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AMAZING FASCIA

The Role of Fascia in Walking & Running

Part A

Introduction to Walking

- Up right walking is a quintessential human pattern of gait
- **Walking** on two legs requires a tremendous act of balance and is **often described as a controlled falling movement**
- Walking requires the ability to have just one foot on the ground & to maintain some form of **equilibrium or balance**

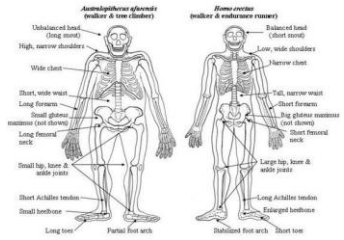
Introduction to Walking

- Up right walking makes use of many adaptations for bipedalism which allow for efficient walking
- This requires extensive coordination between the:

- **brain and the nervous system**
- **muscles of the body**
- **and also makes use of sight, balance and sensation**

Adaptations for Bipedal Gait

- Numerous skeletal adaptations allow for upright walking in humans



Adaptations for Bipedal Gait

- **Primates demonstrate a bent hip, bent knee posture in gait**
- This is not due to limitations in the length of the hip and knee flexors

- Instead a limitation of the lumbar spine does not allow for enough extension to bring the pelvis in line with hips, knees & feet

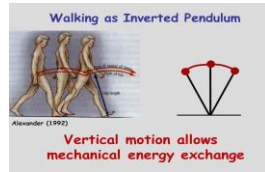
The Pelvis: A Skeletal Adaptation

- A progression to bipedalism has resulted in a more lateral orientation of the ilia
- This allows the hip abductors to stabilise the pelvis
- The hip abductors help stop us from falling sideways when standing on one leg

Species	Iliac blade orientation (Curved forward or Flat)	Iliac blade width/height (Broad/Short or Narrow/Tall)	Sacrum Width (Broad or Narrow)
Humans	*Curved forward*	*Broad/Short*	*Broad*
Chimpanzees			
Australopithecus			

Walking versus Running

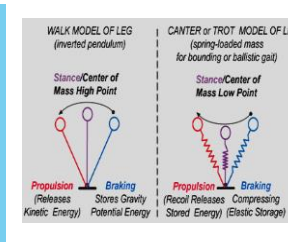
- A key difference between walking and running is how the foot muscles work
- AND in particular the energy used for propulsion



- **The walking body acts like an inverted pendulum, swinging along step-by-step, literally vaulting over stiff legs with locked knees**

Walking versus Running

- The running action is referred to as an **"impulsive" or "springy" gait**
- The leg and foot have a built-in "return energy" system for a significant amount of energy
- **"Elastic recoil"**



Elastic Recoil for Propulsion

- This unique mechanism takes impact energy and uses it for propelling the body forward
- **In particular, the large springy Achilles tendon plays a key role in recycling energy for propulsion**

- This tendon must function with sufficient tension to help in the return energy process, and the muscles it attaches to

Elastic Recoil for Propulsion

1. As a runner's foot hits the ground, impact energy is stored in the muscles and tendons
2. **95 percent of this energy is then used to spring the body forward like a pogo stick**

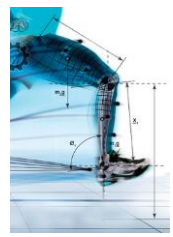
Elastic Recoil for Propulsion

3. **This mechanism provides about 50 percent of the leg and foot energy for propulsion**
4. The other 50 precent comes from muscle contraction

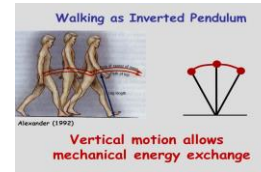
- This applies to level ground running, clearly more muscle work is required when running up-hill (and down-hill)

Elastic Recoil & Running

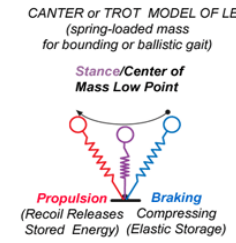
- Instead, the muscles provide an isometric-type tension to stabiles the tendons
- This relies on the Achilles and other tendons to recycle impact energy
- Rebounding along on compliant legs and unlocked knees



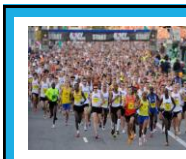
Summary: Inverted Pendulum vs Ballistic Gait



- Return energy from elastic recoil used for propulsion



What are humans bodies adapted for?



Are humans adapted for running?

- **There is no doubt that humans are very efficient endurance runners**
- In fact in all the animal kingdom we are the only ones that exhibit a distinctly bipedal gait which certainly differentiates us from other quadruped land based animals as well as any of the primates
- **There must be something unusual or special about walking upright**
- It almost certainly gave us a unique advantage in the animal kingdom and may have set us on the path of achieving our intelligence as a race

Adaptations for Endurance Running

- There are several features which make for efficient running and especially endurance running; they include **anatomical and physiological features**
- The structural features can be characterised as:

1. **Energetic**
2. **Skeletal Strength**
3. **Stabilisation**
4. **Thermoregulation**

Energy Efficiency and Locomotion

- **One of the key features of efficient locomotion whether walking or running <u>concerns energy efficiency</u>**
- Efficiency is of vital importance for survival
- If we can minimise our calorie output
- And maximise our intake
- We are more likely to survive

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The longitudinal arch of the foot

- During walking, the plantar arch helps to maintain mid-tarsal rigidity for powered plantar flexion during toe-off
- AND absorbs some impact force (but only after heel strike)
- **<u>During running</u>**

The elastic structures of the **plantar arch functions as a spring, returning approximately 17% of the energy generated during each stance phase**

Skeletal Strength for ER

- Running exposes the skeletal system to much higher stresses than walking
- Peak vertical ground reaction forces at heel strike are approximately x2 greater than during walking
- AND even approach **3-4x body weight at higher endurance speeds**
- **One strategy to lower joint stress is to expand joint surfaces and spreading forces over larger areas**

Skeletal Strength for ER

- Many studies show that compared to earlier hominid species humans have substantially larger articular surface areas relative to body mass in most joints of the lower body

1. Femoral head
2. Knee
3. Sacroiliac joint

- **Enlargement of the iliac pillar is another modification of the pelvis to resist stresses associated with running**
- Humans also show a larger cross-sectional area of the calcaneum

Stabilizing the head for running

- During running there is a greater tendency of the head to pitch forward at foot strike than during walking
- This is reduced by:

1. A greater projection of the occiput behind the foramen magnum
2. **Another possible structural modification relevant to running is the nuchal ligament**

- Interestingly, a nuchal ligament is absent in chimpanzees

Thermoregulation & Respiration

- Humans posses many features related to heat dissipation:

1. Cooling through perspiration
2. Presence of sweat glands
3. Reduced body hair to increase convection rates
4. Narrow, elongated body shape
5. Mouth breathing during strenuous activity

- Allowing higher airflow rates with less resistance
- A more effective means of unloading heat during expiration

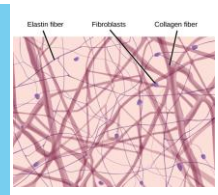
The role of fascia in contributing to efficiency during endurance running

Fascial Membranes

- Each and every part of the body is wrapped within this fibril fascial web of connective tissue which consist predominantly of:

1. ***Collagen***
2. Elastin and
3. a Ground substance

- The fascia hold each and every part of our body together and provides protection both mechanical and chemical



Hydraulic amplifier

- Many of the facial wrapping in the body are extensions of muscular tissue and play an important role in the disposing force by acting as hydraulic amplifiers

- **described by Gracovetsky in 2008 and Vleeming in 2007**

- It is estimate that this form of hydraulic amplifiers can increase the efficiency of muscle contractions up to 30%

- Conversely if the fascia sheets are challenged or damaged as in fasciotomy the efficiency can be reduced by a 10%-16%

Stiffness and Elastic Recoil

- Facia consists of both collagen and elastin fibres
- **Both types of fibres are elastic** and are able to stretch beyond a normal resting length

- and then return to the original resting length

1. When collagen is stretched it will recoil back to its neutral with more efficiency than elastin
2. **This means is that collagen is more '*elastic*' than elastin as it gives more elastic energy back into the system**

Elastic Recoil

- A number of experiments have shown that during repetitive movement such as **running**:

- **there is very little change in the length of the muscle fibres**

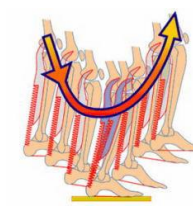
- Muscles are often used in isometric contractions

- They are not becoming shorter when they contract they are simply maintaining their current length

Elastic Recoil

- The lengthening required during running actual occurs in the fascial tissues in the collagen and elastin

- ***Which are then able to recoil from the stretch and return to their resting length like a spring***



Gait analysis

- The difficulty with gait is that people look at gait from many different areas:

1. some focus on the feet
2. others focus on the pelvis
3. some might focus on the muscles
4. and other focus on the skeleton

- **The integrated myofascial system plays a key role in understanding both walking and running**

Areas of fascial interest

- For the purpose of this presentation we will focus primarily on 3 key areas of connective tissue

1. The Thoracolumbar fascia
2. The ITB and the fascia lata and
3. The Achilles tendon complex

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