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Original Research Article

Estimation of Age from Morphological Changes in the Sternal End of the Fourth Rib Using Phase Technique.

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Abstract

I Estimate of age is an important aspect of forensic anthropology. However, as the individual advances in age, estimation of age from bones and tissues becomes less precise. There is a need for a sensitive India-specific instrument to accurately determine age of an individual. Phase analysis method, developed by I-scan amongst White American populations, has been used in our study to estimate age by assessing the morphological changes in the sternal end of the fourth rib. A cross-sectional descriptive study was carried out in Maulana Azad Medical College, New Delhi. Hundred and fifty cases brought to the Dept. of Forensic Medicine for post-mortem were recruited. The sternal ends of the fourth rib from both sides was isolated and studied, and age of the individual was estimated based on three components. The morphological changes in the sternal ends of the ribs were found to be significantly correlated with the age of the individual. There was no difference in the findings of bilateral sides on all components. Study of phase changes in sternal ends of the fourth rib can be used for age estimation in Indian population.

1. Introduction

Estimation of age is an important aspect of forensic anthropology. However, as the individual advances in age, estimation of age from bones and tissues becomes less precise, and little knowledge is available on accurately isolating the age of an individual in a narrow range.¹ Various researchers have studied the clavicle, sternum, scapula, the thyroid cartilage, etc., as means to accurately predict the age of an individual older than 25 years.² However, little consistency has been observed in the findings, which were largely unrepeatable in follow-up studies carried out in people with racial and geographical differences.³

I-scan et al, in 1983, introduced phase method for the estimation of adult age at death from the sternal extremity of the fourth rib. In cases bomb blasts, fragmented bodies found in mass disasters, etc., small bones like the ribs generally remain undamaged and available for age estimation of victims. His primary studies were conducted on White American males.¹ In 1997, he applied his rib phase technique on a Turkish population sample. According to this study rib phase method can be accurately applied to Turks.⁴

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These investigations were very vital because one cannot assume that a method developed from investigations on one group can be applied to a distant population, especially in medico-legal proceedings. Very few studies have been conducted in the Indian sub-continent where age determination has been done using sternal ends of fourth rib. Our present study was conducted to estimate the age of a case from the morphological changes at the sternal ends of fourth ribs based on phase related changes.

2. Materials & Methods

This study was a descriptive cross-sectional study carried out in the Department of Forensic Medicine, Maulana Azad Medical College and Associated Hospitals. A 150 cases (75 male and 75 female), of known age (as ascertained from specific documentation provided by the relative) were recruited and study materials obtained, after informed consent had been obtained from their relatives. Cases whose age was doubtful, who had fractured, diseased or deformed fourth rib or those suffering from endocrinal disorders were excluded from our study. Ethical clearance was also sought from the Institutional Ethics Committee of Maulana Azad Medical College before the study was conducted. All cases aged between 10 and 70 years were included in the study. Cases having fractured, diseased or deformed fifth rib, those having any endocrinal or growth disorder, or those cases whose age was doubtful were excluded from the study.

The study materials comprised of the fourth rib from both sides of the rib cage. The thorax was opened using routine autopsy technique. The sternal ends of fourth rib were removed after identifying and by cutting 2 inches (5cm) long portion along with the costochondral junction with the help of rib cutter. The cut portion was put in a boiling solution containing sodium bicarbonate and boiled for 20 minutes or until the soft tissue coverings have been removed. Following that, the rib was cleaned and dried at room temperature. The sternal ends of the ribs were examined with the help of magnifying lens and the mentioned morphological traits were noted.

- Component I (Pit depth)
- Component II (Pit Shape)
- Component III (Rim Shape and edges of rim wall)

The readings were recorded in a tabular form and were then assigned to one of six stages for each of the components. (See [Table 1-3](#)).

Table 1: Component I – Pit depth (i.e., the maximum depth of the pit was measured with the depth calliper calibrated to 0.1mm). It was divided into six stages².

Stage	Component findings
0	Flat to slight billowing with no indentation (pit) less than 1.1 mm.
A	Definite pit formation with a depth ranging from 1.1 to 2.5mm.
B	Pit depth ranging from 2.6 to 4.5mm.
C	Pit depth ranging from 4.6 to 7mm.
D	Pit depth ranging from 7.1 to 10mm.
E	Pit depth of 10.1mm or more.

Table 2: Component II – Pit shape. It was divided into six stages.

Stage	Component findings
0	Flat and billowy articular surface.
A	A shallow indentation.
B	Formation of V-shaped pit with thick walls.
C	The pit assumes a narrow U shape with fairly thick walls.
D	Wide U shape pit with thin walls.
E	Pit is still wide U shaped, yet deeper, more brittle and poorer in texture with some disintegration of bone.

Table 3: Component III – Shape of rim and edges of rim wall. It was divided into six stages.

Stage	Component findings
0	Smooth regular rim, with no wall formation.
A	Beginning walls with a thick, smooth regular rim.
B	Definite visible walls that is thick and smooth with a scalloped or slightly wavy rim.
C	The scalloped edges are disappearing wall are thinning yet the wall are fairly without fairly study without significant deterioration in the texture.
D	The rim is becoming sharper and increasingly irregular with more Frequent bony Projection, often more pronounced at the cranial and caudal margins. The walls Shows further thinning cranial and are less sturdy with noticeable deterioration in texture.
E	Texture shows extreme friability and porosity, rim is very sharp, brittle and highly irregular with long bony projection. Occasionally windows are formed in areas where the walls are incomplete.

Table 4: Analysis of Fourth Right & Left Rib according to Pit Depth (Stage A to E)

Pit Depth	RIGHT			LEFT		
	N	Mean \pm Std. Dev	Range	N	Mean \pm Std. Dev	Range
A	8	18.88 \pm 2.03	16-23	15	20.60 \pm 3.18	16-27
B	31	24.65 \pm 5.63	19-42	38	26.03 \pm 5.06	21-41
C	37	31.59 \pm 8.14	22-54	36	38.03 \pm 10.67	24-64
D	32	47.13 \pm 6.31	26-58	38	53.55 \pm 7.53	42-73
E	42	60.24 \pm 9.25	45-79	23	61.74 \pm 9.99	46-79
Total	150	40.81 \pm 16.45	16-79	150	40.81 \pm 16.45	16-79

Table 5: Analysis of Fourth Right & Left Rib according to Pit Shape (Stage A to E)

Pit Depth	RIGHT			LEFT		
	N	Mean \pm Std. Dev	Range	N	Mean \pm Std. Dev	Range
A	8	18.88 \pm 2.03	16-23	15	21.33 \pm 3.68	16-27
B	29	24.90 \pm 5.74	19-42	37	25.78 \pm 4.83	20-41
C	40	32.00 \pm 9.66	22-54	42	39.98 \pm 12.21	21-65
D	32	46.87 \pm 6.49	26-58	38	52.39 \pm 7.14	42-73
E	41	60.22 \pm 9.36	45-79	18	65.44 \pm 8.42	52-79
Total	150	40.81 \pm 16.45	16-79	150	40.81 \pm 16.45	16-79

Table 6: Analysis of Fourth Right & Left Rib according to Rim Shape (Stage A to E)

Pit Depth	RIGHT			LEFT		
	N	Mean \pm Std. Dev	Range	N	Mean \pm Std. Dev	Range
A	7	18.43 \pm 1.27	16-20	11	19.91 \pm 3.05	16-26
B	28	23.64 \pm 3.72	18-39	31	24.00 \pm 3.59	20-36
C	40	31.85 \pm 9.49	21-56	32	32.22 \pm 8.86	23-56
D	35	46.74 \pm 6.24	26-61	42	50.83 \pm 8.21	36-72
E	40	60.52 \pm 9.27	45-79	34	58.62 \pm 10.62	37-79
Total	150	40.81 \pm 16.45	16-79	150	40.81 \pm 16.45	16-79

The bones were replaced in the body after the findings were recorded. The data thus collected, was entered in MS-Excel and analysed using MS-Excel and SPSS version 20. The data was summarised as means and proportions. One-way ANOVA was used to test for significance between the age of the study participant and the stages of the morphological traits assessed by the observer.

3. Results

The study was conducted on 150 cases (75 male cases and 75 female) with age ranging from 16 to 79 years. The fourth rib from each side was analysed based on following parameters – Pit Depth, Pit Shape, Rim Shape and Edges of Rim Wall. All parameters had five stages (A – E). Descriptive results indicated that the mean age progressively increased from Stages A to E in Pit Depth, Pit Shape and Rim Shape for the fourth Rib on both sides (Fig. 1 to 3).

For the fourth Right Rib, the mean age of the eight cases having Phase A changes in Pit Depth was 18.88(\pm 2.03) years. Mean age of the 31 cases showing Phase B changes was 24.65(\pm 5.63) years. For the 37 cases showing Phase C changes, mean age was 31.59(\pm 8.14) years. Thirty-two cases showing Phase D changes in Pit Depth had mean age of 47.13(\pm 6.31) years, and Phase E changes showed by 42 cases had a mean age of 60.24(\pm 9.25) years.

Similarly, for the fourth Left Rib, the mean age of 15 cases showing Phase A changes in Pit Depth was 20.60(\pm 3.18) years. Phase B changes were seen in 38 cases with mean age of 26.03(\pm 5.06) years. Phase C consisted of 36 cases with mean age of 38.03(\pm 10.67) years. Phase D consisted of 38 cases with mean age of 53.55(\pm 7.53) years. Phase E changes were seen in 23 cases with mean age of 61.74(\pm 9.98) years. Similar findings were seen in Pit Shape and Rim Shape for both sides

of the fourth rib (Refer [table no. 4 to 6](#)). The magnitude of correlation between the Age of the study participant and the Stages of the three morphological traits were analysed using one-way ANOVA. Age was found to be significantly correlated with the progressive stages of the morphological traits in the study. Paired t-test failed to show any difference between right and left fourth rib for any variables analysed, indicating that there was comparison in the findings of both sides.

Figure 1: Pit floor



Figure 2: Irregular pit margins



Figure 3: U-shaped pit



4. Discussion

This study was done on 150 cases brought for medico-legal autopsy at Mortuary of Lok Nayak Hospital. In this study, the fourth rib from both sides

were studied. The sternal extremity of each rib was analysed in relation to pit depth (component I), pit shape (component II) and rim shape and wall configuration (component III). Mean age in all components for all the ribs was gradually increasing for score A through E in present study.

The study results inferred that the age at death may be estimated from the rib in between third & fourth decade within about 3 years. It inferred that the age at death may be estimated from the rib in the sixth and seventh decade of life within about 6 years. In one-way analysis of variance for fourth right ribs, it was found that 79.9% of studied ribs showed changes in pit depth in accordance with age of the individual. For the other two components, 76.7% of studied ribs showed changes in pit shape and 78.7% of studied ribs showed changes in rim shape and wall configurations were found to be in accordance with the age. One-way analysis of variance of fourth left ribs indicated that, 76.8% of studied ribs showed changes in Pit depth were in accordance with age. 74.6% of studied ribs showed changes in Pit shape and 76.7% of studied ribs showed changes in Rim shape and edges of rim, were in accordance with the age. The analysis of variance statistic was found in total component score to be 73% in Iscan et.al (1984)², 79% in Meena et.al study (2012)⁵ and 83% was found in Meena et al (2014)⁶.

In the present study, statistical analysis showed that there are very little morphological variations in the fourth ribs of both sides. Paired t-test failed to show any difference between right and left sided ribs. Gupta et al in 2007⁷, Meena et al in 2012⁵, Meena et al in 2014⁶ and Doshi et al⁸ made the same findings in 2014. Tyagi et al, conducted a study on 77 males to find out the bilateral metamorphological variation in the sternal end of fourth ribs. The observed that score for Component II & III (Pit Shape and Rim Edge) is more age dependant than Component I (Pit Depth) for right and left sided fourth ribs.⁹ This is in contrast to our present study that showed that Component I (Pit Depth) is more age dependent than Component II & III (Pit Shape and Rim Edge) for all the ribs of both sides.

In our study, it was found that component method is applicable for estimation of age in Indian males and females. The rate of change of morphological pattern in the sternal end of the ribs are statistically associated with age.

5. Conclusion & Recommendation

Multifactorial parametric and comprehensive approach should be the hallmark for arriving at a conclusion regarding the age of the subject. It is essential, especially in medico-legal cases, to have demographic methods known to be accurate in adult Indians, since few standards have been developed from Indian specimens. This study revealed that morphological changes in the sternal ends of the fourth ribs may help to estimate age using component method. Component method can accurately estimate age in Indian population throughout the adult life span. More studies need to be conducted to generate population-specific data on the validity of estimation of age of an individual from the morphological traits studied above.

References:

1. İşcan MY, Loth SR, Wright RK. Age estimation from the rib by phase analysis: white males. *Journal of Forensic Science*. 1984 Oct 1;29(4):1094-104.
2. İşcan MY, Loth SR, Wright RK. Metamorphosis at the sternal rib end: a new method to estimate age at death in white males. *American journal of physical anthropology*. 1984 Oct;65(2):147-56.
3. İşcan MY, Loth SR, Wright RK. Age estimation from the rib by phase analysis: white males. *Journal of Forensic Science*. 1984 Oct 1;29(4):1094-104.
4. Yavuz MF, İşcan MY, Çöloğlu AS. Age assessment by rib phase analysis in Turks. *Forensic science international*. 1998 Nov 30;98(1-2):47-54.
5. Meena MC, Yashoda RA, Mukta RA. Bilateral metamorphological variation at sternal end of fourth rib. *Eurasian journal of anthropology*. 2012;3(2):41-6.
6. Meena MC, Rani Y, Sharma GK. Age Estimation from the Rib by Components Method Analysis in Indian females. *Antrocom: Online Journal of Anthropology*. 2014 Jul 1;10(2):143-147.
7. Gupta P, Rai H, Kalsey G, Gargi J. Age determination from sternal ends of the ribs-an autopsy study. *From Editor's Desk*. 2007;29(4):94.
8. Doshi SM, Chauhan VN, Mangal HM, Pipalia K, Aghera V, Dabhi D. Correlation of age and morphological changes at sternal end of fourth ribs at Rajkot region. *Int J Cur Res Rev | Vol*. 2014 Sep 15;6(18):35.
9. Tyagi Y, Kumar A, Kohli A, Banerjee KK. Estimation of age by morphological study of sternal end of fourth ribs in males. *Journal of Indian Academy of Forensic Medicine*. 2009;31(2):87-94.