The So-called Squatting Number of the Femur in Japanese*

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It was noticed by MARTIN (1932) that the antero-posterior depth of the intercondylar fossa at the level of the intercondylar line was greater in the femora of squatters than it was in those of non-squatting populations. According to him, the relatively increased depth of the intercondylar fossa in the former was due to the pressure by the posterior cruciate ligament when the knee joint was extremely flexed as in squatting. The ratio of this measurement to the greatest antero-posterior depth of the articular surface of the lower end of the femur could be expressed as a ratio or the so-called squatting number, which varied in different populations. The results originally obtained by MARTIN were based on the examination of 75 femora from modern English and Irish and 168 femora from a number of other populations. The subsequent investigations were carried out both by SIDDIQI (1934 & 36) who examined 10 femora from American Indians, 198 femora from Indians and 100 femora from modern Canadians, and by SHAH (1942) who studied 198 femora from Punjabis.

In the present study 378 femora from modern Japanese by whom squatting was habitually adopted both at rest and at work were examined.

MATERIALS AND METHOD

The bones used for this study are composed of 266 cleaned and 112 exhumed adult femora from modern Japanese, all of which are in the Department of Anatomy, Shinshu University School of Medicine, Matsumoto, Japan. The age and sex of the cleaned femora prepared from the cadavers in the Department are recorded, while there are no records of age or sex in the bones exhumed from the Joyama cemetery of Matsumoto City, which were excavated to make way for the present memorial tower.

The depth of the intercondylar fossa at the level of the intercondylar line and the greatest depth of the articular surface of the lower end of the

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femur were measured in the same way as that adopted by MARTIN, the femur being laid on a plane surface with the back of the condyles and the back of the greater trochanter resting on this plane. Through a small hole in the plane a probe was passed up till it touched the highest point on the intercondylar line. The height of the top of the probe above the plane was measured and also the greatest depth of the articular surface of the lower end of the femur in a direction vertical to the plane.

The ratio of the two measurements, that is, the so-called squatting number by which the depth of the intercondylar fossa was to be multiplied to equal the greatest depth of the articular surface was calculated.

FINDINGS AND DISCUSSION

The average mean of the so-called squatting number or the ratio

$$\frac{\text{Greatest depth of the lower articular surface}}{\text{Depth of the intercondylar fossa}}$$

Table 1. Average squatting number of the femur in Japanese with comparative data from four other populations.

Population (Author)	N	Squatting number
Punjabis (SHAH, 1942)	198	2.90 ± 0.017
Indians (SIDDIQI, 1934)	198	3.10 ± 0.015
Japanese (MORIMOTO, 1962 & 69)	378	3.23 ± 0.012
Modern Canadians (SIDDIQI, 1936)	100	3.43 ± 0.017
Modern Irish (MARTIN, 1932)	63	3.44 ± 0.032

Table 2. Distribution of the femora according to the so-called squatting number data from four other populations.

Population (Author)	Number of femora under different													
	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	
Punjabis (SHAH, 1942)	2	3	8	16	31	22	24	40	26	12	9	1	4	
Indians (SIDDIQI, 1934)	2	—	—	2	—	6	28	44	48	30	20	6	6	
Japanese (MORIMOTO, 1962 & 69)														
Cleaned, Male	—	—	—	—	2	1	4	14	28	23	34	32	21	
Cleaned, Female	—	—	—	—	2	6	6	17	23	19	8	2	1	
Exhumed, Sex unknown	—	1	—	1	—	1	6	12	23	17	18	14	10	
Total	—	1	—	1	4	8	16	43	74	59	60	48	32	
Modern Canadians(SIDDIQI, 1936)	—	—	—	—	—	—	—	1	2	11	19	19	32	
Modern Irish (MARTIN, 1932)	—	—	—	—	—	—	1	2	4	11	5	10	10	

for Japanese is tabulated as shown in Table 1 and compared with other published results. It can be seen in Table 1 that the average mean of the squatting number for the Japanese femora is 3.23, occupying an intermediate position between Indian or Punjabi and modern Irish or Canadian ones.

The distribution of the femora according to the so-called squatting number in Japanese with comparative data from four other populations is shown in Table 2. The comparative curves of these squatting and non-squatting populations are given in Fig. 1. From Fig. 1 and Table 2 it is clear that, although the figures range from 2.4 to 4.3, the majority (83.6 per cent) of the Japanese femora examined falls between 3.0 to 3.5. It is also apparent that, although Indians or Punjabis have relatively deeper intercondylar fossae than modern Irish or Canadians as mentioned by MARTIN, SIDDIQI and SHAH, the Japanese femora are intermediately distributed between Indian or Punjabi and modern Irish or Canadian ones. It can be seen, on the other hand, that the majority (73.0 per cent) of the modern Irish femora or that (81.0 per cent) of the modern Canadian ones similarly falls between 3.2 to 3.6. Consequently, there is a considerable amount of overlap of the so-called squatting number between Japanese and modern Irish or Canadians. From this the author finds it difficult to avoid the conclusion that the Japanese femora are not distinguishable from the modern Irish or Canadian ones by the so-called squatting number, although SIDDIQI (1934) stressed that the number in non-squatters tended to rise above and in squatters fall below 3.3.

The greatest depth of the lower articular surface, the depth of the intercondylar fossa and the ratio of the two measurements or the so-called squatting number of the Japanese femora are detailed in Table 3. It should be noted in this Table that in Japanese the intercondylar fossa of the cleaned femora in female is relatively deeper than that in male, the average means of the squatting number for male and female being 3.30 and 3.09, respectively. It is also noted in Table 2 that in Japanese the majority (75.8 per cent) of the male femora studied falls between 3.1 to 3.5, while that (70.2 per cent) of the female ones between 3.0 to 3.2. In consideration of the relatively

squatting number								Total
3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	
—	—	—	—	—	—	—	—	198
2	2	2	—	—	—	—	—	198
17	3	1	—	1	1	—	—	182
—	—	—	—	—	—	—	—	84
4	3	1	—	—	—	—	1	112
21	6	2	—	1	1	—	1	378
7	5	2	1	1	—	—	—	100
10	2	4	—	4	—	—	—	63

Fig. 1 Percentage distribution of the femora according to the so-called squatting number in Japanese, as compared to four other populations.

—— Japanese, ---- Punjabis, Indians, -.-.- Modern Canadians, and --- Modern Irish.

Table 3. The greatest depth of the lower articular surface, the depth of the intercondylar fossa and the so-called squatting number of the femur in Japanese.

Japanese	N	Greatest depth of articular surface	Depth of intercondylar fossa	Squatting number
Cleaned, Male	182	59.8±0.29	18.1±0.12	3.30±0.018
Cleaned, Female	84	54.5±0.30	17.7±0.11	3.09±0.017
Exhumed, Sex unknown	112	57.0±0.37	17.7±0.14	3.22±0.023
Total	378	57.8±0.22	17.9±0.08	3.23±0.012

shallower intercondylar fossa in the exhumed femora of unknown sex examined, it is possible to suppose that they belong to the male sex in the majority of cases. It is definitely indicated in Table 3 that the greatest depth of the lower articular surface of the female femora studied is significantly smaller than that of the male ones, whereas there is no significant difference in the depth of the intercondylar fossa between both sexes. The relatively increased

depth of the intercondylar fossa in female is, therefore, considered to be due to the fact that the articular surface of the femur participating the knee joint in female is absolutely smaller in depth than that in male. Accordingly, it is highly necessary in comparison of the so-called squatting numbers of the femora among different populations to consider first whether given bones are of male or of female.

In addition, the average mean of the squatting index of SHAH (Depth of the intercondylar fossa / Greatest depth of the lower articular surface $\times 100$) for Japanese is found 31.0 (male 30.3, female 32.5), being smaller than that (34.2) for Punjabis obtained by him.

SUMMARY

Observations on the lower ends of 378 femora from modern Japanese who were accustomed to squat both at rest and at work were made and compared with other published results.

The average mean of the so-called squatting number by which the depth of the intercondylar fossa at the level of the intercondylar line was to be multiplied to give the greatest depth of the lower articular surface of the femur for Japanese was 3.23. It gave Japanese an intermediate position between Punjabis (2.90) or Indians (3.10) and modern Canadians (3.43) or Irish (3.44). It was, however, found that the Japanese femora were not distinguishable from the modern Irish or Canadian ones by the so-called squatting number, because there was a considerable amount of overlap of the squatting number among them.

The depth of the intercondylar fossa in female was relatively greater than that in male, the difference being attributed to the fact that the articular surface of the knee joint in female was absolutely smaller than that in male. It was, therefore, necessary in comparison of the so-called squatting numbers of the femora among different populations to consider first whether given bones were of male or of female.

In addition, the average mean of the squatting index of SHAH for Japanese was 31.0 (male 30.3, female 32.5), being smaller than that (34.2) for Punjabis.

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日本人大腿骨のいわゆる蹲踞数について

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大腿骨下端の関節面最大深を、顆間線上において計測した顆間窩深で割った商が MARTIN (1932) のいわゆる蹲踞数である。彼によれば蹲踞の習俗をもつものは蹲踞数が小さく、これは習慣的に膝関節を極度に屈曲するために顆間窩が顆間線の部分で後十字靱帯により圧迫されて深くなるためであるという。

著者は現代日本人大腿骨 378 例の計測から、その大多数 (83.6%) が蹲踞数 3.0~3.5 を示し、その蹲踞数の平均値 3.23 は従来報告されたパンジャブ人 (2.90)・インド人 (3.10) とカナダ人 (3.43)・アイルランド人 (3.44) との中間にあることを知った。SIDDIQI (1934) によれば蹲踞の習俗をもつものは蹲踞数 3.3 以下、もたないものは 3.3 以上を示す傾向があるというが、日本人とカナダ人・アイルランド人との間には蹲踞数の分布にかなりの重なりがみられるので、日本人大腿骨と彼らのそれとを蹲踞数によつて区別することはできない。

日本人でみると、女性 (3.09) は男性 (3.30) より蹲踞数が小さいが、これは顆間窩深の性差によるというよりも、むしろ関節面の最大深が女性は男性より小さいことに起因する。したがつて大腿骨のいわゆる蹲踞数を論ずる場合には、まず資料の性別に留意しなければならない。

なお、SHAH (1942) の蹲踞指数 (上述の顆間窩深を関節面最大深で割つて 100 倍した値) は日本人大腿骨では平均 31.0 (男性 30.3・女性 32.5) であり、パンジャブ人 (34.2) より小さい。

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