The Swing Walkers of Zambia

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Over twenty years ago, Heglund observed (Maloiy 1986) that East African women carry up to 20% of their body weights on their heads without tiring or even breathing more deeply. Apparently, they carry these heavy loads with little additional energy expenditure. The explanation for these women's abilities is still the subject of considerable discussion. In human walking, the body mass rises and falls with each step. Although the fall happens by gravity, the rise requires energy to overcome gravity. Do African women have a special trick for storing the energy of the fall to use for the rise that follows?

Heglund and Cavagna suggested a theory regarding the standing leg as an inverted pendulum (Heglund 1995, Cavagna 2002), but this is unconvincing: an inverted pendulum simply cannot transfer the increased kinetic energy during the fall into an increase of potential energy during the rise. (This is why an inverted pendulum cannot do what a pendulum is supposed to do: *swing*. You can easily make the experiment for yourself.)

Surprisingly, as far as we know, no one has yet considered either that the movement of the upper body or the elasticity of the connective tissue might play a role.
At the European Fascia Research Project at the University of Ulm, our own research of the biomechanical function of the lumbodorsal fascia in human gait suggests that these might be the answer. If the fascia stretches during the fall (loading it with potential energy) and recoils during the rise (releasing the energy), it might well convert the inverted pendulum into a real swinging pendulum.

Participants in the European Fascia Research Project developed a model with shoulders, pelvis, legs, arms and lumbodorsal fascia. We applied to this model a precise mathematical analysis called *Lagrangian formalism*, incorporating actual anthropometric data. Because the lumbodorsal fascia acts as a spring connecting the upper and lower appendicular girdles, we hypothesized that it might be well capable of storing and releasing sufficient energy. Our model predicts increased shoulder rotation and/or arm swing with increasing head load, without any additional muscular effort. (We presented our model at the recent European Conference On Movement Science in Amsterdam and the Fascia Reseach Congress in Boston. To see a visual rendering of our model, visit www.fasciaresearch.de/swingwalker.)

To test our prediction, we went to a small village in southern Zambia where residents carry containers of water from the public well on their heads. Our tools were a laptop computer, a stereo camera (for 3D analysis) and many black-&-white adhesive markers. (Photos of our work are on the facing page.) Unfortunately when two fair-complected aliens with Gigabit-LAN cameras appear in a remote African village lacking even a water pipe system, a modicum of social strain is inevitable. Naturally, we had to pay some money for each walking model. At first, we wondered why all the models were disappointingly unskilled in what we were there to observe. We were almost out of cash before we realized that the women whose movements we were recording were all members of the chieftan's family; naturally, they had the privilege of being closest to all sources of water and money alike.
Still, we did get some good data – but not enough of it for scientific purposes. Although our analysis is incomplete, we already see that the arm swing as well as the hip rotation of our Zambian models is significantly greater than that of the average European. If our data corroborate the swingwalker model, we are determined to make another expedition – this time avoiding chieftains' families.

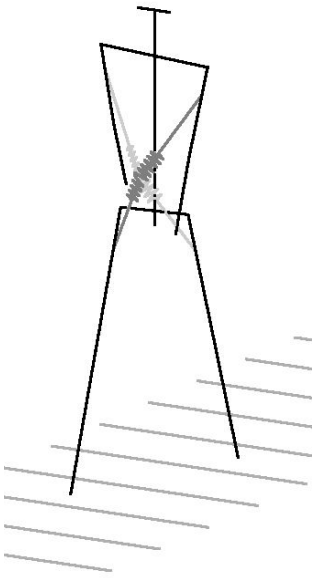

Figure 1 The swingwalker model, with the springs representing the most posterior sheet of the lumbodorsal fascia.

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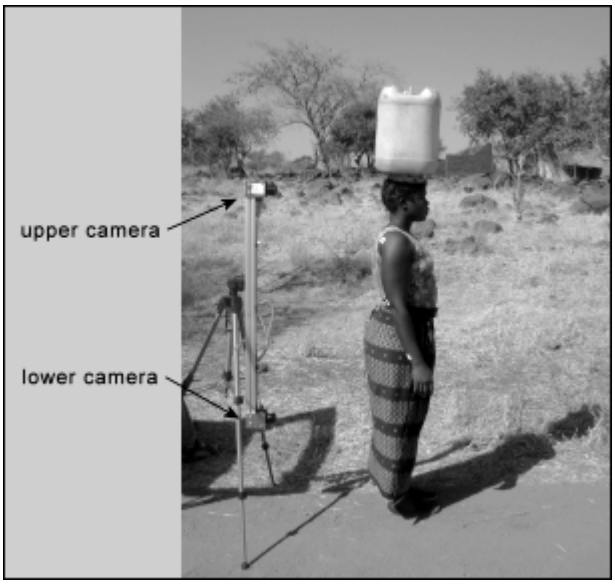
The laptop operator behind the camera.

One of our models, together with the upper eye of the stereo camera

Laptop operator, model with markers, observers.



The stereo camera and model in start position, with a full container of water.

The same model, seen from both eyes of the stereo camera

Observers

The author gives it a try.