Lips are two highly sensitive mobile folds, composed of skin, muscle, glands and mucous membrane, surrounding the oral orifice and forming the anterior boundary of the oral cavity. In the transition zone of human lips, known as vermilion, between the inner labial mucosa and outer skin, normal lines and fissures form wrinkles and grooves. These lip features have been named “sulci labiorum rubrorum” and the examination of lip prints is referred to as „cheiloscopy”, from the Greek word cheilos (χείλος) – lip [1].

Introduction

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Acknowledgement

The authors express their gratitude to all those who volunteered to participate in this research.

Summary

Introduction. Lip prints are considered to be an important form of transfer evidence, analogous to fingerprints, and can be very useful in forensic investigations and personal identification. Although previous studies have confirmed that lip print patterns are individual and unique for each person, they show similarities between family members, strongly indicating the possibility of inheritance pattern of lip prints. Since heredity may play an important role in lip print development, ethnic groups geographically closely located tend to share similar patterns of lip prints in comparison to more distant populations; a characteristic lip pattern may indicate a person’s geographical and racial origin.

Materials and Methods. Lip prints of 211 healthy individuals (107 females and 104 males), residents of Vojvodina Province, Serbia, were analyzed and classified using the Suzuki and Tsuchihashi classification. In the studied sample, type II pattern was the most common in both the upper and lower lip, being predominant in 45.85% of the studied samples. It was followed by types III, I, and IV accounting for 31.28%, 15.28% and 4.62%, respectively. The results of the current study are in accordance with the results of previous studies of European populations. The Pearson chi-square test showed a statistically significant difference between the lip print patterns in males and females. The authors express their gratitude to all those who volunteered to participate in this research.

Sažetak

Uvod. Otisci usana smatraju se značajnim oblikom transfernih tragova, analognih otisicima prstiju, koji mogu biti veoma korisni u forenzičkim istraživanjima i identifikaciji osoba. Iako su prethodne studije pokazale da su obrasci šara usana individualni i jedinstveni za svaku osobu, otisci usana pokazuju sličnosti među članovima porodice, snažno ukazujući na mogućnost postojanja obrasca nasleđivanja. Pošto nasledni faktori mogu imati značajnu ulogu u razvoju usana, geografski bliske etničke grupe mogu pokazivati međusobne sličnosti u morfologiji linija usana, u poređenju sa geografski udaljenijim populacijama. Karakteristični obrasci otisaka usana mogu ukazivati na geografsko poreklo i rasu osobe.


Ključne reči: usna; obrasci nasleđivanja; biometrijska identifikacija; etničke grupe; polne karakteristike; dermatoglifi; forenzička antropologija

Original study

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Despite the fact that the different lip lines were first noticed and described by R. Fisher at the beginning of the 20th century, subsequent years have not lead to a detailed study of the uniqueness or permanence of lip patterns, their genesis in the pre-natal period or their practical application [2, 3]. In 1932, the French criminologist Edmond Locard first acknowledged the importance of cheiloscopy. In 1947, Snyder suggested the possibility of lip print analysis as a method in personal identification, while Santos, in 1967, concluded that lip patterns could be classified into different groups, and each group could be further divided into several subtypes [4, 5].

During the seventh decade of the 20th century, two Japanese scientists, Tazuo Suzuki and Yasuo Tsuchihashi, examined lip print pattern variations in a sample of 1,364 persons at the Department of Forensic Odontology at the Tokyo University. Based on this research, it was concluded that the arrangement of lines on the vermilion is individual and unique for each human being [6]. In 1973, Renaud studied 4,000 lip prints and confirmed the conclusions of Japanese scientists, supporting the idea of lip print singularity [7]. Two identical twins seemed to be indistinguishable by every other means, except their lip prints, which significantly differed [6].

In 1974, Tsuchihashi performed another study which resulted in a simple classification of lip patterns (Figure 1). The results of this study enabled the author to confirm not only lip print singularity, but also lip response to trauma. The author observed that after healing, the lip pattern was equal to that prior the injury [8]. In the following years, several other classifications were suggested, but the classification based on the research of Suzuki and Tsuchihashi is still the most widely used in forensic practice and anthropological studies.

Studies of lip print variations are, in general, rarely conducted in European populations. This is the very first study on the lip pattern polymorphism in Serbia, to our best knowledge.

The aim of the present investigation was to classify the lip print patterns in the sample of the population from Vojvodina Province, Serbia, and to evaluate the potentials of lip print patterns in human identification and in forensic cases. In addition, the study was intended to verify the potential significance of lip print configuration for sex determination in forensics and to contribute to the cheiloscopy literature with the specific characterization of the studied population.

Material and Methods

This study included 211 healthy individuals (107 females and 104 males), residents of Vojvodina Province, Serbia, aged 19 – 58 (mean age 26.1). Written informed consent was obtained from all participants.

Subjects with known hypersensitivity to lipsticks or previous cosmetic or surgical lip treatment were not included in the study. Also, subjects with an inflammatory process or trauma of the lips were excluded.

Lip print collection was done after all the participants cleaned their lips with a wet napkin and a thin layer of lipstick was applied on dry lips. The impressions of the relaxed and slightly separated lips were taken on the copy paper. Two to five lip prints were taken from each participant, in order to obtain at least one complete print sufficient for identification of different lip areas.

Each lip print was divided into four areas, assigned with the numbers 1 – 4 in a clockwise sequence starting from the right half of the upper lip. Thus, 844 segments from 211 individuals were obtained for lip pattern print analysis. Each area was studied separately to determine the type of the grooves.

Lip prints were studied with a standing magnifying lens with an autonomous light source. The lip print pattern was determined by two observers independently using Suzuki and Tsuchihashi classification, based on the predominant type of lines for each area. In case of conflicting results, the third observer held the responsibility of determining the final type of the lip print pattern. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) 19.0 software (IBM Corp., Armonk, NY, USA). A Pearson’s chi-square test was used to compare qualitative data and determine statistical significance between males and females, regarding the upper and lower lip. The level of statistical significance was set at p < 0.05. Post hoc analyses were done after the basic statistical analysis.

Results

The obtained results showed that type II pattern was the most common in both lips, being predominant in 45.85% of the studied samples, followed by types III, I, and IV (31.28%, 15.28% and 4.62%, respectively). The least common patterns were types I and V, accounting for 1.78% and 1.18% (Table 1). The Pearson’s chi-square test of goodness of fit was performed to determine whether the six lip pattern types were equally distributed among our population. As expected, they were not equally distributed, ($\chi^2 (5, N = 844) = 847.60, p < 0.001$).
In males, the lip prints indicated an almost equal predilection of branched and intersected patterns (41.11% and 39.66%, respectively), followed by complete vertical (9.13%) and reticular grooves (6.97%). The irregular and incomplete vertical patterns were infrequent, found in 1.68% and 1.44% of the sample, respectively (Table 1).

In females, the branched pattern was predominant, accounting for 50.47% of the studied lip prints. In contrast to the male sample, similar prevalences of type III and type I were found (23.13% and 21.26%) in the analyzed female lip prints. The incomplete vertical and irregular patterns were found in 2.1% and 0.7% of cases, respectively.

The Pearson’s chi-square test showed a statistically significant difference between genders in lip print pattern types ($\chi^2 (5, N = 844) = 54.80, p < .001$). The post hoc Bonferroni adjustment analysis (p < 0.005) revealed that types I, III and IV statistically significantly differed between genders [9, 10].

In this study, the upper lip in both genders showed a predominance of type II pattern, followed by type III and type I (Table 2), with statistically significant results of Pearson’s chi-square test ($\chi^2 (5, N = 412) = 20.12, p < .05$). Bonferroni post hoc analysis ($p < 0.0042$) revealed that the statistically significant difference in the upper lip pattern between genders was due to the difference in pattern types I and III. On the lower lip, analysis showed that the lip pattern types significantly differed ($\chi^2 (5, N = 412) = 44.536, p < 0.001$), as the branched pattern was predominant in females (53.27%), while type III pattern was the most common in males (40.86%), followed by type II (36.6%). The type I pattern was more often recorded on both lips in females (20.09% and 22.43%, respectively) in comparison to the male lip prints (7.69% and 10.58%, respectively). Post hoc Bonferroni adjustment analysis ($p < 0.0042$) showed that lower lip pattern significantly differed between genders in all lip pattern types except type V and type I'.

**Discussion**

Lip prints are considered to be an important form of transfer evidence, analogous to fingerprints, and can be very useful in forensic investigations and personal identification, being often present on objects such as drinking glasses, cutlery items, paper napkins, cigarette butts or tissues. They can be also found in less typical places, such as the surface of windows, paintings, doors and plastic bags, establishing a link between the subject and the crime scene. These prints are found not only as visible lipstick marks, but as well as marks of humidity present in lips through saliva, mixed with the oiliness secreted by neighboring salivary and sebaceous glands. These substances, particularly the lipids and fatty acids, are transferred to an object through lip contact which becomes visible by using different forensic techniques [11–13].

Although previous studies have confirmed that lip patterns are individual and unique for each person, lip

<table>
<thead>
<tr>
<th>Pattern type</th>
<th>Females n (%)</th>
<th>Males n (%)</th>
<th>Total n (%)</th>
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<tbody>
<tr>
<td>I</td>
<td>91</td>
<td>38</td>
<td>129</td>
</tr>
<tr>
<td>I'</td>
<td>9</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>II</td>
<td>216</td>
<td>171</td>
<td>387</td>
</tr>
<tr>
<td>III</td>
<td>99</td>
<td>165</td>
<td>264</td>
</tr>
<tr>
<td>IV</td>
<td>10</td>
<td>29</td>
<td>39</td>
</tr>
<tr>
<td>V</td>
<td>3</td>
<td>7</td>
<td>10</td>
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</tbody>
</table>

Table 1. Prevalence of lip print pattern types

<table>
<thead>
<tr>
<th>Pattern type</th>
<th>Females n (%)</th>
<th>Males n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>20.09</td>
<td>7.69</td>
<td>22.43</td>
</tr>
<tr>
<td>I'</td>
<td>2.34</td>
<td>0.96</td>
<td>1.87</td>
</tr>
<tr>
<td>II</td>
<td>47.66</td>
<td>46.15</td>
<td>53.27</td>
</tr>
<tr>
<td>III</td>
<td>25.23</td>
<td>38.46</td>
<td>40.86</td>
</tr>
<tr>
<td>IV</td>
<td>3.74</td>
<td>5.29</td>
<td>8.65</td>
</tr>
<tr>
<td>V</td>
<td>0.94</td>
<td>1.44</td>
<td>1.92</td>
</tr>
</tbody>
</table>
print similarities between family members strongly indicate the possibility of inheritance patterns. In 2008, Augustine et al. evaluated a possible hereditary lip print pattern, and found a significant resemblance between parents and their offspring [14]. Vats et al. also concluded that there is a similarity of lip prints among parents and their offspring, with no clear association in lip print patterns of siblings, including monozygotic twins [15]. Ghalaut et al. reported an 83% resemblance of lip patterns and no statistically significant difference in the parents/offspring study, indicating the influence of heredity on wrinkles and grooves morphology present in the red part of human lips [16]. These findings implicate that, since heredity may play an important role in lip print development, geographically close ethnic groups may tend to share similar lip print patterns in comparison to distant populations. Thus, a characteristic lip pattern may indicate the geographical and racial origin of a person [17].

Several studies have confirmed that lip print patterns may significantly vary among distinct populations. A collaborative study of populations from India, Saudi Arabia, Spain and Nigeria showed significant inter-ethnic differences [18]. The Indian prints revealed an almost equal propensity for bifurcated and incomplete vertical patterns (corresponding to types II and I) accounting for approximately 30%. The principal pattern observed in the population of Nigeria was the complete vertical type (corresponding to type I), which was found in 50% of analyzed segments. The bifurcated pattern was the most prevalent in the populations of Saudi Arabia and Spain (38% and 66%, respectively). A study of Malay population showed that the most common lip print pattern among the study group was type I (29.84%) followed by type II and type III [19].

Costa et al. [1] reported the prevalence of types II and III (35.5% and 34%, respectively) in the Portuguese population, while Popa et al. [20] noted similar results in the population of Romania, with the predominance of type III, followed by type II.

The results of the current study are in accordance with the results of previous studies of European populations, showing the prevalence of bifurcated and intersected lip print patterns.

In several recent studies gender differences were recorded in lip print patterns, suggesting that variations in patterns among males and females may help in the context of personal identification and sex determination. In European population [1, 20] patterns I and II were dominant in females, while patterns III and IV were more characteristic for males. However, the most prevalent type for each gender was not the same in every study, suggesting population-specific characteristics of lip patterns [1, 3, 20–22]. Although some researchers claimed high success rate in the detection of gender based on the lip print pattern type, a number of studies reported that there was no statistically significant difference between male and female lip print patterns [18, 23, 24]. Analysis of lip patterns for sex estimation can be a subjective process which must be performed with great caution, since a false estimation can prejudice a forensic case [25].

The results of this study showed that the upper lip in both genders showed a predominance of type II pattern. Statistical analysis revealed a significant difference in upper lip patterns between genders due to type I and III patterns. In addition, lower lip patterns significantly differed between genders in all lip print types except type V and type I, supporting the hypothesis that lip prints may be useful in gender determination.

**Conclusion**

Being permanent and distinctive, lip print patterns may be used to distinguish individuals and they are an important form of transfer evidence which can be found at crime scenes and provide a direct link to a suspect.

Since heredity may play an important role in lip print development, the characteristic lip pattern may indicate the geographical and racial origin of a person.

The current study showed the prevalence of the bifurcated and intersected lip print patterns in the population of Vojvodina Province, which is in agreement with the results of previous studies in European populations.

Cheiloscopy requires more long-term studies with larger samples in order to be substantially documented and provide more reliable and accurate results.

**References**


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