DSO - Neuro Muscular Adaptation

Background

Various systems of the body adapt to weightlessness at their characteristic rates, e.g. bone has a time constant of months while cetain portions of the nervous system adapt in minutes.

Neuromuscular adaptation to weightlessness is an obvious fact to those who have been involved in return to 1-g after spaceflight. Unless one has practiced on entry, it is normally impossible to leave the seat on first attempt. The sensation of heaviness is initially very prominent, and walking requires considerable effort and often appears to be unstable. After flights of 7 days, these effects are reversed in a matter of hours indicating they are neuromuscular rather than muscular changes. The extent, time course, and effects of such adaptation have not been adequately studied, especially the ability to successfully perform emergency egress. Moore found that unknown standard masses were underestimated in weightlessness and early post-flight period. There are also several anecdotal experiences of physical feats during entry and landing. Both theory and experience indicate that

neuromuscular adaptation will seriously reduce physical performance in the entry and landing period.

The following study would document key features of this effect. A simplified isokinetic ergometer will allow measurement of strength of major muscles in arm and leg pre- and inflight, landing and post-flight. This will allow documentation of muscle performance during adaptation and readaptation. Several simple physical maneuvers will document actual performance.

Methodology

Ergometry - a miniature hydraulic isokinetic ergometer will be attached to the limb and a min. of 5 max. effort effort elbow and knee flexions an extensions will be made at 3 fixed angular velocities. Preflight, the same arrangement would be used in the 1-g trainer. Performance force and angular displacement would be recorded by an exsting miniature two-channel tape recorder for ground analysis. Performance demonstrations would exist of two simple maneuvers in 1-g against body weight, e.g. two, and if possible, one leg knee bends and chins. The former would be done with arm stabilization to eliminate vestibular system effects. The second would involve chinning on the middeck hand-hold. Performance would be

documented with still or cine' photography. These maneuvers would be performed pre-flight and post-flight at JSC in the 1-g trainer, in the bird on landing, and with suitable chinning bar in the post-flight exam area.

Subjects and Protocol: An initial sample of 5 subjects, one on a flight, should be made initially using MSs if possible for background stability, otherwise selected P.S. At least 3 pre-flight studies should be done as combined training/measurement sessions. One session should be as close to launch as possibe (in crew quarters would be desirable) to launch. If a cine' camera such as a DAC could be set up after landing, the entire flight phase operation could be accomplished by the subject. Ten maximum effort repetitions by elbow and knee are desired at zero (3 angles) and show medium and high angular velocities.

Knee bends with both legs will be done immediately on leavng the seat at right angles to the camera. Single leg bends should be done if possible. Three reps are desired. The subject will laterally stabilize himself by holding onto structure as required. Chins will also be done at right angles to the camera. A second study should be made during the physical exam period and also prior to return to JSC if possible. Repeat exams should be made at R + 1, 2, 4, and 8, if possible.

Time Required

It is estimated that an hour would be required for indoctrinaton and demonstration followed by a 1.5 hour and 2 each 1 hour measurement periods. It should take approximately 1/2 hour to test and stow the apparatus prior to entry and another half hour to set up and perform on landing. Post-flight tests administered by others should take 10 minutes.

Hardware and Status

The miniature hydraulic ergometers are available but would have to have arms and limb couplings added as well as force and angle transducers added. Dual channel flight qualified recorders and cameras exist. Estimated cost of the ergometer is $10-20 K.

Data Analysis

Initial ergometer data reduction and analysis will consist of graphically recording the angle and force data on a Gould ES-1000 or equivalent. Force at

several fixed points on the angel curve will be measured at each of the rates used. The results will be plotted and statistically analyzed.

Knee bend and chinning activity will be evaluated quantitatively by counting repetions and max. angles obtained and the rate at which they were done. Results will be plotted.