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The Asymmetry in Length Between Right and Left Humerus in Humans

[1]M. Papaloucas, [2]C. Papaloucas, [1]A. Tripolitsioti and [1]A. Stergioulas
[1]Faculty of Human Movement and Quality of Life, University of Peloponnese, Sparta, Laconia, Greece
[2]Department of Anatomy, Thrace University, Greece

Abstract: The aim of the present investigation was to study the phenomenon of asymmetry in length between the right and left humerus. Earlier studies have investigated the asymmetries between long bones both in upper and the lower extremities. These studies confirmed that the right side bone dimensions in upper limb were more prominent especially in length and diaphyseal breadth and as well as more asymmetry in the upper limb when compared with the lower limb. For the purposes of the study 200 pair of humerus, 100 male and 100 female, were elaborated. After results analysis with unpaired t-test observed that the right humerus was longer than the left in both sexes, but more prominent in males. The inheritance and the influence of the individual's activities on the asymmetry is discussed. It is concluded that the phenomenon should be considered as inherited which can be affected by various factors.

Key words: Asymmetry, inherit, enhance, activity, nutrient

INTRODUCTION

The long bones of the human skeleton usually show lateral asymmetries of length (White and Folkens, 2005). Earlier studies concluded that the right upper limb bone dimensions were greater especially in length when compared with the lower limb (Hiramoto, 1993). More, the diaphyseal breadth and the total asymmetry was more prominent in the upper limb (Le May, 1992; Papaloucas *et al*., 2008). The examination of the upper and lower limb asymmetries can be useful to medical scientists, archaeologists and anthropologists (Iscan and Shihai, 1995; King *et al*., 1998), to the police and in forensic investigations for defining the individual's activities in the courts of justice and for medicollegal studies (Steyn and Iscan, 1999; Mall *et al*., 2001).

Previous studies tried to confirm the factors that affects the long bone dimensions and to explain the phenomenon of the different length between the right and left humerus. One possible explanation for the humerus asymmetry is the handedness (Schulter-Ellis, 1980; Schell *et al*., 1985; Vettivel *et al*., 1992, 1995; Scheuer and Black, 2007). Many researchers have been supported since about two centuries (Arnold, 1844; Gennadis, 1858), that this asymmetry it is likely possible to be inherited (Schultz, 1926, 1937; Pande and Singh, 1971; Singh, 1971; Vettivel *et al*., 1995; Scheuer and Black, 2007), neurophysiological (White *et al*., 1994; Steel and Mays, 1995) or solely acquired.

The purpose of this clinical trial was to investigate the length of right and left humerus in both sexes and to confirm older or recent investigations about this topic.

MATERIALS AND METHODS

Authorised by the Athenian University and the Municipality of Athens 100 male and 100 female pairs of humerus were collected from the ossuary of the 3rd Athenian cemetery.

According to the records of the cemetery the specimens belonged to males of age ranging from 25 to 95 with a Mean±SD of 65.9±17.0 and females with age ranging from 29 to 87 and a Mean±SD of 63.0±13.7.

There was no selection other than the availability and accessibility of the remains. Signs of congenital malformation, fracture or operation on the limb were factors that excluded a specimen. Excluded were also specimen with an obviously foreign name. The length of the right and left humerus was measured to the 10th of a centimeters.

The measurements were performed on three, non-sequential occasions by the same person. The coefficient of variations for repeated measurements was calculated and found to be less than 5% over all ranges.

Comparisons were done using unpaired t-test and the level of significant for p-value was set at 0.05 level.

RESULTS

The mean length of the humerus of the men was 34.73 in right hand 34.22 cm in the left, the standard deviation was 0.63 to 0.62 the standard error was 0.063 to 0.062 and the variation of the 95% confidence interval for the mean was 34.60 to 34.85 and 34.10 to 34.35. More, the minimum values of the length of the right humerus

Corresponding Author: A. Stergioulas, 3 Lyssandrou Street, Sparta, 23100, Laconia, Greece

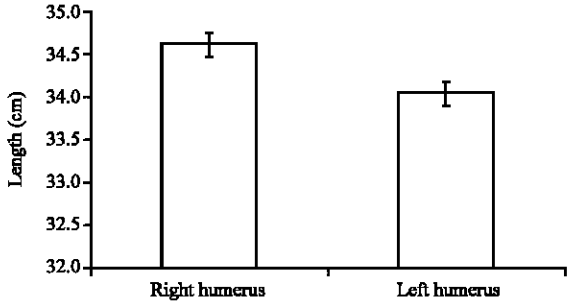

Fig. 1: Mean values for the right and left humerus of the males and significance between them ($p<0.001$)

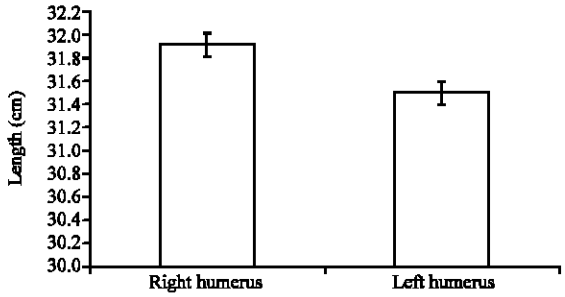

Fig. 2: Mean values for the right and left humerus of the females and significance between them ($p<0.001$)

was 33.00 cm, the maximum value of the length was 35.90 cm, with a range of 2.90 cm. The same values were measured for the left humerus. A comparison between the length of the right and left humerus revealed a statistical difference (t-11.37, 0.001 level, unpaired t-test, Fig. 1).

In the other hand, the mean length of the humerus of the women was 31.91 in right 31.41 cm in the left, the standard deviation was 0.32 to 0.39, the standard error was 0.032 to 0.039 and the variation of the 95% confidence interval for the mean was 31.84 to 31.33 and 31.43 to 31.48. More, the minimum values of the length of the right humerus was 31.00 cm, the maximum value of the length was 32.70 cm, with a range of 1.70 cm. Conversely, the minimum values of the left was 30.00 cm, the maximum value of the length was 32.40 cm, with a range of 2.40 cm. A comparison between the length of the right and left humerus revealed a statistical difference ($t = 14.22$, 0.001 level, unpaired t-test, Fig. 2).

Although in both sexes there was a statistically difference, this was more prominent in the males than in females.

DISCUSSION

The existence of the phenomenon of asymmetry between the bones of the upper limbs has been reported by Arnold (1844), Gennadis (1858), Warren (1897), Schultz (1937), Hiramoto (1993) and Scheuer and Black (2007). It seems to exist, with slight differences, in all races of man and populations (Schultz, 1937; Schell *et al*., 1985) and regardless the racial differences, whatever exist in foetuses it is also present in adults (Schultz, 1926; Le May, 1992).

It is two to three times greater in males than in females (Rruff and Jones, 1981; Hiramoto, 1993) and as it has been estimated by Schultz (1937) this difference is as high as 4.1 mm.

Schell *et al*. (1985) maintained the view that this difference shown is due to the factor-probably that because females are not involved in heavy activities as much as males.

The asymmetry of the limbs is not only a man's phenomenon as it exists also in other primates especially in anthropoid apes (Schultz, 1937) and even in rabbits and frogs (Singh, 1971; Pande and Singh, 1971), but it is more common in man (Hrdlicka, 1932) and it tends to exist more in bigger men (Stirland, 1993).

It decreases with age (Singh, 1971; Pande and Singh, 1971; Ruff and Jones, 1981; Stirland, 1993; Scheuer and Black, 2007), which could be explained because of the redistribution of the inevitable loss of the total skeletal mass and volume with aging and by the decreased activities in that period of life (Newton-John and Morgan, 1970; Dequeker, 1975; Ruff and Jones, 1981). It is also influenced in cases of disuse of a limb, which leads to osteoporosis not only in diseased or aged subjects but even in normal adults (Singh, 1971).

The phenomenon of the right-left asymmetry on the upper limbs is an inherited one which had been suggested even by Arnold (1844) and Gennadis (1858) and supported by Schultz (1926, 1937), Pande and Singh (1971), Singh (1971), Stirland (1993), Vettivel *et al*. (1995) and Scheuer and Black (2007).

White *et al*. (1994) and Steele and Mays (1995) have maintained that because the cerebral hemispheres control the contralateral body segments and the left hemisphere is larger than the right and functionally superior (Vettivel *et al*., 1995), it exhibits its dominance influence on the right upper extremity.

Le May (1992) reported that many of the gross asymmetries seen in normal adult brains are also found in foetal brains.

Chhibber and Singh (1970) maintaining the view of inheritance presume that the muscles of the right upper limb are heavier than those of the left .

Pande and Singh (1971), in order to give evidence that the phenomenon of asymmetry is inherited, they studied in foetuses the weight of the muscles and bones of the upper extremity and they found that the total muscle and bone weight was greater on the right side,

which proves that the individual inherits heavier-stronger muscles and bones in the dominant limb (Singh, 1971).

Apart from inheritance other factors such as mechanical loading on an adult's arm or disuse of one arm may influence the asymmetry (Singh, 1971; Steel and Mays, 1995). Environmental factors such as trauma or toxins in foetal or early life may exhibit an influence on the asymmetry (Pande and Singh, 1971; Le May, 1992).

Protein deficiency diminishes the asymmetry (Steyn and Iscan, 1999; Mall *et al*., 2001).

Activities taken by the dominant limb of athletes cause greater asymmetry between the right and left humerus (Ruff and Jones, 1981). On the contrary, sport games, professional or habitual activities, in which the non-dominant limb is used, may change the asymmetry between the right and left humerus (Stirland, 1993).

Activities taken equally by both hands may result to lack of asymmetry as it was noticed to the Mary Rose males (Rule, 1982; Stirland, 1993). Mary Rose was King Henry's the 8th flagship sank on the 19th July 1545 with the loss of most of its 415 crew just off Portsmouth. The ship became silted and sealed quickly. This process produced an anaerobic environment and avoided the one modification by physical agents (White and Folkens, 2005), maintaining the human bones, for almost five centuries, in excellent condition. The excellent condition of the bones allowed the measurements of the paired humeri and the work every man was doing on the ship was defined. As it was known, considering the equipment excavated, on board there were many of the best professional archers (Rule, 1982; Stirland, 1993) and they were identified from the lack of asymmetry between the right and left humerus because the length of the left arm had been enhanced by the continuous use of the medieval heavy long bow (Stirland, 1993).

CONCLUSION

Asymmetry is not a man's privilege as it exists in other primates and animals. The asymmetry between right and left humerus, as it has been maintained by old and modern researchers, must be considered inherited.

It can be enhanced or reduced according to individual's habits and activities, age, nutrient, overuse or disuse of the limb.

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