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REVIEW ARTICLE

FORENSIC AGE ESTIMATION IN GERIATRIC AGE GROUP

Abstract

In the geriatric population, forensic age estimation could be essential for insurance-related issues, retirement processes, and work permits. Although cases of forensic age estimation are dominant in adolescents and early adults, nowadays the practice of forensic age determination is increasing in the geriatric population as well.

Forensic age estimation, in living and deceased individuals, is among the most commonly studied topics in clinical forensic medicine. However, only few studies have been performed for age estimation in the geriatric population. Based on skeletal bone morphology, skeletal bone radiological traits, chronological dental changes, facial traits, degenerative processes, and automated systems, there are several methods for forensic age estimation in adults and partly in the geriatric population. This paper aims to the draw attention of health-care professionals by discussing methods used for forensic age estimation in the geriatric population.

Keywords: Geriatrics; Age determination by skeleton; Forensic Medicine

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DERLEME MAKALE

GERİATRİ YAŞ GRUBUNDA ADLİ YAŞ TAYİNİ

Öz

Geriatrik yaş grubunda adli yaş tayini özellikle sigorta ilişkili sorunlarda, emeklilik süreçlerinde ve çalışma izni sağlanması sırasında gerekli olabilmektedir. Her ne kadar adölesan ve erken erişkinlere yönelik adli yaş tayini çalışmaları halen yaş tayini alanındaki olguların çoğunluğunu oluştursa da; günümüzde geriatrik adli yaş tayini talepleri de giderek artmaktadır.

Hem yaşayan, hem de ölmüş olgularda adli yaş tayini klinik adli tıp alanında sık çalışılan konulardan birisi olarak karşımıza çıkmaktadır. Ancak geriatrik yaş grubunda adli yaş tayinine yönelik çok az sayıda çalışma bulunmaktadır. İskelet morfolojisi, kemiklerin radyolojik değerlendirmelerine dayanan yöntemler, yaşla ilişkili dental değişiklikler, yüz özellikleri, dejeneratif süreçlerin değerlendirilmesi ve otomatize sistemler erişkinlerde ve kısmen de geriatrik popülasyonda kullanılan yöntemler arasında sayılabilmektedir. Bu yazıda, geriatrik popülasyonda adli yaş tayinine ilişkin literatürde sunulmuş olan yöntemlerin tartışılması ile bu alanda çalışan profesyonellerin dikkatlerinin çekilmesi amaçlanmaktadır.

Anahtar sözcükler: Geriatri; Kemik yaşı tayini; Adli Tıp

INTRODUCTION

Forensic age estimation, in living and deceased individuals, is one of the most studied topics in the field of clinical forensic medicine. However, in the literature, the majority of studies related to age estimation deal with adolescents and early adults, most probably because of the higher case number due to legislations regarding criminal capacity (1).

Forensic age estimation is a necessity when a proper birth certificate is missing and/or birth registration is claimed or suspected to be incorrect. In Turkey, according to the Civil Law numbered 5490, each birth event has to be recorded by Population and Citizenship Affairs officers with a proper birth certificate. In case of missing documents related to birth, the actual date of birth needs to be investigated and approved by legal authorities, which consequently becomes a case for forensic medicine professionals. A majority of the forensic age estimation cases include immigrants, citizens born abroad, and those who are subjected to age-related medicolegal issues.

In the geriatric population, forensic age estimation may be essential for insurance-related disagreements, work permits, and retirement procedures. The issues related to refugees who lack a birth certificate or an identity report stating the exact birth date and the need of refugees to be evaluated in terms of age estimation for several procedures are increasing in most European countries. Although the majority of forensic age estimation cases are related to adolescents and early adults, nowadays cases in the geriatric population are also steadily increasing. This increase might strongly be attributed to the increase in refugee population due to war or conflicts in the Middle East. Thus, it is assumed that forensic age estimation in the geriatric population seems to be relatively increasing due to problems or procedures regarding work permit/retirement and insurance policies toward immigrant/refugee population.

This paper aims to draw attention of professionals to a rarely studied topic and discuss methods with potential use in forensic age estimation in the geriatric population.

FORENSIC AGE ESTIMATION

Forensic age estimation is an important topic for expert witnesses, including forensic medicine specialists, pediatricians, orthopedic surgeons, endocrinologists, radiologists, and anthropologists. Medical reports issued by these professionals guide legal authorities in pursuit of justice.

Forensic age estimation in living individuals have three basic requirements; a) obtaining a complete medical history, including metabolic, endocrine, and skeletal system diseases; medication use history; nutrition style, if specific; skeletal trauma history, b) performing a physical examination before radiological imaging, and c) performing dental examination (2). Further, the data on the profession of the individual, daily routine, and history of sports activities are highly important.

The aim of forensic age estimation in living individuals differs with age groups. For children, adolescents, and early adults, the most common aim is to assess whether the individual is a child or an adult according to the childhood age limit (18 years) set by World Health Organization. This assessment is highly important, especially for child pornography cases, human trafficking cases, and the determination of criminal responsibility/child delinquency for those involved in a crime as a suspected criminal or victim. However, for adult and geriatric age groups, the most common aim is to correct false age in documents (3).

Age estimation may be crucial for penal and civil lawsuits. In penal lawsuits, determining the age of perpetrators and victims during the case is essential. Turkish Penal Code article number 31 arranges minors' situations against penal lawsuits

with legal age limits of 12, 15, and 18 years. Importantly, legal sanction varies according to the age group of offenders. According to Turkish Penal Code article number 82 (intentional murder victims), article number 94 (torture victims), and article number 102 (sexual abuse victims), the duration of punishment increases for perpetrators in crimes against minors. Therefore, in such cases, respondent (defense authority) claims that victims are older than they appeared, and therefore, such situations require forensic age estimation of victims.

Children, adolescents, and early adults comprise the vast majority of cases of forensic age estimation. There are several methods for the estimation of age of individuals who are in the first two decades of their lives. Further, these methods are well established, as accurate as possible, frequently studied, and validated for different populations (4).

Overwhelming majority of forensic age estimation cases in the geriatric population is required for civil lawsuits. Further, forensic age estimation may be essential for insurance-related disagreements, retirement procedures, and work permits in elder population. There are different age restrictions for work permits and retirement procedures in Turkish Civil Code similar to many other countries. According to the Civil Law numbered 5434, the maximum age limit to be an employee in different occupations differs between 41 and 67 years, and individuals with age greater than these limits are not allowed to work in certain jobs. The same law determines the minimum age of retirement as 38 years for women and 40 for men. However, these limits differ between 38 and 60 years of age for different occupations. Another need for forensic age estimation in the geriatric population may arise in lawsuits regarding compensation for disabilities due to faulty actions of another individual by any means. In such cases, the amount of compensation is calculated based on the expected life span of the victim. Therefore, it is essential to calculate the remaining life span of the victim so as to calculate the exact amount of compensation. It is also crucial to know the exact age of the individual, during the event, to calculate the remaining life span, duration of working years, and duration for retirement.

The war in the Middle East has affected many countries and started a refugee crisis mainly influencing the neighborhood. Health-care and forensic professionals have been facing new problems that they are unfamiliar with, of which one is the increasing numbers of forensic age estimation cases in all age groups (5). According to the Turkish Ministry of Interior and European Commission, Turkey, being a neighboring country of the war region, is one of the most affected countries, which had to handle over 3.7 million refugees from Syria. This crisis resulted in various age-related issues, e.g., children could not be integrated into the education system because of their unknown age and adults and elderly individuals had job- and retirement-related problems due to the social security system. Therefore, an urgent need arises for validated forensic age estimation methods in living individuals of all age groups.

Although there is still dominance of adolescents and early adults among forensic age estimation cases, nowadays the practice of forensic age determination in the geriatric population is increasing due to previously described causes. As the number of refugees without proper birth certificates increases in the society, the number of cases related to forensic age estimation in the geriatric population will also increase because of the abovementioned requirements.

Similar to those used in other age groups, methods used for forensic age estimation in the geriatric population might basically be categorized into methods based on skeletal characteristics, dental methods, and experimental methods.

METHODS BASED ON SKELETAL CHARACTERISTICS

There are several studies on developmental or degenerative skeletal characteristics in terms of forensic age estimation, in deceased and living individuals. However, most of the methods are concerning about adolescents and early adults since criminal laws and legislations about asylum seekers are especially concentrating in these age groups in many countries.

Işcan method is one of the methods focusing on the estimation of age in adults and partly in the geriatric population. This method evaluates the shape of the osteochondral junction of the fourth rib, which changes from "V" to "U" shape with increasing chronological age. This method describes eight phases of osteochondral junction, in which the eighth phase indicates individuals of age ≥51 and ≥62 years in males and females, respectively (6,7).

Another method introduced by Suchey and Brooks evaluates and classifies the developmental or degenerative changes of pubic symphysis into six separate phases (8). Depression due to ongoing erosions on symphyseal surface of pubis occurs in the sixth phase, which indicates an age range of 42–87 and 34–86 years in females and males, respectively, with 95% confidence interval (8).

Lovejoy et al. stated that auricular surface of the iliac bone may show "nongranular and irregular" surface as a result of destruction/degeneration and is considered as a sign indicating approximately 60 years of age (9). After two decades, Buckberry and Chamberlain revised the method introduced by Lovejoy et al. (9,10). Their study suggested seven phases with respet to changes in auricular surface of the ilium with a score system that evaluates transverse organization, texture, apical changes, microporosity, and macroporosity of the surface. In this method, the sixth phase indicates an age range between 39 and 91 years with a median age of 66 years, whereas the seventh phase indicates an age range between 53 and 92 years with a median age of 73 years, with 95% confidence interval (10). Later, another method was developed, which evaluates sacral vertebral body fusion, microporosity, macroporosity, surface texture, apical changes, S1 vertebra ring fusion, and coccygeal fusion, thereby subdividing the chronological changes into six phases. In this method, the fifth phase indicates an age range between 21 and 81 years, whereas the sixth phase indicates an age range between 35 and 91 years, with 95% confidence interval (11). However, a study from Portugal claimed that the chronological characteristics of acetabulum and auricular surface of the ilium has power to determine ages up to 60 years (12).

Kunos et al. (13) described a number of chronological changes and their use in cases of forensic age estimation. Digangi et al. (14) also introduced another method, which indicates 37–89 years of age with 95% confidence interval if the individual has the highest scores in geometric shape of the costal face and surface texture of the tubercle facet of the first rib.

Although there are studies regarding the age estimation for skeletal remains, predictive values of these methods in the geriatric population is still controversial (15). Further, a common problem in these methods, as pointed out by Meritt (16), is neglecting weight or body mass that potentially affects the chronological changes evaluated in age estimation and provides erroneous results.

A valid method to determine skeletal age of living individuals in the geriatric population is not available because the majority of studies dealing with skeletal age estimation in geriatric population focus on the identification of human remains. Similarly, a detailed radiological assessment of various skeletal chronological changes, such as osteophytic changes, osteopenia, osteoporosis, cartilage degeneration, degenerative osteoarthritis, and other degenerative signs may be useful in the age estimation of living individuals in geriatric population (17). However, there

are many interfering factors, including genetic conditions, diseases, trauma history, nutrition, and exercise habits (18,19).

Radiological atlas-assisted forensic age estimation is a widely used method for living individuals. However, commonly used and relatively validated methods, including Greulich–Pyle, Tanner–Whitehouse, and Gök methods focus on subadults. Although Gök atlas reveals criteria for the assessment of bone age estimation in adulthood, it still does not present any information on the chronological changes in individuals >50 years of age. Atlas-assisted methods have also been recently criticized for lacking population differences, which might result in erroneous age estimations even in pediatric populations (1).

In the literature, a number of studies deal with magnetic resonance imaging and computerized tomography for the assessment of the skeletal bones to estimate age in adulthood (20,21). However, further investigations with a larger group are required to develop more accurate methods specific to different age groups, including the geriatric population.

DENTAL METHODS

For decades, dental age estimation methods based on different combinations of tooth, pulp, pulp chamber, and root ratios and other time-dependent changes or characteristics on dental structure have been widely studied in the literature. There are two main dental methods that are widely used for forensic age estimation in the geriatric population for living individuals and corpses (22–26). Kvaal's and Cameriere's methods are based on pulp, tooth, and root length ratios, which can be determined using mesial and apical X-ray images (27). Further, Cameriere et al. (27) stated that their method could be applicable with automated image processing systems. On the other hand, Lamendin's method is based on periodontosis and translucency ratios with root lengths (24). Lamendin's method is thought to be more accurate in terms of age estimation compared to many other methods. However, Marroquin et al. stated that repeatability is better and the overall standard estimations are lower in Kvaal's method in comparison with volumetric studies (23).

The determination of dental aspartic acid racemization amounts is another method, which is less practical than other dental methods because it requires a sensitive chromatographic analysis (28).

Although there are several studies dealing with dental age estimation, there is still no method that potentially determines forensic age accurately in the geriatric population. Therefore, professionals suggest that different dental and/or skeletal methods should be combined to achieve more reliable results (4).

OTHER METHODS

Facial traits

Facial characteristics may be useful in age estimation, although it is highly subjective. Estimations of age based on facial characteristics have been studied in the literature not only for forensic purposes but also for understanding cognitive perceptions about age and esthetic processing of the human brains (29). Facial traits, including facial lines, facial growth, skin elasticity, tooth loss, senile hyperkeratosis, racial differences, cherry angiomas, and chronological ocular changes, may help to assess age as well as distort perception about an individual's age (30,31).

Histological methods

Histological methods to determine age are mainly focused on the bone and bone marrow histomorphology. There are studies about chronological changes of the osteon structure and cellularity of bone marrow in the literature. However, none of these studies revealed a validated method although the topic has been studied for decades.

Image-based systems

Image-based evaluation systems have been attracting attention in the last decade. These methods are basically objectified and justified facial trait assessment using software. The method is of great value for individuals who have full facial photographs at proper time intervals (32,33).

Gynecological methods

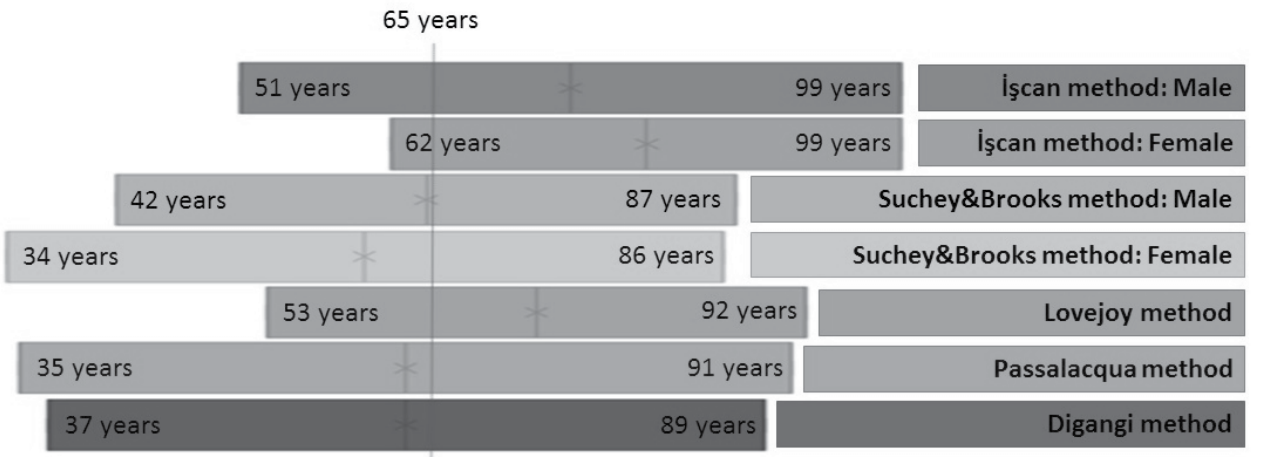
In a case presentation, gynecological examination and the assessment of reproductive hormone levels were used to determine the age of an immigrant in Italy, as a supportive method to dental age estimation (34).

CONCLUSION

Forensic age estimation is one of the most studied topics in the field of age estimation. However, the number of studies dealing with the geriatric population is low and the presented data are relatively inadequate. Although there are few methods to assess age in the geriatric population, they have to be improved. Methods based on bone age estimation reveal a wide range of age instead of an exact age, whereas and dental methods might be of no use because of possible tooth loss in geriatric individuals. Estimated age intervals involving geriatric in respect of utilized method is shown in Figure 1.

Being a relatively rare topic of discussion in the past, age estimation methods in the geriatric population might be an open discussion topic and an attractive study area in near future due to the increasing population of immigrants and refugees and related problems. Thus, more well-established methods are required for forensic age estimation in the geriatric population with the validation of previously described methods in different genetic pools.

Figure 1. Estimated age intervals involving geriatric in respect of utilized method.



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