

Root translucency and its efficacy in forensic age estimation: A review

Manas Bajpai*, Pradeep Yadav**

*Professor, Dept. of Prosthodontics, Swami Devi Dyal Dental College, Barwala, Haryana,

**Prof & Head, Dept. of Conservative Dentistry & Endodontics, Vananchal Dental College, Garhwa.

Abstract

Age is one of the essential factors in the identity of the person. Estimation of the human age is the procedure adopted by anthropologists, archeologists and forensic scientists. Different factors have been used for age estimation but none has withstood the test of time for adults above 25 years. Many variables have been used as age determinants and even dental histological techniques can contribute to age determination. The choice to use teeth for age determination is well accepted due to their longevity, ability of being resilient to change. According to Gustafson's measurement of root dentin transparency is the most reliable criteria for age estimation. Further, Johanson found that translucency was best correlated to age when used alone. The purpose of this article is to discuss not only the various factors that affect translucency but also the different studies done on root translucency with the relation of age estimation.

Keywords: Root translucency, Age estimation, Forensic Odontology.

Introduction

Transparency in dentin was recognized very early, the underlying process itself had not been identified. To this end number of researchers in the early and mid - 20th century undertook a variety of tests, with variable inferences.

Principle underlying translucency

Van Huysen et al¹ believed that translucency was the result of fatty degeneration, Beust² however

Suggested that dentine undergoes "Physiologic hardening" during the life time of a tooth - the result of increased deposition of calcific matter. In order to demonstrate this deposition he examined permeability of dentine in transparent and opaque areas using a variety of dyes. He observed that sclerosed areas of dentine were less permeable to the dyes and attributed it to "physiological elimination" of the odontoblastic process as a result of their calcification. He also observed that resistance to permeability was related to age. Tomes³ stated that translucency was the result of equalization in the different refractive indices of tubular and inter tubular dentine. Manly and Brooks⁴ applied a simple test to explain the optical basis for translucency. According to them, the refractive index (RI) of normal dentine was 1.33 and that of inter-tubular dentine 1.56 based on Tomes' opinion³. Under experimental conditions these

Corresponding author: Dr. Pradeep Yadav,
Post graduate student, Department of Oral and maxillofacial
Pathology, Jaipur Dental College Jaipur.

E-mail: docpradeepy@gmail.com

Tel: 07665129300

researchers tested the effect of different liquid media such as water (RI=1.45) a mixture of petrolatum and alphachloronaphthalene (RI=1.63) immersing tooth sections in these liquids, it was observed that translucency was greatest at RI=1.56, when the RI of tubular and inter tubular dentine was equalized. Thus, not only was the optical mechanism for translucency demonstrated, but also the hypothesis that tubular content was replaced by calcific matter was further supported. This and a number of other studies⁵ revealed the tubules as being completely obliterated by high - density material with an increasing age. Nalbandian et al⁶ demonstrated that in opaque zones of dentin the structure was similar to a sieve (i.e highly electron dense material) interspersed with fairly regular holes (patent dentinal tubules). Takuma observed that mineralized band has its origin during the early stages of dentine mineralization. However, in developing dentine, the border between it and the inter-tubular dentine is transitional whereas in mature dentine this border is well defined, with the peritubular dentine appearing as a ring shaped structure of much higher density. This indicated that peritubular dentine may have a tendency to become more calcified with age⁷. Kvaal et al cite studies confirmed this observation and goes on to state peritubular dentine as containing 9% more mineralized content⁸.⁹Takuma and Eda¹⁰ state that the organic base of the peritubular dentine is composed primarily of a substance that is morphologically structureless and chemically rich in acid mucopolysaccharides which is contrast to inter-tubular dentine. Trub et al¹¹ state that knowledge regarding development of sclerotic dentine is "far from complete", with many conflicting theories. According to Holland, "calcium phosphate precipitates on to the tubule wall from the supersaturated dentinal fluid" however, he adds that this is an oversimplification of the process of mineralization¹². The source of calcium phosphate is unclear: Branstrom and Garberogilo¹³ consider the oral environment, particularly saliva, to contribute the material - a suggestion disputed by Thomas et al since

if it were so, the translucency would be confined to the peripheral regions of the tooth and be a self limiting process.¹⁴ Others such as Vasilliadis et al¹⁵ believed the source to be the pulp, degenerative changes within pulp are more pronounced around the apex than crown. As a result of degeneration or cellular atrophy, there is a decline in the number of odontoblasts. Changes brought about by atrophy display marked spatial differences between the radicular and coronal pulp, which is one explanation for increasing translucency from apex towards crown¹⁶ since the tubules at the apex and around the periphery are narrowest, that get occluded first and are translucent¹⁷. Another reason is that the number of tubules per unit area in these parts of dentine is smaller¹⁸

Factors affecting translucency

Is translucency an exclusively age related process?

The fundamental principle of using translucency in age estimation is that it is a purely age related phenomenon. One of the strongest evidence in this regard comes from the study of Azaz et al.¹⁹ examined impacted canines - teeth that are beyond the influence of external factors that effect teeth and their function - and observed that the length of translucency steadily increase with age.

Bang and Ramm²⁰ had also made similar observation on a smaller sample, although they had not quantified it, these reports indicate that translucency is independent of exogenous factors and is an exclusively age related process.

Effects of pathology on translucency

However, reports also suggest that intra oral and systemic pathology contributes to dentinal translucency. Sengupta et al²¹ thought translucency formation was a defense reaction to caries and dental wear, which may be so in crown dentine. Bang and Ramm²⁰ considered the influence of toxins released

from diseased periodontal tissue and compromised pulp circulation. This was based on observations of exaggerated translucency in teeth with longstanding circulatory deficiencies. Diabetic metabolism is also considered to accelerate translucency²² Solheim and Sundnes²³ found no difference in the reliability of age estimation in cases of caries, pulp necrosis, apical periodontitis and marginal periodontitis is compared to healthy teeth; implying dental pathology did not affect the regressive change. Later Solheim²⁴ stated that periodontal destruction does not affect the distribution of translucency. Beust² argued that "in pathologic irritation lime salts are mechanically precipitated from lymph that soaks into a dying organic matrix "However one may need to consider the effects of tooth vitality on translucency studies carried out by Bang and Ramm²⁰ showed no signs of translucency in non vital teeth and teeth that are non vital for long periods of time may give underestimation of age.

Effects of postmortem interval on translucency

Marjodana et al²⁵ found translucency values to be higher for teeth obtained from skeletal remains from postmortem interval ranging from 21 - 37 years, as compared to freshly extracted teeth. Drusini et al²⁶ on the other hand found that postmortem interval did not affect age estimation using translucency

Effects of race on translucency

Whittaker and bakri²⁷ compared a European sample to three different population group from Asia, including Indians and found recognizable differences - the Europeans had much higher correlations than Asians among whom, Malays had the best followed by Indians and Chinese. Whittaker and Bakris study is one of few to examine racial variations in the relationship between translucency levels and age²⁸

The influence of sex on translucency

Some sex differences in translucency have been found by Solheim²⁹ who states that males have larger degree of translucency in incisors. Lorentsen and Solheim³⁰ also observed that the rate of translucency was faster in males and attributed it to "harder chewing habits of men". It must be noted, through, that these author who undertook analysis of translucency correlation to age for different tooth types - found that sex affected the age estimation outcome in only two of the ten tooth types viz. maxillary lateral incisor and mandibular central incisor. However, Bang and Ramm found no such difference²⁰.

Tooth type, Jaw and Translucency

Bang and Ramm²⁰ found translucency in teeth of the upper jaw to be better related with age although, overall, there was not much difference between the jaws. With respect to tooth type, numerous authors have found that translucency's relationship with age varies in different teeth,

Solheim and Sundncs²³ found maxillary premolars are more amenable to age estimation.

Conclusion

Age estimation of unknown person based on the examination of bodily remains could be performed either by osteological or stomatological method. A relatively simple and objective method for age estimation in adult person is by measuring of root translucency. According to Gustafson measurement of root dentin translucency is the most reliable criteria for age estimation.³¹ It was recognized soon after by Miles that, of the six variables suggested by Gustafson, translucency was among the easiest to assess. Furthermore, it was observed that translucency length had a reasonable linear relationship with age.³²

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