

# Forensic Application of Palatal Rugae in

# DENTAL IDENTIFICATION



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## Abstract

Palatal rugae pattern analysis has been employed successfully in positive human identification. However, reports of the validity of the technique are conflicting. This report explores the viability of the use of palatal rugae in forensic dental identification and discusses the pros and cons of the subject. The level of evidence for the application of palatal rugae in dental identification was found to be insufficient. A well-designed research protocol must be developed to determine if there is a statistical significance in utilizing digital photographs of palatal rugae for forensic dental identification purposes.

One of the main focuses of the forensic odontologist (dentist) is human identification. Dental identification can be used as the sole method of identifying a deceased person. Dental identification is based on the comparison of antemortem and postmortem records. The records collected to identify a decedent should be accurate and totally inclusive of objective findings. Not only should the teeth be assessed, but the findings should come from examining, both clinically and radiographically, the oral cavity and all its structures. Other better-known methods such as DNA analysis and fingerprints are also used alone as means of identification. Some researchers have gone as far as to say: "It is a well established fact that a ruga(e) (an anatomical fold or wrinkle) pattern is as unique to a human as his fingerprints."<sup>1</sup> In the dental identification section of the *Manual of Forensic Odontology*, an example of a dental identification report states: "Although distorted by the trauma, the rugae pattern of Mr... was found to match that of John Doe 'C'."<sup>2</sup> The comparison of the rugae patterns was then graphically shown. The purpose of this article will be to review the literature to determine if there is enough evidence to establish the use of palatal rugae in dental identification.

The palatal rugae are located on the anterior portion of the maxilla (upper jaw) (Figure 1). Anatomically, the rugae consist of around 3 to 7 rigid and oblique ridges that radiate out tangentially from the incisive papilla (a rise in the palatal gingiva immediately anterior to the underlying incisive foramen).<sup>3</sup> Histologically, the rugae are stratified squamous (layered scales), mainly parakeratinized epithelium on a connective tissue base, similar to the adjacent tissue of the palate. Embryologically, Thomas<sup>4</sup> reported differences in the rugae cores from human embryos of over 20 weeks. He found the reticulin fiber content to

be very delicate and the fibroblasts to be different in amount and size from the adjacent palatal tissue. Coslet et al.<sup>5</sup> reported the clinical removal of palatal rugae is not permanent and that when removed, the rugae returned several months later.



In a case study, Breault et al.<sup>6</sup> reported on a single case of a 22-year-old white male. A free gingival graft was placed on the edentulous (toothless) buccal gingiva corresponding to tooth #23. The graft was harvested from the palate and included the palatal rugae. After 2 months, the recipient site displayed prominent ridges and a gingivoplasty was performed. After 9 years, the subject returned for treatment and the palatal rugae had reformed in the graft area. This study shows that the rugae can be transplanted to different parts of the body. If transferred to other areas of the anterior palate, rugae can easily be confused in identification.

In a case report, Thomas and Van Wyck<sup>1</sup> describe the identification of a badly burned body that was found with a set of dentures nearby. These dentures were compared to a set of dentures found in the suspected victim's house. Plaster casts of both maxillary dentures were made and the rugae and midpalatal raphe (the seam-like union of the two

lateral halves of the roof of the mouth) were traced on acetate paper and superimposed on photographs of the other models. The lateral and frontal tracings matched well enough to be beyond doubt. Thus, from a subjective view, the author was able to report to the police a match beyond reasonable doubt.

Jacob and Shalla<sup>7</sup> designed a study in which they collected data from 14 subjects using dental stone casts. The casts were fabricated from the internal aspect of an existing maxillary denture, the maxillary edentulous arch of the subject (representing a model from the deceased's dentist), and the internal aspect of a newly constructed maxillary denture. These casts were then evaluated in 28 trials. The first 14 trials had a single examiner matching 8 casts from the new dentures against 7 randomly chosen existing denture casts. The second 14 trials had a single examiner matching 8 new denture casts to casts of existing dentures and alginate impressions in 2 trials, existing denture casts in 7 trials, and alginate impressions in only 2 trials. The examiner was blinded to the data collection and study design and evaluated each trial of 8 casts based on certain specified matching or non-matching criteria. The examiner also rated his final decision as equivocal or unequivocal, which was purely subjective. When only rugae were used as the criteria for identification, 79% accuracy with equivocation was demonstrated.



Figure 1: Palatal Rugae

**“Dental identification can be used as the sole method of identifying a deceased person. Dental identification is based on the comparison of antemortem and postmortem records .... Not only should the teeth be assessed, but the findings should come from examining, both clinically and radiographically, the oral cavity and all its structures.”**

The authors of the study decided the low level of identification was caused by rugae obliteration in the fabrication of the dentures. This could have occurred during denture adjustment or palatal relief chambers. Also, rugae variation from trauma and disease could explain the missing rugae. Therefore, palatal rugae tracings, derived from dentures, do not give the desired accuracy needed for a forensic dental identification.

In a case report, Gitto et al.<sup>8</sup> gives step-by-step instructions on how to add palatal rugae to a complete denture. The added rugae improve speech patterns by incorporating texture into the anterior denture region. Certain patients require a tactile sense to cue or orient their tongue. The addition of rugae to an existing denture takes about 30 minutes. In forensic identification, each human is considered unique, and stable points of singularity are treasured. The forensic dentist should be aware that forgery of rugae patterns could easily be accomplished.

A concern about palatal rugae voiced by many researchers is the possibility of rugae patterns changing with age and other outside influences. Orthodontic movement,<sup>9,10</sup> extractions of adjacent teeth,<sup>11</sup> cleft palate surgery,<sup>12,13</sup> periodontal surgery, and forced eruption of impacted canines are only some of the concerns. In a double blind study, English et al.<sup>14</sup> selected 25 orthodontic cases with pretreatment and post treatment dental casts. The casts came from subjects over 14 years of age. The time from pretreatment to post treatment was from 18 to 60 months. One hundred maxil-

lary casts were duplicated from random patients treated at the site. The casts were trimmed so only the rugae were visible. Then the 25 post orthodontic casts were placed within the 100 casts. Seven dentists and 2 dental assistants were chosen as evaluators. Five of the dentists with varying forensic experience in identification were assigned as individual evaluators. Two teams were also formed, with one consisting of the two remaining dentists and the other consisting of the two remaining dental assistants; both teams had no forensic experience. Each individual or team was given 25 pre-orthodontic dental casts and was asked to compare them to the 125 casts for matches. The time required for the comparison, coupled with the correct percentage, was recorded. Eight investigators correctly matched 100% of the casts and one investigator correctly matched 88%. The use of teams significantly decreased the time needed for correct identification. From this study, it can be observed that palatal rugae can be used for identification purposes. It also demonstrates that changes that occur from orthodontic movement, extractions, aging, and palatal expansion do not modify the rugae enough to hamper identification.

Almeida et al.<sup>15</sup> conducted a double blind study of 94 patients enrolled to treat early class-II occlusion. Children 6 to 16 years of age were randomly assigned to three groups: a control group, a headgear group, and a functional-appliance group. Palatal rugae and raphe were traced and recorded with a reflex metrograph, which digitalized



**Figure 2: Tracing of Palatal Anatomy (A: Incisive Papilla; B: Median Palatine Suture; C: Rugae)**

the reference points. Results indicated that the medial rugae were stable (the first medial rugae in particular) and no significant differences were found. However, the lateral rugae showed significant changes.

Bailey et al.<sup>16</sup> presented the results of a double-blind study in 57 adult patients. The maxillary casts of pre- and post-orthodontic treatment were examined. Two groups of patients, an orthodontic extraction group (where two maxillary premolars were extracted) and a non-extraction group, were assessed. Statistically significant changes in rugae were noted only in the extraction group.

Though statistically significant changes occurred, the medial and lateral points of the third rugae were not considered clinically significant and can be used for anatomic reference points in dental cast analysis.

Taken together, these two studies highlight the discrepancy in the stability of the palatal rugae after orthodontic treatment and extractions. Almeida et al.<sup>15</sup> purports the first rugae as the most stable, whereas Bailey et al.<sup>16</sup> describes the third rugae as the most stable. These findings present further contradiction to the use of rugae in identification due to possible changes over time and after events.

Few studies using palatal rugae as a means of forensic identification are found in the literature. Most of these studies are case reports or are inadequately designed with small numbers of

subjects. The idea of rugae being unique to an individual but not having exact measurements is a challenging concept. Though promising, there is not enough evidence to allow palatal rugae to be used as a sole means of dental identification.

A research protocol is being developed to attempt to show if there is a statistical significance in utilizing digital photographs of palatal rugae for identification purposes. Palatal rugae will be digitally photographed and placed in a databank similar to that used in digital fingerprint analysis (Figure 2). Identification will be attempted by matching a digital photo of palatal rugae to digital photos in the databank.

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