Individualised assessment of aberrant intervertebral mechanics

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Introduction: Much of low back pain is considered to be the result of soft tissue stresses in the spine **[1]**. However, Individualised biomechanical assessment is problematical due to the spine's inaccessibility to non-invasive physical measurement. This has led to concern about an over-reliance on psycho-social management for people with chronic non-specific spinal pain **[2]**.

Cadaveric experiments have explored the subtle biomechanics of disco-ligamentous sub-failure and muscle overuse caused by added physical demands **[3]**. There have also been attempts to accurately represent the biomechanics of the spine with mechanical models **[4]**. These efforts have recognised the need to access kinetic and kinematic information from the mid-range of motion rather than just at its ends. In the 1980s, the merging of fluoroscopy and image processing to overcome this problem was achieved **[5]**. Between then and now, systems have been improved and some consensus has been reached about how they might be operated **[6]**.

Methods: A series of studies has been conducted into the biomechanics of the lumbar and cervical spines using this this technology, now known as 'Quantitative Fluoroscopy' (QF). These investigated its 2-D measurement properties in terms of conventional intervertebral kinematics, such as maximum RoM, translation and finite centre of rotation. Later, new variables were introduced, namely 'Initial Attainment Rate (a measure of laxity in the mid-range), 'Motion Sharing Inequality' (MSI) throughout the range, representing intersegmental co-ordination and 'Motion Sharing Variability' (MSV) representing spinal control.**[7]** Initial sEMG studies examined the relationship to back muscle activation and QF-informed finite element (FE) loading models were generated.

Results: These studies have found that most of these measurement parameters have good observer repeatability and most good intra-subject reliability, although not necessarily agreement. Laxity and MSI have so far been the best biomarkers for chronic, non-specific low back pain and its relationship to disc degeneration **[7]**. The FE studies have demonstrated the feasibility of more closely representing subject-specific tissue loading with such models **[8]** and contemporaneous sEMG studies have found relationships to spine control (MSV). Only one outcome study has so far been conducted (in the cervical spine), which found no relationship between IV-RoM change and disability score change over a treatment period **[9]**.

Conclusion: Despite these encouraging findings, there is a great deal more work to do to establish the clinical utility of these technologies, not least in the field of spinal surgery, where 'adjacent segment disease' is usually attributed to aberrant motion patterns consequent to surgical procedures. The weight bearing condition has barely been explored for the lower back, but individualised FE load modelling seems a real possibility.

References

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