

The Influence of Age on Tooth Root Colour Changes

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ABSTRACT

The purpose of this study was to examine the relationship between tooth root colour and age, and its possible application in age assessment. In this research altogether 100 tooth roots have been analysed. All teeth, that is their roots, were digitally recorded and the colorimetric treatment was made using Adobe Photoshop 7.0 computer program. Studies have shown no significant difference between RGB values analysed on the whole root surface or only on its central part, with certainty $p > 0.99$. It is also established that there is no statistically significant difference in colouration on four anatomical surfaces (buccal, mesial, lingual, distal) of tooth roots with certainty $p > 0.99$ for red, $p > 0.99$ for green and $p > 0.50$ for blue colouration component. Statistical data interpretation showed that there is a linear correlation between obtained RGB values and age, with $r = -0.994$, $p > 0.99$ for red component, $r = -0.972$, $p > 0.99$ for green and $r = -0.982$, $p > 0.95$ for blue colouration component. From the obtained results it is possible to conclude that analysing the above mentioned parameter we can easily establish dental age and this technique can be the basis of practical application in establishing chronological age of man.

Key words: forensic odontology, age determination, teeth, cementum, colouration

Introduction

The identification of human remains is a recurrent problem in both forensic and anthropological contexts. It understands analysis of three most important parameters: gender and heights identification and age estimation. The most difficult task is age estimation¹⁻⁴. Skeletal methods based on closure of sutures exist, but because of wide biological variations these are not very accurate. Consequently, the teeth present the alternative solution for age estimation^{5,6}. Although there are genetic, nutritious and external influences, the time and periods of teeth development are synchronised according to a very precise model^{7,8}. All teeth, therefore, develop through morphologically different stages that can be established using atlas approach or using scoring systems. After the growth and development is finished and with eruption of third molars, around the age of 24, it is no longer possible to establish the age by the help of this method. For this reason morphological⁹, histological¹⁰, and biochemical¹¹ methods based on degenerative changes in the teeth have been developed to establish chronological age in adults.

Because of their reliability, morphological changes in teeth form the basis of some of the most common methods to estimate age in forensic cases¹². The purpose of this study was the analysis of one of the morphological parameters that is believed to be one of the best for age estimation. In this research the colorimetric treatment of tooth roots with the most recent approach was performed and it was analysed whether it is possible to use the tooth colour criteria as biological marker for dental age estimation.

Materials and Methods

The sample was made of 100 teeth of known age and gender, grouped into five age groups (21-30, 31-40, 41-50, 51-60, 61-70), all extracted upon special indications by oral surgery, orthodontic and paradontology specialists. After extracting them, each tooth was rinsed with water and the tissue remains were removed with tweezers and scalpel from the root. After that the tooth was

disinfected with 5% Na-hypochlorite and the surface was smoothen with a small rubber stone. Material prepared in that way was closed into small plastic boxes. The colourimetric analysis was made using Adobe Photoshop 7.0 computer program. Each root was digitally recorded using a digital camera (Nikon D1X, with illumination of Multiblitz 400) and after that the digital photographs were transferred to the computer. The quantitative analysis of the tooth root colour was made through Red Green Blue system (RGB). In order to show possible differences in colour on the root surface and to choose safer determination of the average colour value, two measurements were made. In the first measurement the RGB values were analysed on the surface that covers all three root areas (cervical, middle and apical third). In the second measurement the RGB values were analysed only on the middle root third. The tooth root colour analysis i.e. red, green and blue component values were made on all four root sides: buccal, mesial, lingual and distal. In order to adjust the analysis better to this research, software was developed to calculate the average RGB values on the exact given surface.

Statistical analysis

The statistical equality of RGB values of two root surfaces and RGB values ratio on all four root sides were tested using the HI² test. The correlation between colour and age was examined using the Pearson test and the certainty by HI² test. All examinations were performed on the 99.5% level of certainty.

Results

This study has shown no difference whether the average RGB values are taken on the whole root surface or only on its central third, with certainty $p > 0.99$. The statistical data processing established also that the measurement results do not depend on the fact whether the samples were taken from buccal, lingual, mesial or distal root sides and that there is no significant difference in

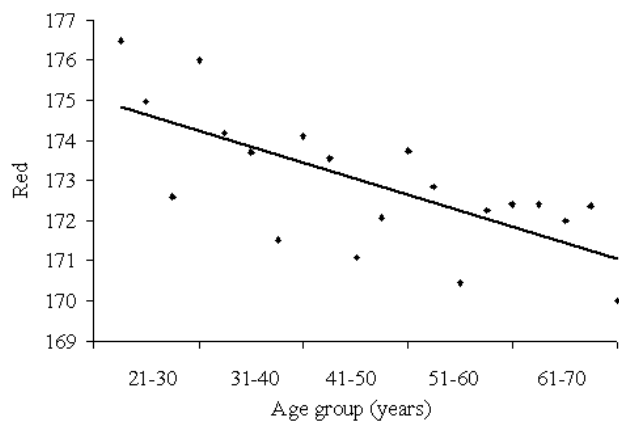


Fig. 1. Relationship between RED colour component and age groups.

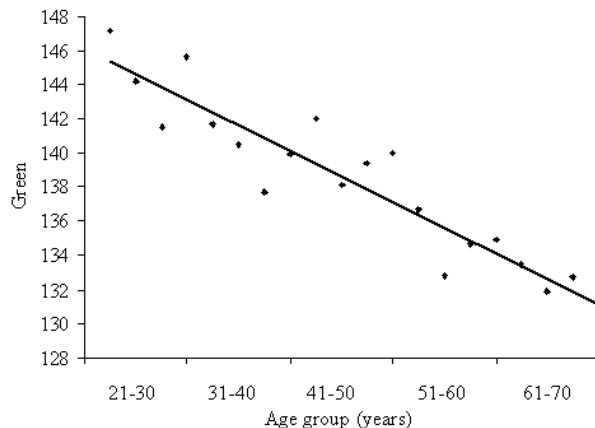


Fig. 2. Relationship between GREEN colour component and age groups.

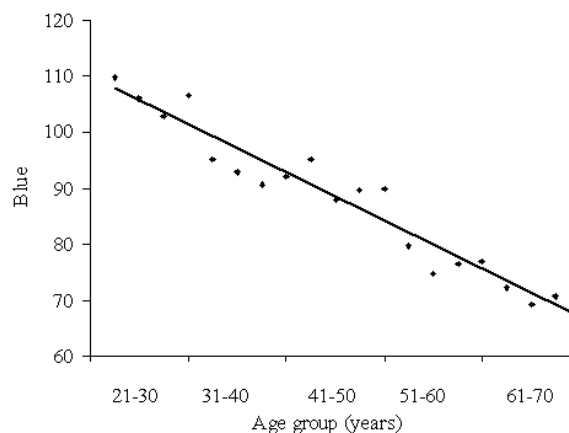


Fig. 3. Relationship between BLUE colour component and age groups.

colouration between mentioned root sides. This is completely valid only for red and green colour component ($p > 0.99$). For the blue component the HI² test value is quite high and results 17.48. For $k = 19$ degrees of freedom for blue component the certainty lies between 0.50 and 0.75, still less than $HI^2 = 35.58$, what means that for this case we can also claim that the given hypothesis was correct with a little certainty ($p > 0.50$). The results of this research have confirmed the hypothesis that there is a correlation between tooth root colour and age. The correlation between the average RGB values of tooth root colour and age shows a linear trend with high correlation coefficients, i.e. $r = -0.994$ with certainty of $p > 0.99$ for red colour component, $r = -0.972$ with certainty of $p > 0.99$ for green and $r = -0.982$ with certainty of $p > 0.95$ for blue component. Figures 1, 2 and 3 show the visual control of the results.

Discussion

The two general methods commonly used to analyse the natural colour of teeth are visual comparison and in-

strumental measurements. Estimation of tooth root colour by comparison with dental shade guides has been used extensively by forensic odontologists, since changes in colour with aging have been described. Nevertheless the use of tooth colour for age estimation in forensic odontology is limited by difficulties with objective measurements^{12,13}. In any visual-colour matching procedure, questions that have to be answered constantly are just how great a colour difference exists between the samples to be matched and the standards and how great a difference is acceptable in given situation¹⁴. In an attempt to develop a more objective method scientific approach should be applied by utilizing a measuring instrument¹². Answers that scientists are always looking for are connected with new and objective enough methods that can be used in everyday routine practise. Several new studies have shown that digital camera can also be used in colour determination^{15–17}. In this study digital measurements have shown that there is a significant correlation between tooth root colour and age, in which all colour components (RGB) correlated well. The results obtained in this study are in agreement with previously published results¹⁸. This change in colour with age is due to continued cementum deposition through life¹⁹ or perhaps due to some undefined intrinsic change in the dentin²⁰. In the study which resembles the most to this one uneven colouration of four anatomic root surfaces was found.

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The percentage of yellow was similar on three of the four sides, and considerably less on the mesial side¹⁸, what was not the case in this research. Although there are assessments about small quantity of cementum found on mesial side comparing with the distal one²¹, the biological mechanisms of tooth root colour should be further examined^{13,18}. The advantage of the colourimetric analysis using digital camera and Adobe Photoshop 7.0 software used in this study, lies in the fact that this method does not require a long and expensive laboratory preparation and can be performed with a minimal knowledge of computer skills. According to the given results it is also objective enough for this kind of examination. The disadvantage of this method is the fact that it belongs to the invasive techniques what means that teeth need to be extracted. One of the problems for age calculation is also the time period when the teeth were found. Namely, some studies have shown that the postmortem interval could affect age-related morphological changes¹³, and that different methods of dental age estimation should be used depending on the time after death^{6,22}.

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UTJECAJ DOBI NA PROMJENU BOJE KORIJENA ZUBA

SAŽETAK

Svrha ove studije bila je ispitivanje povezanosti između boje korijena zuba i starosne dobi u čovjeka. Ispitivanje je napravljeno na uzorku od 100 zubi. Svi zubi, odnosno njihovi korijeni snimljeni su digitalnom kamerom, a kolorimetrijska obrada napravljena je računalno u programu Adobe Photoshop 7.0. Studija je pokazala da nema statistički zna-

čajne razlike između dobivenih RGB vrijednosti na cijeloj površini korijena, u odnosu na samo središnji dio korijena, uz pouzdanost $p > 0.99$. Također je utvrđeno da nema statistički značajne razlike u obojenosti na četiri anatomske površine korijena (bukalno, mezijalno, lingvalno, distalno), uz pouzdanost $p > 0.99$ za crvenu, $p > 0.99$ za zelenu i $p > 0.50$ za plavu komponentu boje. Statistička obrada podataka pokazala je da postoji linearna korelacija između dobivenih RGB vrijednosti i starosne dobi uz $r = -0.994$, $p > 0.99$ za crvenu komponentu, $r = -0.972$, $p > 0.99$ za zelenu i $r = -0.982$, $p > 0.95$ za plavu komponentu boje. Iz dobivenih rezultata može se zaključiti da se analizom promatranog parametra može izračunavati dentalna dob te da ova tehnika može poslužiti kao podloga za praktičnu primjenu u svrhu određivanja kronološke dobi čovjeka.