Contents lists available at
Journal of Association of Radiographers of Nigeria
Journal homepage: www.jarn-xray.org

Radiographic Evaluation of Age and Gender Related Cortical Bone Thinning Using The Metacarpal Index Method: A Lagos Based Population Study.

Ekpo EU[1]*, Ikamaise VC[1], Egbe NO[1], Chiaghanam NO[1], Eke RO[2].
[1] *Department of Radiography, University of Calabar, Calabar*
[2] *Radiology Department , Jos University Teaching Hospital, Jos, Nigeria*

***Correspondence:**
ernestramsey@unical.edu.ng, ernestramsey@live.com

ARTICLE INFO

Article history
Received, 2007
Received in revised form, 2007
Accepted, 2007
Available online, 2007

Keywords:
Metacarpal index, Gender, Age, Radiograph, Request forms.

Abstract

A retrospective study to evaluate age and gender related cortical bone thinning using the metacarpal index (MCI) method was performed. Study sought to evaluate the effect of age and gender on metacarpal index. A randomized collection of 850 (males 436, females 414) dorsi-plantar radiographs of the left hand performed from 2003-2005 and accompanying request forms was carried out. The width of the cortex of the second metacarpal and shaft was measured and used to calculate the metacarpal index. Values were compared across age ranges and sex. Result showed a gradual increase in MCI for both sexes from 20-40 years (peak MCI 57.4±2 and 52.8±02 for males and females respectively at 40 years). A linear decrease after the 5th decade of life was also observed. Males showed a higher MCI than females at all ages with mean values of 53.3±3.2 and 46.21±3.9 respectively. A more rapid decrease in MCI was observed in females than males.

Introduction

The metacarpals are made up of five cylindrical bones numbered laterally from the radial to ulnar side. Each metacarpal consists of a shaft and two epiphyses. The shaft is curved and prismoid in shape. Its medial and lateral surfaces where the muscles are attached are concave and these two surfaces are distinguished from each other by a protruding anterior ridge. The dorsal surface of the shaft is smooth, flat and triangular at two-third of its distal end. The second metacarpal (metacarpal of the index finger) is the longest and has the biggest base of the remaining four metacarpals. The second metacarpal is often used in the studies of metacarpal morphology since it is the largest of the metacarpal bones with morphology more uniform than the other bones of the hand [2, 8].

The study of metacarpal morphology is essential in age determination and assessment of degree of demineralization for the diagnosis of certain diseases. Both invasive and non-invasive methods are used in obtaining metacarpal measurements. Plane radiography of the metacarpal is one of the non-invasive methods used in assessment of bone mass/density. This method is universally used due to its simplicity, minimal radiation exposure, and the availability of multiple ossification centers for evaluation of maturity especially in children [1].

Hand-wrist radiograph for quantitative analysis of bone mass measurement provides an effective one-dimensional view of the medial and lateral metacarpal cortices but allows relatively few parameters for measurements [8].

Extensive studies on as age, gender, weight, stature, physical activities and hand dominance have been carried out on the morphology of metacarpals. Studies show that age has less significant influence on metacarpal morphology except cortical area, medullary area and percentage cortical area [7]. Cortical area increases with age and cortical thickness declines from age of 40 and 50 to 60 respectively [2, 3, 4, 7, 13].

Metacarpal length is found to correlate strongly with stature, diameter and cortical thickness in males but not in females [9, 10, 11, 12].

Correlation between metacarpal morphology and physical activities has been studied intensively in many research works. High level of physical work is said to have a negative effect on the metacarpal index (MCI) which represents the size of the metacarpal. While increased light physical activities such as light repetitive tapping action during computer usage enhances the metabolism of bone thereby increasing MCI [5, 14].

Functional handedness leads to periosteal and endosteal expansion of the second metacarpal cortex on the dominant side, increasing bone strength without increasing cortical thickness [5, 14]. In both right and left-handed individuals, statistically significant side differences have been found in the calculated bone areas and the second moment of area, with the dominant hand being larger. However cortical thickness did not show significant side-related differences for either handedness [5, 14].

Blacks have a higher skeletal mass at all ages than white based on evaluation of rate of subperiosteal apposition and endosteal surface resorption of bone [11]. There is no obvious explanation for the difference in metacarpal length between Africans and Black Americans.

Most reports on metacarpal index remain controversial and thus necessary for more work in this area. This study sought to determine the influence of age and gender on the metacarpal index of the Lagos population.

Methodology

A retrospective research method was employed. A randomized collection of

850 (males-436, females 414) dorsi-palmer radiographs of the left hand performed between 2003 to 2005 was carried out in x-ray departments of various public and private hospitals in Lagos state of Nigeria.

Request forms containing clinical history of the radiologically examined patients were studied to retrieve clinical history, age and gender of the patients. Patients were divided into five (5) groups based on age; GP1 (21-30), GP2 (31-40), GP3 (41-50), GP4 (51-60), GP5 (61-70). Each group was further divided into two (Male and female).

Radiographs were mounted on an illuminator in turn. The widths of the cortex on each side of the second metacarpal were obtained with a transparent ruler. The width of the shaft of each of the 2nd metacarpal was also measured.

Both measurements were used to calculate the metacarpal index (MCI) of each patient (MCI=combined widths of layers of cortex on each side x 100/Total width of shaft).

Result

Results obtained from measurement show that metacarpal index increases until 50 years of age with peak at 31 - 40 years (Peak mean cortical index 57.4±2 and 52.8±03 for males and females respectively) and decreases in a linear fashion after 50 years [Figure 1]. Men have a higher metacarpal index than women (Mean MCI: 53.3±3.3 and 46.2±3.9 respectively) at all ages as shown in Table 1.

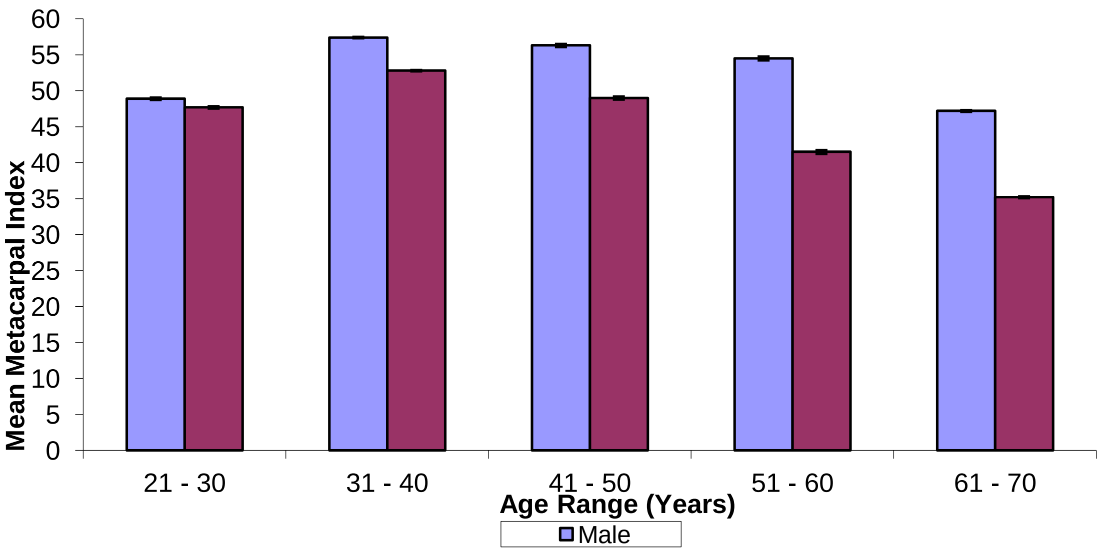

Figure 1: Distribution of mean metacarpal index and age

Table 1: Mean metacarpal index for males and females

Measurement	Male	Females
No of cases	436	414
Range	45-60	33-58
Mean MCI	53.30	46.21
Standard deviation	3.22	3.98

Discussion

Quantification of metacarpal index of individuals is relevant in the evaluation of age and gender related bone changes. MCI represents the size of a metacarpal and can be calculated as the average ratio of the metacarpal length to the metacarpal width at midshaft [8]. The cortical index of a bone is one of the many diagnostic criteria used in determination of severe reduction in bone density. In interpreting bone radiographs, assessment of bone density is always considered foremost.

Our results reveal that metacarpal index representing bone cortical thickness and mineralization is more in males than females at the age range studied. An increase in metacarpal cortical index was observed from 20-40 years of age. The peak mean cortical index of 57.4±20 and 52.8±0.26 for males and females respectively fall within 31-40 years of age. A linear decrease from 51-60 years in both sexes was also observed [Figure1]. This agrees with Kimura et al [6] who reported an increase in MCI with increasing age and a decrease from 40 and 50 to 60 years of age. Mean MCI from our study in males is 53.3±3.2 and 46.2±3.9 in females [Table 1]. Meadows and Jantz [9] also reported a higher metacarpal cortical index in males than females at all ages.

Many factors may be responsible for this variation in bone mass relative to age and gender. It could be suggested that this age related loss of bone is an appropriate consequence of senescence simply reflecting an age dependent dysfunction(s) of bone cellular activity. This also could be related to the comparable decrements in functional capacity of the heart, lungs, muscles, kidney and neural tissues that also attain the aging process [2].

Sexual difference in MCI may be attributed to difference in stature and bodily proportion which could be due to varying degree of muscular development and adiposity [4, 6, 12]. Estrogen withdrawal following menopause can also be implicated in diminishing bone density with age in females [4].

Higher bone density in males may be associated with increased physical activity which results in decrease bone resorption and increase metacarpal bone density. Consequently decreased bone mass in old age may be due to decreased physical activity [5, 14]. Osteoporosis which is a consequence of aging may also be implicated [2]. Measurable change in cortical thickness appears relatively late in the course of aging and developing osteoporosis. Change occurring in osteoporotic bone is a reduction in the quantity of bone substance, and it must be that this represents the end result of an imbalance between the rates of bone formation and bone resorption.

Although many factors may be responsible for reduction in bone density, considerable difference is observed in gender and age. Limitations remain as the MCI does not illustrate the morphology of a human metacarpal in three-dimension.

Conclusion

There is observed difference in cortical bone thinning relative to age and gender in Lagos State of Nigeria. Males have a higher metacarpal cortical index than females, a decrease in bone thickness after the 5th decade of life is usual. This decrease appears to be more in females than males. Further work of this study using other parameters and a sufficient sample size will provide better understanding of the changes in MCI relative to age and gender in this population and other conditions responsible for change in metacarpal morphology.

References

1. Atalabi OM (2002) Metacarpal index in Nigerian adults and children. Nigerian Journal of Medicine, 11: 164-169.

2. Avioli L. (1993) the Osteoporosis syndrome detection, prevention and treatment; (3rd Ed), John Wiley and sons, Inc, Publication,Pg 1-20.

3. Fox KM, Kimura S, Powell-Threets K and Plato CC (1995) Radial and ulnar cortical thickness of the second metacarpal. Journal of Bone and Mineral Research, 10: 1930-1934.

4. Heaney R.P, Barger-Lux M.J, Davies K.M, Ryan R.A, Johnson M.L and Gong G. (1997) Bone dimensional change with age: interactions of genetic, hormonal, and body size variables. Osteoporos Int 7: 426-431.

5. Iwamoto J, Takeda T and Ichimura S (2002) Relationships among physical activity, metacarpal bone mass, and bone resorption marker in 70 healthy adult males. J Orthop Sci, 7: 6-11.

6. Kimura K (1992) Estimation of stature from second metacarpal length in Japanese children. Ann. Hum. Biol., 19: 267-275.

7. Lazenby RA (2002) Circumferential variation in human second metacarpal cortical thickness: Sex, age and mechanical Factors. The Anatomical Record, 267: 154-158.

8. Lazenby RA (1998) Second metacarpal midshaft geometry in an historic cemetery sample. American Journal of Physical Anthropology, 106: 157-167.

9. Meadows L and Jantz RL (1992): Estimation of stature from metacarpal lengths. Journal of Forensic Sciences, 37 (1): 147-154.

10. Nielsen SP. The metacarpal index revisited: a brief overview. J Clin Densitom 2001; 4: 199–207.

11. Odita JC, Okolo AA and Ukoli F (1991) Normal values for metacarpal and phalangeal lengths in Nigerian children. Skeletal Radiology, 20: 441-445.

12. Onat T (1997) Growth of metacarpal II during female adolescence: Relationships to stature, weight and skeletal and sexual maturity. American Journal of Human Biology, 9: 425-438

13. Simon G. (1973). Principles of bone X-ray diagnosis, 3rd Ed, Butterworth and Co. Ltd. London. P.44.

14. Vehmas T, Solvieva S, Riihimaki H, Luoma K and Leino-Arjas P (2005) Hand workload and the metacarpal cortical index. A study of middle-aged teachers and dentist. Osteoporos Int, 16: 672-680.