Biomechanics of Treadmills in Weightlessness -

Locomotion on
Biomechanics of the Shuttle Treadmill -

Cover for Biomechanics T.R.

Introduction:

(Problem) - Loss of locomotor function is one of the major effects of spaceflight and is ~~so~~ followed by disuse atrophy of muscle bone and the cardiorespiratory systems. ~~Dec~~ Such losses are of concern on return to gravity after long space flight. Currently the most promising methodology for preventing or sharply reducing such losses is replacement of ~~the~~ locomotor function ~~c~~ a treadmill. Such a treadmill must ~~obviously~~ provide a load normal to the treads to ~~allow~~ replace subject weight as well as the usual moving & speed tread, ~~and~~ control, ~~and other~~ ~~fa~~ ess. Both US( ) & USSR( ) treadmills use long elastic cords ~~c~~ a truncal harness to provide this ~~The limited~~ tread size allowable in current space craft weight, While there are some relatively small differences is severely limited.
between ~~is~~ normal ~~locom~~ and treadmill running on earth limiting weightlessness, restricted forces to replace body weight and treadmill mechanics all raise the question of how closely such ~~running~~ locomotion approximates that on earth.

STS T/M

~~If for example~~ This question is more than academic for muscle and probably bone is sensitive to magnitude and shape of applied forces i.e. ~~distorted~~ distortion of these factors might severely reduce effectiveness or even lead to ~~use~~ injury c ~~necessary~~ use.

Both USSR and US programs use treadmills. The ~~xxxx~~ USSR flights have employed them extensively since 197 . First U.S. use of locomotion simulated was on 51-J and following this a ~~limited~~ single small true subject driven device was built and ultimately flown on Shuttle STS-3 these when it was replaced c a slightly modified units on each vehicle. Use was at crews option and no instrumentation or other data sources were available, ~~Das~~ is Nor such information on the USSR unit available,

~~As a beginning~~ To do a reasonably complete biomechanical study fast and ff body forces plus continuous position of body leg segments and tread would be required.

A number of operational limitations allowed on limited single plane photography for position studies ie, only kinematics data would be available. Such studies were done on STS-7 +8 and are reported here. — — —

Methods and materials -

The treadmills have been described elsewhere. Essential features are shown in Figure 2. It is powered subject area
Running tread surface is of X cm, and speed range is of — to — MS^{-1} in six discrete steps. Treads are dual rectangular sections mounted on antifriction bearings running in machined tracks for minimum friction. The track is coupled to flywheel which provides the equivalent of — kg. mass inertia to the treads and its angular velocity is controlled by a centrifugal brake. Unlike motor driven treadmills the to develop a driving force along the belt treads' axis it is (e.g. the treadmill must be elevated until the horizontal this component is equal to

the internal resistance of the ~~mm~~ T/M - & Since internal losses

A Subject weight is simulated by ~~on a~~ 4 folded bungees or elastic cords connected to the T.M. at its 4 corners and connected to the subjects harness ~~a~~ fore & aft, ~~a~~ calibrated straps long enough to vary the bungee tension. Nominal length produces a balanced force equal to subject weight. A padded harness Fig 2 ~~was~~ wraps from the back, ~~folds~~ around the iliac crests and is crossed in front. Attached to the front & rear of this hip belt over the shoulder belts. ~~The~~ Nominally approximately 1/3 of the load is carried by shoulder belts ~~is~~ and the remainder by the hips but this is left to the user. Total weight is normally distributed

Ex- Stat.

History

U.S.

Skylab is only U.S. experience

Initial studies/exercise did not include locomotion - only cardio-respiratory and Ca^{++}

Ad Hoc study showed post flight strength losses of ___ % for legs and ___ % for arms in ___ days - ~~Leg~~ not changed

Leg losses were ~~little affected~~ by doubling duration of bicycle exercise on SL-3

Arm losses were sharply reduced by simple, brief strength exercises

~~Cardiorespiratory stud~~ After fluid ~~re~~ equilibration, ~~there was~~ cardio-respiratory capacities were unchanged by any flight -

Bone losses ~~fett~~ approximated on all flights predictions

On SL-4 leg losses were sharply reduced by brief locomotor exercise - exercise was too brief to affect Ca^{++} loss -

Summary -