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Age Estimation from the Rib by Phase analysis - An autopsy study in males

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Abstract

Age is an extremely vital parameter in personal identity and its determination from skeletal remains has been studied and analyzed by many workers. In the present study the sternal end of fourth ribs were used for determination of age by direct observation. One of the great works on this subject was done by M.Yasar Iscan(1984) on white males. Over the years numerous tests have confirmed the reliability of this technique on varied samples from different population. Present study is an effort to test the application of the method developed by Yasar Iscan on a population in the state of Kerala. The sample consisted of fourth ribs on right side from 219 males of known age and race. The ribs were assigned to one of nine phases (0 through 8) based on changes noted at the coctochondral junction.Statistical analysis indicated that these changes were age related and applicable to the population of India also.

Key words: Age estimation, morphology, sternal end of fourth rib.

Introduction

Establishment of individuality of a person living or dead is termed as identification. A complete identification is relatively an easy matter in case of living persons as well as dead bodies recovered before putrefaction has sets in. On the other hand, in cases of mutilated or highly putrefied bodies or in skeletal remains, identification creates a great problem. Currently Forensic and physical anthropologists use two methods for estimating age from skeletal remains of adults. The first method is based on the gross morphologic changes in bones like closure of cranial sutures and metamorphosis of pubic symphysis.The other method involves microscopic analysis of bone changes at histological level viz.osteon counting. Each method has its own limitations and creates difficulties.

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In the present study, the sternal end of rib is used for determination of age by direct observation. The medial end of rib at the costochondral junction is examined with special attention to depth and shape of the pit along with the walls and rim surrounding it. The advantages of using rib for determination of age are (i) the medial sternal end shows change throughout life.(ii) age can be estimated even from a single undamaged rib and (iii) the rib can be obtained easily without mutilating the body.

One of the great works on this subject was done by M.Yasar Iscan(1984) on white males.[1] Over the years numerous tests have confirmed the reliability of this technique on varied samples.[2,3] However, no large scale study has been conducted to test the application of this method on a population of India especially in the state of Kerala. The present study used samples from 219 males of known age.

Materials and methods

In the present study fourth rib from the right side of chest containing the costochondral junction were collected from 219 bodies brought for postmortem examination during the period 15-10-2004 to 14-04-2005 at the Department of Forensic Medicine, Government Medical College, Trivandrum. Specimens were collected from only those cases where exact age, sex and race were known. The specimens were separated from the body by cutting at two points i.e. three centimeter inner to and five centimeter outer to costochondral junction using a rib cutter without damaging the costochondral junction. The muscles attached to the ribs were cut using scissors. The portion of ribs were labeled and kept in water containers for three to four weeks. By keeping in water soft tissues could be easily removed from the bone. The remaining soft tissue and cartilages if any were removed by keeping in boiling water for ten to fifteen minutes. They were thoroughly dried at room temperature. Each rib was examined meticulously to ascertain the stage of morphological change .Based on metamorphosis of features the specimens were separated in to nine groups - phase 0 to phase 8.

These phases were developed based on the changes noted in the form,shape,texture and overall quality of costochondral junction of ribs and shown in TABLE-1.The phases were then stasticlly analysed using the software SPSS(Statistical package for social sciences) 10.0 version.

Table 1. Phase changes on the costochondral junction of ribs.[1]

Phase 0	The articular surface is flat or billowy with a regular rim and rounded edges. The bone itself is smooth, firm and very solid.
Phase 1	There is a beginning amorphous indentation in the articular surface, but billowing may also still be present. The rim is rounded and regular. In some cases, scallops may start to appear at the edges. The bone is still firm, smooth and solid.
Phase 2	The pit is now deeper and has assumed V- shaped appearance formed by the anterior and posterior walls. The walls are thick and smooth with a scalloped of slightly wavy rim with rounded edges. The bone is firm and solid.

Phase 3 The deepening pit has taken on a narrow to moderately U – shape. Walls are still fairly thick with rounded edges. Some scalloping may still be present but the rim is becoming more irregular. The bone is still quite firm and solid.

Phase 4 Pit depth is increasing ,but the shape is still a narrow to moderately wide U. The walls are thinner, but the edges re4main rounded. The rim is more irregular with no uniform scalloping pattern remaining. There is some decrease in the weight and firmness of the bone; however the overall quality of the bone is still good.

Phase 5 There is little change in pit depth but the shape in this phase is predominantly a moderately wide U. Walls show further thinning and the edges are becoming sharp. Irregularity is increasing in the rim. Scalloping pattern is completely gone and has been replaced with irregular bony projections. The condition of the bone is fairly good; however there are some signs of deterioration with evidence of porosity and loss of density.

Phase 6 The pit is noticeably deep with a wide U-shape. The walls are thin with sharp edges. The rim is irregular and exhibits some rather long bony projections that are frequently more pronounced at the superior and inferior border. The bone is noticeably lighter in weight, thinner and more porous, especially inside the pit.

Phase 7 The pit is deep with a wide to very wide U – shape. The walls are thin and fragile with sharp, irregular edges and bony projections. The bone is lighter in weight and brittle with significant deterioration in quality and obvious porosity.

Phase 8 In this final phase the pit is very deep and widely U-shaped. In some cases the floor of the pit is absent or filled with bony projections. The walls are extremely thin fragile and brittle with sharp, highly irregular edges and bony projections. The bone is very light weight, thin brittle, friable and porous.” window” formation is sometimes seen in the walls.

Results and Discussion

In the present study fourth rib from the right side of the chest containing the coctochondral junction were collected from 219 bodies. The samples were collected from a wide range extending from six months to eighty four years. The coctochondral junction of these ribs were examined and graded using the phase analysis method as was originally used by Yasar Iscan et al (1984).The age grouping was also done in the same way as the original study for comparison purpose. Distribution of cases according to age in the present and that of Yasar Iscan is given in Table-2.

Maximum numbers of cases (23.7%) were from the age group of 50-59 years in the present study. In the original study by Yasar Iscan(1984) it was 20-29(32.2%).

The age wise distribution of cases according to phase analysis in the present sample was compared with that of Yasar Iscan et al.The results are given in Table-3.

Table2: Frequency and percentage distribution of specimens by age intervals

Age group in years	Sample of Yasar Iscan et al		Sample of present study	
	Number of cases	Percentage	Number of cases	Percentage
0-16	10	8.5	14	6.4
17-19	6	5.1	8	3.7
20-29	38	32.2	34	15.5
30-39	15	12.7	30	13.7
40-49	15	12.7	40	18.3
50-59	11	9.3	52	23.7
60-69	12	10.2	25	11.4
70 and above	11	9.3	16	7.3
Total	**118**	**100**	**219**	**100**

Table 3: Distribution of cases according to phase analysis

Phase	Age range in sample of Yasar Iscan et al	Age range in sample of present study
1	17-18	17-24
2	18-25	20-29
3	19-33	28-38
4	22-35	37-47
5	28-52	40-58
6	32-71	33-70
7	44-85	56-69
8	44-85	54-84
Total	**17-85**	**17-84 yrs.**

Table 4 shows the number of cases in each phase and their percentage in both the studies.

Table 4: Phase wise distribution of cases

Phase	Sample of Yasar Iscan et al		Sample of present study	
	No. of cases	percentage	No. of cases	percentage
0	—	—	13	5.0
1	4	3.8	12	5.5
2	15	13.9	29	13.2
3	17	15.7	26	11.9
4	12	11.1	24	11.0
5	14	13	50	22.8
6	17	15.7	23	10.5
7	17	15.7	25	11.4
8	12	11.1	17	7.8
Total	**108**	**100**	**219**	**100**

The initial morphological changes started to appear from age 17 years onwards in the present study. No significant changes in the sternal extremity of ribs was noted till the age of 16 years in 70 percentage samples and till 18 years in 30 percentage samples. This may be due to cessation of growth and this would indicate that the maturity in the rib is reached by about 18 years .The corresponding age in the study of Yasar Iscan was 16 years.

The rate of phase changes was found to be very slow in the phase 6, 7 and 8 .So the age determination can be done within a wide range only in these phases. In the present series 22.8 % cases belong to phase 5 ,followed by phase 2 (13.2 %).The distribution was almost equal in phases 3,6 and 7(15.7 % each) in Yasar Iscan's study.

The phase 1 changes started from the age of 17 years and lasted up to 24 years in the present study with a mean age of 20.17 .In the study by Yasar Iscan the mean age of phase 1 was 17.3.All other phases showed a higher value of mean age in the present study except phase 7 which showed a mean age of 63.6.Phase 7 has a higher mean age than Yasar Iscan(59.2%)

Two hundred and nineteen cases in the age group of three months to eighty four years (mean age 43.9) were subjected to statistical analysis. The results are given in Table-5.

Table 5: Mean age and 95% confidence interval

Phase	Mean Age		95 percent confidence interval	
	Sample of Yasar Iscan	Sample of present study	Sample of Yasar Iscan	Sample of present study
1	17.3	20.8	16.5-18.0	19.1-21.2
2	21.9	24.7	20.8-23.1	23.8-25.6
3	25.9	33.8	24.1-27.7	32.7-34.9
4	28.2	44.0	25.7-30.6	42.6-45.3
5	38.8	51.6	34.4-42.3	50.3-53.1
6	50.0	51.7	44.3-55.7	47.8-55.6
7	59.2	63.6	54.4-64.1	62.2-65.0
8	71.5	71.7	65.0-78.0	65.8-77.7
Total	**41.0**	**43.9**	**—**	**—**

The above result showed that 95% confidence interval is becoming wider with advancing morphological changes. It is evident that the width which is only around two years in phase-1 became 11.9 years in phase-8.

The rate of advancing change in younger age group was found to be more; as evidenced by the fact that the phase-1 changes were seen only for a period of eight years while phase 2 for a period of ten years and phase 3 and 4 changes for a period of eleven years each. But in older specimens the rate of phase changes was more. Phase -6 was represented by an age range of thirty eight years and phase-8 by thirty one years.

The width of 95 percent confidence interval and mean age were found to increase as the age advances in both studies.

The statistical significance of the distribution of the samples according to the age and phase were analyzed by CROSSTABS PROCEDURE. The results are given in Table-6

In phase 2 all the samples belonged to a single decade (20-29). 96 % of samples belonged to age grup30-39 in phase 3. 96% of Phase 4 samples included in 40-49 age group, in phase 5 it was 74% in 50-59 age group. The greatest variability was observed in phase 6 with representation from five different decades with maximum samples(48%) in sixth decade.88% of phase 7 samples belonged to sixth decade and in phase 8 ,75% samples belonged to age group 70 years and above. In phases 3, 4 and 5 the changes did not extend in to the higher age groups.

Statistical analysis was done with chi square test. The value obtained as891.6 with a degree of freedom 56.Degree of freedom= (row-1) x (column-1).Here it is (9-1) x (8-1).From the above values P value was estimated and obtained as P= 0.000.Thus it was shown that age estimation from the phase changes of sternal end of ribs is significant.

Table 6: Frequency distribution of phase by age intervals

	Age group in years								
	0-16	17-19	20-29	30-39	40-49	50-59	60-69	70 & above	Total
Phase 0	9	4							13
Row %	69.23	30.77							
Column %	64.29	50.00							
Phase 1	4	4	4						12
Row %	33.33	33.33	33.33						
Column %	28.57	50.00	11.76						
Phase 2			29						29
Row %			100						
Column %			85.29						
Phase 3			1	25					26
Row %			3.85	96.15					
Column %			2.94	83.33					
Phase 4				2	22				24
Row %				8.33	91.67				
Column %				6.67	55.00				
Phase 5	1				12	37			50
Row %	2.00				24.00	74.00			
Column %	7.14				30.00	71.15			
Phase 6				3	5	11	2	2	23
Row %				13.041	21.74	47.83	8.70	8.70	
Column %				10.00	12.50	21.15	8.00	12.50	
Phase 7						2	22	1	25
Row %						8.00	88.00	4.00	
Column %						3.85	88.00	6.25	
Phase 8					1	2	1	13	17
Row %					5.88	11.76	5.88	76.47	
Column %					2.50	3.85	4.00	81.25	
Total	14	8	34	30	40	52	25	16	**219**

Conclusions

1. The initial morphological changes in sternal end of ribs started their appearance from 17 years onwards. The early phase changes did not extend into higher age groups.
2. Phase 2 belonged to a single decade (20-29 years)
3. More than 96% of phase 3 belonged to the decade 30-39 years.
4. 92% of phase 4 belonged to 40-49 years and the rest to phase 3.
5. 74% of cases of phase 5 were from 50-59 years.
6. The phase analysis method was found to be useful in Indian population, except in phase 6-8 where age can be determined only within a wide range.

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