Material Behaviours of Healthy, Degenerate and Hydrogel Injected Bovine Intervertebral Discs

Dougill G[1], Thorpe A[2], Andrews K[1], Sammon C[2], Reeves ND[1], Le Maitre CL[2], Cooper G[3]
1 Manchester Metropolitan University. 2 Sheffield Hallam University. 3 University of Manchester.
G.Dougill@mmu.ac.uk

Introduction

Low back pain is an increasing drain on developed economies due to direct medical costs and lost working days [1]. The majority of medical costs can be attributed to long-term problems resulting from specific physiological conditions [2]. Acute injury and chronic degeneration of the intervertebral disc (IVD) have been linked with long term pain with high levels of nerve in-growth in degenerate IVDs [3]. The fact that disc degeneration is a structural failing and not just a pathogenesis of pain may lead to reduced mobility and quality of life.

Mesenchymal stem cell interventions have been proposed as a treatment for degenerate IVDs but little is known about how the injection of a hydrogel matrix required by such interventions affects the material properties of the intervertebral disc and what effects this might have on disc health.

This study aimed to determine the difference in material behaviours of healthy, degenerate and hydrogel injected IVDs subjected to cyclic loading simulating activities of daily living.

	Needle inserted through AF in to NP	Collagenase injected and disc incubated for 2 hours at 37°C	Hydrogel Injected	Subjected to cyclic loading
Healthy				✓
Control	✓			✓
Degenerate	✓	✓		✓
Hydrogel	✓	✓	✓	✓

Figure 1 – Test interventions for each group.

Methods

Bovine coccygeal discs were dissected whole from tail sections and split in to four equal test groups; healthy, degenerate, hydrogel injected and a control group. Degenerate and hydrogel injected groups were injected with a 2 mg/ml collagenase solution and incubated at 37°C for 2 hours to simulate moderate degeneration, the hydrogel injected group then received a hydrogel injection. Control group discs received a needle puncture but no material was injected in to the disc.

All discs were then cycled sinusoidally between 0.53 and 0.65 MPa at 2Hz simulating loads in the lumbar spine during walking. Mechanical data was then analysed to determine the respective material behaviours of each group.

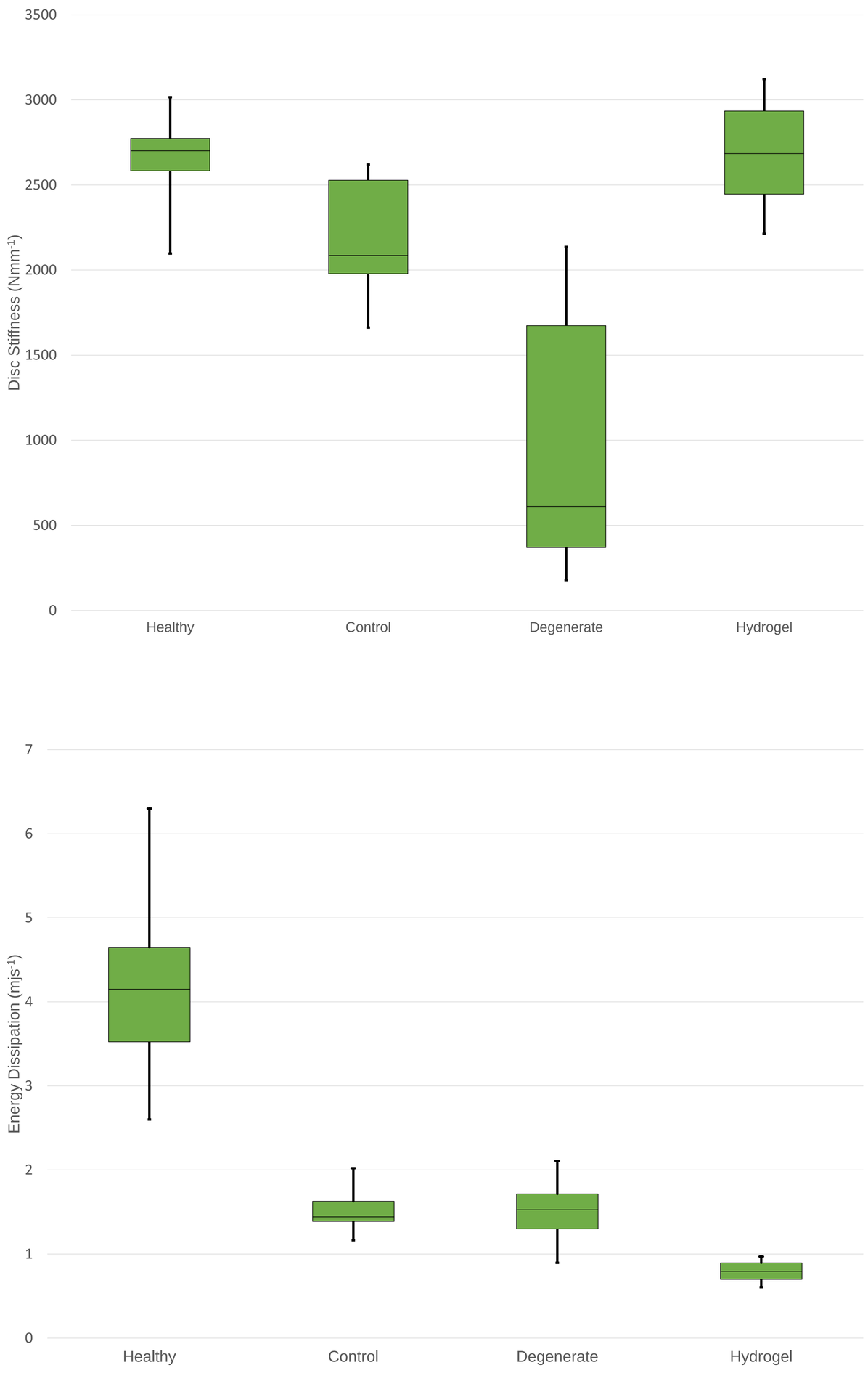

Figure 3 – Box plots of energy dissipation per second for each test group.

Conclusions

Elastic stiffness and energy dissipation was greatly reduced in degenerate discs compared with healthy disc baselines. Discs damaged through needle puncture alone suffered a smaller reduction in elastic stiffness than degenerate discs but a similar loss of energy dissipation.

Degenerate discs injected with hydrogel demonstrated pre-degeneration elastic stiffness but lower energy dissipation than any other group.

Hydrogel injections appear to restore healthy elastic mechanical function in degenerate discs but did not recover pre-degeneration energy dissipation.

[1] S. Bevan, "The Impact of Back Pain on Sickness Absence in Europe " University of Lancaster2012.
[2] J. W. Frymoyer and W. L. Cats-Baril, "An overview of the incidences and costs of low back pain," *Orthop Clin North Am,* vol. 22, pp. 263-71, Apr 1991.
[3] Y. Peng and F. J. Lv, "Symptomatic versus Asymptomatic Intervertebral Disc Degeneration: Is Inflammation the Key?," in *Crit Rev Eukaryot Gene Expr*. vol. 25, ed United States, 2015, pp. 13-21.

DISCS 10th Henry V Crock Lecture Conference