Estimation of Age @ Death by Counting Number of Osteons from the Sternal RIB

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Abstract

Background: Identification of an individual becomes essential in a dead body more than when he is alive. Identity becomes a problem in a dead person when the body is decomposed, mutilated, in skeletal remains or in mass causality death. The foremost essential thing in medico legal cases, becomes identity of the dead , rather than opinion about the cause of death, time since death or manner of death. The aim of this study was to arrive at the regression formula for assessing the age of the dead, based on the number of osteons in the sternal rib bone.

Methods : The study involved 41 sternal ribs taken from 20 to 50 years old persons from the south Indian population at Institute of Forensic Medicine Department Madras Medical College. After autopsy a portion of rib bone was removed from the shaft of the fourth sternal rib near their anterior ends. A slide from the bone section was placed in the light microscope to study the number of osteons in full thickness of the compact bone of the rib.

Result & Conclusion: In this study, age was plotted in the X– axis and the number of osteons were plotted in the Y – axis. A correlation coefficient (r) is derived. It summarizes the significance in the relationship of two variables. This study illustrates the estimation of age at death by counting the number of osteons in the rib bone from the age group of 20 to 48 years. It was proved that the number of osteons increases with age.

Key Words: Identification,skeletal remains,mass disaster, number of osteons, sternal rib and regression formula

Introduction

Identity or identification is defined as the recognition of the individuality of a person, in both live or dead. It is vital in both the cases. The results of trials, in court of law, often depend upon the exact identity of the deceased. Another important situation for identity is during mass disasters in natural calamities like Earth quake, bomb blast or conflagration of a crowded building. Where ever the skeletal remains have been recovered, they should be submitted for experts' opinion. The most elemental thing is to distinguish human from non-human remains.

The first and foremost task for the autopsy surgeon is to establish the identity of the corpse. When a skeletonized body is subjected for autopsy,

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the first duty of forensic anthropologists is "doing the big four" that is identifying age, sex, stature and race.. For the living - the following features are useful for the identification : Photography, Handwriting, Speech, Finger Prints etc. To identify the dead one, we have to look for the following demographic features: Age, Sex, Stature, Race and Religion, Communal Characters, Hair, Dentition and dental records, Tattoo marks, Moles, Scars, Finger, Foot and Lip Prints, DNA Profile and Finger Printing. Dental records are used by the developed countries for identity. Personal identification is the traditional goal in the recovery of human skeletal remains. These identification processes may be carried out through several levels like anatomical, biological and circumstantial.

Materials and Methodology

After getting proper permission, concurrence and clearance well in advance, the samples were selected randomly from the autopsied bodies with known age group ranging from 20 years to 50 years of age, The bone samples, used in this study composed of sections which have been taken from the shaft region near the anterior ends of fourth sternal ribs from 41 South Indian Population. The materials are mostly from the male bodies and few from the female bodies. The sample materials were taken from the already known age group. Samples with suspicious pathological conditions were positively omitted from the study.

As mentioned earlier, the age ranged between 20 years and 50 years with a mean age of 34 years. The range of age for male gender was between 22 and 48 with mean age of 28.22 years. The range of age for female gender was between 20 and 42 with mean age of 29.66 years. There was a good representation of all the categories of age. After completion of autopsies of an known age group individual, the portion of bone was removed from the shaft of the fourth sternal rib near their anterior ends because near the anterior end, the bone has maximum breadth. And the sternal ends of the fourth rib change as people get older. The bone was cut across the longitudinal axis of the bone.

Histological analysis of bone slides: (Bone slides were prepared by the method proposed by **Maatetal (2003)**

A slide of the bone section was placed in the well illuminated ordinary transmission light microscope. With 10 X objective and 10 X ocular lens, the section of the bone focused the osteons of the bone. After focusing the osteons, the entire cross section of the bone was scanned completely. This would enable us to study the distribution of the osteons in full thickness of the compact bone of the rib. Then, the number of osteons per single field was counted. The counting field was selected in such a way that the number of osteons should be relatively maximum in number. Two fields were selected randomly to count the number of osteons. Then, the average number of osteons was taken for the analytical purpose.

Observations and Results

Statistical analysis was done in SPSS (Software Package for Social Science) for the study of regression analysis. Regression analysis offers the mathematical formula used to predict one variable. Observed data has been documented in the Scatterplot diagram. We can get a visually analyzable relationship between the variables.

In this study, age was plotted in the x – axis and the number of osteons were in the y – axis. A correlation coefficient (r) is derived. It summarizes the significance in the relationship of two variables. The following observations were obtained.

R In the statistical studies, if 'r' value ranged from 0.75 to 0.99, the study was considered as having a high correlation value. And if the values ranged from 0.5 to 0.74, it was considered as having moderate and if the values were 0.25 to 0.49, then considered as having low correlation values.

The limitation of the 'r' value is the dependency of the sample size. So, the best way to determine the relationship is the calculation of r^2. " r^2" is the coefficient determination. If the "r^2"is closer to 1.0, then the study is for positive relationship and if away from 1.0, negative for relationship.In this study simple linear regression analysis method was applied.

Table 1: Over all Mean, Median and S.D. for both the genders.

Mean	28.63
Median	26.00
Std. Deviation	7.172

In this study, over all mean was 28.63, median 26.00 and S.D. was 7.17

Table 2: Frequency of distribution of osteons

Sl. No.	Distribution of age	Frequency of distribution of Osteons	Percent
1	20 -28	26	63.4
2	28-48	15	36.6
3	Total	41	100.0

Table 3: Frequency of gender distribution of osteons

Sl. No.	Characteristics	Male	Female
1	Total samples	35	6
2	Distribution of osteons (%)	85.4	16.6

This table indicates, out of 41 cases, 24 cases (58.5%) have 4 – 7 osteons per field. 26.8% cases (11 samples) have only 1 – 3 osteons. Maximum number of osteons perfield is 8 – 10 and only 6 cases (14.6 %) have 8 – 10 osteons per fields.

Table 4: ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	31833.259	2	15916.629	161.622	.000
Residual	3840.741	39	98.481		
Total	35674.000	41			

The independent variable is Osteon_Avg.

The equation was estimated without the constant term.

From this study, p-value is measured as 0.001. It indicates satisfactorily significant in age estimating formula.

Table 5: Quadratic Model Summary*

R	R Square	Adjusted R Square	Std. Error of the Estimate
.945	.892	.887	9.924

The independent variable is Osteon_Avg.

*The equation was estimated without the constant term.

The r^2 is 0.89, that is 89% of the variance in age estimation from the sample can be explained by counting the number of osteons.

Table 6: Coefficients

	Unstandardized Coefficients		Standardized oefficients		
	B	Std. Error	Beta	t	Sig.
Osteon_Avg	11.086	.975	2.067	11.366	.000
Osteon_Avg^2	-.933	.136	-1.247	-6.857	.000

Regression equation: $Y= ax^2+bx+error$

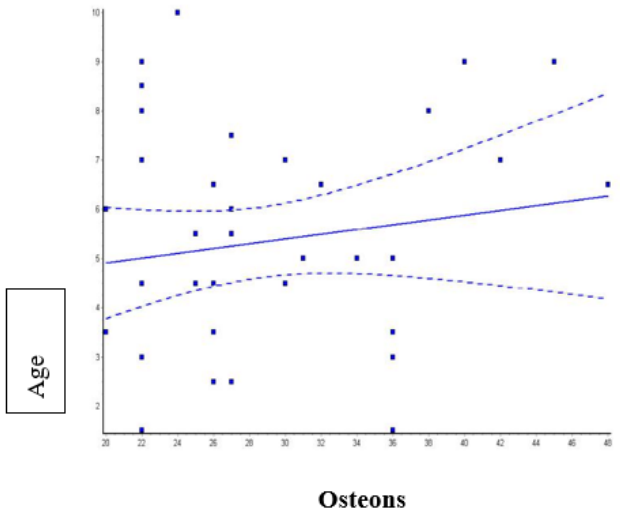
(Y= Age; A and B = No of osteon's average; X= 2.067; X^2= -1.247)

Graph 1 showing distribution of osteons for both genders:

(Total number of samples, n = 41)

____ Linear Regression

------ 95% Confidence Level



This linear regression graph showing that the number of osteons is increasing viz. 20 years – 4.8 osteons; 22 years – 5 osteons; 32 years – 5.5 osteons; 42 years – 6 osteons and 48 years – 6.5 osteons.

Conclusion

The study showed that the number of osteons is in increasing trend as the age advances. It is supporting the other studies using the microscopic analysis of rib bone to estimate age. The number of osteons is increasing in such a way that, the number of osteons - at 20 years – 4.8 osteons; 22 years – 5 osteons; 32 years– 5.5 osteons; 42 years – 6 osteons and 48 years – 6.5 osteons. The equation for detecting age at death using osteons, is derived as -

Regression equation: "Age = Y= $ax^2+bx+error$" in which Y= Age; A and B = No of osteon's average; X= 2.067; X^2 = -1.247. In this study, the 'r^2'value is estimated as 0.892. And so, the study concluded that, the study is positively correlated with the similar previous studies and as the age advances, the number of osteons also increases.

This study also indicates, that the distribution of osteons within a given cross-section of rib do not follow a consistently dispersed pattern, despite the fact that, remodeling can occur on any bone surface not covered by cartilage or osteoid. This study correlates well with the study done by **Martin et al., 1998** and **Pankovich et al., 1974.** These estimates have proven most accurate when analyzing individuals between the third to fifth decades of life.

Limitations of the study:

1. While taking bone samples from the rib cage, there are chances to get unevenly broken bone with partial thickness of the rib. This may have been overcome by selecting the adequate thickness of the bone while selecting the piece of bone.
2. While grinding the bone sample, there were chances for the bone to get thinner than the adequate or to get broken.
3. If the bone had not ground adequately, difficulties may be encountered not only in counting the osteons and also in visualizing the osteon itself.
4. There was possibility of getting pricked by the uneven fractured edges, in the grinding finger, when the bone sample is becoming thin and in turn there is occupational hazards. To overcome this, the analyzer may use double gloves when grinding. Once again, grinding the bone sample by using of double gloves may lead to lesser grip in grinding.
5. Age dependent variables that have been associated with increasing age include cortical area and osteon density. Some studies have suggested using mean osteon size as an age dependent variable though it remains controversial.
6. The number of samples should be increased. And, the selection of bone samples should be concentrated from the 20 – 60 years of age group.For developing the study further, more than one variable should be taken instead of using only one like osteon number.

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Declaration of Conflicting Interest: Nil

Ethical Clearance: This research has received approval from the Institutional Ethics Committee of Madras Medical College, Chennai.

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