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.
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


- 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

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References


