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NEW ESTIMATES OF FEMORAL LENGTH IN EARLY HOMINIDS

ABSTRACT: Femora and tibiae of 54 early hominids (14 A. afarensis, 13 A. africanus, 3 A. robustus, 14 A. boisei, 10 Homo habilis) and 17 Homo erectus/early Homo sapiens individuals were studied with a goal of the reconstruction of the femoral length of the given individuum. Most of the fossil specimens were studied on casts in Musée de l'Homme, Paris, National Museum, Praha and Anthropos Institute, Brno, rest of them on photographs from original descriptive studies. Original measurements were preferred if possible. Two independent sources of data were used for each case when possible. The length of femur was either reconstructed or estimated by regression methods or both methods were used to ensure the reconstructed values in fossil specimens. Length of femur was estimated by 14 stepwise multiple regression and 4 linear regression models, both L. S. and M. A. (hominoid and hominid models). BMDP 386 and SOLO 4.0 were used for computing the regression models. Our results are basically similar to those published recently by McHenry. The reconstructions based on multiple and head regression of australopithecines gave usually slightly lower values in comparison to head regression published by McHenry. It has probably been caused by different samples for computing of regression equations. A relatively comprehensive sample of femora of Plio-Pleistocene hominids with relatively precisely predicted femoral length seems to represent a basic pattern of early hominid variability. Our new reconstruction of 30 femoral lengths indicates some decreasing of femoral length in Australopithecines on the one hand, and a marked elongation of femur in genus Homo on the other hand.

KEY WORDS: Early hominids – Australopithecus – Homo – Femoral length – Comparative reconstruction – Regression estimates.

INTRODUCTION

Femoral length is the most precise parameter for the estimate of body height (McHenry 1991, Vančata in press) in early hominids. Several authors have recently reviewed early hominid fossil samples (Geissman 1976, McHenry 1991) to present values of femoral length and body height in early hominids. However, the studies do not give very consistent results from the point of view of hominid evolution. There are also differences in estimates of femoral length in individual cases. As we have proved in previous studies (Vančata 1991 a, b) estimates of femoral length must be taken very carefully due to various allometrical processes in early hominid evolution. From this reason we have started a project on reconstruction of body size and limb proportions in hominoid evolution (Vančata in press). This report presents the most confident reconstructions of femoral length in Australopithecus and early Homo samples based exclusively on relatively well preserved femoral remains.

MATERIAL AND METHODS

Basic morphometric and morphological features of 466 hominoid femora and tibiae were analysed (Recent man – 63, Australian aborigines – 44, Slavic – 29, Neolithic – 95, Mesolithic and Upper Palaeolithic – 16, early Homo sapiens/Homo erectus – 9 (casts), Pan troglodytes – 70, Gorilla gorilla 68, Pongo pygmaeus – 33, gibbons (Hylobates/Symphalangus) – 32, Miocene hominoids – 7 (casts) and their morphology and metrics (see Vančata 1991 a, b, in press, for the details) have been used for the reconstruction and regression analysis of the early hominid sample.

We studied femora and tibiae of 54 early hominids (14 *A. afarensis*, 13 *A. africanus*, 3 *A. robustus*, 14 *A. boisei*, 10 *Homo habilis*) and 17 *Homo erectus*/early *Homo sapiens* individuals (Vančata in press). The early hominid femora analysed in this study are listed in *Table 1*. Most of the fossil specimens were studied on casts in Musée de l'Homme, Paris, National Museum, Praha and Anthropos Institute, Brno, rest of them on photographs from original descriptive studies. Original measurements were preferred if possible. Two independent sources of data were used for each case when possible.

The length of femur was either reconstructed or estimated by regression methods or both methods were used to ensure the reconstructed values in fossil specimens. Length of femur was estimated by 14 stepwise multiple regression and 4 linear regression models, both L. S. and M. A. (hominoid and hominid models). BMDP 386 and SOLO 4.0 were used for computations, Quattro Pro 4.0 and Paradox 3.5 for database management.

RESULTS

Values of estimates of femoral length for studied early hominids are presented in *Table 1*. The specimens where the estimate of femoral length is based on regression formulas only, both head and multiple regression equations, will not be particularly discussed in this study.

Australopithecus afarensis

AL – 288 (*Stern and Susman 1983*): The fragment of femur, where more than one third of distal part is missing, is about 184 mm. The missing distal epiphysis is estimated to be about 37 mm and missing distal part of diaphysis should range between 60 to 70 mm. Regression estimates give values between 281 and 289 mm. It corresponds very well to our reconstruction. The most probable length of AL-288 femur is 283 mm at least.

TABLE 1. *List of examined fossil specimens, their taxonomy, reconstruction type and comparison of our new reconstruction and results published by McHenry (1991). With some exceptions (2) the taxonomy follows taxonomic analysis published recently by McHenry (1991, 1992) and Wood (1992). Reconstruction cases are in bold both for our new reconstructions and for McHenry sample (1991). References in the Table 1 – (1)* Johanson D., Shreeve J., 1989, (2) Geissman T., 1976, (3) Day M. H., Molleson T. I., 1976, (4) Day M. H. 1971.

Vančata				McHenry 1991	
Museum	Taxonomy	Reconstruction type	Femoral length	Femoral length	Reconstruction type
AL-129_1	A. afarensis	Multiple & head regression	297		
AL-288	A. afarensis	**Comp. reconstr.**, Mult. & head regression	**283**	**280**	**Reconstruction**
AL-333-95	A. afarensis	Multiple & head regression	394		
AL-333w-56	A. afarensis	Multiple & head regression	367		
AL-333_3	A. afarensis	Multiple & head regression	391	404	Head regression
AL-333_4	A. afarensis	Multiple & head regression	333		
Sts 14	A. africanus	**Comp. reconstr.**, Mult. & head regression	**292**	295	Head regression
Sts 34	A. africanus	Multiple regression	325		
Stw 99	A. africanus	Multiple & head regression	362	380	Head regression
TM-1513	A. africanus	Multiple regression	336		
SK-82	A. robustus	Multiple & head regression	348	337	Head regression
SK-97	A. robustus	Multiple & head regression	363	367	Head regression
ER-1463	A. boisei	**Comp. reconstr.**, Mult. & head regression	**320**	**310**	**Comp. reconstruction**
ER-1500	A. boisei	**Comp. reconstr.**, Mult. & head regression	**318**	**310**	**Comp. reconstruction**
ER-1503	A. boisei	Multiple & head regression	350	349	Head regression
ER-1809	A. boisei	**Comp. reconstr.**, Mult. & head regression	**313**	**310**	**Comp. reconstruction**
ER-738	A. boisei	**Comp. reconstr.**, Mult. & head regression	**328**	335	Head regression
ER-993A	A. boisei	**Comp. reconstr.**, Mult. & head regression	**368**	**365**	**Comp. reconstruction**
OH 20	A. boisei	Multiple & head regression	360		
OH 62Y	A. boisei	**Comp. reconstr.**, Mult. & head regression	**318**	**315**	**Reconstruction (1)**
ER-1465	Homo habilis	Multiple & head regression	420		
ER-1472	Homo habilis	**Reconstruction-cast**	**400**	**401**	**Reconstruction**
ER-1481	Homo habilis	**Reconstruction-cast**	**397**	**396**	**Reconstruction**
ER-1592	Homo habilis	**Comp. reconstr.**, Multiple regression	**468**	**470**	**Comp. reconstruction**
ER-3728	Homo habilis	**Comp. reconstr.**, Mult. & head regression	**400**	**380**	**Comp. reconstruction**
ER-1807	Homo erectus	**Comp. reconstr.**, Multiple regression	**420**	**420**	**Comp. reconstruction**
ER-1808	Homo erectus	**Comp. reconstr.**, Mult. & head regression	**500**	**485**	**Reconstruction**
ER-736	Homo erectus	**Comp. reconstr.**, Multiple regression	**497**	**482**	**Reconstruction (2)**
ER-737	Homo erectus	**Comp. reconstr.**, Mult. & head regression	**434**	**420**	Comp. reconstruction
OH 28	Homo erectus	Multiple & head regression	447	**456**	**Reconstruction (3)**
OH 34	Homo erectus	**Comp. reconstr.**, Mult. & head regression	**437**	**432**	**Reconstruction (4)**

Australopithecus africanus

Sts 14 (*Robinson 1972*): Femur, about 2/3 of bone, is estimated to be of 198 mm (Robinson 1972). Our reconstructions and regression estimates of femoral length range between 292 and 300 mm.

Australopithecus boisei

ER-738 (*Leakey et al. 1972*): The length of femoral fragment is 218 mm and it is estimated to be about two thirds of the femur. Consequently, the femur should be about 327 mm long. Regression estimates are about 328 mm.

ER-993 A (*Walker 1973*): The bicondylar length of femur with missing proximal part is estimated to be of 295 mm. The reconstruction of missing part based on distance between trochanters is 73 – 75 mm (68 mm plus 5 – 7 mm for the head). The reconstruction of missing part based on distance of trochanter minor to neck is 72 – 73 mm (60 mm plus 12 – 13 mm for the head). The femoral length estimate is between 367 and 370 mm. Multiple regression estimate is 368 mm.

ER-1500 (*Leakey et al. 1976*): Proximal femur is estimated to be about 65 mm, distal femur ranges between 100 and 110 mm. Missing 2/3 of femoral shaft are predicted to be of 155 mm. Femoral length ranges between 310 and 320 mm, which corresponds to regression estimates 312 – 318 mm.

ER-1809 (*Leakey et al. 1976*): Femoral fragment is 215 mm long, missing distal part is estimated tobe about 40 mm and proximal part should range between 55 and 60 mm. Femoral length is at least 315 mm which corresponds to regression estimate 313 mm.

Australopithecus incertae sedis

OH 62Y (*Johanson and Shreeve 1989, Johanson et al. 1987, McHenry 1992*): Body of a very gracile femur is estimated, including reconstructed head, to 158 – 160 mm. This part is approximately 50 % of femoral length that should range from 316 to 320 mm. Regression estimate of total length is 318 mm.

Homo habilis

ER-1463 (Leakey et al. 1976): Femoral body is 265 mm long. Missing part of femoral head is predicted to 10 – 12 mm, missing distal part is estimated to 39 – 42 mm. The estimated femoral

length is of 314 – 320 mm which corresponds to regression estimate 320 mm.

ER-1592 (*Leakey and Walker 1985*): The bicondylar length of femur, where the missing part is about 60 %, is estimated to 187 mm. The reconstructed length ranges between 467 and 470 mm. Multiple regression gives values about 465 mm. Midpoint estimate is of 468 mm.

ER-3728 (*Leakey and Walker 1985*): The length of preserved part of bone is estimated to be 350 – 355 mm, the missing part of head is 7 – 9 mm and the missing distal part is estimated to 39 mm. The estimated femoral length is of 396 – 403 mm.

Homo erectus

ER-736 (*Geissman 1976, Leakey et al. 1972*): The preserved femoral shaft has 288 mm. Missing proximal part is approximately 36 mm and the missing one third of femur on distal end is estimated to 160 – 165 mm. The resulting estimate ranges between 484 – 489 mm.

ER-737 (*Day and Leakey 1973*): The femoral shaft has 362 mm, missing part of the head is estimated to 22 (20 – 23) mm and the missing part of distal femoral epiphysis is at least 50 mm. The length should be about 434 mm.

ER-1807 (*Leakey et al. 1976*): Femoral shaft is of 227 mm, missing proximal part is estimated to 120 mm and the missing distal part is at least 70 mm. Very approximate value of femoral length should be about 420 mm.

ER-1808 (*Leakey and Walker 1985*): The length of preserved part of femur estimated for the reconstruction is 420 – 423 mm (433 mm maximal length). The missing part of femoral head is estimated to 18 mm. The missing distal part of the femur should be at least 63 mm. The resulting estimate is supposed to be more than 500 mm.

OH 34 (*Day 1971*): Preserved femoral body has 411 mm. Missing part of femoral head is estimated to 6 mm. Missing part of femoral condyle is of 20 mm. The femoral length is at least 437 mm.

DISCUSSION AND CONCLUSIONS

Our results are basically similar to those published recently by McHenry (1991). The reconstructions based on multiple and head regression of australopithecines gave usually slightly lower values in comparison to head regression published by McHenry (1991). It has been probably caused by different samples for the computing of regression equations. We based our samples exclusively on prehistoric human populations where the civilisation influence can be excluded. Femora of early Homo populations were probably longer than McHenry (1991) has presented.

AL 288-1 is the only relatively complete femur of Pliocene hominids but still too fragmentary to be sure of its length. The femur was probably longer than it has traditionally been presented (Geissman 1976, Jungers 1982, McHenry 1991). The value 283 mm, published by Schmid (1983) is supposed to be the most realistic estimate but the values up to 290 mm cannot be excluded.

The distribution of femoral length values in individual groups is of great interest (*Tab. 1*, *Fig. 1*). The extensive variability in *A. afarensis* shows probably a very high sexual dimorphism (Vančata in press). The variability in femoral length in *A. africanus* and *A. robustus/boisei* is much lower. A very high sexual dimorphism in *Homo habilis* (Vančata in press) is not clearly reflected by the reconstructed sample. Only large and middle sized femora were complete enough to be suitable for reconstruction or multiple regression. It is difficult to make any interpretation but one. *Homo habilis* has relatively very long femora, at least *H. habilis* males. This fact probably excludes very small individuals as OH 62Y from the range of variability of "Homo habilis *sensu stricto*" (McHenry 1991, 1992, Vančata in press, Wood 1982). We have proposed a new species *Australopithecus gracilis* (Vančata in press) but the taxonomy of "small Homo habilis" is still open.

We can conclude that there is a relatively comprehensive sample of femora of Plio-Pleistocene hominids with relatively precisely predicted femoral length (Geissman 1976, McHenry 1991, Vančata 1991 a, b, in press). Our new reconstruction of 30

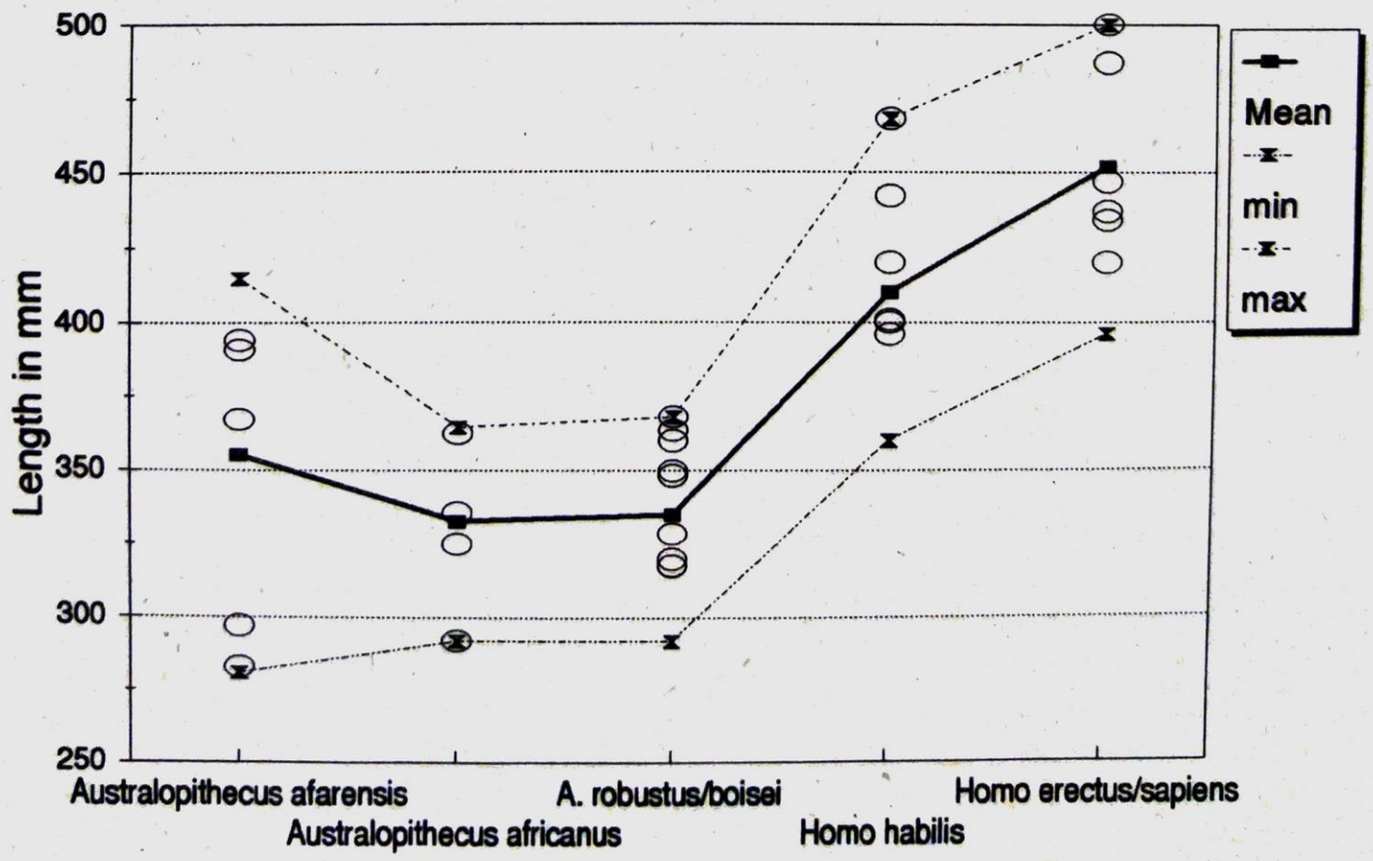

FIGURE 1. *Reconstruction of length of femur for australopithecine and early Homo species. Mean minimum and maximum values are taken from the sample published elsewhere (Vančata in press), empty circles are individual cases listed in* Table 1.

femoral lengths indicates some decreasing of femoral length in Australopithecines on the one hand and a marked elongation of femur in genus Homo on the other hand.

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