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Supplementary information

Postcranial evidence of late Miocene hominin bipedalism in Chad

In the format provided by the authors and unedited

1. Supplementary Notes 1, 2, 3, 4, 5

2. Supplementary Table S1, S2, S3, S4

Supplementary Note 1. **Context of the discoveries**

The Mission Paléontologique Franco-Tchadienne (MPFT, directed by Michel Brunet) has conducted field missions in the Djurab desert since 1994. Its first major discovery was a partial mandible attributed to a new species, *Australopithecus bahrelghazali*[90,91], found in the fossiliferous sector of Koro Toro (upper Pliocene). In 1997, Brunet led an exploratory team in the western part of the Djurab that discovered a new fossiliferous sector dominated by upper Miocene outcrops (Toros-Menalla, TM). From 1997 to 2001, the MPFT documented the full extension of this large area (ca. 100 km along an East-West axis) and initiated its systematic survey. In July 2001, a technical team of four MPFT members[*] performed a recognition survey at TM and reached a particularly rich area (locality TM 266), at that time a ca. 1.5 km^2 surface more or less clear of sand accumulations. The team collected an abundant sample of fossil specimens and documented photographically the work, but did not performed precise recording of specimen positions relative to each other within the locality. The partial cranium TM 266-01-060-1 proposed as holotype specimen for *Sahelanthropus tchadensis* by [92], the femur TM 266-01-063, and one of the ulnae (TM 266-01-050) were among the collected specimens. The participants to this mission reported conflicting information regarding the precise locations within the locality TM 266 of the various fossil remains collected during this mission. Pictures used to discuss the original position of the femur and cranium[93] do not include the ulna TM 266-01-050, and do not present contextual elements allowing identifying the location and timing of their shooting. Most specimens observed on these pictures, also including various craniodental and postcranial remains of other vertebrates, do not display the dust and sand coverage usually observed on surface finds in the Djurab desert: they were therefore photographed after handling. This corroborates claims by Chadian team members that these pictures did not record the initial position of the fossils and that they were shot after the fossils were gathered from the surroundings. Given the minimum number of three hominin individuals calculated for TM 266, suggestions that TM 266-01-060-1 and any of the newly described postcranial elements belong to the same individual remain highly hypothetical.

In N'Djamena, the team roughly sorted the 561 specimens collected during the mission (141 for TM 266) by high-level taxonomic ranks and eventually stored most of the postcranial specimens as an "indet." group (including 55 specimens for TM 266). This was the case for the femur TM 266-01-063 and the ulna TM 266-01-050. The material then waited for examination by skilled anatomists, which did not happen during the two following years. At the time, the MPFT gave the highest priority to other tasks. First, the study of the craniodental material and the initial characterization of the TM 266 faunal assemblage occupied all the research time and resulted in their first description in Nature a year after TM 266 discovery[94,95]. Second, several field missions aimed at unearthing further specimens at TM 266 and adjacent areas in the context of quickly increasing cover of the hominin locality by eolian sands and of extreme sand-blast erosion of surface specimens. From 2001 to 2003, despite the low density of fossil remains in Djurab fossil-bearing localities, the MPFT collected more than 7,000 specimens at TM,

including new craniodental specimens attributed to *Sahelanthropus* and described by [96].

In early 2004, prior to careful examination by paleontologists with a suited expertise, various postcranial remains discovered in July 2001 were selected for the training (research internship) of a master student in taphonomy, including TM 266-01-063. Seeking expertise, the student handed this specimen to Roberto Macchiarelli[97], not a member of the MPFT. Macchiarelli correctly identified the femur to be that of a hominin. In parallel, the MPFT identified the ulnar remains. Since 2004, the MPFT attempted discovering in the field further postcranial remains of hominins documenting the postcranial anatomy of the TM hominins, to date unsuccessfully. The present team of coauthors initiated its study of the postcranial specimens in 2017.

[*] Including three Chadian technicians of the Centre National d'Appui à la Recherche (CNAR, now CNRD), Ahounta Djimdoumalbaye, Fanone Gongdibé, and Mahamat Adoum, led by one "cooperation assistant" from the Embassy of France to Chad, Alain Beauvilain.

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Supplementary Note 2. **Detailed descriptions of the TM 266 hominin postcranial material**

Left femur (TM 266-01-063)

TM 266-01-063 is a left femoral shaft of about 242 mm, lacking the distal epiphysis and its adjoining metaphyseal region, and most of the proximal epiphysis. The femoral shaft is curved anteroposteriorly. The femoral head is missing, the neck being broken about 15 mm above the margin, which delineates the lesser trochanter proximally. In proximal view, the neck is compressed anteroposteriorly. The medial border of the neck is oriented proximally, only the medialmost portion of the intertrochanteric line is visible, as a small rugose surface, proximomedial to the lesser trochanter. Lateral to the neck, the greater trochanter and the trochanteric fossa are lacking. The preserved portion of the posterior face of the neck presents a slight depression, which could be evidence of the presence of the *externus obturator*. The lesser trochanter preserves only its basal surface bordered by a prominent margin. It has a raindrop shape, of 25.3 mm long and 16.2 mm wide. Preserved evidences suggest that the lesser trochanter was substantially developed albeit there is no definitive indication on its overall orientation. The lesser trochanter connects to the neck with a slightly concave surface. There is no evidence of an intertrochanteric crest. A *linea pectinea*, expressed by a bulge, arise from the distal margin that delineates the lesser trochanter. There is no evidence of a hypotrochanteric fossa or lateral pilaster. There is no evidence of superomedial and inferolateral fossae. Just distal to the lesser trochanter location, the diameter of the shaft is 24.0 mm anteroposteriorly and 32.0 mm mediolaterally illustrating subtrochanteric platymeria.

Lateral to the lesser trochanter level, the insertion of the *m. gluteus maximus* left a small but sharp relief, indicative of the gluteal tuberosity, continuing into a rugose surface distally. This rugose surface blends with the lateral component of the *linea aspera* distally. Medially to the lesser trochanter runs the spirale line for the insertion of the *m. vastus medialis*. It consists in a straight line, which confounds distally with the medial border of the *linea aspera*. The *linea spirale* delimits posteriorly a medial shallow fossa.

The lateral border of the *linea aspera* forms a well-marked, sigmoid, and continuous line from the gluteal tuberosity to approximately 37.5 mm to the distalmost end of the shaft. It curves medially at about 20 mm distal to the nutrient foramen. The medial and lateral borders of the *linea aspera* do not form a pilaster. The distance between medial and lateral borders of the *linea aspera* is 12.2 mm in its minimum. The anterior face of the proximal end bears a large slightly concave surface, with no discernable relief except a restricted rugose surface located on the proximal border. There is no evidence of the femoral tubercle.

Enlargement of the diaphysis start soon after mid-shaft (diameters are 27.6 mm mediolaterally and 25.3 mm anteroposteriorly). Distally, there is no anatomical evidence to estimate the location of the metaphyseal region. The medial and lateral borders of the *linea aspera* diverge at about the distal fifth of the shaft length. In anterior view, no patellar fossa is visible. No reliable indicator allows estimating the length of the missing distal portion of the femur.

Inner structure: The medullar cavity is almost completely filled by sediment and no trabecular network is preserved except at proximal end with limited evidences close to the cortical bone. At this level, the lesser trochanter is strengthened internally by a spur of bone, also called *calcar femorale*, projecting out superiorly from the cortex into central cancellous bone. Precise

location of the midshaft is uncertain, but there is a distinct nutrient foramen located posteriorly at about the maximum of curvature of the shaft. Overall preservation of the bone and taphonomic aspects prevents from having exact estimation of the average cortical thickness. Nevertheless, linear measurements obtained from micro-CT slice orthogonal to the long axis of the shaft, at nutrient foramen show thickest cortical bone laterally and thinnest anteriorly. The outline of the bone at the same level of the shaft is subcircular with a posterior flattened portion corresponding to the space between the lateral and medial margins of the *linea aspera*.

***Right ulna* (TM 266-01-358)**

It is a half proximal portion of a right ulna, of about 155 mm, preserving most of the proximal epiphysis. The trochlear notch is almost complete but the anteroproximal end of the anconeal process and most part of the posteroproximal portion of the olecranon. At the level of the coronoid process, the preserved posterior portion of the ulna demonstrates that the olecranon does not project posteriorly. The trochlear notch is keeled, narrow in its middle portion, and enlarging distally. In anterior view, the trochlear notch axis defined by the anconeal and coronoid processes is in line with the shaft axis. In medial/lateral view, the trochlear notch faces anteriorly. The distomedial portion of the trochlear notch is weakly concave and is proportionally large mediolaterally when compared with its lateral counterpart.

The articular surface of the radial notch is not preserved but its outline shows that it was not rounded but rather subrectangular with 15.6 mm wide anteroposteriorly and 12.6 mm long proximodistally. The radial notch is on a promontory. In proximal view, the plan of the radial notch makes an acute angle (~28°) with the major axis (as defined by the keeling axis) of the trochlear notch. In the coronal plane, the radial notch should have not been vertical but slightly oblique distally. Distally, the supinator crest emerges directly from the posterior border of the radial notch and run distally for about 40 mm, the distal end being difficult to estimate due to taphonomic alterations.

Posteriorly to the supinator crest, a wide and concave fossa for the *anconeus* is posteriorly delimited by a sharp crest running from the base of the olecranon process to 15 mm distally to the level of the distal border of the radial fossa and then become smooth. Distally, the shaft is subtriangular in section. It is defined by an anterior edge due to the insertion of the interosseous membrane, this later separates medially the face for the *m. flexor digitorum profondus*, and laterally the face for the *extensor ulnaris carpi*. The posterior border is delimited laterally by the crest delimiting the *anconeus* attachment and medially by the edge for the insertion of the *m. flexor ulnaris carpi*. The proximal portion dedicated for the attachment of the *m. flexor digitorum profundus* corresponds to a large and shallow depression. The shaft is curved in profile and twists transversally, the insertion of the interosseous membrane deviating laterally.

***Left ulna* (TM 266-01-050)**

TM 266-01-050 consists in a left ulnar diaphysis of 239 mm long as preserved. The proximal epiphysis is badly damaged. In anterior view, the trochlear notch is eroded preserving only a small distal portion of the *m. anconeus* process. Most part of the olecranon is missing but its preserved posterodistal portion indicates that the olecranon does not project posteriorly.

In overall shape, the trochlear notch is narrow in its middle portion. The coronoid process is unpreserved, making impossible any reliable estimation of the trochlear notch angle. The fossa for the *m. brachialis* is located anteriorly, in line with the estimated trochlear notch axis (as defined by the anconeal-coronoid processes) and is 15-16 mm long.

The articular surface of the radial notch is lacking. The radial notch is on a promontory which outline is comparable in shape to the right ulna. Distally, the supinator crest emerges directly from the posterior border of the radial notch, and despite taphonomic damage shows comparable condition to the right ulna.

Posteriorly to the supinator crest, a wide and concave fossa for the *m. anconeus* is posteriorly delimited by a sharp crest running distally from the base of the olecranon process to the level of the radial fossa and then fades into a rounded margin. At midshaft, the ulna is subtriangular in section, in the same configuration of the right ulna and becomes oval distally. As for TM 266-01-358, the posterior face of the ulna is bordered laterally by the crest delimiting the *m. anconeus* attachment and medially by the insertion edge for the *m. flexor ulnaris carpi*, forming a noticeable flat surface. The proximal portion dedicated to the attachment of the *m. flexor digitorum profundus* corresponds to a large and shallow depression. There is no medial protuberance for the attachment of the *m. flexor digitorum profundus*. The shaft is curved in profile, sigmoid coronally and twisted transversally, the insertion of the interosseous membrane deviating laterally. Distally, the shaft is likely broken proximal to the quadratus pronator attachment.

The nutrient foramen is located at 92 mm from the anteroproximal surface of the lateral quadrant of the trochlear notch.

Supplementary Note 3. **Comments on figures 2 and figure 3.**

Comments on Figure. 2, Comparative analysis of the subtrochanteric and midshaft cross-sectional contours of the TM 266 femur.

Comments on Figure 2a.

Distribution of the specimens along PC1 describes mainly the variation of the posterior border of the cross-sectional contour. At 80%, the femoral cross-sectional contour varies between two poles, illustrating either a relative postero-lateral expansion of the area distal to the lateral tuberosity and corresponding to the insertion of the *m. gluteus maximus* (positive values) or a relative postero-medial expansion of the area distal to the lesser trochanter and corresponding to the proximal insertion of the *m. vastus medialis* (negative values). Along PC2, distribution of the specimens mainly describes anteroposterior expansion of the femora cross-sectional contours (positive values) relative to mediolateral expansion (platymeria, negative values). Non-human extant apes are characterized by an expanded postero-medial border suggesting a developed enthesis for the *m. vastus medialis* associated to varying degree of subtrochanteric stenomery (i.e., anteroposterior diameter superior to mediolateral). Extant humans are characterized by an expanded postero-lateral border suggesting a developed enthesis for the *gluteus maximus* associated to varying degree of subtrochanteric stenomery. While the European Miocene apes *Hispanopithecus* falls into the variation of the extant African apes, fossil hominins and *Dryopithecus* occupy a particular morphospace better characterized by a pronounced platymeria and a more elliptical cross-sectional contour, emphasized in early *Homo* specimens. The TM 266-01-063 femur falls into the australopith variation and departs from extant apes variation. The Kenyan specimens of *Or. tugenensis* falls into fossil hominin variation along PC1, but occupies an intermediate position between fossil hominins and extant humans along PC2 due to a relatively reduced platymeria.

Comments on Figure 2b.

Distribution of the specimens along PC1 mainly describes a variation from platymeric cross-sectional contours (negative values) to stenomeric contours (positive values). Along PC2, distribution of the specimens illustrates the modification of the posterior border of the femora cross-sectional contours, from circular contours showing a rather flattened posterior border (negative values) to rain-drop shaped contours showing an expansion of the posterior border corresponding to the presence of the femoral pilaster (positive values). PC1 distinguishes extant humans and gorillas/orangs, the later displaying a noticeable midshaft platymeria. The chimpanzees occupy an intermediate position, the bonobos being closer to the extant human morphospace than the common chimpanzees. Extant humans differ from all other extant apes by an anteroposteriorly elongated cross-sectional contour and by a variably developed femoral pilaster. In this pattern, European Miocene apes falls within the variation of extant non-human apes, essentially into chimpanzee variation for *Hispanopithecus* and closely to gorillas/orangs distribution for *Dryopithecus*.

TM 266-01-063 occupies a central position, in between extant non-human apes and extant humans distributions, close to the chimpanzee, early *Homo* and australopith variations. The

position of the Chadian specimen is mainly due to its posterior femoral morphology in having a low and broad *linea aspera* and a moderate midshaft diaphyseal platymeria. *Or. tugenensis* occurrences clearly depart from this pattern, as they fall within the orang variation, in having a more elliptical midshaft cross-sectional contour. The relative position of *Or. tugenensis* and *S. tchadensis* illustrates the variation of the midshaft morphology (due to PC1) in Miocene hominins, but such a variation does not differ noticeably from the variation observed among the extant taxa.

Comments on Figure. 3, Comparison of cortical thickness distribution between *S. tchadensis* and extant great apes.

Compared to extant apes, the femur of *S. tchadensis* most resemble the typical modern human bipedal condition in its posterior and lateral aspects. As in humans[98,99], the cortical thickness distribution pattern of the femoral shaft is characterized by three relative reinforcement area (colored in red to yellow) corresponding to the proximomedial, lateral and posterior portions of the diaphysis. Medially, the thickest diaphyseal bone is situated at about 65%-80% (and slightly above) of the biomechanical length and extends distoposteriorly following the medial lip of the 'proto *linea-aspera*'. Posterior thickening of the cortical bone occurs at about the level of the nutrient foramen, around 35%-55% of the biomechanical length, where the 'proto-*linea aspera*' is the narrowest. Laterally, a patch of thick cortical bone is evident between 70-80%, and is prolonged distally by a slightly less thick cortical bone towards the 40% of the biomechanical length. Anteriorly, the femoral cortical thickness distribution is characterized by a relative cortical thinning (green to blue), with a proximodistal gradient.

Marked differences between *Homo sapiens*/TM and *Pan*/*Gorilla*/*Pongo* are visible in cortical bone thickness distribution for the 35 to 80% portion of the femoral biomechanical lengths. As exemplified by the figured non-human specimens (*Pan, Gorilla and Pongo*), two distinct reinforcements can be identified on the proximal shaft portion, medially and at a much lesser extent, laterally. Such an observation is in line with Puymerail's previous results[98], *Pan* and *Gorilla* (n=20 and n =10 respectively) having a significant tendency for bone thickening, medially and laterally, at the 40%-80% interval. The "crook-shaped imprint" typical of the lateral face of non-human apes femora[99] is evident on the gorilla individual and is absent on our sampled chimpanzee specimen and the *S. tchadensis* femora. Besides, quantitative analysis by Puymerail[99], based on individual morphometric maps, shows that most discriminant areas are "in terms of relative cortical bone thickness variation, the posterior and the lateral diaphyseal reinforcements" in bipedal modern humans. Two features that characterize also the Chadian femur. The lateral reinforcement pattern appears to parallel an insertion area including the *mm. vastus lateralis*, and *gluteus maximus* proximally, and the attachment zone of the *m. vastus intermedius* distally. In medial view, the relative cortical thickening is restricted to the proximal portion of the femoral shaft, corresponding to the attachment of the *m. vastus medialis* (see also [100]). The posterior reinforcement corresponds to an insertion area delineated by the two *mm. vasti* and comprising the hip adductor and extensor (*m. biceps femoris*) muscles. In functional terms, the cortical thickness distribution data observed on hominid femora echoes the functional differences that characterize major habitual locomotor behaviors of humans and non-human apes. In the former, the extensor muscles and *m. gluteus maximus* are assumed to stabilize the hip[101] enhancing the effectiveness of hip extension (extensors and adductors[102]) during upright

bipedalism[103]. In the later, the hip is more effective in ab-adduction (vasti muscles), facilitating bridging and climbing on discontinuous and variably oriented substrates[99,102-110]. In these aspects, the Chadian femur is in line with the stereotypic human upright bipedalism, and contrasts with the patterns observed for non-stereotyped positional behaviors in non-human apes. Yet, considering the total cortical bone signature (e.g., including some aspect of the medial thickening), the retention of climbing capacity for *S. tchadensis* cannot be completely ruled out (*sensu* [111]).

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Supplementary Note 4. **Notes on cross-sectional geometric properties**

Femur TM 266-01-063

Percent of cortical area measured at 80% and 50% biomechanical levels are respectively 68.4% and 67.5% (see Methods; Extended Data 6), corresponding to relatively low values for hominins, though higher than A.L. 288-1 (*A. afarensis*; 80% and 50%) and KNM-WT 15000 (*H. ergaster*; 50%), and close to KNM-ER 737 (early *Homo*; 80%). Response to bending loads assessed at 80% and 50% (see Methods) of the biomechanical length using second moment of area[112-114] are respectively 0.57 (I_x/I_y), 1.79 (I_{max}/I_{min}) and 0.82 (I_x/I_y), 1.31 (I_{max}/I_{min}). At 80%, the Chadian femur approaches the extinct hominin condition in its I_x/I_y ratio with a value corresponding to the lower range of the extant human and orangutan variation. At 50%, whereas the I_x/I_y ratio of TM 266-01-063 clearly falls within the australopith/early *Homo* variation, it departs from extant humans in which a posterior pilaster develops[115]. The femora of *Or. tugenensis* display an equivalent trend, with somewhat higher I_x/I_y ratio values at 80% and lower values at 50% compared to *S. tchadensis*. In all cases, both early hominin taxa depart from Miocene apes variation. Concerning I_{max}/I_{min}, both *S. tchadensis* and *Or. tugenensis* femora fall within the australopith and/or early *Homo* range of values, *Or. tugenensis* having slightly higher I_{max}/I_{min} values at midshaft, and both taxa are excluded from the Miocene ape variation at 80% level.

Ulna TM 266-01-050

Proximally, the percent of cortical area is 74.4%, measured at about 80% of the estimated articular length of the ulna (see methods). It is within the range reported for *Australopithecus* specimens from Sterkfontein (65.8-88.5%, n=8). At mid-shaft, the percent of cortical area is 79.4%. It falls within the variation of extant and Late Pleistocene hominins (*H. sapiens*: females, n=5, 71.7% ± 15.1; males, n=19, 77.7% ± 8.8[116]; early *H. sapiens*: n=8, 80.1% ± 6.6[117]) and approaches the values reported for South African specimens of *Australopithecus* (StW 326, 84.5%; StW 349, 87.8%, StW 431, 91.4%[118]).

I_{max}/I_{min} and I_x/I_y are respectively 2.02/1.67 at 80% level and 1.61/0.95 at midshaft. Values at midshaft for I_x/I_y fall inside the reported variation for modern humans and African non-human apes, and is within the lower range of gibbons[116,119] (Extended Data 7). Additionally, I_{max}/I_{min} computed for TM 266-01-050 is within the range of variation of extant modern humans, Asian apes, and *Gorilla* to a lesser extent.

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Supplementary Note 5. **Notes on pronograde and orthograde clambering**

The definition provided below mainly follows[120]. Clambering is a horizontal mode of progression (i.e., within 45° of horizontal) that can basically imply either i) a horizontally-oriented torso main axis (pronograde) relatively to the substrate, or ii) a vertically-oriented (orthograde) torso main axis.

Pronograde clambering is defined as a non-suspensory torso-pronograde quadrupedal progression lacking a regular gait. This type of locomotor behavior potentially implies sure-grasp and erratic limb excursions and occurs at relatively slow speed. Locomotion substrates are mostly of small diameters, irregularly placed and variously angled. This type of behavior is named bridging when an individual has to use highly discontinuous substrates.

Orthograde clambering refers to a forelimb-suspensory torso-orthograde locomotion where the four limbs at various orientations act as propulsors, distributing the body weight over different limbs and supports. Kinematically this mode differs from suspension, in that the hindlimbs provide support from virtually any orientation, including completely abducted limbs. Orthograde clambering approximates what [121], more recently followed by [122], designed under the term « cautious climbing ». Importantly, orthograde clambering also includes hand-assisted bipedalism (involving extended hip and knee)[123], a behaviour proposed as the evolutionary precursor of the hominin terrestrial bipedalism[123,124].This latter behavior differs from other orthograde clambering behaviors when most of the body weight is supported by its legs while general balance is maintained with the help of one or both arms[125].

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Supplementary Table S1. **Femoral and ulnar measurements**

		TM 266-01-63 (Left)
Maximum length (preserved portion)		242 mm
Biomechanical length (estimated, see methods)		283.8 mm
Total length (indicative, see methods)		303 [297-313] mm
Medio-lateral diameter, subtrochanteric		32.0 mm
Antero-posterior diameter, subtrochanteric		24.0 mm
Medio-lateral diameter taken at midshaft		27.6 mm
Antero-posterior diameter taken at midshaft		25.3 mm
Minimum width of the linea aspera taken at midshaft		12.2 mm
Diaphyseal torsion (see methods, Extended Data 6)		38.5°
Cross sectional geometric properties		
80% of the biomechanical length	CA/TA	68.4%
	I_x/I_y	0.57
	I_{max}/I_{min}	1.79
50% of the biomechanical length	CA/TA	67.5 %
	I_x/I_y	0.82
	I_{max}/I_{min}	1.31

		TM 266-01-358 (right)	TM 266-01-050 (left)
Maximum length (preserved portion)		155 mm	239 mm
Maximum proximo-distal diameter of the radial notch[126]		12.6 mm	-
Maximum anteroposterior diameter of the radial notch[126]		15.6 mm	(15.4 mm)
Radial notch angle[126]		28.2°	-
Mediolateral breadth of middle portion of the articular surface of the trochlear notch (UTW2)[127]		17.2 mm	-
Maximum anteroposterior distance from the tip of the coronoid to the posterior margin of the ulna (UCP1) [127]		32.1 mm	-
			-
Mediolateral breadth of trochlear notch measured immediately posterior to radial notch (UNR2) [127]		32.3 mm	-
Mediolateral breadth of articular trochlear and radial notches (UTR2) [127]		31.7 mm	-
Mediolateral breadth of articular trochlear notch anterior to radial notch (UTB2) [127]		24.8 mm	-
Distance from posterior margin of ulna to the maximum depth of the keel of the trochlear notch (UPC2) [127]		16.5 mm	(15.5 mm)
Mediolateral breadth of diaphysis immediately distal to radial notch (USM2) [127]		(19.5 mm)	(21 mm)
Proximal trochlear keeling[127]		101°	-
Distal trochlear keeling[128]		117°	-
Anteroposterior diameter à 80% of the biomechanical length		-	21.1 mm
Mediolateral diameter à 80% of the biomechanical length		-	17.1 mm
Anteroposterior diameter à 50% of the biomechanical length		-	15.7 mm
Mediolateral diameter à 50% of the biomechanical length		-	17.0 mm
Cross sectional geometric properties			
80% of the biomechanical length	CA/TA	-	74.4%
	I_x/I_y	-	1.67
	I_{max}/I_{min}	-	2.02
50% of the biomechanical length	CA/TA	-	79.4%
	I_x/I_y	-	0.95
	I_{max}/I_{min}	-	1.61

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Supplementary Table S2. **Comparative femoral cross-sectional geometric properties in extinct and extant apes.**

See separate file.

Supplementary Table S3. **Morphological state of the main preserved features in femur and ulnae of *Sahelanthropus tchadensis*, and their comparative in extant and extinct hominines.**

See separate file.

Supplementary Table S4. **Comparative samples.**

A. Comparative samples of extant apes for the 2D Geometric morphometric analysis of the femoral cross-sections (at 80% and 50% of the biomechanical length) and of the femoral curvature analysis.

Specimen	Sides*	Sex	Origin	Institutions**
Pan paniscus				
15293	R(m), L	F	Stanleyville (terr. Stanleyville), RD Congo	MRAC
15294	R(m), L	M	Stanleyville (terr. Stanleyville), RD Congo	MRAC
15295	R(m), L	F	Stanleyville (terr. Stanleyville), RD Congo	MRAC
15296	R(m), L	F	Stanleyville (terr. Stanleyville), RD Congo	MRAC
27696	R(m), L	M	Ponthierville (Walengolas), RD Congo	MRAC
29040	R(m), L	F	Wamba (Basankusu), RD Congo	MRAC
Pan troglodytes				
153	R(m), L	F	?	MRAC
4188	R(m), L	?	Poko, RD Congo	MRAC
5891	R(m)	F	?	MRAC
11363	R(m), L	M	Moba, RD Congo	MRAC
15233	R(m)	M	Mayumbe, Gabon	MRAC
15350	R(m), L	?	Ekwangatana, RD Congo	MRAC
19534	L	?	Watsa, RD Congo	MRAC
18188	R(m)	?	Tshoa (Seda), RD Congo	MRAC
Bio-04	R(m)	M	?	UP
USNM 220062	R(m), L	F	Fernan Vaz (Alboona), Gabon	NMNH
USNM 220063	R(m), L	F	Fernan Vaz (Animba), Gabon	NMNH
USNM 395820	L	M	?	NMNH
Gorilla				
2257	R(m), L	M	Mount Mikeno (Virunga), RD Congo	MRAC
2260	R(m), L	M	Mount Mikeno (Virunga), RD Congo	MRAC
2263	R(m), L	F	Mount Mikeno (Virunga), RD Congo	MRAC
9405	L	M	Tshibinda (Katana), West Kivu, RD Congo	MRAC
8187	R(m), L	?	?	MRAC
USNM 396935	R(m), L	F	Tsundura (Virunga), Rwanda	NMNH
USNM 395636	R(m), L	M	Mount Visoke (Virunga), Rwanda	NMNH
USNM 397351	R(m), L	?	?	NMNH
Bio 02	R(m)	M	?	UP
Pongo				
USNM143590	R(m), L	M	Aru Bay, Sumatra,Indonesia	NMNH
USNM143593	R(m), L	M	Aru Bay, Sumatra,Indonesia	NMNH
USNM143596	R(m), L	F	Aru Bay, Sumatra,Indonesia	NMNH
UP-145	L	?	?	UP

Table A (continued)

Homo				
Ind MA 289	L	?	Poitiers, France	UP
POI MA 072	R(m)	?	Poitiers, France	UP
POI MA 073	L	?	Poitiers, France	UP
VL MA 006	R(m)	?	Poitiers, France	UP
PA PO 74-160 a30	R(m)	F	Poitiers, France	UP
PA PO 74-160 a31	L	F	Poitiers, France	UP
PA PO 74-160 a33	L	F	Poitiers, France	UP
PA PO 74-160 a34	R(m)	F	Poitiers, France	UP
Individual 11	R	?	Poitiers, France	UP
Individual 12	R	?	Poitiers, France	UP
Individual 13	R	?	Poitiers, France	UP
Individual 14	R	?	Poitiers, France	UP

* R, right; L, left; (m), mirrored 3D models of right femur.
** MRAC, collections of the Musée Royal d'Afrique Centrale, Tervuren (Belgium); NMNH, Smithonian National Museum of Natural History, New York (United-States); UP, Université de Poitiers, UMR 7262 laboratoire PALEVOPRIM, Poitiers (France).

B. Fossils specimens included in 2D GM analysis of the femoral cross-sections (80% and 50%) and of the femoral curvature analysis (x = 2D geometric morphometric analysis, c = anterior curvature).

Specimens	Side*	Femoral biomechanical length		Femoral anterior curvature	Source
		80%	50%		
Miocene hominids					
Hispanopithecus, IPS 18800	L	x	x		[129]
Hispanopithecus, IPS 18800	R	x	x		[129]
cf. *Dryopithecus*, IPS41724	R	x	x		[129]
Sahelanthropus, TM 266-01-063	L	x	x	c	This study
Orrorin, BAR 1002'00	L	x	x	c	This study
Orrorin, BAR 1003'00	L	x			This study
Australopithecus					
A.L. 288-1 ap	L	x	x		[112]
A.L. 211	R	x			This study
StW 573m	L			c	[130]
StW 99	R	x	x		[118]
StW 121	R		x		[118]
Paranthropus					
SK 82	R	x			[131]; this study
SK 97	R	x			[131]; this study
African early Pleistocene *Homo*					
OH 62	L		x		[132]
KNM-ER1472	R(m)	x	x	c	[132]; this study
KNM-ER1481a	L	x	x	c	[132]; this study
OH 28	L		x		[133]
KNM-WT 15000BO	L		x		[133]

* R, right; L, left; (m), mirrored 3D models of right femur.

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