SOME CHARACTERISTICS OF THE CHINESE FEMUR

By C. K. Tan

SYNOPSIS

This study has provided some anthropometric data on femora of adult Chinese residing in Singapore.

The data are compared with those of the English, American white, American Negro and Maori thigh-bones.

Several distinctive features are noted and their significance discussed.

Characteristics of the human femur had been described by Parsons (1914) for the English thigh-bone, Walensky and O'Brien (1968) for the American white and American Negro, and Schofield (1959) for the New Zealand Maori. This study presents some anthropometric data of the femora of Chinese adults residing in Singapore which do not appear to have been presented previously.

MATERIAL AND METHOD

66 adult Chinese femora were cleaned as described previously (Tan, 1972). Lengths were measured with a measuring board while diameters and widths were determined with sliding calipers. Angles were measured with protractors by conventional as well as by photographic means (Tan, 1972). All the cadavers were aged 50 years and above at death. Only femora which appeared normal on gross inspection were studied.

Statistical calculations were carried out with an electronic calculator which was provided with programme memory. Statistical tables (Fisher and Yates, 1963) were consulted to determine the significance of the results.

OBSERVATIONS

The results of measurements of various parameters of the femur are presented in Table I. There was no significant sexual difference in various indices calculated (Table II). Differences between the right and left sides observed in the oblique length of the bone was shown to be statistically not significant (Table III). Similar slight differences of the two sides in other parameters had also been found to be not significant. The small difference noted between maximum and oblique lengths of the femur was also not significant (Table IV). Correlations studies between various parameters of the bone are presented in Tables V to VII.

DISCUSSION

The present study has confirmed the common observations that the average local Chinese adults are of smaller stature than Europeans, Americans and Negroes. Many small differences were noted between the data of this series and that of others but their significance could not be statistically determined. However, a few of the parameters were distinctively different.

The femoral neck angle was more obtuse than that of American whites and American Negroes but was more acute than that of the Maori. Races with smaller femoral neck angles show a greater tendency to sustain fractures of the femoral neck (Walensky and O'Brien, 1968). This can explain in part the low incidence of this type of fracture observed by Wong (1966) in Singapore. The Chinese femur also has a small angle of obliquity which can better withstand the stresses of weight bearing (Walensky and O'Brien, 1968).

The angle of femoral torsion showed a very wide range of variation, from $-11°$ to $+28°$ in the male and $+12°$ to $+40°$ in the female. Kingsley and Olmsted (1948) had noted this not only between different ages but also within a particular age group. They had shown that in infants it varied from $-10°$ to $+64°$; in children, from $-45°$ to $+38°$; and in adults, from $-20°$ to $+38°$.

Although some of the indices of the femur had been used in sexing an unknown bone, it had not been found to be useful in this respect in the present series. The parameters, however, can be used for forensic sexing only at their extreme values for a great deal of overlap occurs between the sexes around the mean values. This study has also not shown any definite feature which can distinguish the bone from that of other races.

Correlation studies had shown that many parameters of the bone showed positive correlation

Department of Anatomy, University of Singapore.
C. K. TAN, M.B., B.S.(S'pore), Lecturer.

TABLE I

SEXUAL DIFFERENCES IN VARIOUS PARAMETERS OF THE FEMUR

Parameter	Sex	Range	Mean ± S.D.	t
Upper End of the Femur				
Greatest Diameter of the Head of Femur	Male	41·3 mm. - 51·6 mm.	45·2 mm. ± 2·8 mm.	P<0·001
	Female	35·8 mm. - 40·4 mm.	38·3 mm. ± 2·1 mm.	Significant
Length of the Neck of Femur	Male	29·0 mm. - 45·0 mm.	36·0 mm. ± 3·8 mm.	P<0·05
	Female	27·5 mm. - 30·0 mm.	28·8 mm. ± 0·2 mm.	Significant
Angle of the Neck of Femur	Male	115·5° - 149·0°	129·8° ± 5·7°	P>0·05
	Female	125·5° - 143·0°	129·9° ± 7·2°	Not Significant
Angle of Femoral Torsion	Male	−11·0° - +28·0°	+13·2° ± 10·2°	P<0·01
	Female	+12·0° - +40·0°	+24·3° ± 14·7°	Significant
Shaft of Femur				
Oblique Length of the Shaft	Male	380 mm. - 470 mm.	426·9 mm. ± 20·9 mm.	P<0·001
	Female	374 mm. - 385 mm.	378·3 mm. ± 3·9 mm.	Significant
Maximum length of the Shaft	Male	384 mm. - 472 mm.	430·6 mm. ± 20·8 mm.	P<0·001
	Female	377 mm. - 387 mm.	381·8 mm. ± 4·6 mm.	Significant
Greatest Antero-posterior Diameter of the Shaft	Male	24·2 mm. - 34·2 mm.	28·3 mm. ± 2·6 mm.	P<0·05
	Female	21·7 mm. - 22·3 mm.	21·9 mm. ± 0·3 mm.	Significant
Transverse width of Shaft at level of Greatest Antero-posterior Diameter of Shaft	Male	22·6 mm. - 32·5 mm.	26·3 mm. ± 2·1 mm.	P<0·05
	Female	19·7 mm. - 21·4 mm.	21·5 mm. ± 0·1 mm.	Significant
Antero-posterior width of Shaft below Lesser Trochanter	Male	21·8 mm. - 29·2 mm.	25·4 mm. ± 1·5 mm.	P<0·001
	Female	19·3 mm. - 23·6 mm.	20·9 mm. ± 1·7 mm.	Significant
Transverse Width of Shaft below Lesser Trochanter	Male	24·4 mm. - 35·0 mm.	30·0 mm. ± 4·5 mm.	P<0·05
	Female	21·4 mm. - 25·8 mm.	24·1 mm. ± 1·4 mm.	Significant
Antero-posterior Bowing of the Shaft	Male	45·6 mm. - 68·2 mm.	55·6 mm. ± 0·5 mm.	P<0·001
	Female	43·8 mm. - 50·2 mm.	48·0 mm. ± 2·5 mm.	Significant
Obliquity of the Shaft	Male	3·0° - 20·5°	7·9° ± 2·1°	P>0·05
	Female	5·0° - 11·5°	9·8° ± 1·7°	Not Significant
Lower End of the Femur				
Bicondylar Width	Male	70·0 mm. - 86·5 mm.	77·2 mm. ± 4·6 mm.	P<0·001
	Female	62·5 mm. - 71·2 mm.	67·4 mm. ± 4·5 mm.	Significant
Maximum Height of Lateral Condyle	Male	52·6 mm. - 66·6 mm.	60·7 mm. ± 3·5 mm.	P<0·001
	Female	53·4 mm. - 56·5 mm.	54·7 mm. ± 1·3 mm.	Significant
Depth of Intercondylar Fossa	Male	15·6 mm. - 20·6 mm.	18·1 mm. ± 1·2 mm.	P<0·001
	Female	15·5 mm. - 17·0 mm.	16·0 mm. ± 0·7 mm.	Significant
Depth of Patellar Groove	Male	5·0 mm. - 8·8 mm.	7·2 mm. ± 1·0 mm.	P>0·05
	Female	5·5 mm. - 7·4 mm.	6·5 mm. ± 0·8 mm.	Not Significant

TABLE II

SEXUAL DIFFERENCES IN SOME INDICES OF THE FEMUR

Index	Sex	Range	Mean ± S.D.	t
Length-Head Index	Male	81 - 107	95·0 ± 4·5	P>0·05
	Female	94 - 108	100·3 ± 5·8	Not Significant
Condylar-Head Index	Male	1·6 - 1·8	1·7 ± 0·1	P>0·05
	Female	1·7 - 1·8	1·74 ± 0·07	Not Significant
Pilastring Index	Male	94 - 126	109·5 ± 7·3	P>0·05
	Female	103 - 113	107·8 ± 3·6	Not Significant
Platymeric Index	Male	72 - 98	84·7 ± 7·5	P>0·05
	Female	82 - 92	87·0 ± 4·5	Not Significant
Index of Bowing	Male	109 - 153	134·2 ± 17·6	P>0·05
	Female	115 - 134	126·8 ± 7·6	Not Significant
Condylar-Intercondylar Fossa Index	Male	2·9 - 4·0	3·4 ± 0·2	P>0·05
	Female	3·3 - 3·5	3·4 ± 0·1	Not Significant
Length-Patellar Groove Index	Male	440 - 84	59·8 ± 11·0	P>0·05
	Female	51 - 68	59·0 ± 7·0	Not Significant

TABLE III

SIGNIFICANCE OF DIFFERENCES OF OBLIQUE LENGTH OF THE FEMUR BETWEEN RIGHT AND LEFT SIDES

Side	Range	Mean ± S.D.	t
RIGHT	380 mm. - 470 mm.	431·3 mm. ± 17·9 mm.	P>0·05
LEFT	381 mm. - 459 mm.	428·9 mm. ± 16·6 mm.	Not Significant

TABLE IV

SIGNIFICANCE OF DIFFERENCES BETWEEN MAXIMUM AND OBLIQUE LENGTHS OF THE FEMUR

Length	Range	Mean ± S.D.	t
Maximum Length	377 mm. - 472 mm.	430·7 mm. ± 21·2 mm.	P>0·05
Oblique Length	374 mm. - 470 mm.	426·9 mm. ± 20·6 mm.	Not Significant

TABLE VI

CORRELATION BETWEEN SOME PARAMETERS OF THE SHAFT AND OTHER PARAMETERS OF THE FEMUR

Parameters		r	P
Greatest Antero-posterior Diameter of the Shaft	Oblique Length of the Shaft	0·68	<0·001 Significant
Antero-posterior Bowing of the Shaft	Greatest Antero-posterior Diameter of the Shaft	0·66	<0·001 Significant
Antero-posterior Bowing of the Shaft	Oblique Length of the Shaft	0·51	<0·001 Significant
Antero-posterior Bowing of the Shaft	Obliquity of the Shaft	0·06	>0·1 Not Significant
Obliquity of the Shaft	Greatest Antero-posterior Diameter of the Shaft	0·31	<0·02 Significant
Obliquity of the Shaft	Oblique Length of the Shaft	0·08	>0·1 Not Significant

TABLE V

CORRELATION BETWEEN SOME PARAMETERS OF THE UPPER END AND OTHER PARAMETERS OF THE FEMUR

Parameters		r	P
Greatest Diameter of Head of Femur	Greatest Antero-posterior Diameter of the Shaft	0·67	<0·001 Significant
Greatest Diameter of Head of Femur	Antero-posterior Bowing of the Shaft	0·63	<0·001 Significant
Greatest Diameter of Head of Femur	Oblique Length of the Shaft	0·41	<0·001 Significant
Greatest Diameter of Head of Femur	Length of Neck of Femur	0·31	<0·02 Significant
Greatest Diameter of Head of Femur	Angle of Femoral Torsion	−0·11	>0·1 Not Significant
Greatest Diameter of Head of Femur	Obliquity of the Shaft	−0·09	>0·1 Not Significant
Greatest Diameter of Head of Femur	Femoral Neck Angle	0·08	>0·1 Not Significant
Length of Femoral Neck	Antero-posterior Bowing of the Shaft	0·47	<0·001 Significant
Length of Femoral Neck	Angle of Femoral Torsion	0·42	<0·001 Significant
Length of Femoral Neck	Oblique Length of Shaft	0·40	<0·01 Significant
Length of Femoral Neck	Greatest Antero-posterior Diameter of the Shaft	0·39	<0·01 Significant
Length of Femoral Neck	Obliquity of the Shaft	0·16	>0·1 Not Significant
Length of Femoral Neck	Femoral Neck Angle	0·08	>0·1 Not Significant
Angle of Femoral Torsion	Oblique Length of the Shaft	−0·42	<0·001 Significant
Angle of Femoral Torsion	Length of the Neck of Femur	−0·42	<0·001 Significant
Angle of Femoral Torsion	Greatest Antero-posterior Diameter of the Shaft	−0·35	<0·01 Significant
Angle of Femoral Torsion	Femoral Neck Angle	−0·18	>0·1 Not Significant
Angle of Femoral Torsion	Antero-posterior Bowing of the Shaft	−0·13	>0·1 Not Significant
Angle of Femoral Torsion	Obliquity of the Shaft	−0·03	>0·1 Not Significant
Angle of the Neck of Femur	Obliquity of the Shaft	0·12	>0·1 Not Significant
Angle of the Neck of Femur	Oblique Length of the Shaft	0·11	>0·1 Not Significant
Angle of the Neck of Femur	Greatest Transverse Diameter of the Shaft	0·06	>0·1 Not Significant
Angle of the Neck of Femur	Antero-posterior Bowing of the Shaft	0·06	>0·1 Not Significant

TABLE VII

CORRELATION BETWEEN SOME PARAMETERS OF THE LOWER END AND OTHER PARAMETERS OF THE FEMUR

Parameters		r	P
Maximum Height of the Lateral Condyle	Oblique Length of the Shaft	0·78	<0·001 Significant
Maximum Height of the Lateral Condyle	Bicondylar Width	0·77	<0·001 Significant
Maximum Height of the Lateral Condyle	Greatest Antero-posterior Diameter of the Shaft	0·64	<0·001 Significant
Maximum Height of the Lateral Condyle	Antero-posterior Bowing of the Shaft	0·63	<0·001 Significant
Maximum Height of the Lateral Condyle	Depth of Intercondylar Fossa	0·63	<0·001 Significant
Maximum Height of the Lateral Condyle	Obliquity of the Shaft	0·07	>0·1 Not Significant
Bicondylar Width	Greatest Antero-posterior Diameter of the Shaft	0·69	<0·001 Significant
Bicondylar Width	Oblique Length of the Shaft	0·52	<0·001 Significant
Bicondylar Width	Obliquity of the Shaft	—0·17	>0·1 Not Significant
Intercondylar Fossa	Maximum Height of the Lateral	0·63	<0·001 Significant
Intercondylar Fossa	Oblique Length of the Shaft	0·57	<0·001 Significant
Intercondylar Fossa	Greatest Antero-posterior Diameter of the Shaft	0·46	<0·001 Significant
Intercondylar Fossa	Bicondylar Width	0·08	>0·1 Not Significant
Depth of Patellar Groove	Oblique Length of the Shaft	0·38	<0·01 Significant
Depth of Patellar Groove	Bicondylar Width	0·13	>0·1 Not Significant
Depth of Patellar Groove	Greatest Antero-posterior Diameter of the Shaft	0·10	>0·1 Not Significant

between each other. Unexpected but statistically significant correlation between a few of the parameters was also observed which might have been spurious. On the other hand, lack of correlation between some parameters could have been due to the influence of other extrafemoral factors which could not be taken into consideration during statistical computation.

This study has provided some useful anthropometric data of the Chinese femur. It has also shown that although the Chinese femur is less massive than that of the English, American or Maori bones, it appears to have structural differences which may be better able to withstand stresses of weight bearing. It has now been observed generally that the younger generation of Chinese in Singapore appear to be taller than their elders. This phenomenon had been shown among immigrant Japanese in Hawaii by Froehlich (1970). This may form an interesting sequel to the present study in the future.

ACKNOWLEDGEMENT

Thanks are due to Professor R. Kanagasuntheram, Professor of Anatomy, for his valuable guidance and criticisms in the preparation of this paper.

REFERENCES

1. Fisher, R. A. and Yates, F.: "Statistical Tables for Biological, Agricultural and Medical Research." 6th Ed. Oliver and Boyd, London, 1963.
2. Froehlich, J. W.: "Migration and the Plasticity of Physique in the Japanese Americans of Hawaii." Am. Jour. Phys. Anthrop., 32, 429, 1970.
3. Kingsley, P. C. and Olmsted, K. L.: "A Study to Determine the Angle of Antetorsion of the Neck of Femur." J. Bone and Jt. Surg., 30-A, 745, 1948.
4. Parsons, F. G.: "The Characters of the English Thighbone." J. Anat (Lond.) 48, 238, 1914.
5. Schofield, G.: "Metric and Morphological Features of the Femur of the New Zealand Maori." J. Roy. Anthrop. Instit., 89, 89, 1959.
6. Tan, C. K.: "A Photographic Method of Measuring the Obliquity, Neck Angle and Angle of Torsion of the Human Femur." Sing. Med. J., 13, 235, 1972.
7. Walensky, N. A. and O'Brien, M. P.: "Anatomical Factors Relative to the Racial Selectivity of Femoral Neck Fractures." Am. J. Phys. Anthrop., 28, 93, 1968.
8. Wong, P. C. N.: "Fracture Epidemiology in a Mixed South-eastern Asian Community (Singapore)." Clin. Orthop., 45, 55, 1966.