

**UNIQUENESS OF PALATAL RUGAE IN FORENSIC SCIENCE- A REVIEW****NABEEL AHAMED,¹ VICTOR SAMUEL^{2*} AND MAHESH R³***1 Under graduate trainee, Department of Pediatric Dentistry, Saveetha University, Chennai**2,3 Assistant Professor, Department of Pediatric Dentistry, Saveetha University, Chennai***ABSTRACT**

Forensic dentistry is the proper handling, examination and evaluation of dental evidence, which will be then presented in the interest of justice. De-oxy ribonucleic acid, fingerprint, post and ante-mortem dental record comparisons are the most commonly used scientific methods of forensic identification. Palatal rugae becomes prominent in prenatal stage and maintain the shape throughout life, although they may increase in dimension. The basic assumption of its use in forensic science is that the rugae pattern was unique to every individual just like fingerprints and did not change during the course of life and was well protected from the various environmental factors. This article aims at reviewing the uniqueness of palatal rugae and its importance in the identification of an individual and their gender for use in forensic sciences.

KEYWORDS: Palatal Rugae, Forensic dentistry, Rugae pattern, Dental evidence

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INTRODUCTION

Forensic dentistry is the proper handling, examination and evaluation of dental evidence. The identification of unknown individual has always been of paramount importance to society¹. Identification of the deceased is a prime requisite for certification of death and for personal, social and legal reasons. De-oxy ribonucleic acid (DNA), fingerprint, post and ante-mortem dental record comparisons are the most commonly used scientific methods of forensic identification. Limitations to the use of fingerprints, photographic or skeletal reconstruction occur in situations where the human body is charred or mutilated. In those cases, oral structures are more durable in identification using dental records as they are more resistant to thermal, mechanical and physical damage. The dental pulp present inside every root canal is an excellent source of DNA². However, many ante mortem dental records may be inaccurate or incomplete as dental therapy undergone by the individual between the events may not be recorded. Also, additional dental treatment might have been performed in the time interval between the creation of a dental record and death of the individual. In such cases palatal rugae would serve as an adjunct to individual and gender identification. This article aims at reviewing the uniqueness of palatal rugae and its importance in the identification of an individual and their gender for use in forensic sciences.

DEVELOPMENT OF RUGAE

Palatal rugae starts to develop at the third month of intrauterine life, from the covering connective tissue in the palatine process of the maxilla. The development is controlled by epithelial - mesenchymal reactions, where specific extra cellular matrix molecules are expressed during development. The rugae then appears distinguished in a 32mm human embryo close to the incisive papilla. They become prominent in prenatal stage and maintain the shape throughout life, although they may increase in dimension³.

HISTORICAL BACKGROUND

Since the initial documentation on the use of palatal rugae in forensic investigations by Allen in 1889 several studies were conducted to assess the utility of palatal rugae especially in

personal identification⁴. The basic assumption of its use was that the rugae pattern were unique to every individual just like fingerprints and did not change during the course of life and was well protected from the various environmental factors. Classification of the rugae based on the length as well as the shape formed the basis for use in personal identification and most of the studies were aimed to determine this aspect of palatal rugae analysis⁵⁻⁸.

ADVANTAGES OF RUGAE PATTERN IN FORENSIC SCIENCES IN COMPARISON WITH OTHER DENTAL STRUCTURES

The uniqueness of palatal rugae is that every individual has a unique pattern of palatal rugae⁶. The palatal rugae are inalterable, that is they never change patterns from birth till and even after death⁶. Palatal rugae is well protected from thermal mechanical and physical insults as it is encased between the floor of the nasal cavity superiorly, the tongue inferiorly, the lips and the maxillary incisors anteriorly and the cheeks and maxillary molars bilaterally⁹. Evidence suggests the stability of palatal rugae in conditions of extreme thermal changes as noticed in a study conducted to determine the extent of preservation of palatal rugae for use as an alternative identification tool in mass disasters, using a study group comprising burn victims and cadavers simulating forensic cases of incineration and decomposition. The thermal effects and the decomposition changes on the palatal rugae of burn victims with panfacial third degree burns and human cadavers in storage were respectively assessed and graded on a new scale. When categorized under grades of burn injuries, 93% of burn victims and 77% of human cadavers had Grade 0 changes (normal). When changes were noted, they were less pronounced than the generalized body involvement of burns in burn victims and the generalized body decomposition of human cadavers⁹. It is easy to analyse the pattern of rugae and is economical and quick as simple impressions using reversible hydrocolloids is suitable for analysis. Moreover, studies showed that the morphology of palatal rugae remains intact even after fixed orthodontic therapy. Gender identification studies demonstrate that there

are differences in patterns of rugae among the two genders⁸. Advantages of casts over photographs add to benefit of rugae analysis. The studies of casts over photographs presented comparatively more advantages as photography is highly technique sensitive and expensive⁵. Souza Lima in 1964¹⁰ assessed rugae of dental casts of individuals submitted to orthodontic treatment, whose dental casts were obtained at treatment onset and after completion to control the evolution of the several types of malocclusion. The author concluded that there are no changes in the morphology or arrangement of palatal rugae. Individuals submitted to surgery exhibited a mild reduction of space among the rugae or even shortening or elongation, depending on the extent of the intervention performed. There was no remarkable damage in any such case¹⁰.

SEQUENTIAL ANALYSIS OF RUGAE PATTERN

The pattern of the rugae, i.e., the length, prevalence and area depend largely on the shape and pattern of the upper dental arch. Thus, it is of at most importance to study the maxillary arch shape and other characteristics. On a systematic basis the analysis begins with *Dental arch and palate analysis*. The dimensions of the palate and the central point of the palate are to be analysed initially. This would give a clue as to how the rugae have been distributed¹¹. *Width of the palate* Line joining the tips of mesio-palatal cusp of permanent maxillary first molar or the deciduous second molar is used to project a point below and perpendicular to it on the gingival margin to determine the width. *Depth of the palate* Point below and perpendicular to line joining the tips of mesio-palatal cusp of permanent maxillary first molar or the deciduous second molar on the mid palatal raphe is used to determine the depth. *Centre point of the palate* Perpendicular distance between the line joining the tips of mesio-palatal cusp of permanent maxillary first molar or the deciduous second molar and the point on the mid palatal raphe determines the centre.

METHOD OF INSPECTING AND COMPARING RUGAE PATTERNS

Various methods of palatal rugae analysis are available currently. Intra-oral examination is the

most used technique as it is easy to perform and is cost effective. The disadvantage is that no records exist with this method which makes future comparisons impossible¹². To obtain a detailed and exact analysis and also to overcome the problems concerning future comparisons, oral impressions and oral photographs are required. The use of dental casts is advantageous as they simplify analysis, reduce costs and can be easily done in any laboratory⁶. The dental casts are made, the rugae outline is drawn confining to the shape of the individual rugae and the length is also measured. This is done as per the standard classification and according to the individual study design. The utilization of digital photography, personal computers and specific software's to edit and use digital images allow a significant improvement in recognition of the rugae pattern thereby allowing easy handling. Another technique describes the superimposition of the photographs for comparison of palatal rugae. The results can be enhanced by the use of computer software such as Adobe Photoshop⁶. Computer software programs such as RUGFP-ID match are available for palatal rugae analysis¹³. Other complex techniques like stereoscopy for obtaining a three dimensional image of palatal rugae anatomy, stereophotogrammetry which allows for an accurate determination of the length and position of every single palatal rugae can also be used¹².

DISCUSSION

Rugae pattern in individuals definitely show differences, and they are also capable in defining the race, geography and gender of the individual.

Race

Rugae patterns among various races show unique evidence of individuality. Analysis of palatal rugae forms in two population groups residing in Australia (Australian Aborigines and Caucasians) found an overall statistically significant association between rugae forms and ethnicity. The number of primary rugae was higher in Australian Aborigines but Caucasians showed higher proportion of rugae longer than 10mm. Among the shapes it was found that straight forms were more common in

Caucasians, while wavy forms were commoner in Aborigines¹⁴.

Geography

In a study which compared rugae pattern among Indian and Tibetan population results show that the former have significantly higher numbers of curved rugae and the latter have a higher number of wavy patterns¹⁵. Other studies carried out amongst geographically different regions in India such as between Madhya Pradesh and Karnataka¹⁶ and Manipur and Kerala¹⁷ have demonstrated significant differences in rugae pattern. A study performed to compare the rugae patterns between two groups of Indian population categorized as Southern Indians and Western Indians showed that wavy and curved forms were more prevalent in both the groups followed by straight rugae. Statistically significant differences were observed between the rugae shapes in the two population groups, but sexual dimorphism was not present¹⁸. A study was conducted to compare rugae patterns among Indians and Nepalese, which revealed that the number of rugae in Indians were more on the right side than the left side and vice versa in the Nepalese⁹. Numbers of primary rugae were higher in Indians, while secondary and fragmentary rugae numbers were higher in the Nepalese. The numbers of rugae on the right side were fewer than on the left side taking into account both primary and secondary rugae¹⁴.

Gender

In a study, observations were made that the Incidence of primary, secondary, straight and wavy rugae were more in females than male

participants, whereas curved rugae had more predilections towards male population. Statistical analysis showed there was no difference in rugae pattern between genders, but there was a statistical difference in the number of the unification type of rugae which was found to be higher among the among the females than the males. In addition, statistical difference was observed between male and female in total number of rugae¹⁹. During the comparison of rugae among men and women, many studies revealed that wavy and curved patterns show sexual dimorphism, but converging type of rugae were seen to be higher in females⁸. A study conducted in Saudi Arabia demonstrated that there was no significant difference in total number of rugae between male and female Saudi Arabians, but significant differences were found in two shapes, the converge type which was found to be higher in females and the circular types were found to be higher in males²⁰.

CONCLUSION

It is clear from all the studies done that the rugae pattern of every individual is unique. Also, there exist similarities between people of the same race and geographic location. Other studies revealed that even identification of gender is possible with the patterns of rugae. Thus, it can be strongly concluded that palatine rugae can serve as an excellent aid in individual and gender identification in cases where finger prints, photographic or skeletal reconstruction is not possible, and also as an adjunct to identification when discrepancies exist in the other samples of evidence.

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