This data is associated with the following dataset:
Costi, John; Tavakoli, Javad; Amin, Dhara; Freeman, Brian (2018): Database for the mechanical properties of the inter-lamellar matrix (ILM), lamellae and elastic fibres network in the intervertebral disc – An ovine model. Flinders University. DOI:10.4226/86/5a79395794c45

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Database for the mechanical properties of the inter-lamellar matrix (ILM), lamellae and elastic fibres network in the intervertebral disc – An ovine model

While few studies have improved our understanding of composition and organization of elastic fibres in the inter-lamellar matrix (ILM) of the disc, its clinical relevance is not fully understood. Moreover, no studies have measured the mechanical failure and viscoelastic properties of the ILM and the elastic fibres in the ILM of the disc. Therefore, this database represents raw data for biomechanical characterization of the ILM and elastic fibres. The viscoelastic and failure curves of the ILM and elastic fibres were presented in both the tension and shear directions of loading. Using an ovine model, isolated ILM samples were stretched to 40% of their initial length at three strain rates of 0.1%s^{-1} (slow), 1%s^{-1} (medium) and 10%s^{-1} (fast) and a ramp test to failure was performed at a strain rate of 10%s^{-1}. The findings from this study identified that the stiffness of the ILM was significantly larger at faster strain rates, and energy absorption significantly smaller, compared to slower strain rates, and the viscoelastic and failure properties were not significantly different under tension and shear loading. We found a strain rate dependent response of the ILM during dynamic loading, particularly at the fastest rate. The ILM demonstrated a significantly higher capability for energy absorption at slow strain rates compared to medium and fast strain rates. A significant increase in modulus was found in both loading directions and all strain rates, having a trend of larger modulus in tension and at faster strain rates. The finding of no significant difference in failure properties in both loading directions, was consistent with our previous ultra-structural studies that revealed a well-organized (±45°) elastic fibre orientation in the ILM. The results from this study can be used to develop and validating finite element models of the AF at the tissue scale, as well as providing new strategies for fabricating tissue engineered scaffolds.

This database contains the following folders:

1- The “ILM data” folder including:
    - Elastic fibre in shear
    - Elastic fibre in tension
    - ILM in shear
    - ILM in tension

The “ILM data folder” represents raw data for biomechanical characterization of the ILM (Studies 4 and 5, J. Tavakoli PhD thesis, 2018). Each sub-folder contains excel files presenting force-displacement data at different strain rates (slow- medium and fast) and failure for at least 10 samples. Digested samples were used for measurement of mechanical properties of the elastic fibres in the ILM.

On the other hand, while microstructural observations have improved our understanding of possible pathways of herniation progression, no studies have measured the mechanical failure properties of the inter-lamellar matrix (ILM), nor of the adjacent lamellae during progression to herniation. The second data set in this database was prepared on the basis of a study (J. Tavakoli PhD thesis, 2018) that employed a multiscale, biomechanical and microstructural techniques to evaluate the effects of progressive herniation on the ILM and lamellae in control, overloaded and herniated discs (N=7). Overloaded and herniated (experimental) groups were subjected to macroscopic compression while held in flexion (13°), before micro-mechanical testing. Micro-tensile testing of the ILM and the lamella from anterior and posterolateral regions was performed in radial and circumferential directions to measure failure stress, modulus, and toughness in all three groups. The failure stress of the ILM was significantly lower for both experimental groups compared to control in each of radial and circumferential loading directions in the posterolateral region ($p<0.032$). Within each experimental group in both loading directions, the ILM failure stress was significantly lower by 36% (overload), and 59% (herniation), compared to the lamella ($p<0.029$). In overloaded compared to control discs, microstructural imaging revealed significant tissue stretching and change in orientation ($p<0.003$), resulting in a loss of distinction between respective lamellae and ILM boundaries.

2- The "ILM-LAM data" folder including:

- Control group
- Overloaded group
- Herniated group

The "ILM-LAM data folder" represents raw data for biomechanical characterization of the ILM (ILM) compared to the lamellae (LAM) during progression of herniation (Study 6). Each sub-folder contains excel files presenting failure properties (force-displacement data) for 7 samples at two different regions of anterior (AN) and posterolateral (PL).