

## Factors Influencing Nutrition of the Intervertebral Disc

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**INTRODUCTION:** The disc is the largest avascular tissue in the body with cells in the centre of an adult lumbar disc 6-8 mm from the nearest blood supply. In order to function and remain viable, the cells require an adequate nutrient supply, and also an efficient means of removing products of metabolism such as lactate. Nutrients reach the cells of the nucleus pulposus by diffusing from blood vessels of the vertebral body through the cartilage endplate into the disc matrix under concentration gradients set up by cellular metabolism<sup>1</sup>. Even in a normal healthy disc, oxygen and glucose levels in the centre of the nucleus. Lactic acid is produced by disc cells at high rates and accumulates, leading to a fall in tissue pH. Failure of nutrient transport is apparent in degenerate discs<sup>2</sup>; it can lead to further fall in pO<sub>2</sub>, glucose concentrations and pH hence affecting cellular activity and even cell survival adversely and may thus be one route to disc degeneration. At present, there are no non-invasive methods for measuring levels of nutrients and metabolites in human discs. However as transport of small solutes such as glucose and oxygen is mainly by diffusion<sup>3</sup>, gradients can be calculated provided values of relevant parameters viz. endplate 'permeability', solute diffusivity through the matrix, disc dimensions and rates of cellular consumption are known. Here we give some results from measurements of these parameters in bovine and human discs.

**METHODS:** Measurements were made on human discs removed at surgery for routine treatment of the scoliotic deformity or bovine caudal discs (18-24 months). Diffusivity of solutes of different molecular weights was determined using a concentration-gradient method<sup>4</sup>. Rates of nutrient consumption and lactate production were measured in a custom-built metabolism chamber with custom-built electrodes<sup>5</sup>. Endplate permeability in human discs was estimated by electrochemical N<sub>2</sub>O measurement<sup>6</sup>. Concentration gradients were calculated from the diffusion equation using a finite element method<sup>7</sup>.

**RESULTS:** Solute diffusivities fell as solute molecular weight increased and as hydration fell. Rates of metabolism showed a non-linear dependence on substrate concentrations and also varied with factors such as mechanical stress. Computation of nutrient profiles showed that with loss of endplate permeability, increase in rates of nutrient consumption or lactic acid production or a fall in diffusivity, nutrient concentrations could fall to levels unable to maintain cellular activity or viability

### DISCUSSION & CONCLUSIONS:

Calculations show that nutrient concentrations throughout the disc can be predicted provided accurate values of material constants are available. Much more data is required before effect of external factors on nutrient concentrations (e.g. various mechanical activities) can be reliably estimated.

### REFERENCES:

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