

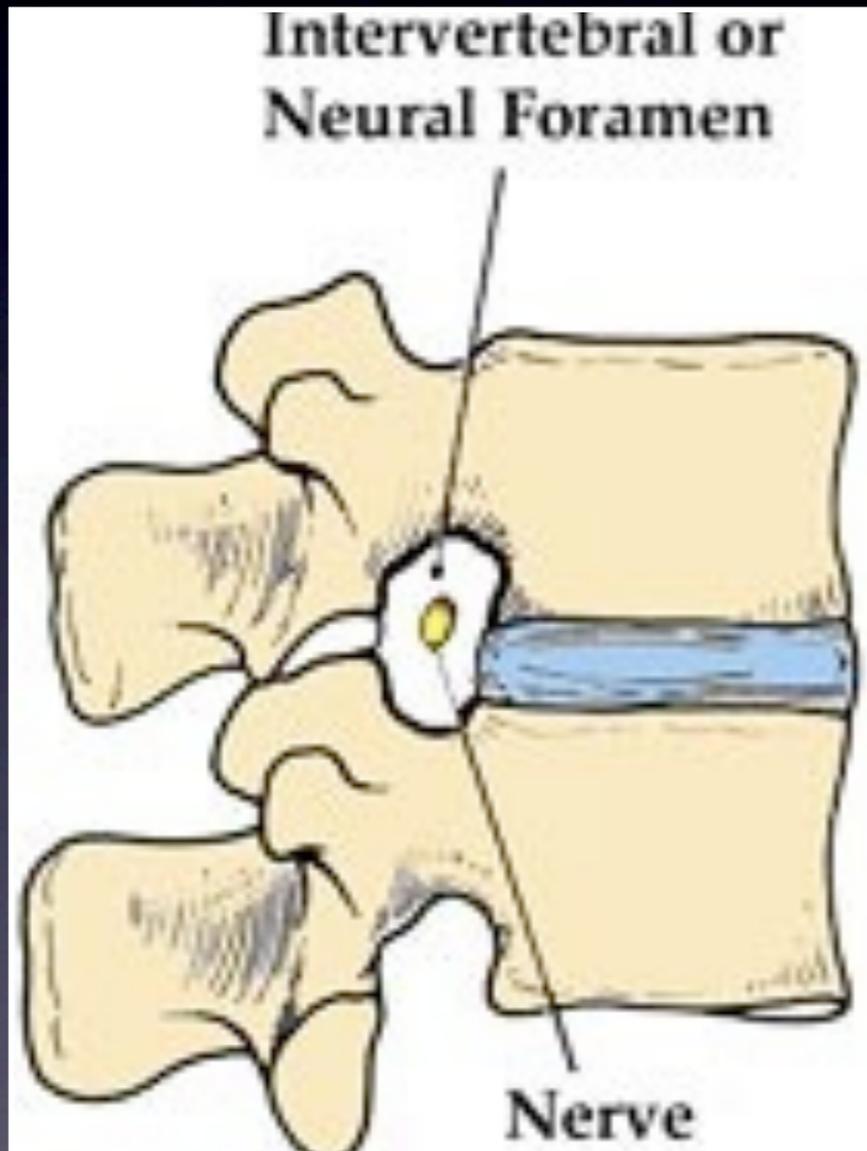
# Quantitative Comparison of Conventional and Oblique MRI for Detection of Herniated Spinal Discs

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ENGN 2500: Medical Image Analysis  
Final Project

# Outline

- Introduction to the problem
  - Based on paper: “A comparison of angled sagittal MRI and conventional MRI in the diagnosis of herniated disc and stenosis in the cervical foramen”
- Approach to the problem
- Plan for project

# Definitions



- Spinal Foramen:  
Opening in the spinal column in which nerves enter and exit
- Spinal Stenosis:  
Narrowing of the spinal foramen.  
Naturally occurs with age, but can be caused by other factors.

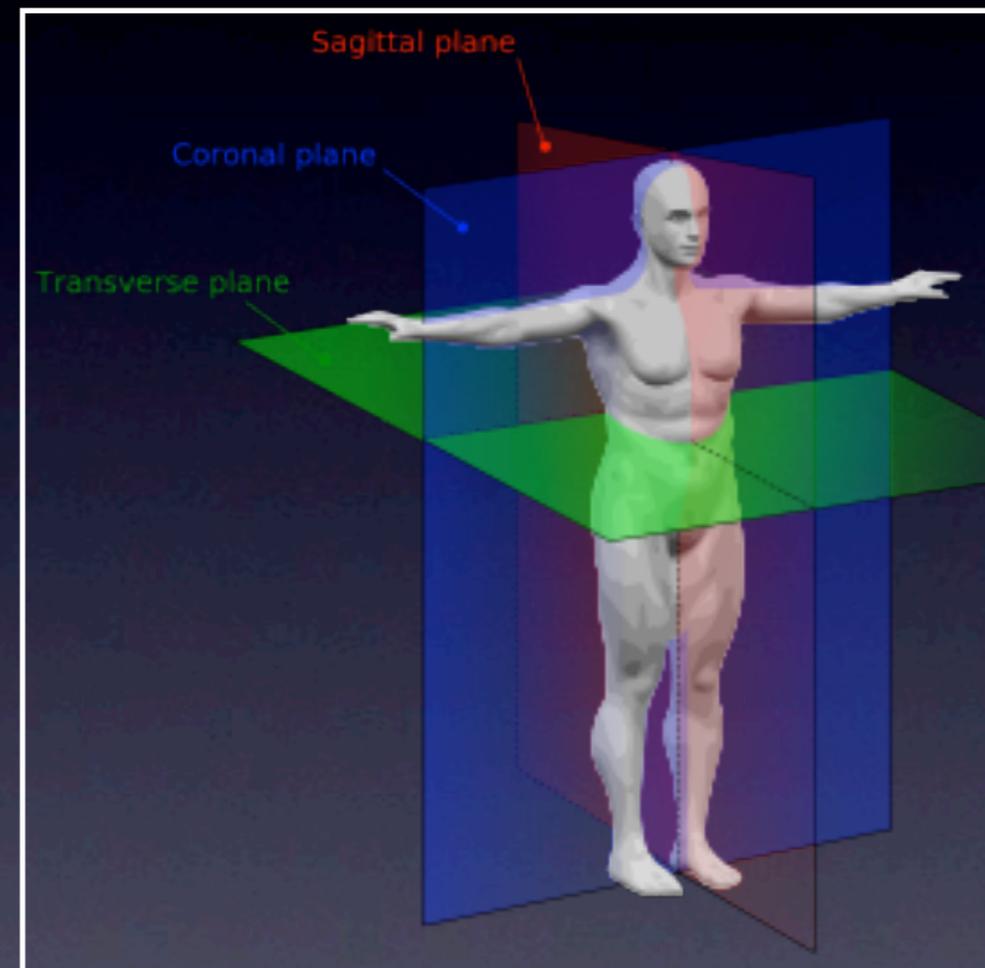
# Definitions (continued)

- Spinal Disc Herniation:  
Tear in the outer, fibrous ring of a spinal disc, causing central portion to bulge out.
- Symptoms range from little/no pain to severe pain (affects nerve roots)

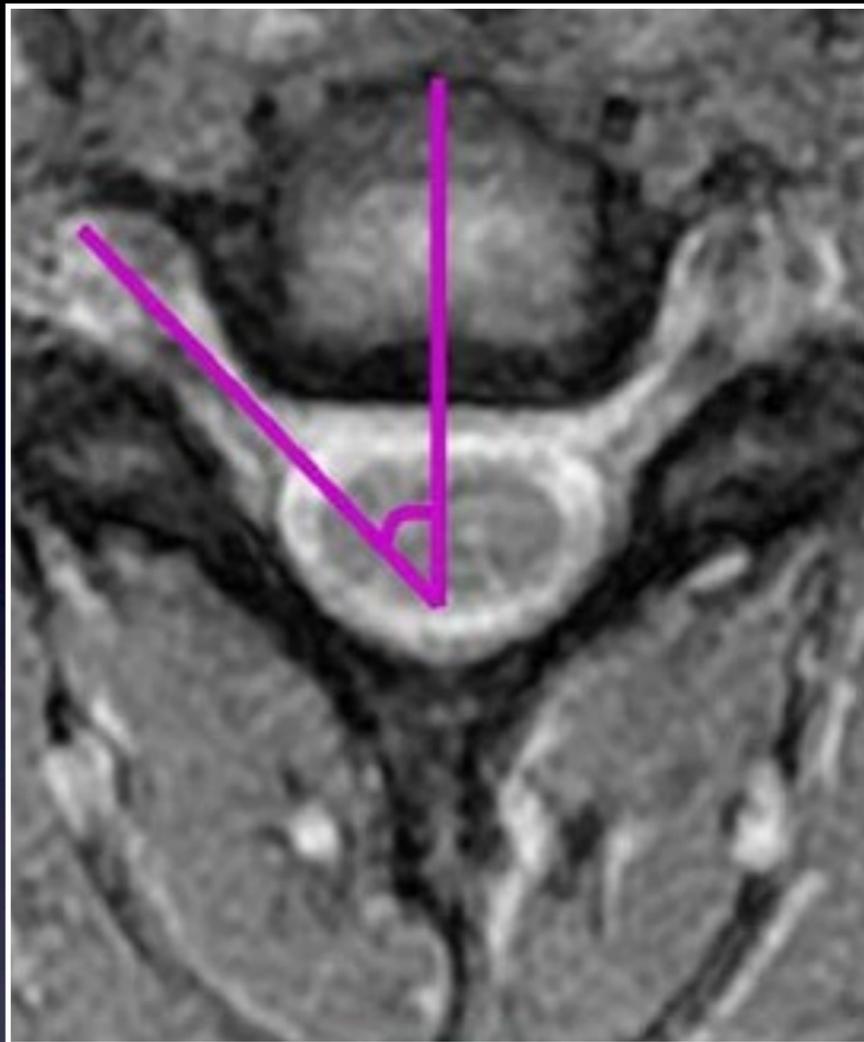


# The Problem

- Difficult to identify herniated discs and spinal stenosis using conventional (2D) MRI techniques
- These conventional methods result in patients condition being misdiagnosed.



“Conventional MRI”: Images acquired along one of three anatomical planes



Axial, T2-weighted Image:  
Cervical Foramen is  
directed at 45 degrees  
with respect to coronal  
plane.



3D reconstructive CT Image  
shows that the cervical  
foramina are directed  
downward around 10-15  
degrees with respect to  
axial plane

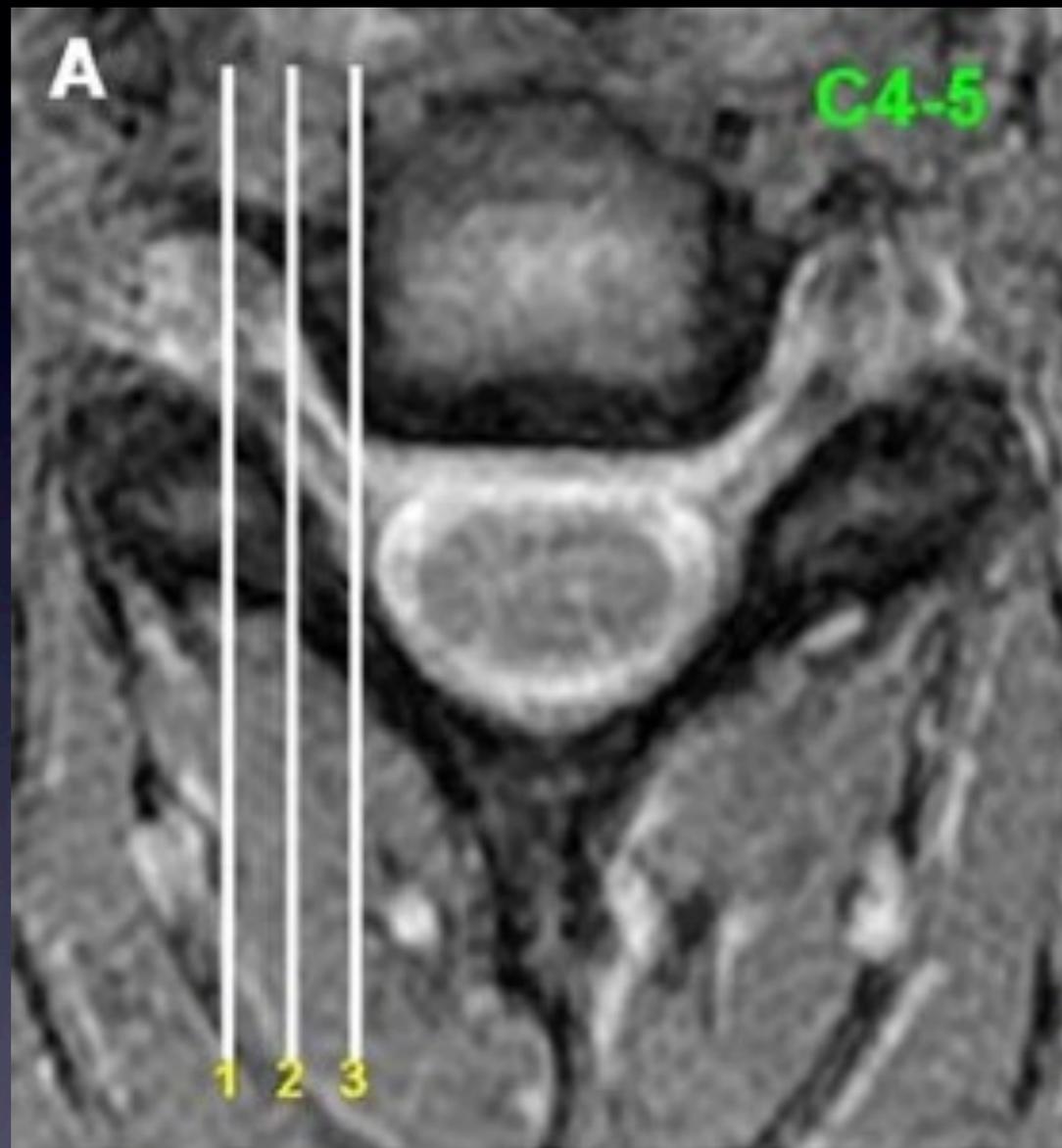
# Oblique or “Angled” MRI

- Humphreys, et al.: Oblique MR imaging provides valuable information about the cervical foramen not available from conventional MR imaging techniques
- Edelman, et al reported that oblique planes are clinically useful in studying organs with axis of symmetry that is different than the coordinate system of the MR system.
- Oblique sections can improve the MR image quality and diagnostic value

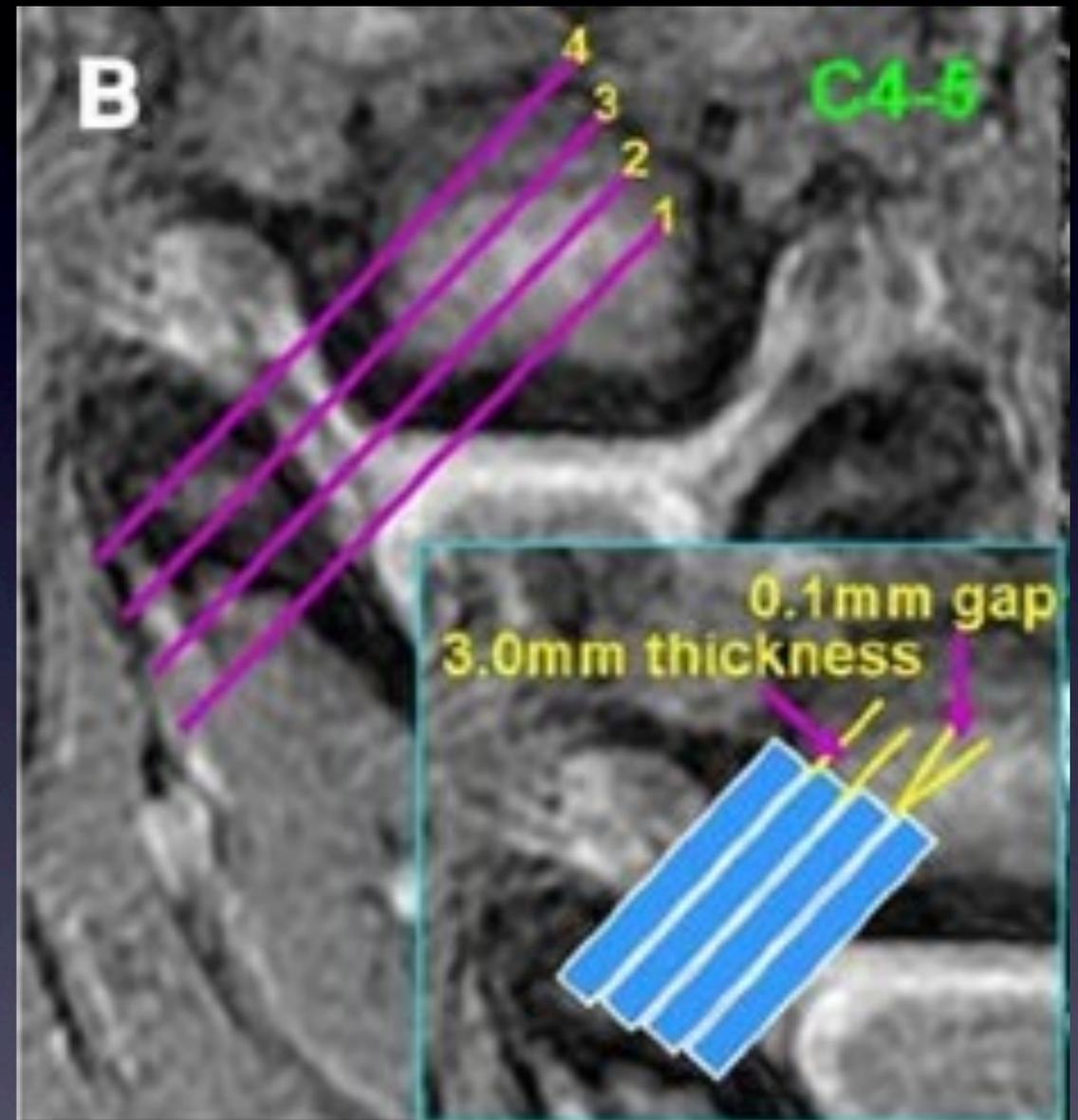
# Methods

- Images were acquired with 1.5T superconducting system on 53 patients (20 men) ranging in age from 31 to 64 years
- Conventional MRI: Sagittal T1 weighted and T2 weighted images
- Angled Sagittal MRI: Images were taken in 40-45 degree sagittal projections. These images were oriented perpendicular to the true course of the neural foramen
- Two tests were evaluated by two independent radiologists. When positive data existed, surgical exploration was performed.
- Interpretations from the MR images (both sets, conventional and oblique) were compared with the results from surgery (positive or negative findings)

# Orientation of Images



Conventional MRI: Sagittal Protocol



Oblique MRI: Sagittal Protocol

# Results

- Discrepancy between conventional MRI and angled sagittal MRI for foraminal herniated disc occurred at 18 levels
- Conventional methods were incorrect at 16 levels while angled sagittal methods were incorrect in 2 levels
- Comparison of findings of conventional and angled sagittal MRI with the operative findings was made and the results were classified.
- Angled Sagittal MRI: Diagnosis of foraminal herniated disc, sensitivity, specificity and accuracy were 96.7%, 95.0% and 96.0% compared with 56.7%, 85.0% and 68.0% with conventional approaches
- Angled Sagittal MRI proved to be a more accurate, sensitive and specific test compared to conventional MRI

# Project

- Compare Conventional and Oblique MRI techniques for detection of spinal discs and problems associated with the spinal discs (stenosis, herniation)
- Conventional MRI Protocol: T1 and T2 weighted sagittal images of the spine
- Oblique MRI Protocol: T1 and T2 weighted sagittal images that are oriented perpendicular with the neural foramen
- Also, include 3D volume acquisition, in which any orientation can be made. Compare whether direction perpendicular to the neural foramen is truly the best or maybe a different angle is preferable.
- This data will be collected at Brown's MRF on a 3T superconducting system using a few volunteers that have been/ will be recruited and screened.

# Project (continued)

- Data will be used for segmentation and detection of herniation of the discs
- In order to compare segmentation technique, gold standard is needed. Therefore, images will be contoured by hand.
- Also, will compare the signal to noise ratio (SNR) and contrast to noise ratio (CNR) with the different techniques to see which method gives the best results.

# Timeline

- Week 1 (4/11-4/16)
  - Work on developing MR imaging protocols and sequences
  - Recruit volunteers (~4-5 volunteers)
- Week 2 (4/17-4/23)
  - Continue developing imaging sequences and begin data acquisition at the MRI facility
  - Will be assisted by Dr. Deoni
- Week 3&4 (4/24-5/7)
  - Continue data acquisition if needed (early in the week)
  - Analysis of Images: Hand contours of ROI's and comparison of MRI protocols
  - Mid Project Presentation: Describe the imaging protocols, present data that had been acquired from previous week, describe what still needs to be done.
- Week 5&6 (5/8-5/16)
  - Continue analysis of MRI protocols. Determine which technique is best for detection of cervical foramina. Base these conclusions on the SNR and CNR measurements as well as the segmentation
  - Final Project Presentation

# References

- Shim JH, Park CK, Lee JH et al (2009) A comparison of angled sagittal MRI and conventional MRI in the diagnosis of herniated disc and stenosis in the cervical foramen. *Eur Spine J* 18:1009– 1116
- Bischoff RJ, Rodriguez RP, Gupta K, Righi A, Dalton JE, Whitecloud TS (1993) A comparison of computed tomography-myelography, magnetic resonance imaging, and myelography in the diagnosis of herniated nucleus pulposus and spinal stenosis. *J Spinal Disord* 6:289–295. doi: 10.1097/00002517-199306040- 00002
- Humphreys SC, An HS, Erk JC, Coppes M, Lim TH, Estkowski L (1998) Oblique MRI as a useful adjunct in evaluation of cervical foraminal impingement. *J Spinal Disord* 11:295–299. doi: 10.1097/00002517-199808000-00005
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