Transforming in vitro Studies of Hypertonic Dextrose Injections for Osteoarthritis: A Wide Range Investigation of Effective Dose with a Physiologically Relevant Model

Johnston, Elisha (School: Palos Verdes Peninsula High School)

A systematic review indicates dextrose injections beneficially treat knee osteoarthritis; one possible mechanism is cartilage regeneration. Scientists have conducted few in vitro studies and results are unimpressive. To explore the disconnect, I developed an in vitro model more realistically simulating human joint space and investigated: which dextrose dose most effectively increases cartilage cell proliferation? For model development, I compared mouse chondrogenic (ATDC5) cells cultured in custom-prepared normoglycemic media to published ATDC5 high glucose reports. To investigate proliferation, I designed an empirically-based dosing schedule (25-400 mM glucose) with a physiologically relevant control (4.24 mM), conducted several experiments with multiple replicates, and analyzed results with t-tests and polynomial regression. Microscopic observation confirmed normoglycemic-cultured ATDC5 cells had a similar phenotype (morphology, 16 hour doubling time, and differentiation). To maximize outcome validity, I experimentally optimized the assay measuring metabolic activity (proliferation indicator). Two independent dose-response trials had compatible and statistically significant results ($p<0.05$). Polynomial regression on Trial 2 data identified a low-dose phase (centered on 25 mM) associated with lower metabolic activity and a high-dose phase (centered on 240 mM) associated with higher metabolic activity ($p<0.05$). In published in vitro studies, scientists administered low-dose dextrose and produced bleak outcomes. My results suggest that in vitro studies employing a dextrose effective dose are more likely to surface molecular mechanisms driving clinical results showing hypertonic dextrose injections are a promising treatment for osteoarthritis.