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Review

The problem of aging human remains and living individuals: A review

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ABSTRACT

Forensic anthropology is affected by the unavoidable limits concerning difficulties in standardization of methods and procedures; age estimation is one of the main tasks of forensic anthropology and odontology, both on the dead and the living: literature has shown several methods of age estimation, and although they may be thought of as equivalent, every procedure has its limits, mean error, practical situation and age range where it gives the best results; the lack of standardization and consensus concerning which method can be used, as well as the lack of a practical approach in different cases is the main limit in a correct age estimation process.

This review aims at exposing the experience of the authors working in the FASE (Forensic Anthropology Society of Europe) subsection of IALM (International Academy of Legal Medicine) in the field of age estimation both on the dead and the living, at highlighting advantages and limits of each method, and suggesting practical solutions concerning the age estimation process for adults and subadults, dead and living, and pedopornographic material.

Contents

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1. Introduction

It is a clear fact that one of the main problems in forensic anthropology (FA), as in many other forensic disciplines, is the lack of "consensus" or uniformity of procedures and methods used. In particular there are specific subareas of FA which need constant updating and harmonization, as, for example, aging, PMI (post-mortem interval determination), determination of ancestry, etc. So far, very few of such recommendations have been produced. One of the main goals of associations of forensic anthropology such as FASE, a subsection of IALM (International Academy of Legal Medicine) [1,2] to whom the authors belong as founding members or members of the Board, is to fill this gap, by bringing together scientists with forensic experience (this working group in particular has a cumulative experience across Europe of over 2000 cases of unidentified human remains, as well as numerous cases of living people where age estimation has a judicial importance) and try to produce a thorough review and practical recommendations on specific issues such as aging.

Aging in the forensic context is necessary both for the dead and the living. For the dead it is principally to aid identification in creating a biological profile which can then be compared to missing persons. For the living the aim is to solve judicial or civil problems concerning age of minors as regards questions of adoption, imputability, pedopornography and, for adults, civil issues on pensionable age and other similar matters for individuals lacking valid identification documents. It should always be borne in mind that, whatever the case is, all a forensic anthropologist or odontologist can do is give the best estimate of biological age. . .regardless of how far it may be from actual chronological age, provided these limits are made clear to judicial authorities.

Some reviews on aging have been performed in the past. There are several age reviews, for instance, in the archaeological context [3,4]. However these may not be exhaustive for forensic purposes because the goals are different and the human material may be different (different states of preservation, taphonomic effects, etc.); also judicial requirements and time are another important factor. There cannot be a simple transferral of methods from the historical disciplines to the forensic context.

Some efforts were performed for the forensic scenario: the main one in 2000 [5] (which, 8 years after, obviously needs updating, although there has not been a great progression in new methodologies). In other words age at death estimation continues to be the Achilles' tendon of anthropology. More recently Rosing et al. [6] and Schmeling et al. [7,8] published recommendations for forensic diagnosis of age on skeletons. However this review does not seem to cover all forensic scenarios and gives no clear cut practical suggestions.

Finally, there is *The Study group on Forensic Age Diagnostic*, a German group, which recently produced articles [7,8] concerning aging the living in the forensic scenario. Although useful general indications are given, the authors do not refer to specific methods for practical conditions.

Both for the living and the dead, the only age one can try to achieve is physiological age which might be quite different from chronological age. The older the person is, the larger is the discrepancy between physiological age and chronological age. Therefore the older the person is, the less accurate the methods are, as can be seen with the increasing error range. Also, different methods are examined with different statistical procedures which make results incomparable.

Additional problems can be the reference samples on which the various methods have been developed, which are also of paramount concern since the methodologies become too specific or dependant on the demographical and chronological profile of the series [9,10].

Research has produced several articles, many of which still have not been tested on different populations, or in different taphonomical contexts, for example. So the operator may feel lost in front of a large quantity of methods available. For this reason even at the risk of seeming excessively simple, the authors have tried to give operators practical suggestions based on literature and experience.

Literature has provided, throughout the past years, several methods aimed at determining age; the most commonly mentioned in the forensic scenario and most acclaimed in literature can be divided into dental and skeletal methods. Among the most popular methods for teeth in case of age estimation of dead individuals one should mention Logan and Kronfeld [11], and Schour and Massler charts [12,13], with revision by Anderson et al. [14] and Ubelaker [15]; cementum annulation by Kagerer and Grupe [16]; the Lamendin method [17,18], and in case of age estimation of the living, the Hunt and Gleiser method [19], Gustafson and Koch [20], Demirjian et al. [21] and its revisited version by Willems et al. [22], Moorres et al. [23], Liliequist and Lundberg [24], Nolla [25], Haavikko [26], the Harris and Nortje method [27], Kohler et al. [28], Kullman et al. [29], Mincer et al. on the third permanent molar [30,31] and aspartic acid racemization [32–34]. The most common skeletal procedures in cases of age estimation of dead individuals are summarized in textbooks such as those by Fazekas and Kosa [35,36] and Scheuer and Black [37]; one should also mention diaphyseal length from long bone measurements [38,39]; cranial suture obliteration as indicated by Meindl and Lovejoy [40], Masset [41], Nemeskeri et al. [42] and Baker [43], pubic symphysis evaluation by Todd [44,45] and Suchey–Brooks [46,47], chondral articular surface of IVth rib analysis by Iscan, Loth and Wright [48–50], ilium auricular surface observation by Lovejoy et al. [51], microscopic analysis of bone structure and osteon counts by the Kerley method [52], improved in the Kerley and Ubelaker revision [53] and revisited in the Ahlqvist and Damsten method [54], Stout and Paine [55]; in cases of age estimation in the living, evaluation of clavicle sternal end fusion degree [56–58], analysis of ossification and fusion of wrist and hand bones by Greulich and Pyle [59], the Tanner–Whitehouse technique [60] and the FELS method [61] are usually mentioned.

However, without knowledge and experience of these and other methods, it is difficult to find one's way in a real case. The following wishes to be a practical guide through the more appropriate and user-friendly methods for forensic purposes, and provide suggestions for cases which in the forensic scenario are just beginning to make their way, such as requests for aging adults in view of pensionable age. It is clear, as mentioned previously [5], that for a method to be considered applicable, it must follow specific requirements: (1) the method must have been presented to the scientific community, as a rule by publication in peer-reviewed journals, (2) clear information concerning accuracy of age estimation by the method should be available, (3) the methods