GAIT AND POSTURE IN THE BIPED

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Habitually quadrupedal apes can stand on two legs for short periods, but as *facultative* bipeds they expend a considerable amount of energy to achieve two-legged stance and make progress in this manner. Human beings, however, are *obligate* bipeds, designed for habitual vertical stance and bipedal gait.

Vertical stance is energy-efficient. The bones of the lower skeleton are close-packed in vertical stance and form an effective ‘pillar’ or ‘pedestal’ by means of which the weight of the body is supported on the lower limbs and transmitted to the ground surface. Balance replaces muscular effort. Skeletal support requires very little muscular intervention, the very small input required for maintenance of balance being applied only ‘on-demand’.

Bipedal *Homo sapiens* – ourselves – have a low centre of gravity. This is situated within the pelvis, just superior to the hip joints. In upright stance, the weight of the upper body falls upon the sacrum, and would tilt the pelvis backwards if the rotation was not resisted by the iliofemoral ligaments. The consequence of this is that the body is balanced at a point in the midline close to the hip joints, and the system promotes extension of the hip joints and prevents ‘jack-knifing’ of the body at the hips.

The knee is held in extension (limb straight) in standing. It can be hyperextended - pressed backwards to lock the joint - preventing collapse when obliged to stand for long periods. Knee extension is aided by the shape of the femoral condyles and the thick cartilage meniscus into which they sit. The femur is prevented from sliding forward or backward off the menisci by the anterior and posterior cruciate ligaments and is retained on the cartilage by the collateral ligaments.

The tibia pivots upon the trochlear surface of the talus. The centre of gravity falls over the midtarsal joint region of the foot, causing the body to have a predisposition to falling forward. Forward motion is countered by contraction of the soleus, originating upon the calcaneum and inserting onto the tibia (this is correctly described when the foot is plantigrade and fixed – remember that origin and insertion are notional terms only and depend upon the ‘fixation’ – the origin is considered to be the ‘fixed’ end and the insertion is on the part that moves *c.f. gastrocnemius*).

When standing on one leg, the centre of gravity is shifted over the stance limb. Alternating to the opposing limb requires that the centre of gravity be transposed laterally to a new position over the contralateral limb. Valgus femurs position the knees and feet beneath the pelvis and close to the body midline so that the shift of the centre of gravity from side to side is minimised.

In gait, the swing side pelvis must be raised to free the limb for swing. Thus with alternation of limbs the pelvis must tilt, first to one side, then the other.

As the swing limb advances, the limb is lengthened and the pelvis rotated so that heel strike occurs as far forward as possible. The same heel must remain on the ground as long as possible at the end of the stance phase and at this point the pelvis is fully counter-rotated.

Pelvic lateral shift, pelvic tilt, pelvic rotation, and valgus femurs all act to minimise the displacement of the centre of gravity. Further smoothing is produced by knee flexion and ankle action. These actions collectively mean that:
“In translating the centre of gravity through a smooth undulating pathway of low amplitude, the human body conserves energy....” (Saunders et al, 1953).

<u>Reference</u>

Saunders JB, Inman VT, Eberhart HD. The Major Determinants in Normal and Pathological Gait
J Bone Joint Surg Am 1953;35:543-558

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GAIT AND POSTURE IN THE BIPED

The questions on this sheet are based upon the above-named paper. Answers should be submitted on A4 paper and should be of sufficient length to demonstrate full understanding of the topic. Single word answers are not permissible. Try to answer in one or two short paragraphs, not more than a ¼ page per answer.

Q1. Why is vertical stance 'energy efficient'?

Q2. Where is the centre of gravity in the human body?

Q3. How is shift of the centre of gravity minimised when changing from one leg to the other?

Q4. How does pelvic rotation contribute to stride length?

Q5. How is energy conserved in gait and stance?

To be valid, all parts of each question must be addressed

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