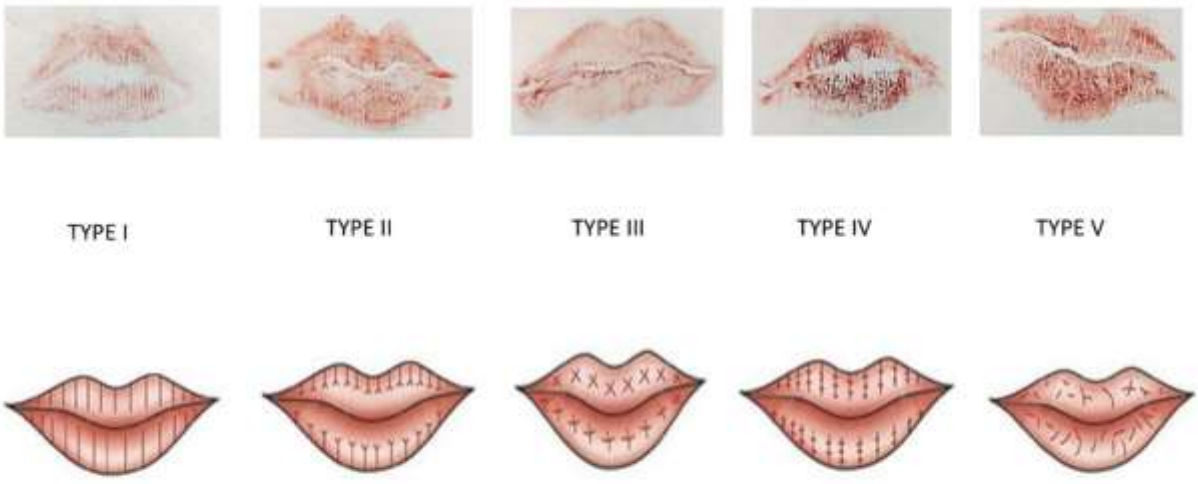

FIGURE 2: **Kuchen classification of finger print as loop, arch and whorl pattern**

DISCUSSION:

Personal identification is an integral component of a personal profile and biodata. Most government and private sectors seeking or involving personal biometric information require individuals to be finger printed to complete routine biometric record and documentation. Not only does finger printing concern the conventional domains of clinical medicine, forensic science, anthropometry, criminology, custom & security agencies, its applicability has been incorporated into every so-called formal **" security screen**".Personal identification is very much necessary for unknown deceased person in homicide, suicide, mass disasters, accidents etc. Comparative study of lip prints and finger prints for the interpretation in personal identification is scanty in the literature. Identification of dead persons can be done by comparing an already existing antemortem record with that of post-mortem records. [8]

The first **study on lip print** was carried out by Hungary in 1961. Tsuchihashi and Suzuki established that the arrangement of lines on the red part of the human lip is individual and unique & grooves were named as Sulci Labiorum& corresponding lip prints as "FiguraLinearumLabiorumRubrorum" by them. [6]. Sivapathasundharam et al stated that the lip pattern recording depended on the way the lip muscles are relaxed to produce a particular pattern [9]. Lip print pattern recorded depends on whether the mouth is open or close. In closed mouth position, the lip prints exhibits well-defined grooves, whereas in the open position the grooves are ill-defined & difficult to interpret, [10]. In this study lip prints were recorded in rest position.In our study, among males, the most common observed lip print

was type II (branched), which was consistent with study conducted by Gondivkar et al (2009) [10] and Nagasupriya et al (2011) [11]. While similar such studies were conducted by Verma Y et al (2015) [12] found type IV (reticular), Kautilya D V et al (2013)[13] observed type III (intersecting). Study by Sultane et al (2014) [14] and Murugan M et al (2014) [15] observed type I (Vertical) as most common observed patterns. In our study,among **females**, the most commonly observed lip print was (vertical lip pattern) type I which was in accordance with many studies such as Nagasupriya A et al (2011), Kautilya DV et al (2013), Sultane et al (2014) &Dongawar GR et al [11,12,13,14,16] In some studies, type II was found to be most common pattern such as in Verma Y et al (2015) &Muragan M et al (2014). [12,17]Fingerprints as a form of identification have been used at least since 7000-6000 BC by the ancient Assyrians and Chinese. Bricks used in houses in the ancient city of Jericho were sometimes imprinted by pairs of thumb prints. In the mid 1800's, scientific studies were begun and established two critical characteristics of finger prints that are true till to this day,no two finger prints from different fingers have been found to have the same ridge pattern and finger print patterns are unchanging throughout the life. These studies led to the use of finger prints for criminal identification, first in Argentina in 1896, then at Scotland Yard in 1901, and to other countries in the early 1900's. [11]

In the late 1990's the introduction of inexpensive finger print capture devices and the development of fast, reliable matching algorithms have set the stage for the expansion of finger print matching to personal use. [10]**Finger prints** are characterised by alternating strips of raised friction ridges and grooves that form peculiar and specific patterns. These patterns develop between 5^{th} and 6^{th} week of intrauterine life and are fully formed by 21^{st} week. Fingerprints or friction ridges are the prime and infallible means of identification in forensic investigations and trials.[18]The following were the observations of the present study. Arch pattern of finger print was seen frequently in 67% of males and 60 % females, Loop pattern was seen in 26% of males and 33% in females and whorl pattern was seen in equal number in both the genders that is 7% in both males & females.In the present study, the overall most frequently observed fingerprint pattern was Arch pattern (63.5%). Males mostly presented arch pattern (67%), while females mostly presented loop fingerprint pattern (33 %) which is similar to Murugan M et al study (2014).[15] The arch pattern was least observed in both the genders in the study conducted by Kapoor N et al (2015)[18]which is in contrast to the findings of our study.

The present study revealed that in males higher prevalence of association of type I (vertical) lip print pattern with arch finger print pattern, (67%), followed by type II (branched) lip print pattern with arch finger print pattern (54.8%) was found. ALSO in females, a higher association was observed between type I (vertical) lip print pattern with arch finger print pattern (75.6%), followed by type II (branched) lip print pattern with arch finger pattern seen in 66.6 % of the participants. The overall association of

lip print & finger print showed value for P= 0.668 (males) and P= 0.075(females) which was an **approachable significance.** Our findings were similar to Nagasupriya et al (2011) study wherein females showed a correlation between type I (vertical) lip print pattern with arch finger pattern, [(11)]however in a study conducted by Gondivkar et al (2009) [(10)] type III (intersecting) lip pattern was seen in 51.05% of males & 37.06% in females and was associated with loop finger pattern which is not in consistent to our present study. The study by Tandon A et al (2017) [19] revealed that in males type II (branched) lip print pattern was associated with whorl fingerprint pattern & in females type I (vertical) lip print pattern was associated with loop fingerprint which did not match with our findings.

The overall correlation of lip & finger pattern with gender showed non-significance (P=0.71). The correlation of lip & finger pattern in males showed weak correlation (r=0.033) & statistical insignificance (P=0.06).

The correlation of lip & finger print pattern in females showed weaker correlation r=0.078 &**statistical weak significance** P=0.075.**Intercommissural distance** (ICD) was more in males (52.63+2.23) than in females (46.41+2.98), which was **highly statistically significant**. The mean ICD was highest among branched type II (branched) lip print pattern similar to as reported by Temitope et al study [20]. The intercommissural distance among type II lip print pattern was on an average 53.89mm.Thus with the availability of lip prints, finger prints and the intercommissural distance, correlating these parameters, could make easy, to suggest the most acceptable possibility of the gender in forensic science.

CONCLUSION

Studies on lip print, finger print are available in literature but correlative studies are scanty. This is a rare study involving three different parameters which are lip, finger & ICD & their correlation. The overall predominant finding among both genders was highly significant however the correlation between the three did not reveal a statistical significant finding. Hence more studies using the above parameters should be carried out in future among various racial groups. Concepts and designs needed to evaluate materials for lip print development - the isolation of DNA, evaluation of inter-rater reliability in identifying their patterns or known potential rate of error - are scarcely mentioned in the literature. Lip print identification has been important historically, but the new paradigm makes the redefinition of the current research necessary to stop guesswork and speculation.

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