Is the human anatomy made for an arboreal climbing lifestyle?

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Humans (Homo sapiens) have evolved from an ancestor that may have been quite similar to the chimpanzee (Pan troglodytes). If humans have evolved from a hominid living an arboreal climbing lifestyle, there should be anatomical structures present in humans, which are uniquely advantageous to the kinematics (movement) of vertical climbing. However, a comparison of today's humans and apes versus prehistoric hominids suggest it is unlikely that humans are suited to living only an arboreal lifestyle. For that matter we may have never even been full time arboreal climbers. With that said, there are numerous advantages to climbing and humans may withhold the idealistic anatomy, allowing us to be long distance runners and partial arborealist climbers.

It is advantageous to climb trees. An abundance of natural resources (fruit, game and honey), can often be found in the highest hanging branches. Other advantages include hiding from predators and staying off of the forest floor. By living off of the ground, one can also avoid disease and infection brought upon by wet conditions and fungi. A partially arboreal lifestyle would have been advantageous to humans throughout evolution and this has remained the same, even today, for indigenous hunter-gatherer human populations.

Figure 1. A chimpanzee climbing in Uganda. Picture by DeSilva (2009).

Anatomical traits, which allow humans to climb

The kinematics centralized around tree climbing explains that a flexible ankle allows the climber to position its center of balance closer to the substrate. Physically coming closer to the tree places less gravitational pressure on the arms and legs, during a climb. Figure 1 shows how a chimpanzee while ascending vertically upwards places its foot sideways, while abducting the ankle towards its shin. Do humans have the same flexibility in their ankles as do our closest relative, the chimpanzee? To shed light on this question indigenous humans known to climb regularly have been investigated.

Twa are a population of indigenous hunter-gatherers living in the Philippines who have a strong connection to climbing from an early age. Climbing in trees for the Twa represents a survival strategy and they exhibit a unique morphology as a result. Figure 2 shows a comparison of ankle flexibility amongst industrialized people, the Twa and chimpanzees. The Twa's ankle flexibility is above that of which would seriously injure an industrialized human. Furthermore, their flexibility is close to that of a wild chimpanzee. The average human who does not climb regularly would receive serious soft tissue damage from flexing the ankle more than 30 degrees.

A study done by DeSilva in 2009 analyzed two tribal groups who regularly climb and compared them with two groups of people who are solely farmers. The Twa and Agta are from climbing populations, while the Monobo and Bakiga are farmers. It would appear that a life centered around an arboreal lifestyle makes for a highly developed calf muscle. The longer and larger the calf muscle fibers are, the more flexible the ankle is and consequently the stronger the leg muscles are as well. Ultrasound tests on the calf muscle of the Twa, Agta and Efe showed that their fibers were both longer and larger. Indigenous climbing populations show that musculature can be adapted to climbing and hence to an arboreal lifestyle. The general bone anatomy in humans however appears to be maladapted to climbing. Bone unlike muscle is also less adaptable.

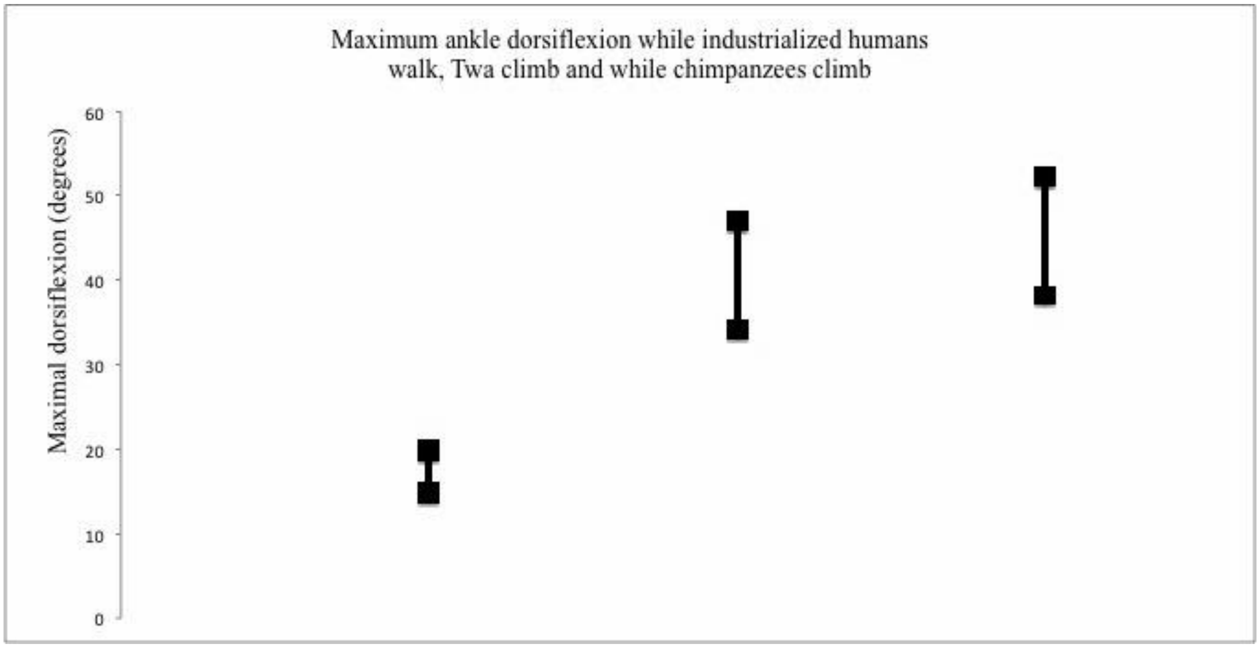

Figure 2. Differential range of grades of dorsalflexion while industrialized humans walk, Twa indigenous people climb and while chimpanzees climb.

Besides a flexible ankle, an opposable thumb allows a human and a chimpanzee to grasp branches and tree trunks while climbing. Interestingly, humans have the largest thumb bone and thumb tendon (flexor pollicus longus) relative to the body, in comparison to all other apes. The large thumb and amazing dexterity humans have in the hand can be regarded as a useful trait for climbing. However, aside from highly developed hands and the ability for a human's muscles to develop and adapt to the activities they endure, the human lacks other anatomical traits, which are highly advantageous to climbing.

Anatomy, which inhibits humans from climbing

Humans lack an opposable toe, which a chimpanzee can use to grasp branches and tree trunks with, as they climb. Furthermore a chimpanzee has a flexible mid metatarsal in its foot. This metatarsal flexion in chimpanzees is often described as a 'break' in the middle of the foot, making the plantar region less rigid as compared to that of a human. Rigid feet are advantageous to long distance running, while flexible feet are most suitable for climbing. The foot and ankle is where the human anatomy falls short in comparison to the anatomy of the chimpanzee with regards to efficient climbing.

Figure 3 shows a comparison of the width of the anterior aspect of the tibia amongst humans and chimpanzees. The width of the anterior aspect of the tibia is directly correlated to flexibility in the ankle. Differing anterior aspects describe different locations to where the bones in the ankle can attach. As a result, differential placement of the bones in the ankle results in different grades of flexibility. Thereby, the longer the anterior aspect, the more flexible the ankle is and thus the more it is suitable for climbing. Humans, including the indigenous people (Twa, Agta and Efe) have a much smaller anterior aspect as compared to the chimpanzee.

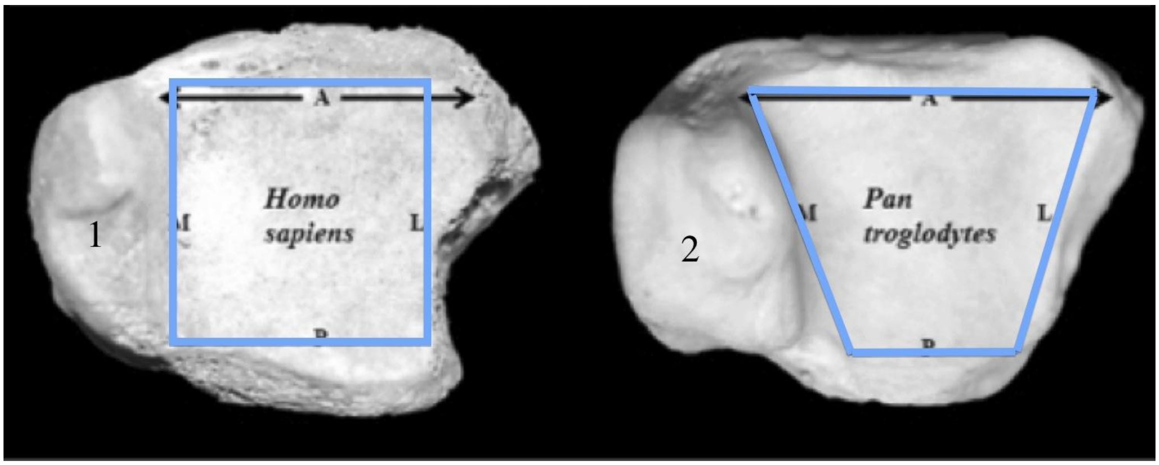

Figure 3. The differences in bone architecture on the tibia and how it creates different articular surfaces. These differences account for how other bones and in turn tendons; cartilage and muscle make for uniquely suited ankles. The trapezoid pattern found in apes is signature to its high level of flexibility while the square like one found amongst humans limit ankle flexibility. Photo reproduced with permission from Jeremy DeSilva.

Bone architecture and articular surfaces of the human body shed light on another trait where we humans are poorly adapted to climbing. A comparison of trabecular density in the shoulders of humans, chimpanzees and orangutangs show that humans exhibit less bone density in the humerus. The consequent bone structure in the humerus of apes is stronger and more suitable to hanging with only the use of arms and in turn for climbing in general.

Humans are maladapted to an arboreal climbing lifestyle as compared to chimpanzees and other apes. We lack a midtarsal break and an opposable toe in our foot. Thus our feet are insufficient of the grasping capabilities seen in chimpanzees. Our ankles are stabile and we have less bone density in our shoulders. This makes us weaker while climbing but lighter and more efficient while bipedal. While we may be poorly adapted to climbing due to inadequate bone structure, we have the ability to compensate with our muscle adaptation. The highly developed and flexible calf muscle is not something the Twa are born with; rather it is developed throughout their lifetime.

Humans are maladapted to living an arboreal climbing lifestyle

So if we conclude that humans are not born efficient climbers, what does our ancestry tree look like? A consensus among paleoanthropologists is that the human became more bipedal around 4-

6 million years ago. The ancestor to humans, *Ardipithecus ramidus* lived 7 million years ago and had an opposable toe. It likely lived both an arboreal and bipedal lifestyle. However the skeletons of *Australopithecus* (1 million years older) points to a much more bipedal one. Of the 13 *Australopithecus* species found, 12 have the distinct square like articular surface on their tibia. There must have been intense evolutionary pressure to become bipedal during that era. *A. ramidus* may have come from an ancestor, which was not as nimble and effective as the African apes. Rather, apes, including chimpanzees, may just be highly developed climbers instead. Thereby, the precursor to humans and monkeys may have been an underdeveloped climbing-bipedalist.

Climbing as a form of locomotion is usefull in terms of procuring resources, however it is not an effective means of travelling long distances. Chimpanzees use most of their daily energy to move from resource depleted areas to areas rich in resources (fruit, game and honey). Humans on the other hand lack the agility to climb and therefore expend more energy climbing than they do walking or running. An indigenous tribe Efe, living in the Republic of Congo, are known to use as much as 39% of their daily energy stores towards climbing up trees in the pursuit of honey. These two discrepencies between humans and chimpanzees represent the requirement for different anatomies depending on what surrounding niche is. Chimpanzees live in the jungle and thereby are required to climb in pursuit of resources. Humans have evolved from an ancestor that became more upright on two legs, allowing to cross great distances on the African Savanah. The refection of the surrounding niche upon the anatomy of humans and chimpanzees makes us look similar in some respects, such as the face and hands, but contrasting in others. Climbing or running over millions of years has made our anatomies so different from one another. The precursor to humans and monkeys was an underdeveloped climbing-bipedalist and while monkeys have evolved to be masters of climbing, we humans may be just right where we began.

Further Information

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