



## CAVITY FORMATION IN HEAD OF FEMUR CAN BE THE BEST DETERMINATE OF AGE: A PROSPECTIVE STUDY

### Anatomy

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### ABSTRACT

Age estimation is important in identification of living individual, forensic and archeological studies. We conducted a study to assess cavity formation of head of femur as one of the best determining factor for age estimation. Method: Volunteers of > 21 year with defined inclusion and exclusion criteria, radiographed and evaluated in parameters of cavity formation by SPSS system. Results: 276/300 participants were imaged and evaluated. Significant linear trend of distribution of cavity formation with increasing age from Non recognizable cavities in column (69.57%) and trochanter major with loosings (30.43%), is significantly better predictor ( $\chi^2=352.8$ ;  $P < 0.0001$ ) in young of 21-30yr while in > 70 years Clearly recognizable cavity in trochanter major (51.22%) and large cavities in column (21.95%). Conclusion: The cavity formation varies with age and good determinate only in extremes of age that is in the beginning of formation and at resolution of it.

### KEYWORDS

Head of femur, Cavity formation, Trabecular pattern, Wards triangle

### INTRODUCTION

Age estimation, combined with sex and ancestry assessment, is a key issue in identification of an individual in forensic science and archaeology. The traditional methods evaluate macroscopically the morphological changes of the teeth and bones, such as cranial sutures, pubicsymphyseal surface, auricular surface, and the sternal end of the ribs. Trabecular architecture of bones has been of interest since a very long time. In 1830, Bourger, Ward and Wyman independently described the regular pattern of trabecular architecture in the proximal femur. Subsequently many workers have done a lot of work in this field.<sup>5</sup>

In 1867 A Swiss anatomist G.H. Von Meyer presented a paper with a line drawing of the cancellous or spongy bone structure that he had observed in the proximal end of human femur.

Kotting (1977) used radiographs of proximal femur to make age determination in an archeological population.

Walker and Lovejoy<sup>8</sup> in 1985, in a landmark study of macroscopic change in the proximal femur humerus clavicle and calcaneum.

Wendy Michelle Jones (2003)<sup>9</sup> of the trabecular architecture of proximal femur based on cadaveric femora collection from different institutes of United States by the researcher evaluated total of 240 individual of known age at death. The sex and racial affinity was also known. She compared her findings with those of Walker and Lovejoy<sup>8</sup> in 1985 and Szilvassy and Kritscher<sup>10</sup> 1990.

The present study was carried out in the Department of Anatomy, Orthopedics and Radiology to study the age related changes in the trabecular pattern of proximal femur in 10 year age wise group population in central India.

This research evaluated both J. Szilvassy & H. Kritscher's (1990) Walker & Lovejoy's (1985)<sup>8</sup> techniques in order to determine if the trabecular architecture of femur can be used regularly for age estimation in forensic & archeological contents.

### AIMS AND OBJECTIVE:

The aim of the study is to assess the study the cavity formation in trabecular architecture of the proximal femur radiographs as best determining factor in 10-year age wise groups of volunteers (age 21 and above) and to assess the gravity of association with other factors.

### MATERIAL AND METHODS;

**STUDY DESIGN:** Observational prospective study  
**STUDY CENTRE:** Department of Anatomy, Department of Orthopaedics & Department of Radiodiagnosis, N.S.C.B. Medical College & Hospital, Jabalpur (M.P.) INDIA. **DURATION OF STUDY:** 1st April 2016 to 31st March 2017

### SAMPLE SIZE:

A total of 300 volunteers grouped as follows –

Group 1	-	21 – 30 years of age
Group 2	-	31 – 40 years of age
Group 3	-	41 – 50 years of age
Group 4	-	51 – 60 years of age
Group 5	-	61 – 70 years of age
Group 6	-	71 and above years of age

In each group 50 volunteers with equal gender distribution.

### Inclusion criteria-

- Age 21 years and above.
- Healthy volunteer who gave consent for the same.
- They should not be suffering from any hip pathology.
- No major systemic illness like hypertension, diabetes, metabolic or autoimmune disease.
- No history of prolonged use of drugs like corticosteroids, tranquilizers, calcium supplements,
- Not using oral contraceptives or drug eluting contraceptive devices.
- No history of trauma.

### Exclusion criteria-

- Person whose age is not known
- Chronic illness like diabetes, hypertension, tuberculosis and metabolic diseases etc.
- Any pathological bone diseases like vascular necrosis, osteomyelitis etc.
- Congenital skeletal dysplasias.
- Known muscular diseases
- Prolonged drug history of steroids and other drug causing osteoporosis.
- History of trauma
- Antenatal, Immediate post partum (within 6 months of

- delivery), lactating women.
- Post or peri partum on oral contraceptives or drug eluting device or on Hormone replacement therapy.

**Investigation Details –**

The radiograph taken in antero posterior plane of right and left hip joint in the healthy volunteer with standard protocol mentioned below

1. MA – 200 ma
2. KVP – 60 – 70
3. MAS – (Exposure time) 24 – 32
4. Tube to base distance - 100 cm
5. For AP view supine position, internal rotation 15 degree, great toes facing each other in midline.

The all parameters collected in xcel sheet and assed by SPSS.

**RESULT**

**TABLE – 1 AGE &SEX WISE DISTRIBUTION OF SAMPLE SIZE**

Age group	Sex		Total
	Male	Female	
21-30	24	22	46
	52.17%	47.83%	100.00%
31-40	24	24	48
	50.00%	50.00%	100.00%
41-50	24	25	49
	48.98%	51.02%	100.00%
51-60	22	27	49
	44.90%	55.10%	100.00%
61-70	23	20	43
	53.49%	46.51%	100.00%
>70	29	12	41
	70.73%	29.27%	100.00%
Total	146	130	276

X<sup>2</sup>=352.8; P < 0.0001

**TABLE – 2 AGE SPECIFIC FINDING OF CAVITY ORMATION**

Age	Cavity Formation	Total							
		None recognizable	Slight loosing in the areas of collums and trochanter major	Beginning of cavity formation in the middle part of the collum and in the trochanter major	Small cavities in the collum and in the trochanter major	Clearly recognizable, mudium size cavity in the collum and in the trochanter major.	Large cavities in the collum and in the torchanter major	Cavities very large	
21-30	32	14	0	0	0	0	0	0	46
	69.57	30.43	0.00	0.00	0.00	0.00	0.00	0.00	100.00
31-40	13	31	4	0	0	0	0	0	48
	27.08	64.58	8.33	0.00	0.00	0.00	0.00	0.00	100.00
41-50	2	22	20	4	1	0	0	0	49
	4.08	44.90	40.82	8.16	2.04	0.00	0.00	0.00	100.00
51-60	0	1	13	19	15	1	0	0	49
	0.00	2.04	26.53	38.78	30.61	2.04	0.00	0.00	100.00
61-70	0	1	11	20	9	2	0	0	43
	0.00	2.33	25.58	46.51	20.93	4.65	0.00	0.00	100.00
>70	0	2	0	8	21	9	1	0	41
	0.00	4.88	0.00	19.51	51.22	21.95	2.44	0.00	100.00
Total	47	71	48	51	46	12	1	0	276
	17.03	25.72	17.39	18.48	16.67	4.35	0.36	0.00	100.00

- This table shows about the age specific finding of Cavity Formation
- Age Range 21-30 years :- In 69.57% cases were observed with Non recognizable cavity and in 30.43% cases found as Slight loosings in the areas of collums and trochanter major.
- Age Range 31-40 years :- 27.08% cases were observed as Non recognizable cavity and in 64.58% cases were with Slight loosings in the areas of collums and trochanter major.
- Age Range 41-50 years :- 44.90% cases were observed as Slight loosings in the areas of collums and trochanter major and 8.33 Cases were with Beginning of cavity formation in the middle part of the collum and in the trochanter major
- Age Range 51-60 years :- 26.53% cases were observed as Beginning of cavity formation in the middle part of the collum and in the trochanter major and 38.78% cases were with Small cavities in the collum and in the trochanter major and in 30.61% cases found as Clearly recognizable, mudium size cavity in the collum and in the trochanter major.
- Age Range 61-70 years :- 25.58% cases were observed as Beginning of cavity formation in the middle part of the collum and in the trochanter major and 46.51% cases were with Small cavities in the collum and in the trochanter major and in 20.93% cases found as Clearly recognizable, mudium size cavity in the collum and in the trochanter major
- Above 70 years :- 51.22% cases were observed as Clearly recognizable, mudium size cavity in the collum and in the trochanter major and there were 21.95 cases with Large cavities in the collum and in the torchanter major.
- In current study we found significant linear trend of cavity formation with increasing age with distribution of Cavity Formation from Non recognizable to Large cavities in the collum and in the torchanter major, but for middle age group(51-60yrs)

this parameter is not very significant because we found 26.53% cases were observed as Beginning of cavity formation and 38.78% cases were with Small cavities, and in 30.61% cases found as Clearly recognizable, mudium size cavity in the collum and in the trochanter major.

- Was found and statistically this was highly significant as (x<sup>2</sup>=352.8; P<0.0001)

**FIGURE NO. – 1 ARCHITECTURE OF THE FEMUR AT 71 YEARS**



**FIGURE NO. – 2**



## DISCUSSION

Evaluation of the Techniques: Based on the current study, neither the **Walker and Lovejoy (1985)**<sup>8</sup> nor the Szilvassy and Kritscher (1990)<sup>10</sup> methods yielded results that were accurate enough to be commonly used in the forensic field and other for age estimation.

Walker and Lovejoy (1985)<sup>8</sup> standards assigned more age categories that were off by more than 20 years from the true age at death than categories that were correct. Thus, this method appears to have little value to forensics. Method it was found more accurate for young and very old ages, it shows that technique was more accurate in the polar categories than in the middle categories. But in current study we use 10 years age groups so in our result no such polar distribution of finding is found.

If we compare Walker and Lovejoy (1985)<sup>8</sup> stressed specific traits such as bone loss in Ward's triangle and the greater trochanter. In the current study, we used specific criteria that is cavity formation and we found that if we include it in their traits with our group division finding of age will be more specific distinct.

Szilvassy and Kritscher (1990)<sup>10</sup> in their technique used several trends. We suspect that with recalibration and further testing, their technique will be more useful in the forensic field and archeological study. We found that their technique consistently aged individuals better and were highly accurate on the base population from which they were formed. They used seven stages of femoral aging, along with greater trabecular loss, the apex, formed by secondary trabeculae in the femoral shaft, moves progressively toward the femoral neck. They took radiographs and cross sections of the proximal femur and proximal humerus from both living people and cadavers. The authors developed 10-year stages of femoral change.

The authors then tested their method against known ages in living and found that the cavity formation in trabecular architecture of the femoral head was highly correlated with age at death of their finding. They particularly stressed the location of the apex of the medullary cavity.

If we compare with our finding with we found that their technique, tended to lose accuracy as age increased.

**Macchiarelli and Bondiolini (1994)** studied age-related changes using three cross-sections of the proximal femur. These researchers found that bone loss was influenced by the types of stresses put on the bone. These stresses include nutritional differences, status, and sexual divisions of labor. Males in this study had a slower rate of bone involution. This bone involution was more erratic in males than in females. They concluded that, due to variability in bone loss, the standards measuring the trabecular architecture of the proximal femur had only a weak chance of accurately placing individuals in defined age categories.

**Kotting (1977)**<sup>7</sup> used radiographs of the proximal femur to make age determinations for an archaeological population. He used four criteria: cortical thickness, trabecular density, trabecular thickness, and visual bone loss. After seriation of the study population, he defined eight phases of trabecular change. The results of his study are site-specific for an archaeological population.

Trends and Variation by Sex: Several authors state that, as age progresses, the differences in bone loss between the sexes get larger. **Ericksen (1979)**, said females have more bone loss in the proximal femur than males. **Riggs and Melton (1986)** state that women will lose about 50% of their trabecular bone while men will only lose about 37%. Thus, differences in the accuracy of these results for males and females should be expected, which correlate with our finding. **The Walker and Lovejoy (1985)**<sup>8</sup> method had mixed results and more accurate for males than for females. **Szilvassy and Kritscher (1990)**<sup>10</sup> technique, clearly, applied better to females than to males and yielded similar results for their all collections. Atkinson et al. (1962) said that bone resorption becomes more variable as individuals age, which is one of our findings with advancing age.

Factors other than sex may contribute to variations in bone loss. Judging from the four collections used, patterns of bone loss vary with the population that is studied. Previous research supports this

conclusion. Health and workload have been cited by several authors as changing the amount of bone lost with age.

**Liel et al (1988)** found that obese women were less likely to develop osteoporosis than non-obese women. This difference between females of similar age may be due to the increase of stress and accompanying muscle mass that is seen in obese individuals. In our study we find similar result.

**Chalmers and Ho (1970)** when studying various geographical populations, found that senile osteoporosis may be linked to differences in physical activity. Populations with easier workloads have a higher incidence of senile osteoporosis than populations that are subject to more physical stress, which is highly similar with our finding.

**Riggs and Melton (1986)**<sup>13</sup> said that there is a, well-known, positive relationship between muscle mass and bone mass in obese women.

**Diet may, or may not, play a part in bone retention.**

**Riggs and Melton (1986)**<sup>13</sup> state that while there is no direct correlation between dietary calcium intake and bone loss, low levels of calcium throughout life will increase the probability of having high levels of bone involution.

## CONCLUSIONS

In current study author use exclusive criteria of cavity formation in head of femur for age estimation. In all the radiographs we found parameter show linear pattern in age wise distribution and is significant statistically. But we found that use of single parameter is not very sensitive method for age estimation. If we use cavity formation with other parameters we will find age more accurately.

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