

INFRARED SPECTRUM ABSORPTION ANALYSIS IN DETERMINING DENTAL AGE: A PILOT STUDY

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Introduction: Determining age on posthumous dental remains is one of the forensically demanding procedures. By analyzing teeth, we can determine the age of unknown human remains, living people or archaeological dental remains. No method for determining age in adults is completely accurate and can give an approximate result ranging from 5 to 10 years. The introduction of infrared spectrometry with Fourier transformation in the analysis in this pilot study opens the possibility to add another method to the current forensic methods that could relatively quickly determine the dental age of an unknown human body.

Materials and methods: A total of twenty tooth samples were used, which are part of the archive of the Department of Dental Anthropology, Faculty of Dentistry, University of Zagreb. The teeth were extracted, cleaned of blood and soft tissue residues, and disinfected in 2% H₂O₂ solution. After drying at room temperature, the teeth were embedded in quick-setting acrylate and cut into 0.5-1.1 mm thick cuts with a precision cutter. The samples were divided into five age groups: 10-19, 30-39, 40-49, 50-59, 60-69 years. Each group had 4 samples, each from a different person, different sex and different teeth. The samples were then placed in a spectrometer, and sampling was performed using attenuated total reflectance. A spectrum analysis of 400-4000 cm⁻¹ in the area of tooth dentin was performed. As a control, the analysis of the acrylate spectrum was performed in order to eliminate possible contamination of the images.

Results: After reducing the dimensionality of the spectrum by analyzing the main components of the spectrum and analyzing linear discriminants, no statistically significant difference between the absorption coefficients between groups ($p>0.05$) was proven, but where in the maximum values of absorption between groups the difference is observed. Wave numbers (823, 1000, 1400, 1540 and 1650 cm⁻¹) were isolated, with the largest increase in the absorption coefficient (present in all age groups). Differences in absorbance coefficients between groups for each of these wave numbers were tested by analysis of variance with post-hoc Holm-Šidak correction. The results showed a difference between groups 50-59 and 60-69 at 873 cm⁻¹.

Conclusion: In this pilot study, there is a statistically significant difference between two of the 5 groups: 50-59 and 60-69 years. We conclude that it is necessary to increase the number of samples in order to obtain a statistically significant difference between other groups.

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Keywords: spectrophotometry, infrared, dental age, forensic odontology

ANALIZA APSORBACIJE INFRARVENOG SPEKTRA U ODREDIVANJU DENTALNE DOBI: PILOT STUDIJA

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Uvod: Određivanje dobi na postumnum ostacima zubi jedan je od forenzički zahtjevnih postupaka. Analizom zubi možemo određivati dob nepoznatih ljudskih ostataka, živih ljudi ili arheoloških dentalnih ostataka. Niti jedna metoda za određivanje životne dobi kod odraslih osoba nije u potpunosti točna i može dati okvirni rezultat u rasponu od 5 do 10 godina. Uvođenjem infracrvene spektrometrije s Fourierovom transformacijom u analizu u ovoj pilot studiji otvara se mogućnost da se u dosadašnje forenzičke metode doda još jedna metoda koja bi relativno brzo mogla odrediti dentalnu starost nepoznatog ljudskog tijela.

Materijal i metoda: Korišteno je ukupno dvadeset uzoraka zubi koji su dio arhive Zavoda za dentalnu antropologiju Stomatološkog fakulteta Sveučilišta u Zagrebu. Zubi su ekstrahirani, očišćeni od ostataka krvi i mekog tkiva, te dezinficirani u 2% otopini H₂O₂. Nakon sušenja na sobnoj temperaturi zubi su uloženi u brzovezujući akrilat i preciznom rezalicom narezani na rezove debljine 0,5-1,1mm. Uzorci su podijeljeni u pet dobnih skupina: 10-19, 30-39, 40-49, 50-59, 60-69 godina. Svaka skupina imala je 4 uzorka, svaki od različite osobe, različita spola te različitog zuba. Uzorci su tada postavljeni u spektrometar, te je uzorkovanje provedeno pomoću dodatka za prigušenu potpunu refleksiju. Učinjena je analiza spektra od 400-4000 cm⁻¹ na području dentina zuba. Kao kontrola učinjena je analiza spektra akrilata radi eliminacije moguće kontaminacije snimki.

Rezultati: Nakon redukcije dimenzionalnosti spektra analizom glavnih komponenti spektra i analizom linearnih diskriminant, nije dokazana statistički značajna razlika između koeficijenta apsorbancije između skupina ($p>0,05$), međutim ono gdje se pojavljuje razlika je u maksimalnim vrijednostima apsorbancije između skupina. Izolirani su valni brojevi (823, 1000, 1400, 1540 i 1650 cm⁻¹) na kojima dolazi do najvećeg porasta koeficijenta apsorbancije (prisutno u svim dobnim skupinama). Razlike u koeficijentima apsorbancije između skupina za svaki od navedenih valnih brojeva testirane su analizom varijance sa post-hoc Holm-Šidak korekcijom. Rezultati su pokazali razliku između grupa 50-59 i 60-69 na 873 cm⁻¹.

Zaključak: U ovoj pilot studiji postoji statistički značajna razlika između dvije od 5 skupina: 50-59 i 60-69 godina. Zaključujemo da je potrebno povećati broj uzoraka kako bismo mogli dobiti statistički značajnu razliku između ostalih skupina.

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Ključne riječi: spektrofotometrija, IC spektar, dentalna dob, forenzička stomatologija