CEPHALAD FLUID SHIFT INDUCED NASAL TISSUE SWELLING DURING 70-DAY 6° HEAD-DOWN TILT IN EXERCISER AND CONTROL SUBJECTS

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OVERVIEW

Sixty percent of astronauts report a sense of nasal congestion in space lasting 3-15 days, attributed to headward fluid shift. On Earth, perceived nasal congestion correlates poorly with nasal cavity dimensions. Our current study of olfactory acuity and nasal cavity dimensions in the microgravity analog of head-down tilted bed rest (HDT) provides a record of nasal tissue swelling and its correlate, transient and adapted fluid shift in the head, over a 70-day HDT period relevant to long stays on the ISS.

METHODS

Sixteen subjects of a 70-day HDT study at the NASA FARU in Galveston, TX, are assigned as exercisers (E) or low exercise controls (C). Subjects undergo acoustic rhinometry (A1, GM Instruments) to measure cross-sectional area vs. distance along the nasal cavities. Seven examinations prior to HDT (n=7) set a baseline. Frequent tests in the first 5 days of HDT capture nasal patency transients during fluid shift, followed by tests weekly throughout HDT (n=9), and 7 tests during the 14-day post-HDT (n=7) recovery period.

RESULTS AND DISCUSSION

To date five E and six C subjects have completed the study. All showed similar early response to HDT. Nasal tissue swelled markedly after 1 hour of HDT (12.0% (E) and 15.4% (C) drop in nasal cavity volume). After 24 hours, swelling subsided to 9% (E) and 5% (C), rising again on days 3-5 (11.3%). At day 9 the groups diverged. Swelling persisted through HDT, peaking at day 23 (13.5%) in C but staying between 3 and 8% in E. Recovery post bed rest was similar in both groups. After 48 hr upright, nasal volume recovered to 6% over baseline, remaining at or over baseline thereafter. Although nasal tissue swelling has not been measured inflight, intraocular pressure (IOP) data from six STS missions show a rapid increase in IOP on entering microgravity that returns to baseline by 48 hours. While few data exist on the response of eye and nasal tissues to long- and short-term fluid shift, the close proximity of these tissues, and their common venous drainage, suggest that they may adapt in parallel to microgravity. IOP data from seven of our subjects shows marked similarity to nasal tissue swelling in and after HDT.

CONCLUSIONS

Head-down tilt caused a rapid increase in nasal tissue swelling, consistent with reported measurements of IOP in flight. Our results indicate that fluid shift in the head, as indicated by nasal tissue swelling, does not return to baseline as inflight IOP data suggests. The transients observed on entry to and exit from HDT suggest that fluid distribution, and its effect on nasal cavity dimension, are dynamic phenomena subject to multiple mechanisms of physiological feedback with differing time scales.

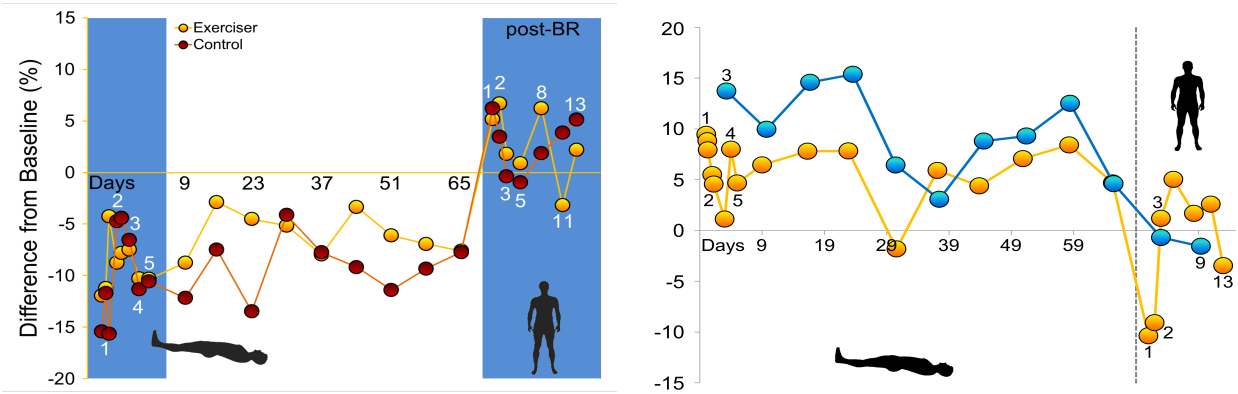

Figure: (Left) Normalized nasal cavity volume for E (n=4) and C (n=6) subjects during HDT and recovery expressed as % change from pre-HDT baseline. Labels are days of HDT or recovery. Data points on days 1 and 2 are tests at 1, 5, 7, 24, and 30 hr. Blue bands divide hourly and daily test frequency (first 5 days of BR and all of post-BR) from weekly tests (days 9-65). (Right) Normalized nasal tissue swelling (amber) and IOP (blue) (n=7).