Kinematic MRI of the Lumbar Spine
The UMMC Experience

Background
• Magnetic resonance imaging provides excellent anatomic detail of spinal tissues, but fails to provide the type of information that permits a definitive diagnosis in many patients with back pain.

Dynamic Myelogram
- Prone
- Lateral
- Prone with needle in situ
- Prone centre at L4/L5
- Prone centre at L5/S1
- LAD RAO

Background
• New imaging strategies that can be applied to the study of intervertebral disc degeneration include diffusion-weighted imaging (DWI), magnetic resonance imaging, diffusion tensor imaging, magnetic resonance spectroscopy, functional magnetic resonance imaging, dynamic computed tomography and magnetic resonance imaging, and T2 relaxometry.

Changes in Cross-Sectional Measurements of the Spinal Canal and Intervertebral Foramina as a Function of Body Position: In Vivo Studies on an Open-Configuration MR System

OBJECTIVE: The purpose of this study was to evaluate physiological changes of the cross-sectional area of the spinal canal and intervertebral foramens in young asymptomatic volunteers.

SUBJECTS AND METHODS: Twenty asymptomatic volunteers were examined in a 1.5-T open-configuration MR system. T2-weighted fast spin-echo images were obtained in weight-bearing prone, supine flexed, upright, and supine extended positions. The cross-sectional area of the spinal canal and the thickness of the dura-mater were measured on sagittal and axial images at the L3-L4 level. The anteroposterior diameter of the spinal canal and cross-sectional areas of the neural foramens were measured on sagittal images from L1 to L5.

RESULTS: In all levels, the cross-sectional area of the spinal canal varied significantly between body positions, most notably between the weight-bearing prone, 286 mm², and the upright extended position, 226 mm² (p < 0.001). The maximum thickness of the ligamentum flavum increased in the extended position (p < 0.001). The cross-sectional areas of the neural foramens underwent position-dependent variations of as much as 44%. The smallest cross-sectional areas were found in the extended position.

CONCLUSION: In asymptomatic volunteers, MR imaging is able to show position-dependent changes in the cross-sectional areas of the spinal canal and the intervertebral foramens. The extended positions best reveal important findings.
Axial loaded MRI of the lumbar spine

Neutral position

Change in lumbar lordosis

Axial loaded Images

Neutral position

Axial loaded Image

Axial loaded Image

Reduced spinal canal diameter

Neutral position

Axial loaded Images

Narrowing of the lateral recesses

Presence of the occult facet ganglion/cyst
Definition

- It is natural to begin this discussion by considering the various possible types of motion in themselves, leaving out of account for a time the causes to which the initiation of motion may be ascribed; this preliminary enquiry constitutes the science of Kinematics. — ET Whittaker

Kinematic MRI of the lumbar spine in UMMC

- Effectiveness Of Kinematic And High Resolution CISS Sequence Of Magnetic Resonance Imaging In Evaluation Of Lumbar Spondylosis

Effectiveness of Kinematic and high resolution CISS sequence of MRI in evaluation of lumbar spondylosis

- OBJECTIVES:
  - To assess the added value of Kinematic Magnetic Resonance Imaging (full extension, full flexion and especially the lateral flexion positioning in comparison to recumbent or neutral MRI imaging in lumbar spondylosis).
  - To assess the value of CISS (constructive interference in steady state) sequence of MRI imaging in lumbar spondylosis.
  - To assess correlation between kinematic MRI and clinical symptoms in comparison to conventional MRI imaging.

Effectiveness of Kinematic and high resolution CISS sequence of MRI in evaluation of lumbar spondylosis

- With the advent of open configuration MRI systems, dynamic or kinematic studies allow evaluation of physiological as well as pathological changes in the relationships of the intervertebral disc, the spinal canal, and the neural foramina as well as the assessment of segmental instability in physiologic body positions.

CISS (constructive interference in steady state) sequence

- Provides better spatial and contrast resolution particularly in the imaging of nerve roots and neural foramina morphology.

Kinematic MRI of the lumbar spine in UMMC

- Neutral supine position
Kinematic MRI of the lumbar spine in UMMC

- Right bending position
- Left bending position
- Lateral flexion position
- Lateral extension position

Right bending | Left bending | Lateral extension | Lateral flexion
Drawback / Limitation

- Induced pain
- Time consuming
  - Normal sequence: about 30 min
  - Kinematic sequence: additional 45 min
- Remedy action
  -> analgesia prior to procedure
Conclusion

Weishaupt D et al; Positional MR imaging of the lumbar spine proved that positional MR imaging more frequently demonstrates minor neural compromise than does conventional MR imaging. It also concluded that positional pain differences are related to position-dependent changes in foraminal size.

Saifuddin A et al; Axial loaded MRI of the lumbar spine; concluded in the erect–extension position, or with axial compression can identify occult nerve root compression not identified on conventional supine imaging.

Conclusion

Ramli N et al concluded that CISS imaging provides superior topographical information regarding extradural and intradural pathology. It also has the advantages of imaging nerve and neural tethering in fine detail; as well as delineating structural abnormalities of nerve root compression.

With kinematics (dynamic / positioning) imaging, the relative motions of normal and degenerated lumbar motion segments can be evaluated noninvasively and provide the clinicians better diagnosis and outcome.

Thank you for your attention.