CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

Isabel N. Goronzy

Project Number

31469

Project Title

Stress Hormones, DNA Damage Repair, and Cellular Aging

Abstract

Objectives/Goals

Studies have shown that excessive stress compromises health and accelerates aging. To determine whether stress hormones inflict DNA damage leading to nuclear instability and cellular aging, the effects of the catecholamine epinephrine, an acute stress hormone, and the steroid dexamethasone, a chronic stressor, on DNA damage and the DNA repair machinery were examined.

Methods/Materials

The impact of epinephrine and dexamethasone on DNA intactness and cellular function was tested in the T cell line Jurkat. Cells were cultured with increasing amounts of both hormones and then subjected to DNA damage stress with H2O2. DNA was extracted and DNA damage lesions were measured by binding a tag to abasic sites (lesions typically formed from oxidative stress) and quantifying by ELISA (OxSelect Oxidative DNA Damage Quantification kit, Cell Biolabs). Functional intactness was assessed by determining the expansion capacity of the cells in culture. Cell numbers were enumerated by counting with a hematocytometer.

Results

When exposed to H2O2, cells conditioned in epinephrine (10-100 umol/mL) accumulated higher loads of DNA lesions than cells cultured in medium alone. Furthermore, epinephrine-pretreated cells expanded less efficiently after DNA damage reaching only half of the cell numbers seen in control cultures. Dexamethasone lowered the levels of H2O2-induced abasic DNA lesions in a dose-dependent fashion; cells preconditioned in 100 umol/mL carried less than one third the number of AP sites than cells cultured in the absence of dexamethasone. Protection from DNA damage translated into enhanced growth capacity of dexamethasone-pretreated cells in which cell recovery was double as high as in dexamethasone-untreated cells.

Conclusions/Discussion

Physiologic doses of the two major stress hormones epinephrine and dexamethasone markedly influence cellular responses to oxidative DNA damage. The adrenal catecholamine epinephrine impairs DNA repair and cellular growth. Conversely, the steroid hormone dexamethasone enhances DNA repair and promotes cellular proliferation. Excessive amounts of epinephrine undermine cellular health, foster DNA mutation and deplete the organism of cells. Dexamethasone may have a role in adapting the cell to persistent stress and could possibly be used in therapies enhancing tissue regeneration.

Summary Statement

Acute and chronic stress hormones have drastic and opposing effects on cellular DNA damage and growth, affecting the healthy aging and well-being of every individual.

Help Received

Used lab equipment at Stanford university. Dr. Li, research associate, extracted DNA. Dr. Shao, postdoctoral fellow, assisted with the ELISA.