TISSUE CHANGES FOLLOWING VENOUS OCCLUSION USING PHOTON ABSORPTIOMETRY

Richard B. Mazess, Dept. of Radiology and Space Science and Eng. Center
University of Wisconsin, Madison, Wisconsin

Direct photon absorptiometry was used to measure changes of the upperarm following venous occlusion in two adult males. A blood pressure cuff was placed on the upper part of the arm and inflated to 80 mm Hg to venous return. Absorptiometric scans were made immediately below the cuff (about 8 cm from the elbow) with a 200 mCi source of ^{125}I (27.4 keV). The source was placed on one side of the limb and mechnaically linked to a scintillation detector system on the other; these were passed at uniform speed (2mm/sec.) across the limb. Measurements were made during a 10-minute control period prior to cuff inflation, about once every minute after cuff inflation, and on one subject a scan was also made 2 to 3 minutes after release of pressure from the cuff. A plastic arm holder was used at the measurement site to compress the soft tissue across the bone thereby allowing a better measurement of bone mineral content. This holder was removed at the tenth minute after occlusion on one subject.

The bone mineral content was subtracted from the total upperarm tissue to get a measure of "soft tissue" absorption. The fat content (previously determined to be about 15% in both subjects) was subtracted from the soft tissue to obtain the measure of "fat-free tissue" absorption. The protein content of the fat-free tissue was assumed to be about 22%, and this was subtracted to give an approximate "fluid" content of the upperarm at the scan site. Since the only component to change during occlusion was fluids, the initial values for the non-fluid components (determined for the control period) could be subtracted from each measurement during occlusion.

RESULTS

The relative changes in different compositional compartments are shown in Figure 1. One subject stopped the experiment at 7-minutes (point A) due to dizziness, while the other subject continued for 15-minutes (point C) at which time pressure was let out of the cuff. In the latter case the plastic arm holder was removed at 10-minutes (point B); this resulted in a large influx of fluid at the scan location.

The most rapid changes of composition occurred within the first 3-minutes in which there was a 10% increase of fluids. This increase would probably have been even larger had not the plastic arm holder been used. Between 10 and 15-minutes it was found that the fluid increase changed from 13 to almost 20% without the arm holder. Fluid content returned to the baseline with pressure removed from the cuff.

DISCUSSION

A fluid shift of from 10 to 20% appeared to occur in the upperarm following venous occlusion. This corresponded to an increase of 5 to

DISCLAIMER

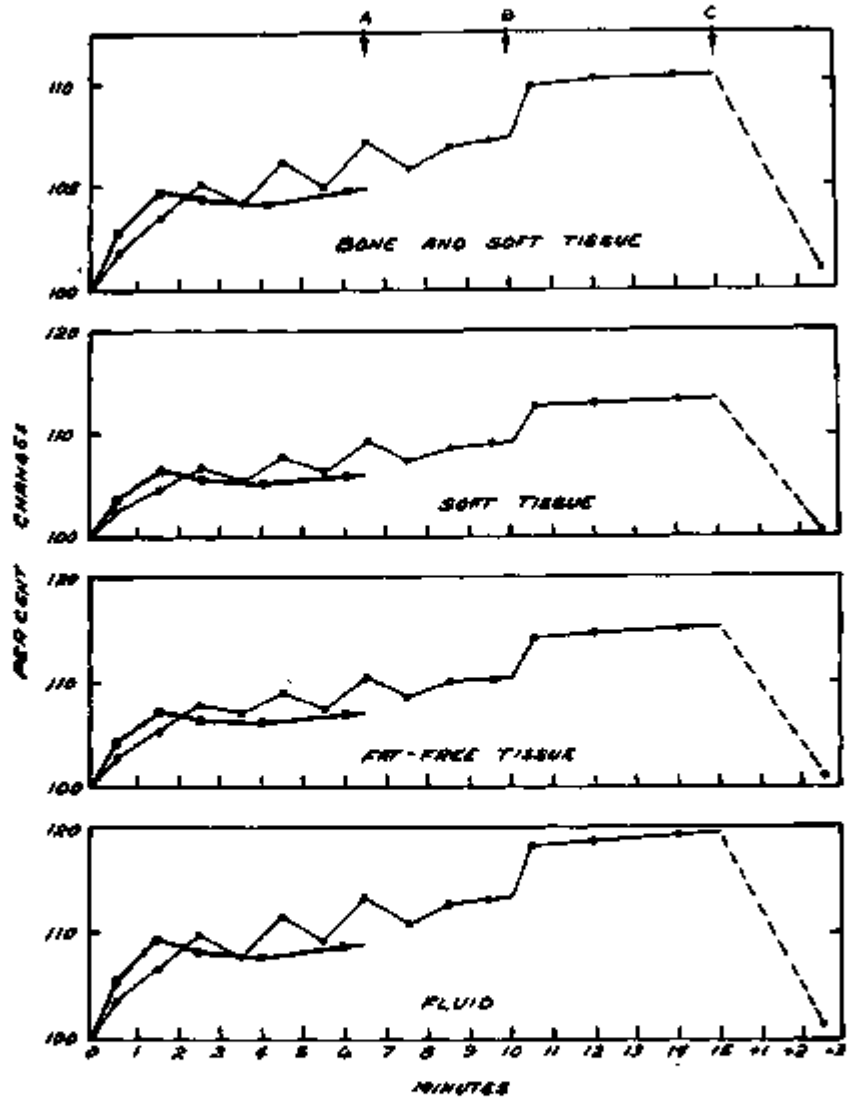

Figure 1. Percent change in components of upperarm during venous occlusion.

10% in total absorption (including fat, mineral and protein). On the typical upperarm the absolute magnitude of such an increase is about 15 to 40 scan integral units. This increase is much larger than the experimental error. A standard measured at the same time as the above experiment showed a standard deviation of only 0.645 scan units. Consequently the magnitude of the changes occurring with occlusion are about 20 to 60 times greater than the measurement error. Precision can be increased further by making multiple measurements.

At present a scan across the upperarm takes about 60-seconds, but the scan time could easily be reduced to about 20-seconds. This would allow better definition of the rate of fluid changes.

CONCLUSION

Absorptiometric scanning appears to be a very safe and simple method for precise and accurate measurement of tissue changes. The method could be used to evaluate both edema and hypohydration and would provide a means for monitoring shifts occurring in extreme environments, on the tilt table, or during immobilization or space flight. The dose from each measurement is about 5 mrem and is confined entirely to the small path (3-mm wide) across the limb being measured. The maximal permissible dose for the limbs is 7.5 rem/year for the general public and 10 times that for occupational exposure.