Importance of palatal rugae in Prosthodontics as an aid an individual identification

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ABSTRACT

Fingerprints and dental means represent the most scientifically reliable methods of identification. In general, the greater the degree of tissue destruction, the greater the importance of dental characteristics in affecting proper identification. Palatine rugae are permanent and unique to each person, and clinicians and scientists can use them to establish identity through discrimination. Marks such as imprints of palatal rugae on dentures can be of use in identification if previous records exist. One hundred and fifty casts were randomly selected for patients from the prosthodontics clinic, their ages ranged from 25 to 50 years. A primary maxillary alginate impression was made for every patient. The impression were poured in dental stones. All casts were photographed, studied and described. Comparing the photographs and matching them with their corresponding casts was done by medicolegal experts and dentists. A classification system was developed on the basis of the morphologic features of the palatal rugae. Three district types were noticed, namely parallel linens (50.66%), arborizations (24.67%) and irregular pattern (24.67%). The study showed that the palatal rugae pattern is sufficiently characteristic to discriminate between individuals. Palatal rugae plays a significant role in prosthodontic clinic.

Keywords: Forensic dentistry, palatal rugae ,human identification, dental record

1. Introduction

Fingerprints and dental records represent the most scientifically reliable methods of identification. In general, the greater the degree of tissue destruction, the greater the importance of dental characteristics in affecting proper identification.

The United Nations Universal Decoration of Human Rights issued in 1948 states that "everyone has the right to recognition everywhere as a person before the law". This implies that any individual has a right "to possess his personal identity unquestioned even after death". In other words persons who are born with an identity, deserve the right to die with an identity (Keiser-Nielsen 1968).

In modern society, death is a complicated medico-legal matter. The accurate identification of human remains is a public duty justified by social, legal and insurance considerations (Puerini, 2005). Odontologic evidence is second only to fingerprints as the best and most accurate means of identification. Upon exposure to physical injury and putrefaction changes, the human dentition, the enamel of which is the hardest substance of the body, outlasts. all other tissues (Krishan *et al.,* 2015). Some of the important legal problems of identification are wills, the settlement of estates, exclusion of possible foulplay, the remarriage of survivals, and the issuance of death certificate. Quite often these problems cannot be resolved unless the unknown is positively identify (Hinchliffe, 2011).

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The basis for the science of forensic odontology is the fact that teeth, dental restorations, prosthesis ,trabeculae in bone pattern, rugae of the hard palate, cracks and bony protuberances present a vast number of individual details (Patil *et al*., 2008; Sheikhi *et al*., 2018).

Odontologic identification is also based upon the process of comparison. In the case of an identified victim, the odontologist compares the evidence derived from an oral autopsy with preexisting dental records and radiographics. Dentures may be helpful in identification, where they can be used for comparison of the alveolar ridge contour and palatal soft tissue configuration. Retained impression casts of the ridges may also be useful in these instances (Kar *et al*., 2016).

Cases are quoted where teeth or dentures have played a major role in identification, in violence, accidents, war disaster, and also in cases of loss of memory, unconsciousness, in old people's home, geriatric units and mental homes (Krishan *et al*., 2015).

For centuries anatomists have shown interest in the evolutionary development of the folds of tissue found in the roof of the human mouth which is the palatal rugae. Situated just behind the central incisors and slightly in front of the position of the anterior palatine canal is a small pear-shaped eminence called the papilla of the palate (incisive papilla). Extending posteriorly from this, and following the raphs, is also a ridge of mucous tissue. A number of smaller irregular ridges pass out laterally and extend back as far as the second bicuspid or premolar. These are called plicae palatinae, or folds of the palate. The papilla, with is posterior extension, together with lateral ridges which are arranged on either side in known as the rugae (Fig,1) .Their core is made of a dense connective tissue layer with fine interwover fibres (Indira *et al*., 2012).

The oral cavity plays a significant role in identification of victims because it comprises of unique anatomy of dentition. Palatal rugae have been considered important for human identification due to its stability and accuracy, which is equivalent to that of fingerprint. The palatal rugae are very important in dental and forensic practice. Also it can be used to evaluate the dental movements, as they remain stable over a person's life. Finally, the palatal rugae can be used as reliable guide to the forensic identification (Mohammed *et al*., 2013). Rugae are protected from trauma by their internal position in the head and they are insulated from heat by the tongue and the buccal fat pads (Thomas and Kotze 1983; Hermosilla *et al*., 2009). The palatal rugae are unique for an individual and remain unchanged during individual's lifetime. Furthermore, because of their anatomical position inside the oral cavity, palatal rugae have higher probability of remaining intact in trauma, incineration, and decomposition. These unique characteristic make the palatal rugae an ideal and reliable human identification tool (Caldas *et al*. 2007).

The present study was carried out to develop a classification system of the palatal rages and to determine the frequency distributions of morphologic features of the rugae, in order to prove that palatal rugae are an aid in identification.

Material and Methods

One hundred and fifty dental casts of patients were selected randomly from the Prosthodontic clinic. Their ages ranged from 25 to 50 years. They were 75 males and 75 females.

Primary maxillary impression of the dental arch for every patient was made using irreversible hydrocolloid impression material (Alginate, Dentsply, York, Pa) in a rim lock metal stock tray. Impression was poured in type III dental stone (Golden, WhipMix Corporation). The materials are mixed according to the manufacturer's instructions. The dental casts obtained with a good quality (free of air bubble or void in anterior palatal area) and with known age, sex. Exclusion criteria were lesion or scar in the anterior palatal region, gross maxillary anomalies.

The casts were divided into 3 groups, each of 50 casts. The first group was complete edentulous casts, the second group was partially edentulous casts and the third group was complete dentulous casts. The casts of the first and second groups are replica of the patient's dentures.

All casts were photographed. The pattern of the palatal rugae were observed and described.

Trials to compare and match the photographs with their corresponding casts were done by five medicolegal experts (staff members of forensic Medicine & Toxicology and five dentists, in order to prove that palatal rugae characteristic for every individual.

3. Results

One hundred and fifty casts were thoroughly studied and described in this study. A classification system was developed on the basis of the morphologic features of the palatal rugae. Three distinct types were noticed, namely parallel lines, arborization and irregular ridges (figures 2-4). Parallel lines passing laterally from the raphe were observed in 50.66% of casts. In 24.67% of casts the ridges took the shape of arborization or tree-like with one or two bifurcations on each side of the raphs. The remaining (24.67%) showed irregular pattern (Table I).

Table I: Frequency distribution of different patterns observed on 150 casts.

Type of pattern	No.	%
Parallel lines	76	50.66
Arborization (tree like)	37	24.67
Irregular pattern	37	24.67
Total	150	100.00

Table II showed that the parallel lines were the more common types that were symmetrically arranged on both sides of the raphe (57.89%). Only 10.81% of the casts with irregular ridges, showed symmetrical arrangement.

The number of ridges in the casts with parallel lines (n= 76) ranged between 2 and 5. More than half of the casts (52.63%) showed 3 parallel lines or ridges. Casts with 5 parallel ridges were the least commonly encountered (5.26%). 28.95% of casts with parallel lines had 4 ridges, while 13.16% had 2 ridges (figures 2, 5 and 6).

In the casts with pattern of arborization, 3 ridges were found in 56-76% of casts, and the remaining (43.24%) showed 4 ridges. One bifurcation on the branches on each side was observed in 56.76% of casts. The remaining (43.24%) showed 2 bifurcations (figures 3 and 7).

In the casts with irregular pattern, irregular prominences were observed in 67.57%, while the remaining (32.43%) showed multiple laterally placed ridged or lines with an irregular arrangement (figures 4 and 8).

Table II: Distribution of symmetrical and asymmetrical arrangement of the different pattern in 150 casts.

Type of pattern	Symmetrical Arrangement		Assymmetrical Arrangement		Total	
	No.	%	No.	%	No.	%
Parallel lines	44	57.89	32	42.11	76	100.00
Arborization (tree like)	14	37.82	23	62.16	37	100.00
Irregular pattern	4	10.81	33	89.19	37	100.00
Total	62	41.33	88	85.67	150	100.00

Table III showed the ratio between the rugae and the hard palate. In the casts with irregular ridges, rugae formed a wider area of the hard palate (figure 9). It ranged between 26.32% and 53.57% of the hard palate with a mean of 37.72 ± 6.78%. The area of the hard palate with rugae were narrower in the casts with parallel lines, as it formed a mean of 32.22 ± 3.86% of the hard palate.

Table III: Ratio between the palatal rugae and the hard palate.

Type of pattern	Range (%)	Mean (%)	S.D.
Parallel lines (n = 76)	20.00 - 46.7	32.22	3.86
Arborization (tree like) (n = 37)	28.57 - 46.67	37.36	7.698
Irregular pattern (n = 37)	26.32 - 53.57	37.72	6.87

All trials to compare and match the photographs with their corresponding casts were successful.
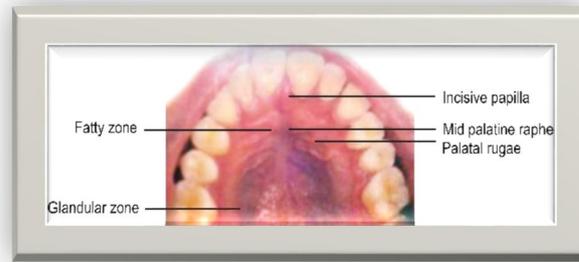
Fig.1: The different zones of the hard palate

Fig 2: Photography of complete edentulous cast showing palatal rugae in the form of 4 symmetrical parallel lines forming 37.5% of the hard palate

Fig 3: Photography of partially edentulous cast showing palatal rugae in the form of asymmetrical arborisation with one bifurcation forming 37.5% of the hard palate.

Fig 4: Photography of complete dentulous cast showing palatal rugae in the form of irregular pattern (irregular prominences) forming 39.47% of the hard palate.

Fig 5: Photography of complete edentulous cast showing palatal rugae in the form of two symmetrical parallel lines forming 23.26% of the hard palate

Fig 6: Photography of complete edentulous cast showing palatal rugae in the form of four symmetrical parallel lines forming 37.5% of the hard palate .

Fig 7: Photography of complete edentulous cast showing palatal rugae in the form of symmetrical arborisation with two bifurcation and forming 35% of the hard palate.

Fig 8: Photography of complete edentulous cast showing palatal rugae in the form of irregular pattern (laterally placed ridges) forming 31.11% of the hard palate.

Fig 9: Photography of complete edentulous cast showing palatal rugae in the form of irregular
       pattern forming 37.78 % of the hard palate.

4. Discussion

Dentures found at scene of accident or assault usually remain unharmed. They have marks which help to identify the victim. As denture markings are still uncommon, however, other marks such as imprints of palatal rugae can be of use in any antemortem record exists (Thomas and van Wyk, 1988). Palatal rugae are transverse, irregular, and asymmetric ridges of the mucous membrane that are situated in the anterior part of the palate behind the incisive papillae. During the 3rd month of intrauterine life, palatal rugae appear as localized epithelial thickening, next to the incisive papillae. They are completely formed by the 12th to 14th of the prenatal life. Thereafter, they experience changes in their size because of growth, but their shape remains stable. They are unique to each individual and of constant shape throughout life. Also found that the pattern of rugae similar in twins but no identical (Nayak *et al*. 2007, Gandikota *et al*., 2012; Herrera *et al*., 2017; Sheikhi *et al*. 2018).

In the present work, studying the casts of one hundred and fifty patients and their photographs helped us to develop a classification system. Three distinct types of pattern of parallel lines (50.66%) arborization (24.67%) and irregular pattern (24.67%).

Indira *et al.* (2012) described rugae as irregular and asymmetrical ridges passing laterally and obliquely. The ridges are not necessarily paralleling each other. They may have the appearance of symmetrical tree trunk with spreading branches

In the present study, the casts with parallel lines showed symmetrical arrangement of these lines or ridges on both sides of the raphe in 57.89% of cases, while symmetrical arrangement was in 37.84% of the casts with arborization and only 10.81% of the casts with irregular pattern.

In the present study, the number of ridges were counted. They ranged between 2 and 5 ridges in the casts with parallel lines. More than half of the casts showed 3 parallel ridges, while only 5.26% of the casts had 5 lines or ridges. In the casts with arborizations 3 or 4 branches were noticed to spread laterally from the raphe, with 2 or more lateral branches. In the casts with irregular pattern, irregular prominences were observed in 67.57% of cases, while laterally placed ridges in 32.43%. This results was in accordance with the report categorized rugae patter into 2 ways. Specifying the number of rugae and extend of rugae relative to teeth, further distinguished two types of rugae namely simple or primitive and more developed. There are different ways to analyze the palatal rugae. Intraoral inspection is easy, and economic method to record and does not require complex instrumentation but is difficult if a future comparative review is required. A more detailed and accurate and the need to preserve evidence may justify the use of photographs or impressions (Utsuno *et al.,* 2005). Currently, the digital models are effective tools in evaluating the different palatal rugae patterns (Taneva *et al*. 2015; Gibelli *et al*., 2018).

Comparing the photographs and matching them with their corresponding casts was successful in all trials by five forensic scientists and five dentists. This is in accordance with the results of several authors who compared and matched positively pre-and post-orthodontic treatment casts (Bailey *et al*. 1996; Hoggan and Sadowsky, 2001; Christou and Kiliaridis, 2008; Jang *et al*. 2009).

5. Conclusion

The palatal rugae are very important in dental, prosthodontic and forensic practice. palatine rugae used as a significant landmark in various dental treatment modalities and a reliable guide in superimposition of dental casts for prosthodontic purpose.

From this study, it was found that palatal rugae are sufficiently characteristic to discriminate between individuals. A palatal rugae pattern can be thus regarded as a mark if it can be compared to antemortem record. This forms the basis of the virtually important and often applied procedure for identification.

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Conflict of Interests

The authors declare that they have no conflict of interest.

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