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Lip prints: The barcode of skeletal malocclusion

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Abstract

Introduction: In orthodontics, apart from essential diagnostic aids, there are so many soft tissue analyses in which lips are major part of concern. However, lip prints have never been used in orthodontics as diagnostic aid or forensic tool. Therefore, this study was designed to explore the possible association of lip prints with skeletal malocclusion. **Materials and Methods:** A sample of 114 subjects in the age group of 18-30 years, from North Indian adult population were selected on the basis of skeletal class I, class II and class III malocclusion, each comprising of 38 subjects with equal number of males and females. Lip prints of all the individuals were recorded and digital soft copies of lateral cephalograms were taken. Lip prints were compared between different skeletal malocclusions. **Results:** It was found that branched lip pattern was most common in North Indian adult population with no sexual dimorphism. The Z-test for proportion showed that the prevalence of vertical lip pattern was significantly higher in subjects having skeletal class III malocclusion. **Conclusion:** A definite co-relation of vertical lip patterns with skeletal class III malocclusion was revealed.

Key words: Lip prints, orthodontic diagnosis, skeletal malocclusion

Introduction

Suitable diagnostic procedures and appropriate analysis of pertinent diagnostic data are the basis of comprehensive plan of orthodontic therapy.[1] There exist many diagnostic soft tissue analyses in which lips play a vital role.[2-7]

Lip prints consist of normal lines and fissures in the form of wrinkles and grooves present in the zone of transition of human lip between the inner labial mucosa and outer skin. The study of lip prints is referred to as Cheiloscopy. The use of finger prints in personal identification and in criminal investigation is accepted part of forensic science. Similarly, in recent past several research studies had established that lip prints can be used as evidence in personal identification and criminal investigation in forensic dentistry.[8-12]

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The relationship between the skeletal malocclusions (Class I, II and III) and soft tissue facial morphology has been an arena of vast research in contemporary orthodontics. The lip prints are unique to an individual just like the fingerprints and shows strong hereditary pattern.[8] Therefore; this study was designed to explore correlation of lip prints with skeletal base relationship in North Indian adult population and if possible, to establish lip prints as relevant diagnostic and forensic tool.

Materials and Methods

A sample of 114 subjects from North Indian adult population were selected on the basis of skeletal class I, class II, and class III, each comprising of 38 subjects with equal number of males and females. Digital soft copies of their lateral

cephalograms were taken and lip prints on white colored bond papers were recorded for all the subjects.

Criteria for sample selection included subjects having no lesions on the lips, no congenital facial defects, no congenitally missing teeth or extracted teeth (except third molars). Individuals with known hypersensitivity to lipsticks were not included in this study and none of the subjects had undergone orthodontic treatment or maxillofacial surgery previously. A written informed consent was obtained from all the subjects as prescribed and approved by ethical committee.

The study sample was categorized in class I, class II, and class III skeletal patterns with ANB angular measurements given by Riedel.[13] ANB angle is used to determine the Sagittal discrepancy between maxilla and mandible.[14] If ANB angle was in between 0 to 4 degrees (maxilla and mandible in normal sagittal relationship), the subjects were categorized into skeletal class I, if ANB angle was greater than 4 degrees (mandible is retrognathic, maxilla is prognathic or any one is normal), the subjects were categorized into skeletal class II, and if ANB angle was lesser than 0 degrees or in negative value (mandible is prognathic, maxilla is retrognathic or any one is normal), the subjects were categorized into skeletal class III.

Lateral cephalograms of all the subjects were taken in natural head position (NHP) with the help of digital cephalometric X-ray system, Pax-400C VATECH, value added technologies, Korea. The study sample was evaluated to assess the sagittal discrepancy of the maxillary to mandibular skeletal bases (anteroposterior jaw discrepancy) with angular measurements of ANB by using software Nemoceph Nx-2005.

There are different methods of recording lip prints like lipstick-paper-cardboard method, photography, lipstick-paper method, lipstick-cellophane method, or using dental impression materials to make three-dimensional casts of the lips. The most commonly used lipstick-cellophane technique was adopted in the study, which provides a good clarity and accuracy.[15]

The subjects were asked to sit at relaxed position on a dental chair, and the lips of the subjects were cleaned with the help of wet cotton. Then a portion of red colored lipstick was cut with the help of bard parker knife which was put into the dappen dish, from where it was applied on the lips with the lip brush. The subjects were asked to rub both the lips together to spread the lipstick. Over the lipstick, the glued portion of the cellophane tape strip was placed and a lip impression was made by dabbing it first in the center and then pressing it uniformly towards the corners of the lips. The cellophane strip was then stuck to the white bond paper for permanent record and the lip impressions were subsequently visualized with the use of a magnifying lens. Every measure was taken to prevent any cross contamination **[**Figure 1].

The classification of lip print patterns as proposed by Tsuchihashi,[9] was followed which was [Figure 2]:

Type I : Clear-cut vertical grooves that run across the entire lips.
Type I' : Similar to type I, but do not cover the entire lip.
Type II : Branched grooves (branching Y-shaped pattern).
Type III : Intersected grooves (criss-cross pattern, transverse grooves).
Type IV : Reticular grooves.
Type V : Undetermined (grooves do not fall into any of the type I-IV and cannot be differentiated morphologically).

Type I i.e., full vertical grooves and type I' i.e., partial vertical grooves (Tsuchihashi classification) were very difficult to differentiate between each other, therefore were considered as a single group in this study.

For classification, the middle part of the lower lip (10 mm wide) was taken as study area, similar to the study by

Figure 1: Procedure for recording the lip print of an individual

Sivapathasundharam *et al.*[8] The lip print pattern was determined by counting highest number of lines in this area having similarity to the Tsuchihashi classification.

To reduce the errors in the method all the lip impressions were evaluated thrice, once by the researcher and second by an orthodontist and third by one resident of forensic medicine, and the lip pattern that was confirmed by majority was utilized in the study. At the time of lip pattern analysis, the skeletal jaw relations of the individuals were not disclosed to the examiners. Statistical analysis was performed using the Z-test (standard normal variate test) for proportion to compare different lip patterns in different groups and a $P < 0.05$ was considered to be statistically significant.

Results

After interpretation of lip patterns of 114 individuals, it was found that branched lip pattern was most common (32.46%) followed by vertical lip pattern (25.44%), intersected lip pattern (21.93%), reticular lip pattern (17.54%), and undetermined lip pattern (2.63%).

When the lip patterns were evaluated in both males and females subjects of the total selected sample, it was found that branched lip pattern was most common in both males and females subjects i.e., 35.09% and 29.82% respectively, while the least common was undetermined lip pattern in both males and females subjects i.e. 3.51% and 1.75% respectively. The Z-test (standard normal variate test) for proportion showed no significant difference in the lip patterns between male and female subjects [Table 1].

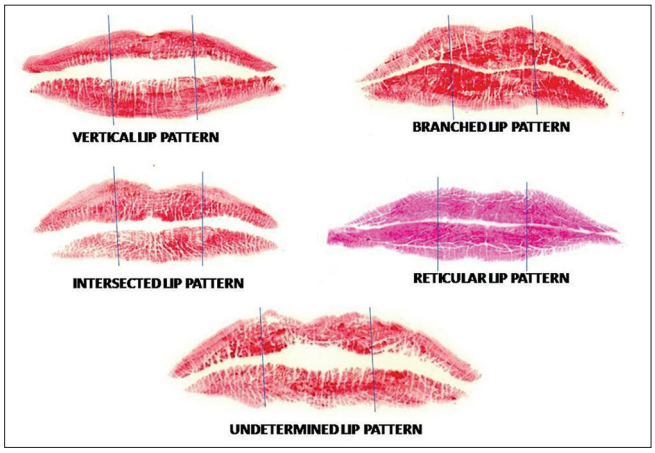


Figure 2: Different types of lip pattern

The lip patterns were evaluated in different skeletal malocclusions subjects i.e. skeletal class I, class II and class III [Figure 3].

In overall skeletal class I group, branched lip pattern was most prevalent (31.58%), followed by reticular lip pattern (26.32%), intersected lip pattern (21.05%), vertical lip pattern (18.42%) and undetermined lip pattern (2.63%). When the lip patterns were compared between male and female subjects having skeletal class I, it was found that both branched (31.58%) and reticular (31.58%) lip patterns were most common in males while only branched (31.58%) lip pattern was most common in females. The least common was undetermined lip pattern in both males and females subjects (5.26%). The Z-test showed no significant difference in the lip patterns between males and female subjects [Table 2].

In overall skeletal class II group, branched lip pattern was most prevalent (36.84%), and this was followed by intersected lip pattern (23.68%), reticular lip pattern (18.42%), vertical lip pattern (15.79%) and undetermined lip pattern (5.26%). When the lip patterns were compared between male and female subjects having skeletal class II, it was found that branched lip pattern was most common in both males and females i.e. 36.84% and 31.58% respectively, while the least common was undetermined lip pattern in both males and females subjects (5.26%). The Z-test showed no significant difference in the lip patterns between males and female subjects [Table 2].

In overall skeletal class III group, vertical lip pattern was most prevalent (42.11%), followed by branched lip pattern (28.95%), intersected lip pattern (21.05%), and the reticular lip pattern (7.89%), while the undetermined lip pattern was completely absent. When the lip patterns were compared between male and female subjects having skeletal class III, it was found that vertical lip pattern was

Table 1: Prevalence of different lip patterns in North Indian adult population

	No. of subjects=114								
Lip patterns	**Total subjects**	**%**	**Males**	**%**	**Females**	**%**	**Z-CAL†**	**Z-TAB‡**	***P* value**
Vertical	29	25.44	13	22.81	16	28.07	0.71	1.96	>0.05
Branched	37	32.46	20	35.09	17	29.82	0.57	1.96	>0.05
Intersected	25	21.93	10	17.54	15	26.32	1.43	1.96	>0.05
Reticular	20	17.54	12	21.05	8	14.04	1.43	1.96	>0.05
Undetermined	3	2.63	2	3.51	1	1.75	0.92	1.96	>0.05
Total	114		57		57				

Z-CAL† = Z Calculated value, Z-TAB‡ = Z tabulated value at α = 5% level of significance

most common in both males and females i.e. 36.84% and 47.37% respectively, while the least common was reticular lip pattern in both males and females subjects i.e. 10.53% and 5.26% respectively. The undetermined lip pattern was completely absent in both males and females of skeletal class III. The Z-test showed no significant difference in the lip patterns between males and female subjects [Table 2].

The Z-test (standard normal variant test) for proportion, showed no significant difference in the lip patterns in overall subjects having skeletal class I and class II ($P > 0.05$) [Table 3 and Graph 1]. Similar results were found when lip patterns were compared between males of skeletal class I and class II ($P > 0.05$) and between females of skeletal class I and class II ($P > 0.05$) [Table 3].

The Z-test (standard normal variant test) for proportion, in overall subjects having skeletal class I and class III, showed a significantly high ($P < 0.05$) proportion of vertical lip pattern in subjects having skeletal class III as compared to skeletal class I, while the proportion of reticular lip pattern was significantly high ($P < 0.05$) in subjects having skeletal class I as compared to skeletal class III [Table 4 and Graph 1]. On comparison between males and females

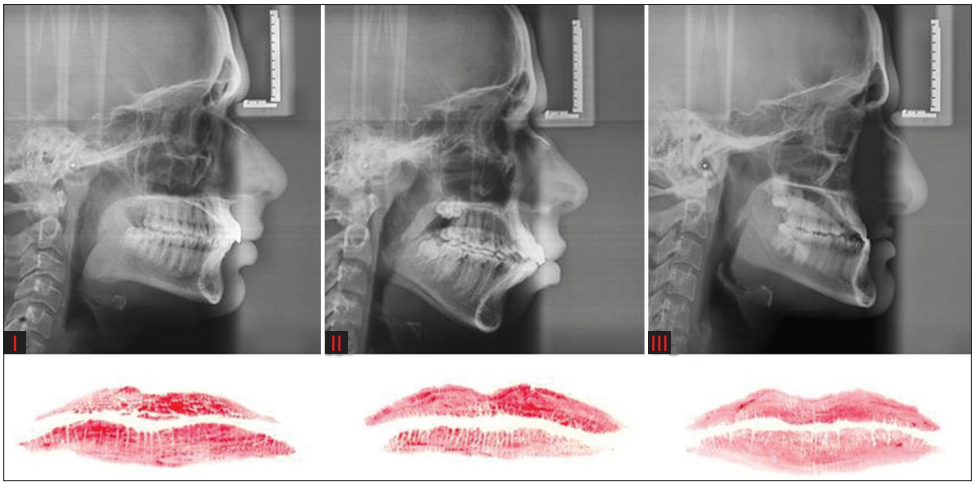


Figure 3: Lip prints of subject having different skeletal malocclusion with their lateral cephalograms: Intersected (transverse) lip pattern in skeletal class I, branched lip pattern in skeletal class II, and vertical lip pattern in skeletal class III malocclusion

Table 2: Prevalence of different lip patterns in subjects having different skeletal malocclusion

Lip patterns	Total subjects	%	Males	%	Females	%	Z-CAL†	Z-TAB‡	*P* value
Skeletal class I									
Vertical	7	18.42	3	15.79	4	21.05	0.50	1.96	>0.05
Branched	12	31.58	6	31.58	6	31.58	0.00	1.96	>0.05
Intersected	8	21.05	3	15.79	5	26.32	1.04	1.96	>0.05
Reticular	10	26.32	6	31.58	4	21.05	0.91	1.96	>0.05
Undetermined	1	2.63	1	5.26	0	5.26	-	1.96	-
Total	38		19		19				
Skeletal class II									
Vertical	6	15.79	3	15.79	3	15.79	0.00	1.96	>0.05
Branched	14	36.84	7	36.84	7	36.84	0.00	1.96	>0.05
Intersected	9	23.68	4	21.05	5	26.32	0.50	1.96	>0.05
Reticular	7	18.42	4	21.05	3	15.79	0.50	1.96	>0.05
Undetermined	2	5.26	1	5.26	1	5.26	0.00	1.96	>0.05
Total	38		19		19				
Skeletal class III									
Vertical	16	42.11	7	36.84	9	47.37	0.60	1.96	>0.05
Branched	11	28.95	7	36.84	4	21.05	1.40	1.96	>0.05
Intersected	8	21.05	3	15.79	5	26.32	1.04	1.96	>0.05
Reticular	3	7.89	2	10.53	1	5.26	0.92	1.96	>0.05
Undetermined	0	0.00	0	0.00	0	0.00	0.00	1.96	>0.05
Total	38		19		19				

Z-CAL† = Z Calculated value, Z-TAB‡ = Z tabulated value at α = 5% level of significance

of skeletal class I and class III respectively, predominance of vertical lip pattern was very obvious in skeletal class III malocclusion group ($P < 0.05$), and reticular lip pattern was significantly high in skeletal class I malocclusion group ($P < 0.05$) [Table 4].

The Z-test (standard normal variate test) for proportion, in overall subjects having skeletal class II and class III, showed the proportion of vertical lip pattern as significantly high ($P < 0.05$) in subjects having skeletal class III as compared to skeletal class II [Table 5 and Graph 1]. Similarly comparison of lip patterns between skeletal class II and class III showed vertical lip pattern as significantly high ($P < 0.05$) in skeletal class III malocclusion group for

Table 3: Comparison of different lip patterns in subjects having skeletal class I and class II malocclusion

Lip patterns	Total subjects	Skeletal class I	Skeletal class II	Z-CAL†	Z-TAB‡	*P* value
Vertical	29	7	6	0.21	1.96	>0.05
Branched	37	12	14	0.43	1.96	>0.05
Intersected	25	8	9	0.29	1.96	>0.05
Reticular	20	10	7	1.07	1.96	>0.05
Undetermined	3	1	2	0.92	1.96	>0.05
Total	114	38	38			
Lip patterns	**Males**	**Skeletal class I**	**Skeletal class II**	**Z-CAL†**	**Z-TAB‡**	***P* value**
Vertical	13	3	3	0.00	1.96	>0.05
Branched	20	6	7	0.36	1.96	>0.05
Intersected	10	3	4	0.71	1.96	>0.05
Reticular	12	6	4	0.85	1.96	>0.05
Undetermined	2	1	1	0.00	1.96	>0.05
Total	57	19	19			
Lip patterns	**Females**	**Skeletal class I**	**Skeletal class II**	**Z-CAL†**	**Z-TAB‡**	***P* value**
Vertical	16	4	3	0.43	1.96	>0.05
Branched	17	6	7	0.43	1.96	>0.05
Intersected	15	5	5	0.00	1.96	>0.05
Reticular	8	4	3	0.52	1.96	>0.05
Undetermined	1	0	1	-	1.96	-
Total	57	19	19			

Z-CAL† = Z calculated value, Z-TAB‡ = Z tabulated value at α = 5% level of significance

Table 4: Comparison of different lip patterns in subjects having skeletal class I and class III malocclusion

Lip patterns	Total subjects	Skeletal class I	Skeletal class III	Z-CAL†	Z-TAB‡	*P* value
Vertical	29	7	16	2.21	1.96	<0.05*
Branched	37	12	11	0.21	1.96	>0.05
Intersected	25	8	8	0.00	1.96	>0.05
Reticular	20	10	3	2.50	1.96	<0.05*
Undetermined	3	1	0	-	1.96	-
Total	114	38	38			
Lip patterns	**Males**	**Skeletal class I**	**Skeletal class III**	**Z-CAL†**	**Z-TAB‡**	***P* value**
Vertical	13	3	7	1.98	1.96	<0.05*
Branched	20	6	7	0.36	1.96	>0.05
Intersected	10	3	3	0.00	1.96	>0.05
Reticular	12	6	2	1.99	1.96	<0.05*
Undetermined	2	1	0	-	1.96	-
Total	57	19	19			
Lip patterns	**Females**	**Skeletal class I**	**Skeletal class III**	**Z-CAL†**	**Z-TAB‡**	***P* value**
Vertical	16	4	9	1.98	1.96	<0.05*
Branched	17	6	4	0.57	1.96	>0.05
Intersected	15	5	5	0.00	1.96	>0.05
Reticular	8	4	1	1.97	1.96	<0.05*
Undetermined	1	0	0	0.00	1.96	>0.05
Total	57	19	19			

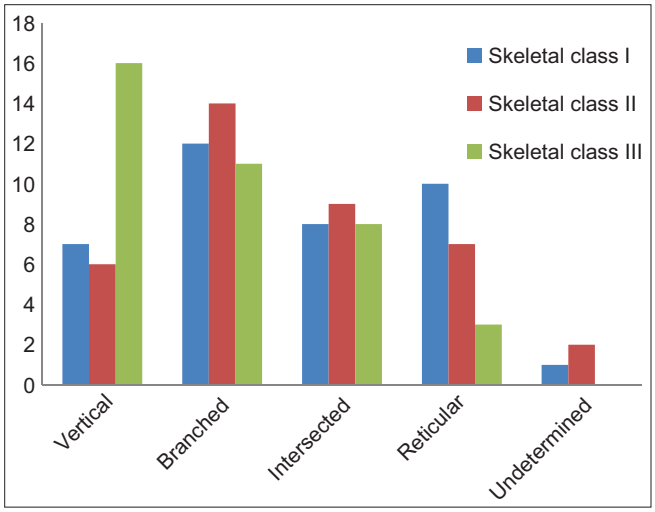
P<0.05 (Significant)* at α = 5% level of significance, Z-CAL† = Z calculated value, Z-TAB‡ = Z tabulated value at α = 5% level of significance

both males, as well as females [Table 5].

Discussion

The soft tissue diagnosis in orthodontics comprises of different analyses which take into account various parameters like lip thickness, lip length, lip competency, lip strain. Cheiloscopy as par our data search has been related to malocclusion only in one study.[16]

Different studies have yielded varying results, Tsuchihashi, in his study in Japanese population found that intersected lip pattern was the most frequent.[9] Vahanwala and Parekh, in their study in Mumbai found that vertical lip pattern was most common.[17] Sivapathasundharam, Prakash and Sivakumar, studied the lip prints of Indo-Dravidian population and noted that intersected lip pattern was predominant.[8] Verghese *et al*., in Kerala found that reticular lip pattern showed the highest incidence.[18] In our North Indian adult population subjects, it was observed that branched lip pattern was most common in overall subjects (32.46%), as well as in both, males (35.09%) and females (29.82%) and the least common was undetermined lip pattern in overall subjects (2.63%), as well as in both, males (3.51%) and females (1.75%). All these studies clearly indicate that lip prints show regional differences.



Graph 1: Comparison of different lip patterns between subjects having skeletal class I, skeletal class II, and skeletal class III malocclusion

The utility of lip prints were assessed by comparative evaluation of lip patterns among subjects having different skeletal malocclusions (class I, class II and class III).

It was observed in the present study that there was no significant difference in lip patterns of males and females in each of the groups (Skeletal class I, skeletal class II, and skeletal class III malocclusion); which probably indicates that there is no sexual dimorphism in lip patterns, this is in accordance with the study of Tsuchihashi,[9] in which intersected lip pattern was predominant in both males (31.3%) and females (33.3%), and in accordance with the study of Verghese[18] in which reticular lip pattern was most frequently observed in both the sexes. But in studies of Vahanwal *et al*.,[19] Babu *et al*.,[20] Gondivkar *et al*.,[21] there was a difference in lip patterns of males and females through which they determined the sex of the individual.

Table 5: Comparison of different lip patterns in subjects having skeletal class II and class III malocclusion

Lip patterns	Total subjects	Skeletal class II	Skeletal class III	Z-CAL†	Z-TAB‡	*P* value
Vertical	29	6	16	2.43	1.96	<0.05*
Branched	37	14	11	0.64	1.96	>0.05
Intersected	25	9	8	0.29	1.96	>0.05
Reticular	20	7	3	1.43	1.96	>0.05
Undetermined	3	2	0	-	1.96	-
Total	114	38	38			
Lip patterns	**Males**	**Skeletal class II**	**Skeletal class III**	**Z-CAL†**	**Z-TAB‡**	***P* value**
Vertical	13	3	7	1.98	1.96	<0.05*
Branched	20	7	7	0.00	1.96	>0.05
Intersected	10	4	3	0.71	1.96	>0.05
Reticular	12	4	2	0.94	1.96	>0.05
Undetermined	2	1	0	-	1.96	-
Total	57	19	19			
Lip patterns	**Females**	**Skeletal class II**	**Skeletal class III**	**Z-CAL†**	**Z-TAB‡**	***P* value**
Vertical	16	3	9	2.18	1.96	<0.05*
Branched	17	7	4	1.21	1.96	>0.05
Intersected	15	5	5	0.00	1.96	>0.05
Reticular	8	3	1	1.25	1.96	>0.05
Undetermined	1	1	0	-	1.96	-
Total	57	19	19			

P<0.05 (Significant)* at α = 5% level of significance, Z-CAL† = Z calculated value, Z-TAB‡ = Z tabulated value at α = 5% level of significance

These contrary results indicate that cheiloscopy may be used with skepticism for sex determination as adjunct to other methods (not as a sole method).

On comparison of lip patterns in different skeletal malocclusions, our study showed branched and reticular patterns as most prevalent in class I malocclusion subjects while class II subjects showed branched and intersected patterns as most prevalent type of lip print patterns. There was no significant difference between the lip print patterns of class I and class II subjects. While in individuals with skeletal class III vertical lip pattern was most prevalent with similar results for both the sexes when compared separately. The presence of vertical lip print patterns in class III subjects was significantly different from class I and class II subjects ($P < 0.05$).

In only one of the study of this type in the past, using four quadrants of upper and lower lips found 1, 3 and 2, 3 types of lip print combination in class I subjects, 1, 4 and 3, 4 types of lip prints in skeletal class III and 1, 2 type in class II subjects but we could not compare this with our study because of difference in lip print analysis method.[16]

As documented by various researchers that the lip prints,[10,22] as well as skeletal class III malocclusion show strong inheritable tendency,[23,24] may possibly explain the reason for having a significant relationship of vertical lip patterns and skeletal class III malocclusion. In our study the subjects were selected on the basis of ANB angle without considering the etiology i.e. heredity or environmental which may be a possible reason, for the absence of significant difference in lip patterns between subjects having skeletal class I and skeletal class II malocclusion.

Our study associates vertical lip patterns with skeletal class III malocclusion. Similarly, Kulkarni[16] *et al*., concluded that it is easier to relate lip print patterns to class I and class III sagittal malocclusion subjects as compared to class II subjects but the association of lip patterns with different skeletal malocclusion needs a extensive research with a large sample from varied ethnical groups for conclusive results. Hence, further research is needed for the evaluation of lip prints in a larger sample with specifically hereditary malocclusions to further validate the correlation between lip patterns and skeletal malocclusions.

This relationship if further corroborated might perhaps be of help in forensic dentistry, as we might sort out possible suspects by examining their skeletal malocclusion. If lip print records are available then dental profiling could be done by skeletal malocclusion only and help in determining possible identity of the victim.

Conclusion

1. Lip prints may be used for identification of skeletal malocclusion.
2. A significant correlation was found between vertical lip pattern and skeletal class III malocclusion, even though class I and class II relationship with lip prints was inconclusive.

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