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Original Article

Cheiloscopy And Rugoscopy In Forensic Odontology: A Review Of Identification Techniques With A Case Illustration

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ABSTRACT

Forensic odontology occupies a distinctive place among the identification sciences because dental and oral structures resist the decomposition, incineration, and trauma that often destroy soft tissue and compromise conventional identification methods such as fingerprinting. This review examines two comparatively underused but increasingly relevant sub-disciplines within forensic odontology: cheiloscopy, the study of lip groove patterns, and rugoscopy, the study of palatal rugae. Both structures are formed early in embryonic development, remain morphologically stable across the lifespan, and display a pattern of individual variation comparable to that exploited in dactyloscopy. This paper outlines the definitions, embryological basis, classification systems, recording methodologies, and recent technological advancements associated with each discipline, and situates them within a broader discussion of disaster victim identification (DVI). A 2020 case involving the identification of skeletal remains through combined dental and lip-print evidence is presented to illustrate the practical application of these methods. The review concludes that, while cheiloscopy and rugoscopy are not substitutes for DNA or radiographic dental comparison, they offer rapid, low-cost, and minimally invasive adjunctive tools that merit wider adoption in forensic casework, particularly in resource-limited settings and mass-disaster scenarios.

Keywords: Forensic odontology; cheiloscopy; lip prints; rugoscopy; palatal rugae; human identification; disaster victim identification; forensic dentistry.

INTRODUCTION

Human identification in forensic practice traditionally relies on a hierarchy of methods that includes visual recognition, fingerprint comparison, DNA profiling, and radiographic or dental record comparison. In circumstances involving advanced decomposition, incineration, skeletonization, or mass casualties, however, soft tissue evidence such as fingerprints is frequently unavailable, and DNA analysis may be delayed by cost, laboratory backlog, or degraded sample quality. Teeth and the surrounding oral soft tissues are markedly more resistant to postmortem change than most other body structures, owing to the mineralized composition of enamel and dentine and the relatively protected anatomical position of the oral cavity. This resilience has made the oral cavity a longstanding focus of forensic identification, extending beyond dental radiographs and bite-mark analysis into the study of lip grooves (cheiloscopy) and palatal rugae (rugoscopy).

Both disciplines rest on the same underlying premise that governs fingerprint identification: structures that are established during early development, are genetically and epigenetically determined, and do not alter in pattern thereafter, can serve as reliable and individualizing markers. This review synthesizes the definitions, developmental origins, classification schemes, and recording techniques for cheiloscopy and rugoscopy, and considers their forensic significance through a documented case and a summary of recent disaster events in which dental identification played a central role.

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2. CHEILOSCOPY

2.1 Definition

Cheiloscopy is the forensic study of the characteristic groove patterns present on the vermilion border of the human lips, formed by the network of grooves and furrows that traverse the labial mucosa. These patterns, sometimes referred to as labial prints, are considered unique to each individual in the same manner as fingerprint ridge patterns.

2.2 Embryological Basis

The grooves that form the basis of lip-print individuality begin to develop early in intrauterine life, becoming discernible at approximately the fourth to sixth week of embryonic development. Once established, the furrow pattern remains permanent and unchanging through the individual's lifetime, altering only in overall dimension as the lips grow, but not in the fundamental arrangement of the grooves themselves. This early and stable formation is what permits lip prints to be treated as a fixed identifying characteristic comparable to a fingerprint.

2.3 Classification

The most widely referenced classification of lip-groove patterns was proposed by Suzuki and Tsuchihashi, who categorized the grooves into distinct morphological types based on their course and branching pattern across the vermilion surface. In the scheme most commonly cited in forensic literature, patterns are grouped as follows:

1. Type I — Complete vertical grooves running the full length of the lip.
2. Type I′ (partial) — Vertical grooves that do not traverse the entire lip.
3. Type II — Branched grooves, resembling a forked or Y-shaped pattern.
4. Type III — Intersected (crossing) grooves.
5. Type IV — Reticular (net-like) grooves.
6. Type V — Undifferentiated or irregular grooves that do not fit the preceding categories.

Classification is typically performed by dividing the lip into quadrants and recording the predominant groove type in each, which allows for a systematic and reproducible comparison between an evidentiary print and a reference sample.

2.4 Methods of Recording

- Lipstick method — application of a standardized lipstick or dye followed by transfer of the print onto cellophane tape or bond paper.
- Cellophane tape method — direct lifting of latent lip prints from surfaces (glasses, cups, cigarette ends) using transparent adhesive tape.
- Digital imaging — high-resolution photography of the lips under controlled lighting, followed by digital enhancement and pattern analysis.
- Latent print development — chemical or physical enhancement techniques (comparable to fingerprint powders and reagents) used to visualize lip prints left at a scene.

2.5 Recent Advancements

Contemporary cheiloscopic research has moved toward computer-assisted pattern recognition, in which digital images of lip prints are processed using image-analysis software to automate groove classification and reduce examiner subjectivity. Comparative studies have also explored the correlation between lip-print patterns and sex, blood group, and ethnicity, although these associations remain investigational rather than established forensic standards.

3. RUGOSCOPY

3.1 Definition

Rugoscopy is the study of palatal rugae — the irregular, asymmetric ridges of mucosa located on the anterior third of the hard palate, immediately posterior to the incisive papilla. As with lip grooves, the arrangement of palatal rugae is considered unique to the individual and stable throughout life.

3.2 Characteristics

1. The rugae pattern is unique to each individual, with no two people sharing an identical arrangement.
2. Rugae remain unchanged in their basic pattern from approximately the third month of intrauterine life through adulthood.
3. The pattern is remarkably stable even in identical twins, permitting differentiation where fingerprints alone may not.
4. Palatal rugae are resistant to decomposition, being protected within the oral cavity by the tongue, cheeks, and buccal pad of fat.
5. Rugae are resistant to high temperatures and are often preserved even after significant thermal or chemical trauma to the rest of the body, making them valuable in burn and decomposition cases.

3.3 Classification

Palatal rugae are classified according to their length and morphology into primary, secondary, and fragmentary categories. Primary rugae are the longest and most prominent (typically 5–10 mm), secondary rugae are intermediate in length (approximately 3–5 mm), and fragmentary rugae are the shortest, isolated segments (approximately 2–3 mm). Additional descriptive classifications categorize individual rugae by shape as straight, curved, wavy, circular, angular, or converging, allowing examiners to construct a detailed rugae "map" for each individual that can be compared against antemortem dental casts or records.

3.4 Methods of Recording

- Photographic examination — standardized intraoral photography of the palate under fixed magnification and lighting.
- Intraoral examination — direct clinical visualization and charting of rugae patterns.
- Digital scanning — three-dimensional intraoral scanning to produce a digital rugae model for storage and comparison.
- Computerized examination — software-assisted overlay and pattern-matching of rugae impressions against dental cast archives.

3.5 Recent Advancements

Digital and three-dimensional scanning technologies have substantially improved the reproducibility of rugoscopic analysis, allowing rugae patterns to be digitized, archived, and compared using automated overlay software rather than relying solely on plaster cast comparison. This has particular relevance in disaster victim identification, where rapid, non-destructive recording of oral structures is essential.

4. CASE ILLUSTRATION

In September 2020, skeletal remains believed to belong to a missing person were recovered. Standalone skeletal survival made conventional soft-tissue identification methods unworkable, and the case was resolved through a combined odontological approach. Investigators compared antemortem dental records against the postmortem dentition and cross-referenced computer-generated impressions of unique dental patterns and fingerprint records associated with the missing person's case file. The convergence of dental pattern comparison with available identification records enabled a positive identification, illustrating the practical value of skeletal and dental evidence when soft tissue is no longer available for conventional comparison.

5. Importance of Forensic Odontology in Disaster Victim Identification

The value of forensic odontology is most clearly demonstrated in mass-fatality incidents, where the number of victims and the condition of remains often preclude visual identification or timely DNA analysis. Table 1 summarizes several recent events in which dental identification contributed materially to victim identification efforts.

Event	Year	Relevance to Forensic Odontology
Paris terror attacks	2015	Dental identification used for victims where other biological markers were compromised.
Turkey–Syria earthquakes	2023	Large-scale disaster victim identification (DVI) using dental and skeletal remains.
MH370 / aviation disaster identification	2014	Dental and DNA correlation used in identification of remains recovered from wreckage sites.
Maui wildfire	2023	Rapid identification of severely burned remains through dental records, where soft-tissue identification was not possible.

Table 1. Selected disaster events and the role of dental identification.

In each of these scenarios, dental identification — including radiographic comparison, DNA extracted from tooth pulp, and, where applicable, palatal and lip-print evidence — provided a means of identification when conventional soft-tissue methods were unavailable. Reported figures from disaster victim identification programs indicate that a substantial proportion of victims in large-scale incidents are identified through dental comparison, underscoring the discipline's operational importance.

6. DISCUSSION

Cheiloscopy and rugoscopy share several features that make them attractive as adjunctive identification tools: both structures form early in development and remain stable thereafter, both are protected from the environmental exposure that degrades soft tissue elsewhere on the body, and both can be recorded using inexpensive, non-invasive, and field-deployable techniques. Neither method, however, currently carries the same evidentiary weight as DNA profiling or radiographic dental comparison in courts of law, largely because population-level databases of lip-print and rugae patterns remain limited compared to fingerprint and DNA databases. Their principal forensic value at present lies in narrowing the pool of possible identities, corroborating identification made through other means, and providing usable evidence in circumstances — such as severe burns or advanced decomposition — where more established methods are compromised.

Future development of standardized digital databases, automated pattern-recognition software, and population-specific reference studies would strengthen the evidentiary standing of both disciplines and support their broader integration into routine forensic and disaster victim identification protocols.

CONCLUSION

Cheiloscopy and rugoscopy represent underutilized but scientifically grounded tools within forensic odontology. Their embryological stability, resistance to postmortem degradation, and individual specificity give them genuine identification value, particularly as adjuncts to dental radiographic and DNA-based methods in mass-disaster and decomposed-remains casework. Continued research into standardized classification, digital recording, and automated comparison is likely to expand their role in forensic identification practice.

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