Dynamic Chiropractic

CHIROPRACTIC (GENERAL)

What Are the Effects of Zero Gravity on the Spine?

CHIROPRACTIC STUDY SEEKS THE ANSWERS WITH NASA'S HELP

It was Thursday evening, the night before our first flight aboard the NASA aircraft that would introduce us to the wonders of weightlessness. We took turns lying face down on an examining table in a south Houston motel room, electrodes and wires bristling from our backs, as a chiropractor systematically pinged our spines with an Activator.

"We" included a half-dozen representatives of the mechanical engineering department at the University of Vermont (UVM) -- four undergraduates, a graduate student and a faculty member -- and myself, an accompanying journalist, who were participating in NASA's 1999 Reduced Gravity Student Flight Opportunities Program. The program is an innovative outreach effort that allows nearly 100 teams of college students annually to conduct scientific experiments -- designed and built by the students themselves -- in zero-gravity aboard NASA's KC-135, an aircraft normally used for astronaut training and hardware testing. Our experiment involved a complex and exquisitely designed piece of machinery that would record the activity of fruit flies in zero gravity.

But before we left for Houston in March, Arlan Fuhr,DC, Chris Colloca,DC, and our faculty adviser on the NASA trip, Dr. Tony Keller, an associate professor of mechanical engineering at UVM, discussed a possible side-project related to the NASA trip: What if an Activator instrument was used to measure the stiffness of the students' spines before and after experiencing zero-gravity? Wouldn't such a study be of great interest to NASA, which is building its program around space flights of longer and longer duration?

Dr. Keller had worked with the chiropractors from the National Institute of Chiropractic Research (NICR), Drs. Colloca and Dr. Fuhr, both of Phoenix, Arizona, in diagnosing and treating spinal dysfunction through assessing spinal stiffness via an Activator instrument linked to a computer. As Dr. Fuhr, president and founder of NICR, explained to me, "NASA is very concerned with the issue of rehabilitation surrounding people who stay in space for very long periods of time. This is the first time chiropractic has been involved in studying the effects of zero-gravity on the stiffness of the spine, and it seems like we may have an important role to play there."

First, there were the spinal tests to complete on the students who would go up in the KC-135, which is why I found myself face-down on the examining table. Dr. Colloca applied electrodes to my skin on either side of my L5 and L3 vertebrae and began systematically firing a consistent amount of force into my spine with the Activator. The feeling was similar to getting flicked on the back by a strong finger. The Activator was equipped with two sensors to measure load and acceleration to calculate effective dynamic stiffness. Attached to my muscles were electrodes that measured the energy produced by the corresponding muscular reaction to the thrusts. The data on stiffness and electromyography were sent to a signal converter, which recast the data in digital terms and shuttled it on to a computer manned by Dr. Keller.

"The main thing we're looking for is the association between the spine and the surrounding muscles," Dr. Colloca told me when the test was complete. "People with back pain, whether it's

spinal joint dysfunction or subluxation, disc degeneration, arthritis, or other problems, have spines that function differently than people with healthy backs. Thus, these people's spines resonate differently than normal spines do. When we put a shock wave into the spine, we look at both the force that returns and how fast that force is returned. The more the back stiffens and absorbs the ping, the more likely there's a problem of degeneration and overall stiffness. The stiffness data coupled with analyzing the muscular reflexes that accompany the tests provide us with objective biomechanical and neurophysiological measures. We feel that this research has important implications for pilots and astronauts and other people who regularly subject their backs to extreme forces."

The flights on Friday were postponed due to weather, but Saturday dawned cool and breezy with a high overcast. The aircraft, a converted tanker similar to a commercial Boeing 707, creates zero-gravity in the cabin by flying a series of steep, rolling arcs between 25,000 and 35,000 feet; zero-g conditions exist for about 20 seconds at the top of each arc before the airplane plunges downward and begins another stomach-wrenching two-g climb. Each two-and-a-half-hour flight includes 40 zero-g arcs, and an arc that simulates lunar gravity and one that simulates Martian gravity. In short, a chiropractor's dream of researching the effects of loading and unloading on the spine.

Nausea is a problem that, despite widespread use of motion-sickness medication, affects about half the people who fly the KC-135 -- hence its nickname, "The Vomit Comet." "It was a little rough on the old tummy," student Nutting commented after his flight, walking gingerly toward the hangar. "But it was still definitely worth it. It's the wildest rollercoaster ride I've ever been on." Drs. Colloca and Keller were waiting for the students in the hangar. Barnett and Nutting immediately shed their t-shirts, the ones that said "Why Yes, I Am A Rocket Scientist," as Dr. Colloca pinged their backs in the post-flight Activator tests.

At 1:30 p.m. Barnett, Cheung and I took off on our own weightless adventure. Twenty minutes or so into the flight we were given the okay to leave our seats and prepare for the first series of arcs. I was nauseous even before I got on the plane. For days, people who'd already flown had felt obligated to regale those of us who hadn't with an array of colorful stories involving zero-g vomiting. But that we were finally engaged in the flight came as an immense relief.

"One minute!" a NASA spotter called out, preparing us for the climb.

I stretched out on my back, to better dissipate the powerful downward g-forces, and began repeating a silent, involuntary mantra: "I will not get sick. I will not get sick."

Suddenly, alarmingly, the two-g climb began. My lips felt stretched against my teeth, and I imagined all the blood in my head pooling in the back of my skull. My tiny camera, suspended from a cord around my neck, pressed down uncomfortably into my stomach. A new mantra emerged from my bloodless brain: "Oh boy. Uh-oh. Oh boy. Uh-oh."

Then the pressure suddenly slackened, like a giant weight had been lifted. Then it slackened more.

"Here we go!" the spotter shouted.

I felt my legs leave the floor. I arched my back a little, pushed against the floor with my elbows, and began slowly floating toward the ceiling. Amazingly, improbably, I was weightless. I laughed out loud just as another floater, trying to figure out how to propel herself about the cabin, accidentally kicked me in the back.

After a couple of arcs, most of us seemed to get the hang of moving in weightlessness. As Cheung and Barnett floated around the UVM experiment, explaining it for a NASA videographer, I crawled

upside down along the ceiling of the cabin, stopping here and there to do back flips. The sensation was like cavorting underwater, but without the resistance. There were odd moments when I couldn't discern up from down, and only by concentrating on the bolted-down experiments was I able to get my feet to the floor before the zero-g period ended.

The flight passed in a blur. I considered it a kind of miracle that I didn't get sick. Back in the hangar with electrodes on my skin and Dr. Colloca once again pinging me with the Activator, all I could do was lie there with a big grin on my face and scheme about how I could get up in the KC-135 again.

That evening at dinner the students discussed the flights with Dr. Colloca, Dr. Keller and Mark Miller, the graduate student who conceived the original idea for the fruit fly experiment.

The trip was worthwhile for Drs. Fuhr and Colloca for a number of reasons, including the unique opportunity to apply chiropractic techniques to the effects of zero-gravity.

"We're very pleased with our relationship with Dr. Keller," Dr. Fuhr told me when he'd returned to Phoenix. "We've been working with him for four years, and the integration of chiropractic into the university system is beginning to pay off. Through a matching grant program we conducted through NICR, Dr. William Harris of the Foundation for the Advancement of Chiropractic Education (FACE), donated $100,000 to match some $150,000 in funds from NASA to the Vermont Space Grant Consortium. It's this kind of giving that allows us to conduct quality research with people of Dr. Keller's caliber and NASA."

The NICR-supported work has allowed Drs. Keller, Colloca and Fuhr to publish on the validation of their diagnostic technology with their paper, "Validation of the Force and Frequency Characteristics of the Activator Adjusting Instrument: Effectiveness as a Mechanical Impedance Measurement Tool," in the February issue of the *Journal of Manipulative and Physiological Therapeutics.* More recently, they have had a paper accepted for presentation at the 1999 International Society for the Study of the Lumbar Spine Conference. The paper, "Muscular and Mechanical Behavior of the Lumbar Spine in Response to Dynamic Posteroanterior Forces," reports stiffness and muscular data collected on 22 subjects seen at Dr. Colloca's office last spring.

"This preliminary work serves well to demonstrate differences between normal subjects and patients with spinal dysfunction," Dr. Fuhr commented. "We're also very excited by the possible roles chiropractic could play working with NASA. Our preliminary data shows that the subjects' spines were out of balance following the flights, especially in the fifth lumbar area. This corresponds with what I heard from NASA's exercise countermeasure people. I didn't realize until I sat down and talked with them that the rehabilitation process was a real concern following prolonged space flight. That's where chiropractic can have the greatest impact, in identifying post-flight problems and devising treatments for them. I definitely see a future for chiropractic in space."