Shock absorption of the human foot during heel strike

submaximal rotations followed almost exactly the corresponding parts of the full range moment curves.

In other experiments inversion of the foot was maintained by pulling forces, which were exerted on the tendons of the mm. tibialis anterior and posterior, instead of applying an externally rotating moment on the tibia. In the first place we simulated isometric contractions of these muscles to study relaxation phenomena. In these experiments we observed a considerable amount of tendon relaxation. Relaxation finished after only approximately 50 min, during which the force in the tendons decreased to 45% of their initial values.

In another series of experiments the loaded tendons had to keep the foot in a certain inversion position after removing the exorotating moment. The m. tibialis anterior gave way to much more internal rotation of the tibia than the m. tibialis posterior. Likewise, the increase in tension was largest in the tibialis anterior. Apparently the m. tibialis posterior contributes more effectively to inversion than the m. tibialis anterior does. After lengthening the tendons in steps of approximately 1 mm in a similar experiment, we plotted the forces in the tendon against the angle of external rotation of the tibia, and observed another difference between both muscles. The force curve of the m. tibialis posterior was very similar to the curve of the externally rotating moment with a characteristic peak at approximately the same angle of internal rotation. The force curve of the m. tibialis anterior, however, showed a characteristic peak which was nearer to the neutral position of 0°.

Finally we loaded the tendons of the mm. tibialis anterior and posterior as well as the tendon of the peroneus longus with a constant force of 60 N, simulating isotonic conditions, and measured the externally rotating moments as a function of the tibial rotation angle. In these experiments we see that the m. peroneus longus acts as an antagonist during inversion of the tarsus and that again the m. tibialis posterior is a more effective invertor than the m. tibialis anterior.

So far our experiments have only confirmed the ideas about the functional effects of these muscles, as stated earlier by other investigators. However, these older observations were mostly based upon manipulation of isolated muscles in an unloaded and mechanically undefined situation. Moreover, the results of these older observations were not quantified in terms of pulling forces.

Reference

1 Benink RJ. The constraint mechanism of the human tarsus. Acta Orthop Scand Suppl 1985;56:215.

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The mechanism of shock absorption of the foot is still poorly understood. Structural and functional factors that play an important role are the heel pad and the neuromuscular control mechanism respectively. Insufficient absorption of the shock wave during landing of the foot may be an important factor in the development of, eg arthritis and arthrosis of the joints in the lower limb.

The present study concentrates on experimental techniques used to record accelerations of the skin under the heel as well as the accelerations of skin and bone proximally and distally on the tibia. Miniature accelerometers (mass: 0.65 g) were selected for the analysis. Mounting of accelerometers on the skin does not give reliable results for the *shape* of the shock wave of the underlying skeleton. This was shown by Fourier analysis in an experiment where transducers mounted on the skin and transducers mounted on the skeleton were simultaneously excited. The *peak* accelerations on the skin and skeleton may, however, be very similar. This last result was also found by Light *et al. (1)*.

Under the foot peak accelerations of 70 g are found during walking on a hard surface. The peak values on the distal tibia are approximately ten times lower, showing the considerable shock absorbing capacity of the foot and its control apparatus.

Reference

1 Light LH, McLellan GE. Klenerman L. Skeletal transients on heel strike in normal walking with different footwear. J Biomech 1980;13:477–8.

Demonstrations

Cross-sectional anatomy of the fetal heart: a help for fetal echocardiography.

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The technical development (including increased resolution) of two-dimensional echocardiography continues to make younger developmental stages accessible for morphological investigation.

Comparison with tissue sections of young fetal hearts is difficult, since the standard planes in which serial microscopical sections are made are not necessarily the same as the standard planes used in fetal echocardiography. We have, therefore, used a graphic reconstruction technique to obtain several sets of sectioning planes from a single microseries. Two human embryos were used. Their CR-lengths were 28 and 29 mm, corresponding to an age of 7 to 8 weeks, at which age most congenital malformations would be able to be diagnosed.

One embryo was serially sectioned in the transverse plane. From this we obtained three sets of parallel planes, at different angles with the sagittal plane. From the other embryo, which was cut sagittally, we obtained three sets of parallel planes at different angles with the transverse plane.

In general, the images showed normal cardiac anatomy as it is known from the mature heart. Left and right ventricles could be distinguished by several criteria: the mitral valve adhered directly to the aortic orifice, the supraventricular crest could be seen between inflow and outflow portions of the right ventricle, the right ventricle contained one main (anterior) papillary muscle, the left ventricle showed two distinct papillary muscles. The relative positions of all parts of the heart could be well visualised. In addition, the great vessels (including the arterial duct) were depicted.