

Age Estimation by the Morphometric Analysis of Sternal End of Fourth Rib

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Abstract

Estimating the age at death in the adult skeleton is problematic owing to the biological variability in age indicators and the differential skeletal response to environmental factors over an individual's life. While the pubic symphysis and intracortical morphometry have provided successful results in estimating age at death, other methods and sites in the skeleton are needed to improve the accuracy of age estimation. Present study is an attempt to develop a new method for estimation of age from sternal end of fourth rib. Currently there are different parameters available to determine the age of a person like study of teeth, ossification of bones and other ancillary data, but the accurate reliability of these measures is only limited to a particular age group i.e. 25 ± 5 years. For the age beyond this, many workers in different parts of the world have done their studies to accurately determine the age of a person from the skeleton. A random study of 100 cases for age estimation from sternal ends of the fourth ribs were carried out to estimate the age after death with minimal error.

Keywords: Fourth rib, Age estimation, Morphometric analysis.

Introduction

Identification of any individual is the first step for assessing the dead body, as in the cases of sudden or unexpected death or in any unclaimed bodies.

The Identity of a person is done by using various parameters as Sex, Age, Stature, Genetic constituents, etc. Age is an extremely vital parameter in the personal identity of living subjects as well as skeletonized dead bodies.⁽¹⁾

Age estimation of unknown skeletal remains is very important in medico-legal practice. The procedures for age determination are complex and involve the

consideration of many factors. Changes related to chronological age are seen in both hard and soft tissue. Amongst the hard tissues, bones are important as they undergo a series of changes from prenatal to postnatal life and changes in their composition and structure continue into old age and even after death. Hence, bones form a reliable source of information regarding growth and growth changes.

Morphologic methods are fast and easy to use for purpose of age determination. The sternal ends of the ribs are a reliable method of age estimation from late adolescence to old age.

Metamorphosis at the sternal extremity of the rib has already been established as a reliable indicator of age at death. It was shown that an accurate estimation of age can be made by direct examination of the bone itself.⁽²⁾

Therefore we have used the sternal end of the 4th ribs to determine the age of the Individual. The sternal

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end of the rib is chosen because it has been shown from earlier study by Iscan et al^(2,3,4) to be a perfect bone to show the advancement of age and the age can also be estimated by this method if the partial skeleton is found.

This study aimed to develop regression formulae for estimating age at death using a macroscopic feature of bone.

Materials and Method

The present study was conducted in the Department of Anatomy, S. P.M.C, Bikaner & SMS&R, Sharda University, Greater Noida on 100 samples of 4th rib taken from dead bodies brought for postmortem examination. Its particulars were recorded and age was noted and it was cross-checked from relatives by authentic ID proof. The research work was approved by the ethical committee. Before taking the sample from the deceased the consent form was filled & signed by the kin of the deceased.

The specimens were separated from the body by cutting the fourth rib at two points i.e. three centimeters inner to and five centimeters outer to costochondral junction using a rib cutter without damaging the

costochondral junction.

Macroscopic measurement had been taken after the extraction of bone. All of the measurements were taken with a sliding caliper calibrated to the nearest 0.1mm. The following measurements were used to determine age:

1. Maximum Superior Inferior Height (SIH) : the maximum distance between the most superior and inferior points at the end of the rib

2. Maximum Anterior-Posterior Width (APW): the maximum distance between the most anterior and posterior points at the end of the bone

3. Maximum Pit Depth (PD): the maximum depth of the pit was measured with a depth

caliper keeping the caliper perpendicular to the base of the pit.

All the readings were taken thrice and an average of the three readings was taken for better accuracy. After calculating the above measurements the linear regression analysis was applied.

Observations & Results

In present study total 100 cases were examined. Out of 100 cases males constituted 67 while females constituted 33 of the samples.

Table 1: Age distribution of study sample (N = number of individuals)

AGE RANGE	Groups coding	N	% distribution
15-30	1	55	55
31-45	2	27	27
46-60	3	17	17
<60	4	01	1
TOTAL	4	100	100

The age of all sample ranged between 15 and 62 years with a mean age of 32.73 years. The age range for males was between 15 to 60 years (mean age=34.38 years), while the females range was between 18 to 62 years (mean age=29.36 years).

For Age determination following parameters had been studied. Their descriptive statistics also calculated. (Table 2).

Table 2:- Descriptive statistics of study samples according to their SIH, APW, PD (All values in cm)

S. No.	Parameters	MEAN	SD
1	SIH (Maximum Superior-Inferior height)	1.379	0.233
2	APW(Maximum Antero-posterior Width)	0.445	0.121
3	PD(Maximum Pit depth)	0.18	0.74

For the calculated data for linear regression analysis SPSS 21.0 software has been used. Simple linear regression analysis was done. Data was charted in order to identify possible outliers. Regression analysis was undertaken in order to evaluate apparent trends for each of the three variables examined with actual age. For each variable the regression equation also has been derived after statistical analysis of data.

Table 3:- Comparison between r value, r square, Standard error of estimate (SEE), t-value and significance level.

S. No.	Variable	R value	R square	SEE (years)	t- value	Significance value
1.	SIH	0.275	0.76	12.194	2.835	0.006
2.	APW	0.412	0.170	11.559	4.47	0.0001
3.	PD	0.493	0.243	11.037	5.608	0.0001

According to the Table 3, the simple linear regression analysis that is best related to age for this pooled sexes sample is the Maximum Pit Depth (PD). The coefficient of determination (r^2) for this formula is 0.243 and the standard error of the estimate is ± 11.03 years.

Table 4:- Simple linear regression Equation (single variable only)

S. No.	Variable	Regression Equation
1.	SIH	Age Predicted = 12.046 + 14.898 (SIH)
2.	APW	Age Predicted = 13.594 + 42.688 (APB)
3.	PD	Age Predicted = 17.43 + 84.222 (PD)

From Analysis it is cleared that Maximum Superior-Inferior Height, Maximum Antero- Posterior Width and Maximum Pit Depth are all reliable factors. This indicates that these variables are easy to score and thus prove useful in age estimation techniques.

For better result Multivariate linear regression analysis has been done with same variables. In the multivariate analysis, the change in the coefficient of determination was noticed in comparison with the univariate analysis, with a slight improvement in the SEE.

Table 5:- Multivariate Regression Analysis for Sexes Pooled

S. No.	Variables	R value	R square	SEE (Years)	Regression Equation
1.	SIH, APW, PD	0.562	0.294	10.603	Age (Predicted) = 9.844 – 2.988 (SIH) + 31.584 (APB) + 71.178 (PD)

Morphometric Study: Measuring SIH (Image 1) and APW (Image 2).

The highest coefficient of determination was 0.562. The best standard error of the estimate for the multivariate analysis was ± 10.603 years (Table 5). This indicates that there is a slight improvement in the standard error

of the estimate and also improvement seen when the coefficient of determination is taken into account.

The question that remains is whether it is more practical to use the complex multiple regression formulae or the simpler, and less tedious linear regression formulae to estimate age at death.



Image-1 Measuring the Superior Inferior Height

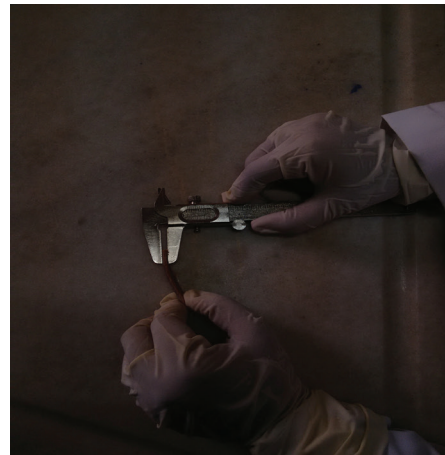


Image-2 Measuring the Antero-Posterior Width

Discussion

There are various methods and various bones were examined for estimation of age but very few methods are based upon morphometric or morphological analysis

of bone. Morphometric Analysis are easy, Feasible and result can be achieved very fast.

In the present study morphometric analysis of Fourth rib has been done on 100 study sample and regression

equation for age prediction was derived. More of the previous studies on sternal end of fourth rib for age estimation are mainly based on Histological, osteometric analysis and radiological techniques but Morphometric analysis based studies are very less.

Results of the present study showed that the age of a subject can be estimated from metamorphic changes in the sterna end of 4th ribs in all the age groups, as the t-values computed in all the cases were found to be significant.

Iscan et al^(3,4) concluded that age at death can be estimated from a rib within about 2 years in 2nd decade to about 7 years in the 5th and 6th decades of life and **Singh et al**⁽⁵⁾ revealed that age can be estimated from sternal end of 4th rib with an accuracy ranging between ± 2 years upto 3rd decade and about ± 8 years in the older age which is slightly invariance with our study. **Pankaj Gupta et al**⁽⁶⁾ concluded that in the age group 17-30 years, age can be estimated from sternal end of 4th rib with an accuracy ranging between ± 8 years, in the second age group 31 to 44 years ± 15 years and in the third age group 45 years and above again ± 8 years.

However, from the present study, for the sexes pooled and in all age group we could analyze that PD is most reliable among all factors and for this SEE is 11.037 years. for the better result in present study we had done the multivariate regression analysis and result showed SEE is 10.603 years.

So still in the field of Forensic Medicine, we remain handicapped to exactly pinpoint the accurate age from one single factor, as metamorphic changes in the sternal end of the 4th rib alone are not sufficient to assess the accurate age of a subject.

Conclusion

Positive identification involves matching of an “unknown” individual to a “known” individual. The identification of skeletal and other decomposed human remains is very important for legal and humanitarian reasons.

Most research on estimating age-at-death using human skeleton material suggested that degenerative processes are good indicators for age estimates. However, these processes can vary among populations, depending upon factors such as biological affinity and relate to growth and development.

The objective of this research was to estimate the age by using the sternal end of the fourth rib. We selected specimens of known age and sex. It was possible to observe the relationship between morphological changes and known age. For the fourth rib the morphometric features included in this study were SIH, APW and PD had a significant relationships with age.

The results of the analysis suggest that we can estimate age at death but for more precise and accurate results one must include we are also of the opinion that unifactorial parameter to assess the age from the sternal end of the ribs for practical purposes is not completely accurate. So multifactorial parameteric/ comprehensive approach should be the hallmark for arriving to conclusion as regard to the age of the subject.

We hope that these results will promote the evaluation of methods for estimation of age-at-death and a more critical consideration of factors that influence human variation.

Acknowledgement: We would like to thank Department of Anatomy, SMS&R, Sharda University for providing support throuout the research. We would like to thank Mr. Neeraj Pal singh, Biostatitician, SMS&R for helping in statistics work. We would like to extend our sincere thanks to Dr. Pooja Rastogi (Associate dean, SMS&R,) for valuable advice and suggestions. We Sincerely thanks & are very Grateful to Dr. Manisha Jindal (Dean, SMS&R, Sharda University) who assisted immeasurably with her feedback and support.

Ethical Clearance: Taken From Ethics committee, S.P. Medical College & associated Hospitals, Bikaner (Rajasthan)

Source of Funding: Self

Conflicts of Interest: None

References

1. Subrahmanyam BV. Modi's Medical Jurisprudence and Toxicology, 22nd edition, Butterworths, India, 1999; 37-38: 49.
2. Iscan MY, Loth SR and Wright RK. Age estimation from the rib by phase analysis: white females. *Journal of Forensic Science*, 1985; 30: 853-863.
3. Iscan MY, Loth SR and Wright RK. Age estimation from the rib by phase analysis: white males. *Journal of Forensic Science* 1984b; 29: 1094-1104.
4. Iscan MY, Loth SR and Wright RK. Metamorphosis at sterna rib end: A new method to estimate age at death in white males. *American Journal of Physical Anthropology*, 1984; 65: 147-156.
5. Singh D, Parkash C, Tyagi S, Pandey AN. Determination of age from the metamorphosis at sternal end of right 4th rib in North West Indian males. *Journal of Indian Academy of Forensic Medicine* 1999; 21: 77-85.
6. Pankaj gupta, Hakumat R, Gurdeep K. Age Determination from Sternal ends of the Ribs- an Autopsy Study. *JIAFM*, 2007 - 29(4).