TO CORRELATE THE WEIGHT OF LONG BONES, HUMERI AND FEMORA WITH THEIR VERTICAL HEAD DIAMETERS

Qaisar Zaman[1], Niaz Mohammad[1], Anwar-ul-Haq[2], Maqbool Ilahi[1], Khalid Javed[3], Rizwan-ul-Haq[4]

ABSTRACT

Objective: To evaluate the correlation of bone weight with their vertical diameter of head in humeri and femora bilaterally and also to compare this effect observed in humeri with that of femora.

Material and Methods: This study was carried out on cadaveric bones in Anatomy Department KGMC Peshawar. A total of 13 pairs of humeri and 14 pairs of femora were selected for this purpose. The weight and vertical diameter of head of each bone was noted and recorded on observation sheets. All these measurements were done with help of vernier caliper and electronic scale. The difference observed in measurement of weight and diameter of humeri and femora were compared and analyzed for conclusion.

Results: The mean bony weight, and vertical diameter of head of each humerus was measured. The mean weight of right humeri were 119.91±6.60g and the mean weight of left humeri were 113.33±7.39g. The mean vertical diameter of right humeral head was 42.37±1.19 mm and mean vertical diameter of left humeral head was 43.58±1.06 mm. The mean weight of right femora were 339.85±12.91g and the mean weight of left femora were 325.78 ±26.71g. The mean vertical diameter right femoral head was 46.42±0.61mm and the mean vertical diameter of left femoral head was 44.71±1.15mm.

Conclusion: More asymmetry were noted when weight of right and left humeri were compared with that of right and left femora but less asymmetry noted when humeral head diameter were compared with that of femoral head diameter bilaterally. This was interesting to note that the diameter of humeral head were rather decreasing with increasing weight of humeri in contrast to femora where heavier right femora were associated with longer femoral head diameter.

Keywords: Diameter of humeral head, Diameter of femoral head, Weight of long bone.

INTRODUCTION:

The weight of bone can be one of the most important parameter in bone studies which reflects the local physiological stimuli like or many other pathological stimuli (osteoporosis or osteomalacia etc.) in the form of stress and strain. The bone consists of a spongework of trabeculae which are arranged in a pattern adapted to resist the local stress and strain. If for any reason there is an alteration in the strain to which a bone is subjected there is a rearrangement of the trabeculae. This process of bone moulding results from the resorption of existing bone and deposition of new bone which is reflected in the form of bone weight. It is not known how these activities are controlled and coordinated. An increase in bone weight may be associated with increase in body weight. The body weight can change the local stress and strain on bone which can also be reflected in the form of change in different parameters of bones like diameter of head and socket[1]. It has been observed by Murphy and Carroll that bone mass can be regulated by mechanical loading[2]. As in rats immobilization led to a decrease in whole body weight and length which was also associated with decrease in length, thickness, and mass of the long bones. It was also noted that circulation to the femoral head was diminished along with changes in articular surfaces. An increase in length, thickness, mass, and epiphyseal circulation of the long bones were observed as results of enforced activity in animals[3].Upper and lower limbs have many similarities. Modifications for functional needs produce some differences in the form of weight and length of different parts. The humeri and femora are articulated to the glenoid cavity and acetabulum respectively[4]. It has been observed in studies on animals that the total bone weight in the fore limb is unequal when right side bones are compared with left side bones. The bone weight may be regarded as good parameter to see other associated changes like diameter of head and socket. The weight asymmetry has been seen in limb bones in many other studies. One interesting finding in a study was that the bones of the right lower extremity were as

[1] Department of Anatomy, Khyber Girls Medical College, Peshawar - Pakistan.
[2] Department of Forensic Medicine, Khyber Girls Medical College, Hayatabad, Peshawar - Pakistan.
[3] Department of Pathology, Khyber Girls Medical College, Hayatabad, Peshawar - Pakistan.
[4] Department of Forensic Medicine, Peshawar Medical College, Peshawar - Pakistan.

Address for correspondence:
Dr. Niaz Mohammad
Department of Anatomy, Khyber Girls Medical College, Peshawar - Pakistan.
E-mail: dr.niaz303@gmail.com

a whole heavier and longer as compared to left side of the body except femur which was longer on left side[5].

The weight and linear dimension of bones have been studied for any correlation with skeleton weight in literature. Apart from other factors growth of femur is more related to the changes in body weight as compared to humerus[6]. In a study on animals it has been noticed that circumference of diaphysis of long bones is weakly influenced by compression forces and is strongly related to the body weight[7]. Hammett found that the bone length and weight could be correlated to body weight and length[8]. Yin et al also observed that cardiac hypertrophy could be quantified by relating heart weight to tibial length which may have applicability for assessing relative sizes of body organs[9]. Asymmetry in limbs is mainly attributable to differential mechanical loading during bone growth related to handedness which may also be associated with changes in articular structure. Apart from genetic factors biomechanical factors are also important in the development of different bony parts[10]. Among the long bones, femur and humerus are selected for this study to observe any correlation of weight with the diameter of head in these bones. It can be hypothesized that increase in weight is associated with increase in vertical diameter of head of bone. This study is also planned to study asymmetry present in limb bones. The present work would be helpful in obtaining certain standard value which could be applied in local population of KPK, for different sorts of local investigations and patient management. The aim of this study is to evaluate the effect of bone weight on diameter of bone head and to compare these effects observed with that of femora bilaterally.

MATERIAL AND METHODS:

This study work was carried out from January 2012 to December 2014 on cadaveric bones collected from Anatomy department of Khyber Girls Medical College Peshawar. A total number of unbroken bones 13 right humeri, 13 left humeri, 14 right femora and 14 left femora were collected for this study. The damaged bones were excluded from this study while all other remaining available bones were included. Before measurement of weight and vertical diameter head all bones were numbered. Weight of paired femora and humeri along with vertical diameter of head were recorded on observation sheets. The measurement of length an weight were done with vernier caliper and electronic scale. Total data was entered in SPSS version 20. The Student's t-test was applied for quantitative data. A p-value of ≤ 0.05 was taken significant.

RESULTS:

This study was done on two main groups of limb bones. The mean bony weight, and vertical diameter of head of humeri (right and left) and femora (right and left) were measured. The mean weight of right humeri was 119.91±6.60 g and the mean weight of left humeri was 113.33±7.39 g. The vertical diameter of right humeral head was 42.37±1.19 mm and vertical diameter of left humeral heads was 43.58±1.06 mm. (Table 1).

Table 1: Comparison of both humeri regarding the weight and vertical diameter of head

Parameters	Right humeri	Left humeri	P. value
	N = 13	N= 13	
	Mean ± SE	Mean ± SE	
Weight(g)	120 ± 6.6	113.3 ± 7.4	0.532
Vertical diameter of humeral head (mm)	42.4 ± 1.2	43.6 ± 1	0.356

KEY: N = Number of specimens SE= Standard error of mean * = Statistically significant

Table 2: Comparison of both femora regarding the weight and vertical diameter of head

Parameters	Right Femurs	Left Femurs	P. value
	N = 14	N= 14	
	Mean ± SE	Mean ±SE	
Weight(g)	340 ± 13	325.8 ± 26.7	0.644
Vertical diameter of femoral head (mm)	46.4 ± 0.6	44.7 ± 1.1	0.234

KEY: N = Number of specimens SE= Standard error of mean * = Statistically significant

The mean weight of right femora were 339.85±12.91 g and the mean weight of left femora were 325.78 ±26.71 g. The vertical diameter right femoral heads was 46.42±0.61mm and the vertical diameter of left femoral head was 44.71±1.15mm (Table 2).

DISCUSSION:

This study was carried out on two main bones of upper and lower limb. First the mean bony weight, and vertical diameter of humeral head were measured bilaterally. In this study there was no significant difference in the mean weight of right humeri which were 119 g and the mean weight of left humeri were 113 g. Researchers have shown that humans demonstrate more asymmetry in the upper limb as compared to lower limb[11] and Green et al reported that movement mainly influence the development of muscles and bones[12].

A decrease in mass of long bone is also associated with decrease in their length and thickness which may be affected by activities of concern limb[13] as changes in bone structure is associated with past behavior[14] in which muscles may play an important role[15].

Mean right vertical humeral head diameter was less (42 mm) as compared to left side (43 mm) which was not significant. This is in accordance with result of a study by Boa and Wang[16] that the vertical diameter of right humeral head was 43 mm and that of left humeral head was 44 mm. This study also shows that the diameter of humeral head is rather decreased on right side as compared to left side.

There was no significant difference between mean weight of right femora (339 g) as compared to left femora (325 g). This is in accordance with the result of a study by Singh and Mohanty, who reported that there was a higher incidence of heavier femur on the right side which may be due to right dominance[5]. It has been reported by Petit et al that early body weight gain may inhibit the bone development[17].

Mean value of vertical femoral head diameter (46 mm) was not significantly different from that of left side (44 mm). But it was interesting to note that this asymmetry present in lower limb bones were not identical with upper limb bones. We anticipated that diameter of head of humerus was not more on the heavier side but in this case the heavier femur on right side has larger head diameter as compared to lighter femur on left side. This may be due to the weight bearing role of the lower limb bones which are well adapted to body weight, sex and other conditions differently, as compared to upper limb bones[18,19,20].

CONCLUSION:

Although not significant but more asymmetry were noted when weight of right and left humeri were compared with that of right and left femora. Asymmetry in diameters of humeri were less in humeri when compared with femora bilaterally but this was interesting to note that the diameter of head of humeri were not proportionally more on the heavier (right) side but it were rather decreasing with increasing weight in contrast to femora where the increase in weight were associated with increase in diameter head of femora which may be due to different functional role of upper limb as compared to lower limb.

REFEREENCES:

1. Mc Minn RMH. Last's anatomy. Introduction to regional anatomy. 8th ed, London: Churchill Livingstone, 1990.
2. Murphy NM1, Carroll P. The effect of physical activity and its interaction with nutrition on bone health. Proc Nutr Soc. 2003; 62: 829-38.
3. Steinberg ME, Trueta J. Effects of activity on bone growth and development in the rat. Clin Orthop Relat Res. 1981; 156: 52-60.
4. Mc Minn RMH. Last's anatomy. Lower limb. 8th ed, 1990.
5. Singh G, Mohanty C. Asymmetry in the weight and linear measurements of the bones of the lower limb. BR. 2005; 16: 125-27
6. Ruff C. Growth in bone strength, body size, and muscle size in a juvenile longitudinal sample. Bone. 2003; 33: 317–29.
7. Campione NE, Evans DC. A universal scaling relationship between body mass and proximal limb bone dimensions in quadrupedal terrestrial tetrapods. BMC Biol. 2012: 10:6
8. Hammett FS. A comparison of bone growth in length with bone growth in weigh. J Gen Physiol. 1925; 9: 63–71.
9. Yin FC, Spurgeon HA, Rakusan K, Weisfeldt ML, Lakatta EG. Use of tibial length to quantify cardiac hypertrophy: application in the aging rat. Am J Physiol. 1982; 243: 941-7.
10. Plochocki JH1. Bilateral variation in limb articular surface dimensions. Am J Hum Biol. 2004; 16: 328-33.
11. Auerbach BM, Ruff CB. Limb bone bilateral asymmetry: variability and commonality among modern humans. J Hum Evol. 2006; 50: 203-18.
12. Green DJ1, Richmond BG, Miran SL. Mouse shoulder morphology responds to locomotor activity and the kinematic differences of climbing and running. J Exp Zool B Mol Dev Evol. 2012; 318: 621-38.
13. Steinberg ME, Trueta J. Effects of activity on bone growth and development in the rat. Clin Orthop Relat Res. 1981; 156: 52-60.
14. Rabey KN, Green DJ, Taylor AB, Begun DR, Richmond BG, McFarlin SC. Locomotor activity influences muscle architecture and bone growth but not muscle attachment site morphology. J Hum Evol. 2015; 78: 91-102.
15. Heinonen A, Sievänen H, Kannus P, Oja P, Vuori I . Effects of unilateral strength training and detraining on bone mineral mass and estimated mechanical

characteristics of the upper limb bones in young women. J Bone Miner Res. 1996; 11: 490-501.

16. Bao HW, Wang Q. Anatomical research on proximal humeral fracture treated with humeral head replacement. Zhonghua Yi Xue Za Zhi. 2010; 7: 90: 3217-9.
17. Petit MA, Beck TJ, Hughes JM, Lin HM, Bentley C, Lloyd T. Proximal femur mechanical adaptation to weight gain in late adolescence: a six-year longitudinal study. J Bone Miner Res. 2008; 23:180-8.
18. Allen MD, McMillan SJ, Klein CS, Rice CL, Marsh GD. Differential age-related changes in bone geometry between the humerus and the femur in healthy men. Aging Dis. 2012; 3: 156–63.
19. Lee JH, Kim YS, Lee UY, Park DK, Jeong YG, Lee NS, Han SY, Kim KY, Han SH. Sex determination using upper limb bones in Korean populations. Anat Cell Biol. 2014; 47: 196-201.
20. Witkowska A, Alibhai A, Hughes C, Price J, Klisch K, Sturrock CJ, Rutland CS. Computed tomography analysis of guinea pig bone: architecture, bone thickness and dimensions throughout development. PeerJ. 2014; 2: 615.