TO STUDY ASYMMETRY PRESENT IN LIMB BONES USING SKELETAL MASS INDEX AS AN ADDITIONAL PARAMETER FOR COMPARISON

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ABSTRACT

Objective: To study asymmetry present in humeri and femora using weight, length and skeletal mass index(SMI) as main parameters for comparison.

Material and Methods: This study work was carried out on bones collected from cadavers in Anatomy Department of KGMC Peshawar. A total of 26 humeri and 22 femora of both right and left side were included in this study. Skeletal mass index was calculated from weight and length as an additional parameter for this study. Total data was entered in SPSS version 20. Student's t-test was applied forquantitative data. A p-value of ≤ 0.05 was taken significant.

Results: The mean weight and length of right humeri, left humeri, right femora and left femora were118.38±6.23g, 113.92±6.95g, 346.81±26.63g and 337.18±34.82g and 30.26±0.44cm, 30.96±0.50cm, 42.92±0.81cm and 42.90±1.15cm respectively.The SMI of right humeri, left humeri, right femora and left femora were 1.29±0.05kg/m^2, 1.17±0.05kg/m^2,1.84±0.08kg/m^2 and1.76±0.09kg/m^2respectively.There was a significant difference when the weight, length and SMI of humeri were compared with that of femora ipsilaterally.

Conclusion: This study concludes that more asymmetry seen in right upper limb bones could be due to right sided dominance which is largely compensated in lower limb by environmental factors, like walking and runningleading to less prominent asymmetry. The SMI is also a useful parameter to be used for comparing various bonesand would also help to identify age and disease related changes in bones.

Key Words:Humerus weight. Humerus length.Limb asymmetry.Femur weight Femur length.

INTRODUCTION

Bones are a type of connective tissue having a calcified ground substance along with cells and fibres. A continuousremodeling occurs by removal of old bone by osteoclasts and replacement by osteoblasts[1]. The lower limb is built upon the same plan as the upper limb which is true of the hind limb and fore limb of all animals. A modification for functional needs produce very great differences structure as well as proportion of different bones but the basic pattern remain unchanged[2].

Most of the population is right-handed having left dominant hemisphere which may or may not be associated with the dominant right lower limb[3]. It has been observed in a study that the total bone weight in the fore limb is unequal bilaterally. The bone weight may be a reliable index to know the limb dominance provided no pathological process like marble bone disease or osteoporosis.In approximately half the animals studied showed a crossed relationship in dominance of the upper and lower limb. The tendency to use one limb in preference to the other may be inherited or acquired in life. This may also reflect the changes occurred in bone which could be measured in the form of weight and length[4].

In other study performed on human fetuses, it is observed that the upper limb have a significant difference in muscle and bone weight on the right and left sides, giving an evidence that babies have much stronger muscles and bones in the dominant limb as compared to non-dominant limb[5].

A close relationship exists between bone weight and the mechanical stresses imposed on the bone. It can therefore be presumed that variation in activity as a result of limb preference would also reflect the bony changes in the form ofweight and length. This study in cadaveric bones is aimed to know the bone weight and length and analyzed to compare the differences in the upper limb as well as lower limb bones. The difference in the bones of upper limb would also be compared with the difference in the bones of lower limb. These observations would be analyzed for conclusion. Body mass index is commonly used for obesity[6] but I would also use this important index in bones to compare these different groups of bones which would be called skeletal mass index (SMI). This SMI is closely related with the measurement of density of bones with help of ultrasound study in living body[7] but in cadaver this parameter is much helpful for different studies on bones to get an idea about time since death as dehydration of bone with time will reduce its weight and SMI.

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MATERIAL AND METHODS

This study work was carried out on bones collected from cadavers at Anatomy department of KGMC Peshawar fromJanuary 2012 to December 2014. A total of 26 humeri and 22 femora of both right and left side were included in this study. The bones which were damaged were excluded from studywhile all other remaining available bones were included in this study. After numbering these bones, weight and length was measured. The calculation of skeletal mass index of all bones was done in the same way as body mass index. This study was carried out on unbroken bones, humeri and femora available in Anatomy department. The upper limb bones were grouped into 13 right humeri and 13 left humeri and lower limb bone were subdivided into 11 right and 11 left femora. The skeletal mass index of all these bones was calculated by the following formula.

Skeletal Mass Index (SMI) = Weight of bone in kg

(Length of bone in meters)^2

SMI of both humeri and femora were compared bilaterally. The SMI of upper limb bones were also compared with that of lower limb. All these observation recorded were analyzed for conclusion. Total data was entered in SPSS version 20. Student's t-test was applied for all quantitative data. A p-value of ≤ 0.05 was taken significant.

RESULTS

This study was done on two main groups, bones of upper limb and lower limb consisting of 26 humeri and 22femora of both sides.

WEIGHT OF BONES: The mean bony weight, in all groups of bones of upper limb and lower limb were measured. The mean weight of right humeri were 118.38±6.23g and the mean weight of left humeri were 113.92±6.95g (Table 1). The mean weight of right femora were 346.81±26.63g, while the mean weight was 337.18±34.82g in the comparative left femora (Table 2).

LENGTH OF BONES: The mean length of right humeri were 30.26±0.44cm and mean length of left humeri were 30.96±0.50cm (Table 1). The mean length of right femora were 42.92±0.81cm and mean length of left femora were 42.90±1.15cm (Table 2).

SKELETAL MASS INDEX (SMI): Themean SMI

Table 1: Comparison of right and left humeri,regarding the weight, length and skeletal mass index

Parameter	Right Humeri	Left Humeri	P value
	N=13	N=13	
	Mean±SE	Mean±SE	
Weight of Humeri (g)	118.38±6.23	113.92±6.95	0.645
Length of Humeri (cm)	30.26±0.44	30.96±0.50	0.346
Skeletal mass index (kg/m2)	1.29±0.05	1.17±0.05	0.117

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

Table 2: Comparison of right and left femora regarding the weight, length and SMI

Parameter	Right femora	Left femora	P value
	N=11	N=11	
	Mean±SE	Mean±SE	
Weight of femora(g)	346.81±26.63g	337.18±34.82g	0.805
Length of femora(cm)	42.92±0.81	42.90±1.15	0.986
Skeletal mass index(kg/m2)	1.84±0.08	1.76±0.09	0.532

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

Table 3: Comparison of SMI of humeri with femora

Parameter	Humeri	Femora	P value
	N=11	N=11	
	Mean±SE	Mean±SE	
Right side bones	1.31±0.06	1.84±0.07	0.001*
Left side bones	1.17±O.O6	1.76±0.09	0.001*
Right humeri/Left femora	1.31±0.06	1.76±0.09	0.004*
Left humeri/Right femora	1.17±O.O6	1.84±0.07	0.000*

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

of right humeri were 1.29±0.05kg/m^2 which were 1.17±0.05kg/m^2 in left humeri (Table 1). The SMI of right femora were 1.84±0.08kg/m^2 which were 1.76±0.09kg/m^2 in left femora (Table 2). There was a significant difference when SMI of upper limb bones were compared with SMI of lower limb on the same side (p=0.001) which was more significant when bone of left upper limb was compared with that of right lower limb (p value = 0.000), (Table 3).

DISCUSSION

Bone can be used as indicator for many conditions like age, sex[8] and many disease states but this project had an objective to evaluate the effect of changes in bony mass index in response to dominance and functional role. The results presented here show that limb dominance have no statistically significant effects on bony mass index when bones of the upper limbwere compared bilaterally. However the mean bony mass index of bones of upper limb were significantly less than that of lower limb bones which may reflects the functional role played by the concerned bones.

The mean weight of right humeriwas 118.38±6.23g and the mean weight of left humeri was 113.92±6.95g. Though the difference observed in weight, were not statistically significant (p= 0.645).This could be presumed that some of the bones were dominant on left side as well which could have played a role in making this difference insignificant. Similarly the finding of another study demonstrated that the long bones of the upper limb are heavier and longer on the right side. They also observed that the proximal bone of limbs show a greater degree of asymmetry in weight[9]. It has been observed in other study that nine percent of people are left-handed which could have change the result from insignificantto significant as for as difference in weight of right and left humeri are concerned[10].

The mean weight of right femorawas 346.81±26.63g which was 337.18±34.82g in the comparative left femora(p=0.805). Although this result was not significant but the difference between right and left femora were less as compared to difference between right and left humeri. It has been noted by other investigators that the right handers are usually right footed but the left hander may not be left footed in the same way. Thus the footedness may follow handedness in right-handers only but not much in left-handers[11]. The mean length of right and left humeri and right and left femora were similar to the difference observed in their weights which were alsoinsignificant.

The mean SMI of right humeri were 1.29 kg/m^2 which were 1.17kg/m^2 in left humeri and were not significant (p=0.117). It was interesting to note that the difference in SMI of both femora were less as compared to both humeri, showing that both femora are similar and not affected much by dominance. Although our results were insignificant but Latimer and Lowrance noted a significant level of asymmetry in the humeri[8].

There were significant difference between SMI of right humeri as compared to right femora (P= 0.001).A similarly significant difference were noted when SMI of left humeri and left femora were compared (p=0.001). This show that the lower limb bones are stronger and adapted fully to its weight bearing function. The most significant difference noted when SMI of left humeri and right femora were compared (p=0.000). This was because the lighter side of upper limb was compared with the heavier side of lower.

CONCLUSION

This study concludes that more asymmetry seen in right upper limb bones could be due to dominance. This right sided dominance is also present in lower limb bones but this dominance has been largely compensated by environmental factors, like walking and running which lead to reduction in asymmetry visible in upper limb. The SMI may be a useful parameter to be used for identification of various bonesalong with others routinely used parameters.

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