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นางอรสา ชวาลภาฤทธิ์

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THE LIMITED PROTOCOL MRI IN DIAGNOSIS OF LUMBAR DISC HERNIATION

Mrs. Orasa Chawalparit

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By	Mrs. Orasa Chawalparit
Field of study	Health Development
Thesis Advisor	Associated Professor Somjai Wangsuphachart
Thesis Co-advisor	Professor Sathit Vannasaeng

Accepted by the Faculty of Medicine Chulalongkorn University in Partial Fulfillment of the Requirements for the Master 's Degree

…….. Dean of Faculty of Medicine
(Professor Pirom Kamol-ratanakul)

THESIS COMMITTEE

…….. Chairman
(Professor Chitr Sitthi-amorn)

…….. Thesis Advisor
(Associated Professor Somjai Wangsuphachart)

…….. Thesis Co-advisor
(Professor Sathit Vannasaeng)

…….. Member
(Associated Professor Suthisak Suthipongchai)

…….. Member
(Dr. Chulaluk Komoltri)

อรสา ชวาลภาฤทธิ์ : การวินิจฉัยโรคหมอนรองกระดูกสันหลังส่วนเอวกดทับรากประสาทด้วยภาพเอมอาร์ไอท่าเดียว (The limited protocol MRI in diagnosis of lumbar disc herniation) อ.ที่ปรึกษา : รศ.พญ.สมใจ หวังศุภชาติ,พบ.,วว.(รังสีวิทยาวินิจฉัย), อ..ที่ปรึกษาร่วม : ศ.นพ.สาธิต วรรณแสง,พบ.,วว.(อายุรศาสตร์) จำนวนหน้า 46 หน้า ISBN 974-17-3496-4

วัตถุประสงค์:เพื่อศึกษาความเป็นไปได้ของการวินิจฉัยโรคหมอนรองกระดูกส่วนเอวกดทับรากประสาทโดยการสร้างภาพเอมอาร์ไอท่าเดียวเปรียบเทียบกับการสร้างภาพหลายท่าตามปกติ

รูปแบบการทดลอง:การเปรียบเทียบความเท่ากันของผลลัพธ์ และการศึกษาความถูกต้องของการตรวจด้วยภาพเอมอาร์ไอโดยเปรียบเทียบกับผลผ่าตัด

สถานที่ทำการวิจัย :ภาควิชารังสีวิทยา คณะแพทยศาสตร์ศิริราชพยาบาล

วิธีการศึกษา:ผู้ป่วยที่มารับการตรวจเอมอาร์ไอและได้รับการวินิจฉัยจากแพทย์ว่าสงสัยเป็นโรคหมอนรองกระดูกสันหลังกดทับรากประสาทจะได้รับการซักประวัติจากพยาบาลเกี่ยวกับความรุนแรงและระยะเวลาของอาการปวดหลัง ภาพเอมอาร์ไอของผู้ป่วยจะได้รับการแปลผลโดยรังสีแพทย์สามท่าน แพทย์แต่ละท่านจะอ่านผลจากภาพเอมอาร์ไอท่าเดียวและอ่านจากทั้งสามภาพแยกกัน ในแต่ละรายจะได้รับการบันทึกว่ามีหมอนรองกระดูกยื่นออกมาหรือไม่ และมีการกดทับรากประสาทหรือไม่ นำผลที่ได้จากแต่ละวิธีการ(ผลจากภาพเอมอาร์ไอท่าเดียวและจากภาพเอมอาร์ไอสามท่า)มาเปรียบเทียบเพื่อหาความแตกต่าง นอกจากนี้ยังเปรียบเทียบผลที่ได้ในแต่ละวิธีการกับผลผ่าตัดในผู้ป่วยที่ได้รับการผ่าตัด

ผลการศึกษา:ผู้ป่วยที่เข้าร่วมในโครงการทั้งสิ้น 123 ราย (ชาย 61 รายและหญิง 62 ราย) อายุระหว่าง 21-60 ปี(เฉลี่ย 42.91 ปี) มีอาการก่อนมาทำการตรวจเอมอาร์ไอ 1-204 เดือน(เฉลี่ย 31.20 เดือน) ความรุนแรงของอาการน้อยร้อยละ 23.58 ปานกลางร้อยละ 45.52 และมากร้อยละ 30.89 ผู้ป่วยได้รับการรักษาโดยการผ่าตัด 33 รายนอกนั้นได้รับการรักษาตามอาการ จากการแปลผลภาพของรังสีแพทย์พบว่าการให้การวินิจฉัยว่ามีหมอนรองกระดูกยื่นออกมาจากรอยแตกของแอนนูลัสหรือไม่ (lumbar disc herniation)โดยใช้ภาพเอมอาร์ไอท่าเดียวไม่ต่างจากการใช้ภาพครบทั้งสามท่าประกอบกัน (ซีตา = 1.04 หรือมีความแตกต่างร้อยละ 4, 95%CI=0.94, 1.14) แต่การให้การวินิจฉัยการกดทับรากประสาทหรือไม่โดยใช้ภาพเอมอาร์ไอท่าเดียวต่างจากการใช้สามท่าโดยมีความแตกต่าง ร้อยละ 25 ในจำนวนผู้ป่วยที่ได้รับการผ่าตัด 33 ราย พบว่าเป็นหมอนรองกระดูกยื่นและมีการกดทับรากประสาท 22 รายและมีการยื่นของหมอนรองกระดูกโดยไม่มีการกดทับรากประสาท 1 ราย อีก 10 รายไม่มีการยื่นของหมอนรองกระดูก แต่มีการเคลื่อนตัวของข้อกระดูกร่วมกับการกดทับรากประสาท 4 ราย มีการเคลื่อนตัวโดยไม่มีการกดทับ 4 ราย เป็นการนูนของหมอนรองกระดูก โดยไม่มีการกดรากประสาท 1รายและมีการกดอีก 1 ราย ความไว ความจำเพาะและความถูกต้องในการวินิจฉัยการยื่นของหมอนรองกระดูกโดยเอมอาร์ไอท่าเดียว เท่ากับร้อยละ 82.61, 80 และ 81.82 ตามลำดับ โดยสามท่าเท่ากับร้อยละ 82.61, 70 และ 78.79 ตามลำดับ ส่วนความไว ความจำเพาะและความถูกต้องในการวินิจฉัยการกดทับรากประสาทโดยเอมอาร์ไอท่าเดียว เท่ากับร้อยละ 54.84, 100 และ 57.58 ตามลำดับ โดยสามท่าเท่ากับร้อยละ 80.65, 100 และ 81.82 ตามลำดับ ความไวและความจำเพาะ ในการวินิจฉัยการยื่นของหมอนรองกระดูกในภาพเอมอาร์ไอท่าเดียวและสามท่าไม่แตกต่างกัน แต่ความไวในการวินิจฉัยการกดทับรากประสาทในทั้งสองวิธีแตกต่างกันอย่างมีนัยสำคัญทางสถิติ ($p<0.013$, 95%CI = -0.337,-2.501) จากการศึกษานี้สรุปได้ว่า ไม่มีความแตกต่างในการวินิจฉัยการยื่นของหมอนรองกระดูกจากการใช้ภาพเอมอาร์ไอท่าเดียวหรือจากการใช้ภาพเอมอาร์ไอมาตรฐานครบสามท่า แต่มีความแตกต่างในการวินิจฉัยการกดทับรากประสาทซึ่งภาพสามท่าจะวินิจฉัยได้ดีกว่าภาพท่าเดียว

หลักสูตรการพัฒนาสุขภาพ	ลายมือชื่อนิสิต.....
สาขาวิชาการพัฒนาสุขภาพ	ลายมือชื่ออาจารย์ที่ปรึกษา.....
ปีการศึกษา 2546	ลายมือชื่ออาจารย์ที่ปรึกษาร่วม.....

447 544330 30 : MAJOR HEALTH DEVELOPMENT

KEY WORD : MAGNETIC RESONANCE IMAGING / MRI / LUMBARDISC HERNIATION / DIAGNOSIS

ORASA CHAWALPARIT : THE LIMITED PROTOCOL MRI IN DIAGNOSIS OF LUMBAR DISC HERNIATION

THESIS ADVISOR : ASSOC.PROF. SOMJAI WANGSUPHACHART,MD,MSc. THESIS COADVISOR :

PROF.SATHIT VANNASAENG,MD.,MSc. , 46 pp. ISBN 974-17-3496-4

Objective : To assess agreement in detection lumbar disc herniation between limited and full protocol MRI.

Design : Equivalence study and diagnostic cross-sectional study.

Setting :Department of Radiology Faculty of Medicine Siriraj Hospital.

Method :One hundred and twenty three patients requested lumbar spine MRI for diagnosis of disc herniation were assessed for the severity and duration of the low back pain. The routine full protocol MRI was performed in each patient, which was composed of sagittal T1-weighted image, sagittal T2-weighted image and axial T2-weighted image. The sagittal T2-weighted image was selected as the limited protocol MRI. The limited protocol and full protocol MRI of each patient were separately interpreted by three neuroradiologists to assess disc herniation and nerve root compression. The consensus results of findings of limited and full protocol were compared. The diagnostic performance of each protocol was analyzed using surgery as the gold standard. Then the diagnostic statistics of both protocols were compared.

Result : There were 123 patients (62 females, 61 males) enrolled into the study with range of age of 21-60 years old (means = 42.91). The duration of pain before MRI examination was ranged from 1-204 months (mean = 31.20 months). The degree of severity was mild in 23.58%, moderate 45.52% and severe 30.89% of cases. Thirty-three cases were operated and the rest were conservatively treated. For detection of lumbar disc herniation (LDH), the limited protocol MRI gave the interpretation results equally to full protocol MRI (θ = 1.04, 95%CI=0.94,1.14 with accepted range of 0.95-1.05). In nerve root compression, the limited protocol was not equal to full protocol MRI θ= 0.75, 95%CI=0.87,0.63). The sensitivity, specificity, accuracy, PPV, NPV, and LR+ in the surgical group of limited protocol in diagnosis of LDH were 82.61%, 80%, 81.82%, 90.48%, 60.67%, 4.13 respectively. The same results for limited protocol in nerve root compression were 54.84%, 100%, 57.58%, 100%, 12.5%. The sensitivity, specificity, accuracy, PPV, NPV and LR+ of full protocol MRI in diagnosis of LDH were 82.61%, 70%, 78.79%, 86.36%, 63.64%, 2.75 and of nerve root compression were 80.65%, 100%, 81.82%, 100%, 25% respectively. The sensitivity and specificity in diagnosis of LDH were not different in both protocols but the sensitivity of nerve root compression was statistically different ($p<0.013$, 95%CI = -0.33, -0.25). The author concluded that limited protocol MRI may replace full protocol MRI in diagnosis of LDH for patients suspected LDH whom MRI were requested but not in nerve root compression.

Program Health Development Student's signature…….

Field of study Health development Advisor's signature…….

Academic year 2003 Co-advisor's signature…….

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CHAPTER 1

INTRODUCTION

Rationale and Background

Low back pain is the second most common complaint encountered by primary care physicians (after common cold).[1,2] Up to 80% of all individuals will experience low back pain at some point in their lives. It affects men and women equally, with onset most often between ages of 20 and 50 years. It is the most common cause of work-related disability in people under 45 years of age and the most expensive cause of work-related disability both as the medical expenses and work compensation. In Thailand, 62 % of complicated cases that the Provincial Social Security Offices consulted the Medical Committee of the Compensation Fund in 1996-1998 were musculoskeletal causes. Among these, occupational back pain accounted for 25 % and 7 % were occupational lumbar disc herniation.[3] In 1999, the occupational back pain increased to 41%, and 59% were caused by disc herniation.[4] The average medical cost was 10,387.24 baht and average number of day lost was 17.3 days per patient.[4] According to the 1999 report of Ministry of Public Health of Thailand, the rate of out patients visiting public hospitals in Bangkok for musculoskeletal diseases was 57.9 per 1,000 population, being second to gastrointestinal disease.

Table 1 Differential diagnosis of low back pain

Mechanical low back pain Or leg pain (97%)	Nonmechanical spinal condition (~1%)	Visceral disease (2%)
Lumbar strain, sprain (70%)	Neoplasia (0.7%)	Disease of pelvic organ
Degenerative process of disc & facet(10%)	Infection (0.01%)	Renal disease
Herniated disc (4%)	Inflammatory arthritis (0.3%)	Aortic aneurysm
Spinal stenosis (3%)	Scheuermann's disease	Gastrointestinal disease
Traumatic fracture (<1%)	Paget disease of bone	
Congenital disease (<1%)		
Spondylolysis		
Diskogenic low back pain		
Presumed instability		

There have been many reported causes of low back pain. Mechanical causes are encountered about 97%.(Table 1)[7] Unfortunately, a specific diagnosis has not been made in 80% of low back pain.[5,6] Herniated disc is encountered about 4% of all causes.[7] Though this figure is small, it is the most common cause that can be diagnosed before treatment. Lumbar intervertebral disc herniation (LDH) has a favorable prognosis in the majority of circumstances. LDH typically occurs as a result of annular disruption leading to the most common form of clinically recognized LDH. Saal and Saal reported a 90% good or excellent outcome for patients with imaging test verified LDH causing clinical radiculopathy. [8] Treating physicians often will notice a regression of pain before the normalization of neurologic status. The pain often will be a combination of back and leg pain. The acute phase typically will last for 1-2 weeks.[9] The patients who recover without surgery typically demonstrate the initial signs of improvement in the first 3-6 weeks from time of onset, with a gradual recovery pattern.

It is generally unnecessary to order an imaging study to assess the status of a lumbar disc or spinal neural elements during the initial 6-8 weeks after the onset of pain, unless the patient has symptoms suggesting cauda equina syndrome, progressive neurologic deterioration, severe unresponsive intractable pain, or constitutional signs or symptoms suggesting infection or tumor. Careful history taking and physical examination will help to exclude serious pathology. Without redflag signs of serious pathology, it may be reasonable to operate urgently on the patient with progressive neurological deficit, profound neurologic loss that does not demonstrate an improvement trend in approximately 6 weeks, unresponsive intractable pain and cauda equina syndrome.[9] ***If surgery is contemplated, it is necessary to document with an imaging study of the nature (mechanical compression) and extent of the discal abnormality presenting at the clinically suspected level(s).***

Most literatures have suggested that magnetic resonance imaging (MRI) is more preferable. Myelography is clearly a more invasive procedure.[10,11] However, MRI is an expensive modality especially in Thailand in the era of universal coverage or “30-baht” scheme.

The T1-weighted spin-echo pulse sequence is essential in all regions of spine, primarily to demonstrate anatomy but also to provide information about the marrow space. Sagittal T2wi has been used to provide additional contrast between bony structures, soft tissue, intervertebral disc and cerebrospinal fluid (CSF) to create myelogram-like images, thereby increasing the conspicuousness of extradural defects. In the past, axial T1wi was more preferred in the lumbar spine since it had a significant higher signal-to-noise and the relatively more epidural fat in this region supplied the necessary contrast between the thecal sac and the adjacent discs or bony structure with the limited scan time. However, with improvement and development of the new fast spine-echo pulse sequence and good signal-to-noise gradient-echo pulse sequence, the axial T2wi has been increasingly used in many centers as the routine protocol of the lumbar MRI. The high signal-intensity on T2wi has been identified in both extruded discs and free fragments. The high signal-intensity of epidural fat is not decreased significantly on the fast spin-echo or gradient-echo T2wi. This also supports the contrast as benefit from T1wi. In the new generation 1.5-tesla machine, the resolution and contrast obtained from axial T2wi is good enough that we use only this pulse sequence together with sagittal T1wi and T2wi as the routine protocol in lumbar MRI. (Fig 2)

From our personal experience as radiologists in Siriraj Hospital, we have reported MRI of lumbar spine on daily service and found that most of them showed no serious conditions that needed prompt surgery or intervention. We also found that even in LDH, most of the information needed only one or two sagittal pulse sequences of the three routine pulse sequences [sagittal T1weighted image (T1wi.), sagittal T2weighted image (T2wi.), and axial T2wi]. If MRI is done in only one pulse sequence, the cost of study can be reduced to one-third of routine protocol cost.

The purpose of this study is to evaluate the accuracy and cost-effectiveness of using limited protocol MRI of lumbar spine compared with full protocol in patients with lumbar intervertebral disc herniation.

CHAPTER 2

REVIEW OF RELATED LITERATURE

2.1 Literature search strategy

The literature search strategy used to locate the information in this review is the Pub-MED reference database and additionally by going through the reference list of other articles and institutional database. The keywords used were **low back pain, magnetic resonance imaging, MRI, lumbar disc herniation**, and **diagnosis**. The year covered by the search was from 1960 – 2001.

2.2 Low back pain and clinical syndrome

Treating patients with low back pain can be particularly frustrating for clinicians. It is generally more useful to address three questions: (a) Is a systemic disease causing pain? (b) Is there social or psychological distress? (c) Is there neurological compromise that may require surgical evaluation? In the absence of redflags for malignancy or infection, no diagnostic study beyond the history and physical examination are required. Improvement occurs in most patients in the absence of infections, cancer or inflammatory diseases.

In the prospective study of Jonsson et al (1993) in 300 patients with lumbar nerve-root compression syndrome, there was a significant overlap between symptoms and signs of disc herniation and lateral and central spinal stenosis.[13] The pre-operative duration of symptoms was significantly shorter and root tension signs, e.g. straight leg raising test (SLRT), cross SLRT (CSLR), was more common in patients with lumbar disc herniation (LDH) than in spinal stenosis. There were also many conditions reported to be the differential diagnosis of clinically suspected LDH such as fracture of vertebral ring apophysis, migrated sequestrated disc, spondylolisthesis, higher level of LDH or spinal stenosis, epidural hematoma, and synovial cyst.[14-19] On the other hand, patients presenting with cauda equina syndrome were reported to be due to LDH.[20]

2.3 Radiological diagnosis of lumbar disc herniation

Myelography is clearly a more invasive procedure than computed tomography (CT) and MRI despite severe post dural puncture headache occurs after this procedure in 5-13% of patients.[10,11] Many reports confirmed the higher accuracy of MRI over myelography in diagnosis of herniated nucleus pulposus.[10,21-23] Albeck et al reported significant informative diagnosis of herniated nucleus pulposus by CT and MRI over myelography.[24] Forristall et al studied MRI and contrast CT of LDH in comparison and correlation with surgical findings.[18] When confirmed by surgical findings, the diagnostic accuracy of MRI is greater than CT (90.3% and 77.4% respectively). In this study, the sensitivity and specificity of MRI were 91.7% and 100% respectively. Thornbury et al reported no statistically significant difference in diagnostic accuracy among plain CT, CT myelography, and MRI in LDH causing nerve compromise.[25] However, only MRI provides information on the physicochemical changes occurring in an aging or degenerating disc. MRI is more sensitive than CT for detection of discitis and epidural abscess, which may manifest only with back pain and radicular signs.[26]

The goal of diagnostic imaging is *not only for detection of LDH*, *but also for prevention of neurologic morbidity from any causes*. The negative myelography cannot exclude conus medullaris lesion or far lateral disc herniation.[27,28] It is also problematic in case of complete block of contrast in myelography. Practically, if myelography cannot explain the clinical symptoms, MRI will be proceeded. The result from MRI usually could guide management decision or diagnosis other causes as well as LDH.

Hashimoto et al compared MRI and myelography in lumbar disc herniation and found that the sensitivity and specificity in diagnosis of unilateral single-disc herniation were very high but myelography was more accurate in multilevel disc herniation.[22] This may be due to the highly sensitive but less specific characteristics of MRI. Besides this, there may be no ideal anatomic standard to control a study of this nature. Patients managed conservatively have no anatomic proof of diagnosis and radiologically normal levels are not explored surgically. Even good gold standard cannot be achieved. Studies of asymptomatic individuals have reported false positive MRI findings of disc abnormalities in 20-52%.[29,30] In addition, the abnormal findings on MRI may not be the cause of the symptoms. So in this type of disease, the diagnostic test will

be useful only when decision of treatment based not only on the test result but also the clinical correlation.

2.4 Management of low back pain and lumbar disc herniation

In a prospective study of herniated nucleus pulposus carried out by Weber showed a significant greater proportion of satisfactory result in surgically treated group (80%) than the conservatively managed group (61%) at one year.[31] More than 85% of patients underwent surgery had a satisfactory result immediately after surgery. Obvious morphological alterations proved to be significant predictors of postoperative pain relief and improvement of disability in daily activities.[32-34]

Because of high sensitivity of MRI, the false negative rate should be very low. The chance of missed diagnosis and delayed treatment seems to be low. So most physicians recommend conservative treatment if there is no other causes of symptoms or serious pathology found.[35] If the positive result of MRI cannot explain the clinical symptoms (e.g., not correlated with side or level of symptoms), the surgeons usually operate on the suspected level and also explore the abnormal level based on MRI findings.

2.5 Studying diagnostic performance of imaging modality in lumbar disc herniation

There is no ideal gold standard in lumbar disc disease accepted. Beattie et al indicated limitation of MRI in determining diagnostic accuracy in low back pain and provided pain reproduction as a gold standard.[36] The discography is the accepted gold standard in this sense. However, the technique is invasive and difficult to interpret. Most of literatures used surgery as the gold standard. The surgical findings alone also showed some controversy, however. Too little information is available on the influence of the surgico-pathologic characteristics on the outcome of surgical intervention. Most literatures commented the large extruded disc with better outcome than contained disc herniation by conservative treatment.[32, 37]

2.6 MRI protocol for lumbar disc herniation

The lumbar spine scans generally consist of sagittal T1 or proton density images and sagittal T2wi using 4 mm thick sections. Axial proton density and T2 weighted fast spin echo images then are acquired extending from the mid L3 body level to the level of upper sacrum. Additional levels are included if degenerative changes are noted on initial sagittal images. Some centers obtain axial T1wi instead of axial T2wi arguing that T1wi offer improved spatial resolution. Newer imaging techniques such as fast spin echo result in superb image resolution.[38,39] Fast spin echo imaging allows for shorter acquisition time, while at the same time permitting long repetition times and long echo times to obtain heavily T2wi. These heavily T2wi allow for superb visualization of the thecal sac contents on axial images. Also nucleus pulposus has higher signal intensity and easier to identify and separate from surrounding dark annulus fibrosus on T2wi than on T1wi. However, ***there is no direct study comparing the various protocols in lumbar disc evaluation.*** The studies of diagnostic usefulness of MRI in LDH used different techniques in axial plane, either T1wi or T2wi.[18,22,24,29,30,40-42] However, the sagittal T1wi and T2wi were the same.

For imaging parameters, the thickness of the scan is the most important factor. Three to five millimeters thickness for both sagittal and axial scans was used in most literatures. The other parameters were not obviously different depending on the type and quality of the machines. The manufactures usually have the suitable parameters for each pulse sequences to obtain the best quality in the proper scan time.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Research question

Can limited protocol MRI of lumbar spine be used instead of full protocol MRI in patients suspected lumbar intervertebral disc herniation and candidates for surgery?

3.2 Objectives

1. To assess agreement in detection LDH between limited and full protocol MRI.

2. To evaluate the diagnostic value of limited and full protocol MRI of lumbar spine by using surgery as the gold standard in detection LDH.

3.3 Hypothesis

Research hypothesis

To determine whether limited protocol MRI can be used instead of full protocol MRI, null hypothesis of difference between two tests is tested against alternative hypothesis of equivalence of 2 tests by using L statistics.[43]

Null hypothesis: There is difference between limited protocol and full protocol MRI in diagnosis of LDH.

Alternative hypothesis: There is equivalence of both tests in diagnosis of LDH.

Statistical hypothesis

$$H_0 : P_{1+}/P_{+1} \leq \theta_0 \text{ or } P_{1+}/P_{+1} \geq \theta_1$$

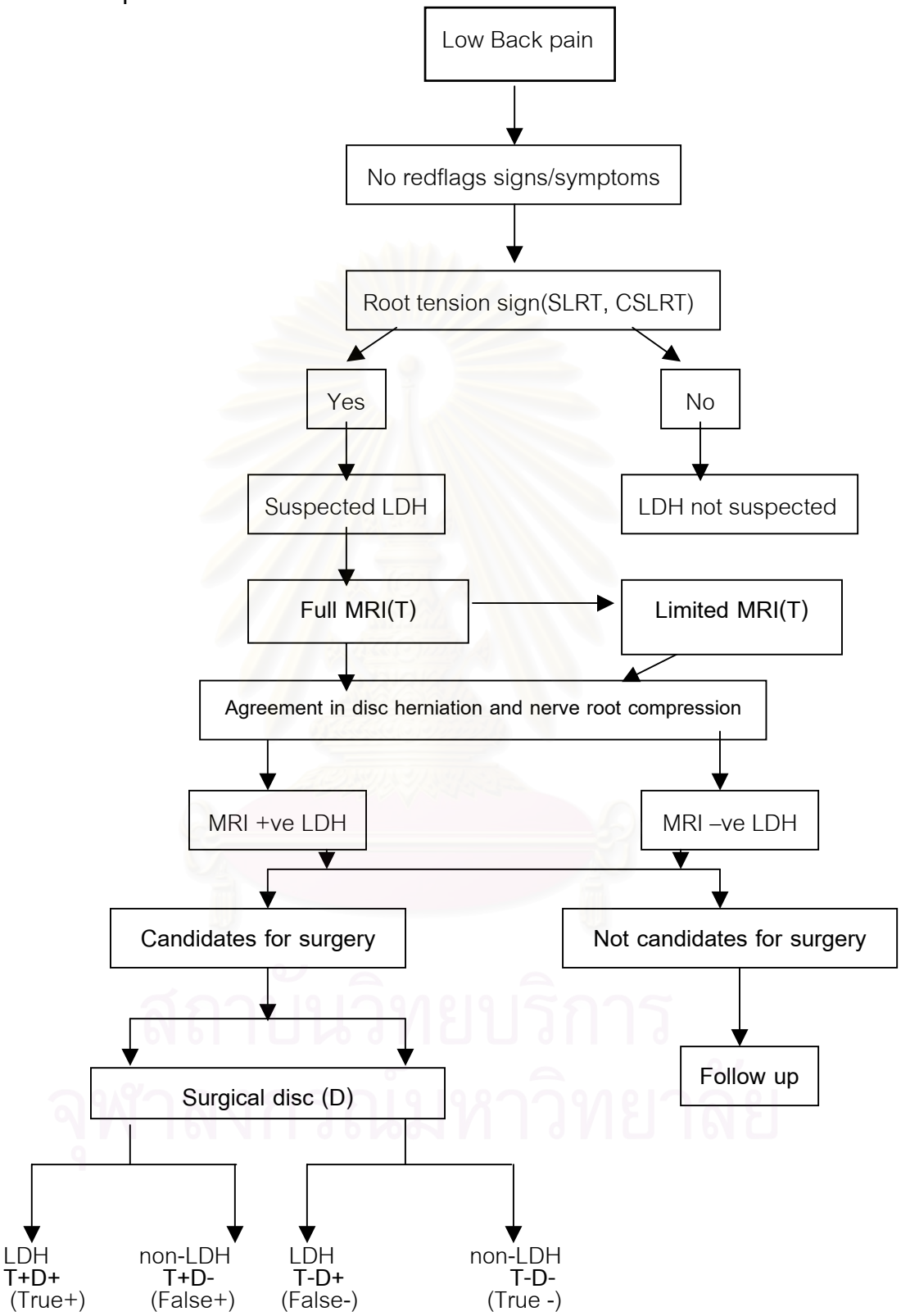
$$H1 : \theta_0 < P_{1+}/P_{+1} < \theta_1$$

P_{1+} = proportion of +ve (LDH detected) by limited protocol MRI

P_{+1} = proportion of +ve (LDH detected) by full protocol MRI

Under the predetermined half-width (w) of 0.05, if the calculated range of θ falls into the range of 0.95-1.05, the null hypothesis will be rejected.

3.4 Conceptual framework



3.5 Assumption : MRI (three pulse sequences)is the standard test for diagnosis of LDH.

3.6 Key words : Magnetic resonance imaging, MRI, lumbar disc herniation, herniated nucleus pulposus, diagnosis

3.7 Operational Definition

- **Low back pain**: pain that confines to lower part of back and waist with or without radicular or radiating pain to leg(s).The pain may be consistent or intermittent pattern.

- **Lumbar disc herniation(LDH)** : condition of herniated nucleus pulposus at the lumbar vertebral level.

- **Herniated nucleus pulposus(HNP)**: focal extrusion of the disc component out of the vertebral body margin with the maximum diameter of the herniated part more than the diameter of the attached base on imaging. (Fig 1, 3)

- **Extrusion** : extrusion of the disc out of the annulus fibrosus but still within the posterior longitudinal ligament (PLL) on surgical finding. This will be equivalent to herniated nucleus pulposus on imaging. (Fig 1,3)

- **Bulging disc** : diffuse protrusion of the disc component out of the vertebral body margin with the maximum diameter of the protruded part less than of the attached base on imaging. No predominant area of protrusion in all sagittal images. (Fig 2)

- **Protrusion** : protrusion of disc out of the vertebral body margin but within the annulus fibrosus on surgical finding. This will be equivalent to bulging disc on imaging.

- **Sequestration** : The disc component extruded out of the vertebral body margin without connection with the mother disc.(Fig 1)

- **Redflags**: signs that indicate possibility of malignancy, infection, inflammation or trauma.

- **Full protocol MRI of lumbar spine**: MRI of lumbar spine protocol used as routine service in Department of Radiology, Siriraj Hospital. It composes of sagittal T1wi., sagittal T2wi and axial T2wi.

- **Limited protocol MRI of lumbar spine**: sagittal T2wi of MRI from the full study technique.

- **Nerve compression**: evidence on MR images or surgical finding that the nerve roots are displaced from its usual position with no fatty tissue separating between the nerves and the surrounding structures.

- **Health status assessment** : assessment of the patients' health status by using Roland Disability Questionnaire (24 points).

- **Gold standard** : surgical findings of anatomic morphology of the operated disc.

- **Suspected LDH** : patients with signs and symptoms suspected LDH such as short duration of onset of symptoms, pain on coughing, pain at rest/night, SLR/CSLR, signs and symptoms of focal nerve root compromise

- **Candidates for surgery** : patients with low back pain who have indication for surgery which are (1) cauda equina syndrome, (2) profoundly and progressively severe neurological deficit, (3) unresponsive intractable pain, and (4) progressive neurological loss not demonstrate an improvement trend in approximately 6 weeks conservative treatment.

- **Contraindication for MRI** : (1) patients with pace-maker, (2) intracranial aneurysmal clip, (3) intra-occular metallic foreign body, (4) Claustrophobia.

3.8 Research Design

-Equivalence study

-Diagnostic cross-sectional study

3.9 Research Methodology

Population

1.1 ***Target population*** : Patients suspected of LDH (as described in operational definition) coming to Siriraj Hospital.

1.2 ***Studied population*** : Patients suspected of LDH coming to Department of Radiology, Siriraj Hospital and requested for full protocol lumbar MRI and no contraindication for MRI.

1.3 ***Eligible criteria***

Inclusion criteria

1. Clinically suspected LDH

2. Age 20-60 years old.
3. Requested for routine protocol of MRI lumbar spine.
4. Willing to enroll into the study and inform consent.

Exclusion criteria

1. Post-surgery of spine.
2. History of spinal trauma.

3.10 Sample size

The sample size estimation was based on the primary objective of the study to test if proportion of LDH from limited protocol MRI is equivalent to that from full protocol MRI. When the observations are paired and dichotomous, comparison of a new test with the previously existed test to evaluate the equivalence of the two tests can be done by using extension of McNemar's test, the so called L statistics.[38] The compound null hypothesis of significant difference in proportion of LDH detected by full protocol MRI and limited protocol MRI is tested against the alternative hypothesis of equivalence between full protocol MRI and limited protocol MRI. Calculation of sample size is then based on 95%CI of the ratio of LDH detected by limited protocol MRI to LDH detected by full protocol MRI, P_{1+}/P_{+1} as shown in the following formula.

		Full MRI		
		+	-	Total
Limited MRI	+	P_{11}	P_{12}	P_{1+}
	-	P_{21}	P_{22}	$1-P_{1+}$
Total		P_{+1}	$1-P_{+1}$	1

$$N = Z^2_{1-\alpha/2} [P_{1+}(P_{12} + P_{21})] / [w^2 P^3_{+1}]$$

where P_{1+} = probability of positive result from the limited protocol MRI.

P_{+1} = probability of positive result from the full protocol MRI .

P_{12} = probability of a randomly chosen subjects falling into the category positive limited MRI and negative full MRI.

P_{21} = probability of a randomly chosen subjects falling into the category positive full MRI and negative limited MRI.

α= type I error = 0.05 (2-sided)

w = half-width =0.05

In clinical experience, the clinically suspected LDH can be predicted in 75-80% of cases.[39,40] We assumed that the prevalence of LDH detected by full protocol MRI in our institute was 0.8. So it was expected that P_{+1} = 0.8. The limited protocol MRI was also expected to have less positive result of LDH detected than full protocol MRI, then P_{1+} = 0.75, P_{12} = 0, P_{21} =0.05 as displayed in the Table 2.

Table 2 Expected positive and negative results of LDH detected by full and limited MRI

		Full MRI		
		+	-	Total
Limited MRI	+	0.75	0	0.75
	-	0.05	0.2	0.25
Total		0.8	0.2	1

Thus, for α = 0.05 and half-width w = 0.05, the required sample size was at least 113 subjects. Therefore n = 120 were studied.

3.11 Intervention The routine full protocol lumbar MRI composes of sagittal T1wi, sagittal T2wi, and axial T2wi. The study was done with 1.5 tesla machine (Philips ASCII) in Department of Radiology, Siriraj Hospital as a routine service. The sagittal T1wi was done in spin echo technique. The sagittal and axial T2wi were done in turbo spin echo technique. The parameters for each pulse sequence are shown in Table 3.

Table 3 Parameters of pulse sequences used in MRI lumbar spine

Pulse sequence	TR(msec)	TE(msec)	Thickness/gap(mm)	FOV(mm)	NSA
Sagittal T1wi	400-600	12-15	4/0.4	280-300	6
Sagittal T2wi	2000-2600	120-150	4/0.4	280-300	6
Axial T2wi	2200-2900	100-150	3/0.3	220	8

TR=repeated time, TE=echo time, FOV=field of view, NSA=number of signal acquisition

3.12 Outcome Measurement

3.12.1 ***Main outcomes*** : Proportions of positive and negative test result (LDH) of limited and full protocol MRI.

3.12.2 ***Variable to be measured***

1. Administrative variables : Name ,address, telephone, HN

2. Zero state variables :

- Age (year)
- Gender
- Roland disability score of 0-24 (24 = healthy person) to assess the heterogeneity of severity of the study population.
- Duration of pain(months) before seeing the physicians.

3. Outcome variables :

- MRI Data

  # Disc : negative = normal /bulging
  positive = herniation/sequestration

  # Nerve root compression : negative = no
  positive = yes

  # Other abnormality

- Surgical data (in cases that surgery had been done after MRI study)

  # Disc : negative = normal/protrusion
  positive = extrusion/sequestration

  # Nerve root compression : negative = no
  positive = yes

  # Other abnormalities

3.13 Data collection

1. General data and clinical assessment were collected by research nurse in the team when patients came to the MRI unit before the MRI examination.

2. The MRI were done by the 1.5 Tesla machine (ACS III, Philips) in Department of Radiology as routine protocol. The parameters and pulse sequences are described in section 3.11.

3. The limited and full protocol MRI data were interpreted blindly from clinical information and separately by three radiologists (with more than 3 years of experience in radiology). Each radiologist interpreted each set of imaging protocol at least 3 weeks separately to prevent memory bias from previously seen image. For example, the full protocol set interpreted today would be kept for at least 3 weeks, then the limited protocol set of the same patients (sagittal T2wi) were given to the same radiologist for interpretation. The case record forms for both protocols were the same form.

Both sets of interpretation from each radiologist were analyzed separately. The images were repeatedly interpreted together to make the consensus when there was any discordance between the 3 radiologists for the same patient(s) and protocol. Then the final result was analyzed.

4. The surgical finding was recorded by the surgeons.

3.14 Statistical analysis

Baseline characteristics (age, gender and severity of disease) of all patients suspected of LDH were presented as mean, standard deviation and percentage as appropriate. Severity of disease was classified as severe, moderate, mild and normal according to the Roland disability score of 0-7, 8-15, 16-23 and 24 respectively.

Agreement between each pair of three radiologists (inter-observer reliability) on limited and full protocol MRI data were evaluated using unweighted Kappa statistic.

Because of time constraint, the intra-observer reliability was assessed in only one radiologist using unweighted Kappa statistic. The assessment was done at least two weeks apart.

To determine whether limited protocol MRI can be used instead of full protocol MRI, null hypothesis of difference between two tests was tested against alternative hypothesis of equivalence of 2 tests by using L statistics. Detailed computation is displayed in Section 1 of Table 4.

For the secondary objectives of the study to evaluate sensitivity, specificity, accuracy, predictive value and likelihood ratio of limited MRI and full protocol MRI, 2x2 tables were constructed using surgical finding as a gold standard (Section 2 of Table4.).

Table 4 Dummy tables for evaluation of limited and full protocol MRI

1. Limited MRI vs. Full protocol MRI

		Full MRI		
		+	-	Total
Limited MRI	+	p_{11}	p_{12}	p_{1+}
	-	p_{21}	p_{22}	p_{2+}
Total		p_{+1}	p_{+2}	1.0

Let p_{1+} = sample proportion of +ve (LDH detected) by limited protocol MRI

p_{+1} = sample proportion of +ve (LDH detected) by full protocol MRI

H_0 : $P_{1+}/P_{+1} \leq \theta_0$ or $P_{1+}/P_{+1} \geq \theta_1$

$H_1 : \theta_0 < P_{1+}/P_{+1} < \theta_1$

Under the predetermined half-width (w) of 0.05, if the calculated range of θ falls into the range of 0.95-1.05, the null hypothesis will be rejected.

2. Sensitivity and specificity of limited and full protocol MRI

		Gold standard (Surgery)		
		+ (LDH)	- (Non-LDH)	Total
Full MRI	+	a	b	a+b
	-	c	d	c+d
Total		a+c	b+d	a+b+c+d

		Gold standard (Surgery)		
		+(LDH)	- (Non-LDH)	Total
Limited MRI	+	q	r	q+r
	-	s	t	s+t
Total		q+s	r+t	q+r+s+t

3.15 Ethical consideration

The routine service of MRI lumbar spine was performed for all patients requested from the clinicians as usual. No additional intervention or cost was given. Also MRI is a safe diagnostic procedure.[46]The study protocol was explained to the patients and informed consent was obtained in all cases.

3.16 Limitations

This study was performed under the economic constrain and after universal coverage scheme launched. The patients enrolled in the study may be selectively biased from only who could pay the MRI examinations. Patients who could not pay for the examination such as labors mostly had symptoms after loading work and this would cause subgroup of traumatic disc herniation drop out from the study. Generalization may be limited.

To study diagnostic performance of a test, the gold standard and the test should not see each other before conclusion. But in our study we could not blind the surgeons from the imaging findings because of the ethical issue. Also many cases were not operated but conservatively treated. The operated cases were explored only clinically suspected levels. This made negative result could be evaluated only in cases with other diagnosis such as spinal stenosis from other causes or spondylolisthesis. All of these have some power on the result of the diagnostic performance of the tests. Also the negative levels were not operated making low power of diagnostic performance.

3.17 Expected outcome and benefits

The limited protocol MRI may be cost-effectiveness for diagnosis of patients with lumbar disc herniation. Most patients with lumbar disc herniation can be diagnosed clinically. Surgeons use imagings to confirm and also as the documents for preoperative diagnosis. Decision for operation does not depend on the imaging findings alone. From this reason, the only needed information in cases with strong clinical diagnosis is yes or no for disc herniation. In the situation of economic constrain, limited protocol may be useful for this purpose.

3.18 Obstacles

The first problem was radiologists had to interpret imagings in a limited time. This causes delayed conclusion of the study. So the intra-observer reliability was done only in one radiologist (O.C-author). The quality of the MRI was not constant. It depends on many factors including the status of the machine, and the body of the patients themselves. This influences judgment of interpretation and caused radiologists used their own experience to interpret the findings. Also not all surgeons who operated the patients were in our team. So the operative findings mostly were from the medical records not from the designed record form. The last problem was that most patients were not operated and improved conservatively.

CHAPTER 4

RESULTS

4.1 Demographic and baseline data

One hundred and twenty-three patients suspected of lumbar disc herniation who met the eligible criteria were enrolled into the study during March 2002-January 2003 at Department of Radiology, Faculty of Medicine Siriraj Hospital. Among 123 patients, 62 were female and 61 were male. The range of age was 21-60 years with mean of 42.9 years. The duration of pain before performing the MRI were between 1 and 204 months with mean 31.2 months. The severity of pain was summarized in Table 5.

Table 5 Severity of pain according to Roland's disability score.

Grading of severity	Number of patients(%)
Mild	29 (23.6%)
Moderate	56 (45.5%)
Severe	38 (30.9%)

4.2 Outcome analysis

4.2.1 Reliability analysis : The three radiologists are now called #1, #2, and #3.

4.2.1.1 By interspace analysis

Radiologist #1 and #2 interpreted the MRI findings for each patient from intervertebral disc spaces of first lumbar through first sacrum. So 5 levels (L1-2, L2-3, L3-4, L4-5, L5-S1) on each sides (right and left) resulted in 10 interspaces for each patient. Then a total of 1230 interspaces were analyzed. The prevalence of disc herniation and nerve root compression observed by radiologist #1 and #2 were shown in Table 6. Regarding interspace analysis, agreement between two radiologists assessing limited protocol MRI was fair for both disc herniation and nerve root compression.(k =0.27, 0.23 respectively) The agreement was fair in disc herniation (k=0.27) and good in nerve root compression (k=0.66) on full protocol MRI. Summarized result of inter-observer agreement was shown in Table 7.

Because of time limitation, the intra-observer agreement by interspace analysis was not done.

Table 6 Prevalence of LDH and nerve root compression observed by radiologist #1 and #2. (n=1230 by interspace and 123 by subject respectively)

		Disc herniation		Nerve root compression	
		Interspace(%)	Subject(%)	Interspace(%)	Subject(%)
Radiologist #1	Limited MRI	121(9.8%)	54(43.9%)	17(1.4%)	11(8.9%)
	Full MRI	157(12.8%)	67(54.5%)	71(5.8%)	68(55.3%)
Radiologist #2	Limited MRI	23(1.9%)	17(13.8%)	33(2.7%)	47(38.2%)
	Full MRI	27(2.2%)	23(18.7%)	114(9.3%)	50(40.7%)

Table 7 Inter-observer agreement between radiologist #1 and #2 by interspace analysis (kappa, 95%CI))

	Limited MRI	Full MRI
Lumbar disc herniation	0.27(0.18, 0.36)	0.27(0.18, 0.35)
Nerve root compression	0.23(0.07, 0.38)	0.66(0.58, 0.74)

4.2.1.2 By subject analysis

The findings of LDH and nerve root compression for each patient and each protocol were concluded as yes or no without considering the level or side. These data were analyzed by subject. So a total of 123 subjects were analyzed.

The intra-observer reliability evaluated in radiologist #3 was found to be excellent to good in interpretation of disc herniation and nerve root compression on both limited and full protocol MRI as shown in Table 8. Regarding inter-observer reliability, the agreement between radiologist #1 and #2 was fair for diagnosis of disc herniation on both limited and full protocol MRI. The agreement of disc herniation between radiologist#1 and #3 was fair on both limited and full protocol MRI. For agreement of radiologist #2 and #3 in disc herniation, the result was fair on both limited and full protocol MRI. The details of Kappa values were presented in Table 9.

Table 8 Intra-observer agreement of radiologist #3 , kappa statistic (95%CI)

	Limited protocol MRI	Full protocol MRI
Lumbar disc herniation	0.78(0.67, 0.89)	0.75(0.63, 0.86)
Nerve root compression	0.82(0.64, 0.98)	0.86(0.71, 1.0)

Table 9 Inter-observer agreement of three radiologists, kappa statistic (95%CI)

	Disc herniation		Nerve root compression	
radiologist	Limited MRI	Full MRI	Limited MRI	Full MRI
#1 VS #2	0.32(0.19,0.46)	0.33(0.20, 0.45)	0.20(0.05,0.36)	0.59(0.45,0.72)
#2 VS #3	0.36(0.22, 0.50)	0.44(0.29, 0.59)	0.44(0.29, 0.59)	0.50(0.37, 0.64)
#1 VS #3	0.50(0.35, 0.66)	0.57(0.43, 0.71)	0.16(0.07, 0.25)	0.60(0.46, 0.74)

The agreement in nerve root compression for each pair of radiologists were fair to good on full protocol MRI but rather poor on limited protocol MRI. The possible reason will be discussed in next chapter.

4.2.2 Primary objective analysis

From the L statistics, to determine whether limited protocol MRI can be used instead of full protocol MRI, null hypothesis of difference between two tests was tested against alternative hypothesis of equivalence of 2 tests. Conclusion on disc herniation and nerve root compression in each subject was based on consensus from three radiologists.

		Full MRI		
		+	-	Total
Limited MRI	+	p_{11}	p_{12}	p_{1+}
	-	p_{21}	p_{22}	p_{2+}
Total		p_{+1}	p_{+2}	1.0

Let p_{1+} = sample proportion of +ve by limited protocol MRI

p_{+1} = sample proportion of +ve by full protocol MRI

H_0 : $P_{1+}/P_{+1} \leq \theta_0$ or $P_{1+}/P_{+1} \geq \theta_1$

$H_1 : \theta_0 < P_{1+}/P_{+1} < \theta_1$

1. For disc herniation

		Full MRI		
		+	-	Total
Limited MRI	+	45	4	49
	-	2	72	74
Total		47	76	123

So $p_{1+} = 49/123$, $p_{+1} = 47/123$

Then $p_{1+}/p_{+1} = (49/123)/(47/123)$

$\theta = 1.04$

95% CI for $\theta = \theta \pm 1.96\sqrt{Var(\theta)}$

$= 1.04 \pm 1.96\sqrt{n_{1+}(n_{12}+n_{21})/(n_{+1})^3}$

$= 0.94, 1.14$

2. For nerve root compression

		Full MRI		
		+	-	Total
Limited MRI	+	45	3	48
	-	19	56	75
Total		64	59	123

So $p_{1+} = 48/123$, $p_{+1} = 64/123$

Then $p_{1+}/p_{+1} = (48/123)/(64/123)$

$\theta = 0.75$

95% CI for $\theta = \theta \pm 1.96\sqrt{Var(\theta)}$

$= 0.75 \pm 1.96\sqrt{n_{1+}(n_{12}+n_{21})/(n_{+1})^3}$

$= 0.63, 0.87$

The null hypothesis was rejected in lumbar disc herniation and accepted in nerve root compression. This means that for detection of lumbar disc herniation, the limited protocol MRI can replace full protocol MRI. However, because the 95%CI (0.94, 1.14) is not in the predetermined range (0.95-1.05), the detection is not statistically

significant. For nerve root compression, the limited protocol MRI cannot replace full protocol MRI.

4.2.3 Secondary objective analysis

Of the total 123, 54 patients were treated conservatively and had some improvement after being treated of 3-6 months. There were 33 patients operated on the suspected lumbar levels. Thirty-six patients were loss follow up or treated outside the hospital.

Of the 33 operated cases, herniated disc with nerve root compression were found in 22 , herniated disc without nerve root compression in 1, no herniated disc but nerve root compression from other causes mostly spinal stenosis in 9, and only mild bulging disc without nerve root compression in 1 case. The detail of operated cases was summarized in Table 10.

Table 10 Surgical findings of operated cases (n=33)

Findings	Number
Disc herniation	**23**
With nerve root compression	22
Without nerve root compression	1
No disc herniation	**10**
Spondylolisthesis with nerve root compression	4
Spinal stenosis with nerve root compression	4
Bulging disc/osteophyte with nerve root compression	1
Bulging disc without nerve root compression	1

4.2.3.1 Diagnostic performance of each test.

The diagnostic performance was analyzed in 33 operated patients by using surgical findings as the gold standard. The details of 2 x 2 table and values of diagnostic test were summarized in the Table 11 and 12.

Table 11 The 2x2 table of limited and full protocol MRI

1.Detection of lumbar disc herniation

		Surgery		
		+ (LDH)	- (Non-LDH)	Total
Full MRI	+	19	3	22
	-	4	7	11
Total		23	10	33

		Surgery		
		+(LDH)	- (Non-LDH)	Total
Limited MRI	+	19	2	21
	-	4	8	12
Total		23	10	33

2.Detection of nerve root compression

		Surgery		
		+ (nerve root compression)	- (no nerve root compression)	Total
Full MRI	+	25	0	25
	-	6	2	8
Total		31	2	33

		Surgery		
		+(nerve root compression)	- (no nerve root compression)	Total
Limited MRI	+	17	0	17
	-	14	2	16
Total		31	2	33

Table 12 Diagnostic performance of the limited and full protocol MRI with their 95%CI

		Sensitivity(%) (95%CI)	Specificity(%) (95%CI)	Accuracy(%) (95%CI)	PPV(%) (95%CI)	NPV(%) (95%CI)	LR(+)
Limited MRI	LDH	82.6 (62.9, 93.0)	80 (49.0, 94.3)	81.82	90.5 (71.1, 97.3)	66.7 (39.1, 86.2)	4.13
	Nerve root	54.8 (37.8, 70.8)	100.0 (34.2, 100.0)	57.58	100 (81.6, 100.0)	12.5 (3.5, 36.0)	-
Full MRI	LDH	82.61 (62.9, 93.0)	70 (39.7, 89.2)	78.79	86.4 (66.7, 95.3)	63.6 (35.4, 84.8)	2.75
	Nerve root	80.6 (63.7, 90.8)	100 (34.2, 100.0)	81.82	100 (86.7, 100.0)	25.0 (7.1, 59.1)	-

PPV = positive predictive value, NPV = negative predictive value, LR(+) =likelihood ratio positive

Nerve root = nerve root compression

4.2.3.2 Comparison of diagnostic performance between limited and full protocol.

1. Sensitivity (by using exact binomial test because of small sample size)

Table 13 The 2x2 table comparison of sensitivity.

(a) When surgical finding is positive for disc herniation :

		Full MRI		Total
		LDH(+)	LDH(-)	
Limited MRI	LDH(+)	18	1	19
	LDH(-)	1	3	4
		19	4	23

The difference between the sensitivity of full and limited protocol MRI = 0 with 95% CI = (-16.5%, 16.5%)

p = 1

(b)When surgical finding is positive for nerve root compression :

		Full MRI		Total
		(+)	(-)	
Limited MRI	(+)	17	0	17
	(-)	8	6	14
		25	6	31

The difference between the sensitivity of full and limited protocol MRI = 25.8% with 95% CI = (8.6%, 41.2%) and p =0.0047 .

2. Specificity (by using exact binomial test because of small sample size)

Table 14 The 2x2 table comparison of specificity

When surgical finding is negative for disc herniation :

		Full MRI		Total
		(+)	(-)	
Limited MRI	(+)	2	0	2
	(-)	1	7	8
		3	7	10

The difference between the specificity of full and limited protocol MRI = 10% with 95% CI = (-17.3%, 36.4%) and p =1

When surgical finding is negative for nerve root compression(n=2), both limited and full protocol MRI interpreted negative in all cases. So the specificity of both tests are equal.

In conclusion : IIn patients suspected LDH whom MRI were requested, there was statistical significance of the difference of sensitivity of limited and full protocol MRI in diagnosis of nerve root compression. There was no detectable difference of sensitivity in diagnosis of lumbar disc herniation, specificity in diagnosis of disc herniation or nerve root compression between limited and full protocol MRI.

CHAPTER 5

DISCUSSION

5.1 Operational definition of image interpretation

Many terminology classifications were purposed in describing pathology of lumbar disc herniation. Surgical approach and imaging approach often contradict. American Society of Neuroradiology, American Society of Spine Radiology and North American Spine Society recommended nomenclature and classification of lumbar disc pathology adapted from Milette PC.[47] In this recommendation a herniated disc means the observation of displacement of disc material beyond the edges of ring apophyses less than 50% of the circumference of the disc in axial plane and beyond the limit of intervertebral space in sagittal plane. A protrusion and extrusion differ in the maximum cranio-caudal diameter of the herniated part compared with edge of the base. For a protrusion, the herniated distance is less than its base whereas in an extrusion the distance is greater than its base. (Fig 1) This nomenclature cannot describe bulging disc in sagittal plane. A bulging disc was defined in axial plane, however. When the cranio-caudal distance is less than its base, it could be both bulging and herniated disc. In practice, partial volume averaging can cause images appearing focal herniation in axial plane if the plane of scan is not exactly parallel with disc space especially in very narrowed disc from pathologic degeneration. In our study we found that careful evaluation the shape of the disc in sagittal plane in every image scan can separate the bulging disc from protruded disc. If the displaced disc was seen in nearly all sagittal images, it could be bulging disc. If the displaced disc was seen focally or predominantly in one area, it could be protrusion.

Contained disc or low volume of displaced disc material was found to have better outcome treated by conservative way compared with non-contained or low volume herniated disc.[9,48] Usually imaging finding of contained disc is the same as protrusion which has cranio-caudal distance of herniated part less than its base.[9,48] In this point, imagings help in selecting patients candidate for early surgery.

From both reasons above, we decided to include protrusion in Milette's nomenclature into bulging disc if no predominant area of protrusion seen in all images of sagittal T2-wi. There may be the reason that made the limited protocol MRI agree with full protocol MRI.

5.2 Is the limited protocol MRI enough for diagnosis of disc herniation?

Our study demonstrated that though the equivalence test between sagittal T2-wi and full protocol MRI for evaluating whether there is herniated disc or not is falling into the accepted range but this finding does not show statistical significance (as the 95%CI fell outside the predetermined accepted range). This may be because of not enough sample size. The limited protocol MRI also cannot be used to evaluate the nerve root compression.

Considering diagnostic performance of the test, in this point, the good test should have low false positive. Because LDH can be treated conservatively, so operation in patients with no LDH (also no other causes) makes more harm than not operated on patients with LDH (false negative test). In another words, we need a test which has high specificity or high positive predictive value (PPV) and acceptable sensitivity or negative predictive value (NPV). In this study we found that full protocol MRI had specificity of 70% and PPV of 86.36%(LR positive of 2.75) approximately the same as other study (specificity = 70%, LR positive = 2.8).[10] When compared with limited protocol MRI which has specificity of 80% and PPV of 90.48% (LR positive of 4.13), the diagnostic performance of limited protocol is better than full protocol. We think that the way radiologists interpreted the images influences the result. In limited protocol, radiologists tried to interpret the findings using the predetermined operational definition. But in full protocol, radiologists interpreted the findings by using their own previous experience. The axial T2wi influenced decision making more than sagittal T2wi and caused over reading (more false positive).

For nerve root compression, sagittal T2wi cannot give information as axial T2wi do. This made lower accuracy and more false negative. Though the sensitivity of nerve root compression in full protocol is significantly better than limited protocol, the specificity is the same. In the point of patient management, surgeons usually consider

nerve root compression on the patients' signs and symptoms. Also they can better evaluate nerve root compression in the operative field. Pain can also be from other causes such as refer pain from annular tear. In conclusion, the decision of operation for nerve root decompression is from signs and symptoms rather than from imaging findings.

Patients or subjects in our study were only cases suspected LDH and could pay the MRI examination. This influenced limitation of the study for diagnostic performance in general use. We cannot conclude the findings for all cases with low back pain but only whom clinically diagnosed or suspected LDH. The prevalence of detected LDH by MRI is about half of the total cases whereas the prevalence of operated cases is about 70%. The true predictive values may be changed according to the prevalence of the population. Further study to assess the diagnostic performance of the tests is needed such as follow up for the non-operated cases. This will cost more time and money.

5.3 Reliability study of the radiologists.

The intra-observer agreement was good (radiologist #3) that implies reliable interpretation of the images. The inter-observer agreements in LDH were not so good between radiologist #2 and #1 or #3 especially in full MRI. This may be because the basic knowledge of radiologist#2 differed from #1and #3. The inter-observer agreements in nerve root compression on limited protocol were very low between radiologist #1 and #2 or #3. This may be because radiologist#1 believed that nerve root compression can be evaluated only in axial plane (instrument bias). Raininko R, et al (1995) studied about inter-observer agreement in assessment of disc herniation using the same protocol as our study and found that kappa coefficient was 0.30.[40] Brant-Zawadski M, et al (1995) also studied inter-observer agreement by using two nomenclature of interpretation of disc abnormality.[41] They found that the kappa statistics was good (0.61). Their results were not so different from ours (0.32-0.59).

However, we found that controlling observers to interpret the findings as define in operational definition was difficult especially in experienced radiologists with high self confidence. This may be another bias in this study.

Conclusion

The limited protocol MRI (sagittal T2wi) may be enough for evaluating lumbar disc herniation before surgery in cases of clinically suspected LDH but not enough for evaluating nerve root compression.

Recommendation

If, after completing the initial evaluation of a patient with back or radicular pain, a clinician arrives at working diagnosis of an herniated disc as the cause of the patient's symptoms, treatment usually can be initiated without the performance of an imaging study. Only when therapy is unsuccessful, a precise anatomic diagnosis is needed to guide therapeutic decisions. Imaging studies certainly have a role in selecting surgical candidate, but they probably have an equally important role when there is diagnostic uncertainty and the patient is not responding to appropriate conservative care. The documentation of a normal lumbar spine may be as important to patient care as demonstrating discal abnormality when a patient does not respond to the treatment. We recommend that sagittal T2wi may be enough in this patient. If there are any other abnormalities more than disc herniation detected on the images, the full protocol MRI should be performed. Or if the image shows negative finding for LDH, the full protocol MRI should be perform for evaluating of lateral nerve root compression.

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APPENDICES

APPENDIX 1

ข้อมูลที่ผู้ป่วยควรทราบ

(Participant information sheet)

ชื่อโครงการวิจัย การวินิจฉัยโรคหมอนรองกระดูกสันหลังส่วนเอวยื่นกดทับรากประสาทโดยวิธีการสร้างภาพเอมอาร์ไอท่าเดียว

เรียน ผู้ป่วยทุกท่าน

ท่านเป็นผู้ได้รับเชิญจากแพทย์ให้เข้าร่วมการศึกษาการวินิจฉัยโรคหมอนรองกระดูกสันหลังส่วนเอวโดยการสร้างภาพเอมอาร์ไอท่าเดียว ก่อนที่ท่านจะตกลงเข้าร่วมการศึกษาดังกล่าว ขอเรียนให้ท่านทราบถึงเหตุผลและรายละเอียดของการศึกษาวิจัยในครั้งนี้

ข้อมูลทั่วไป โรคหมอนรองกระดูกส่วนเอวยื่นกดทับรากประสาทเป็นโรคที่พบมากที่สุดในวัยทำงาน ทำให้สูญเสียทรัพยากรของชาติจำนวนมากทั้งในด้านการตรวจวินิจฉัยและการรักษา การรักษาโดยการผ่าตัดผู้ป่วยจะหายจากอาการในเวลาที่รวดเร็วกว่า ส่วนการรักษาโดยไม่ผ่าตัดก็ให้ผลในระยะยาวเท่ากัน การตรวจภาพทางรังสีก่อนผ่าตัดเป็นสิ่งจำเป็น วิธีที่ดีที่สุดคือการตรวจด้วยเอมอาร์ไอ ซึ่งมีราคาแพงโดยตรวจสามท่าตามมาตรฐาน ในทางปฏิบัติ บางครั้งภาพท่าเดียวก็สามารถให้ข้อมูลเพียงพอต่อการวินิจฉัยโรค.

ข้อมูลของโครงการ วัตถุประสงค์ในการทำวิจัย เพื่อหาความเป็นไปได้ในการวินิจฉัยโรคหมอนรองกระดูกด้วยการสร้างภาพเอมอาร์ไอท่าเดียว

หากท่านตกลงที่จะเข้าร่วมการศึกษาวิจัยนี้ จะมีข้อปฏิบัติร่วมดังต่อไปนี้

วิธีการวิจัย ผู้ป่วยที่แพทย์สงสัยว่าจะเป็นโรคหมอนรองกระดูกสันหลังส่วนเอวกดทับรากประสาทที่มารับการรักษาในโรงพยาบาลศิริราช และได้รับการส่งตรวจเอมอาร์ไอกระดูกหลังส่วนเอวเพื่อประกอบการวินิจฉัยและการรักษาตามปกติ นอกเหนือจากการตรวจตามปกติ คณะวิจัยจะทำการซักประวัติตามแบบสอบถาม และเก็บบันทึกข้อมูลทางคลินิก, ผลอ่านเอมอาร์ไอ, และสิ่งที่พบจากการผ่าตัดในกรณีที่ผู้ป่วยได้รับการรักษาโดยการผ่าตัด

ความเสี่ยงที่อาจเกิดขึ้น การตรวจด้วยเอมอาร์ไอเป็นการตรวจสร้างภาพของอวัยวะภายในอย่างหนึ่งที่ใช้หลักการของการกำธรของคลื่นแม่เหล็กซึ่งมีความปลอดภัยสูงและไม่มีผลข้างเคียงจากรังสีใดๆ อย่างไรก็ตามผู้ป่วยที่ติดเครื่องกระตุ้นหัวใจซึ่งทำงานด้วยหลักการคล้ายกันเมื่อเข้าไปในเครื่องอาจจะมีผลต่อการทำงานของเครื่องกระตุ้นหัวใจได้ ก่อนตรวจแพทย์และเจ้าหน้าที่จะสอบถามผู้ถูกตรวจก่อน รวมทั้งผู้ป่วยที่มีสารเหนี่ยวนำแม่เหล็กอยู่ในร่างกาย จะไม่ทำการตรวจด้วยวิธีนี้ ผู้ป่วยจะได้รับการตรวจรักษาตามมาตรฐานปกติ

ประโยชน์ที่คาดหวัง คาดว่าจะสามารถนำผลที่ได้ไปใช้กับผู้ป่วยอื่นได้ และสามารถลดค่าใช้จ่ายในการวินิจฉัยโรคได้

การเข้าร่วมการศึกษานี้ เป็นไปโดยสมัครใจ ท่านอาจจะปฏิเสธที่จะเข้าร่วม หรือถอนตัวจากการศึกษานี้ได้ทุกเมื่อ โดยไม่กระทบต่อการดูแลรักษาที่ท่านจะได้รับจากแพทย์

ประการสำคัญที่ท่านควรทราบคือ

ผลของการศึกษานี้จะใช้สำหรับวัตถุประสงค์ทางวิชาการเท่านั้น โดยข้อมูลต่างๆจะถูกเก็บไว้ในคอมพิวเตอร์ และไม่มีการแพร่งพรายสู่สาธารณะชน ขอรับรองว่าจะไม่มีการเปิดเผยชื่อของท่านตามกฎหมาย

หากท่านมีปัญหาหรือข้อสงสัยประการใด กรุณาติดต่อ แพทย์หญิงอรสา ชวาลภาฤทธิ์ ภาควิชารังสีวิทยา หมายเลขโทรศัพท์ 02-419-7086 ซึ่งยินดีให้คำตอบแก่ท่านทุกเมื่อ

ขอขอบคุณในความร่วมมือของท่านมา ณ ที่นี้

APPENDIX 2

CONSENT FORM

แบบยินยอมเข้าร่วมการวิจัย(จุฬา)

การวิจัยเรื่อง การวินิจฉัยโรคหมอนรองกระดูกส่วนเอวยื่นกดทับรากประสาทโดยวิธีการสร้างภาพเอมอาร์ไอท่าเดียว

วันให้คำยินยอม วันที่……เดือน……..พ.ศ……

ก่อนที่จะลงนามในใบยินยอมให้ทำการวิจัยนี้ ข้าพเจ้าได้รับการอธิบายจากผู้วิจัยถึงวัตถุประสงค์ของการวิจัย วิธีการวิจัย หรืออันตรายที่อาจเกิดขึ้นจากการวิจัยรวมทั้งประโยชน์ที่จะเกิดขึ้นจากการวิจัยอย่างละเอียดและมีความเข้าใจดีแล้ว

ผู้วิจัยรับรองว่าจะตอบคำถามต่างๆที่ข้าพเจ้าสงสัยด้วยความเต็มใจไม่ปิดบังซ่อนเร้นจนข้าพเจ้าพอใจ

ข้าพเจ้ามีสิทธิที่จะของดการเข้าร่วมโครงการวิจัยนี้เมื่อไรก็ได้ และเข้าร่วมโครงการวิจัยนี้โดยสมัครใจ การงดการเข้าร่วมการวิจัยนี้จะไม่มีผลต่อการได้รับบริการหรือการรักษาที่ข้าพเจ้าจะได้รับแต่ประการใด

ผู้วิจัยรับรองว่าจะเก็บข้อมูลเกี่ยวกับตัวข้าพเจ้าเป็นความลับ และจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย การเปิดเผยข้อมูลของข้าพเจ้าต่อหน่วยงานต่างๆที่เกี่ยวข้อง กระทำได้เฉพาะกรณีจำเป็น ด้วยเหตุผลทางวิชาการเท่านั้น

ข้าพเจ้าได้อ่านข้อความข้างต้นแล้ว และมีความเข้าใจดีทุกประการ และได้ลงนามในใบยินยอมนี้ด้วยความเต็มใจ

ลงชื่อ……ผู้ให้ความยินยอม

( )

ลงชื่อ……..พยาน

( )

ลงชื่อ……..ผู้วิจัย

( )

ข้าพเจ้าไม่สามารถอ่านหนังสือได้ แต่ผู้วิจัยได้อ่านข้อความในใบยินยอมนี้ให้แก่ข้าพเจ้าจนเข้าใจดีแล้ว ข้าพเจ้าจึงลงนาม หรือประทับลายนิ้วหัวแม่มือขวาของข้าพเจ้าในใบยินยอมนี้ด้วยความเต็มใจ

ลงชื่อ……ผู้ให้ความยินยอม

( )

ลงชื่อ……พยาน

( )

ลงชื่อ……..ผู้วิจัย

( )

กรณีที่ผู้ถูกทดลองไม่สามารถตัดสินใจได้ ให้ผู้แทนโดยชอบด้วยกฎหมายหรือผู้ปกครอง หรือญาติที่ใกล้ชิดที่สุดเป็นผู้ลงนามยินยอม

ลงชื่อ……ผู้แทน/ผู้ปกครอง/ญาติ

( )

ลงชื่อ…….....พยาน

( )

ลงชื่อ…….....ผู้วิจัย

( )

หนังสือแสดงเจตนายินยอมเข้าร่วมโครงการวิจัยทางการแพทย์ (ศิริราช)

วันที่……เดือน……พ.ศ……

ข้าพเจ้า……อายุ……ปี

อาศัยอยู่บ้านเลขที่……..ถนน……..ตำบล……

อำเภอ……จังหวัด……โทรศัพท์……

โทรสาร……ขอแสดงเจตนายินยอมเข้าร่วมโครงการวิจัยเรื่อง การวินิจฉัยโรคหมอนรองกระดูกส่วนเอวยื่นกดทับรากประสาทโดยวิธีการสร้างภาพเอมอาร์ไอท่าเดียว โดยข้าพเจ้าได้รับทราบเกี่ยวกับรายละเอียดของโครงการดังต่อไปนี้

วัตถุประสงค์ของการวิจัย เพื่อหาความเป็นไปได้ของการวินิจฉัยโรคหมอนรองกระดูกส่วนเอวกดทับรากประสาทโดยใช้ภาพเอมอาร์ไอท่าเดียว โดยจะสามารถลดค่าใช้จ่ายในการตรวจผู้ป่วยลงได้หนึ่งในสามของการตรวจแบบเต็ม

ประโยชน์ที่คาดว่าจะได้รับจากการวิจัยคือ เพื่อลดค่าใช้จ่ายในการวินิจฉัยก่อนผ่าตัดในโรคหมอนรองกระดูกส่วนเอวโดยได้ผลประโยชน์สูงสุด

ความเสี่ยงหรือผลข้างเคียงที่อาจเกิดขึ้น ข้าพเจ้าจะไม่ได้รับความเสี่ยงใดๆ นอกจากการตรวจตามปกติที่ได้รับจากการดูแลรักษาของแพทย์ หากข้าพเจ้าไม่สามารถทนต่อการดำเนินการใดๆที่เกี่ยวข้องกับการวิจัยและนอกเหนือจากการตรวจรักษาตามปกติที่ข้าพเจ้าควรจะได้รับ ข้าพเจ้ามีสิทธิที่จะหยุดตรวจเมื่อไรก็ได้ที่ร้องขอ โดยข้าพเจ้าจะยังคงได้รับการดูแลจากแพทย์เช่นเดิม

รายละเอียดที่ผู้ร่วมโครงการวิจัยจะได้รับการปฏิบัติ

1.ตรวจด้วยเครื่องเอ็มอาร์ไอในภาควิชารังสีวิทยาตามปกติ

2.ซักประวัติตรวจร่างกายและตอบแบบสอบถามก่อนทำการตรวจ,

หากผู้วิจัยมีข้อมูลเพิ่มเติมทั้งด้านประโยชน์และโทษที่เกี่ยวข้องกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้ข้าพเจ้าทราบอย่างรวดเร็วโดยไม่ปิดบัง

ข้าพเจ้ามีสิทธิที่จะของดการเข้าร่วมโครงการวิจัยโดยไม่ต้องแจ้งให้ทราบล่วงหน้า โดยการงดการเข้าร่วมการวิจัยนี้จะไม่มีผลกระทบต่อการได้รับบริการหรือการรักษาที่ข้าพเจ้าจะได้รับแต่ประการใด

ข้าพเจ้าได้รับข้อมูลของโครงการข้างต้น ตลอดจนข้อดีข้อเสีย ที่จะได้รับจากการเข้าร่วมโครงการในครั้งนี้ และข้าพเจ้ายินดีที่จะเข้าร่วมในโครงการดังกล่าว โดยขอให้ผู้วิจัยงดการเปิดเผยชื่อ ประวัติ ตลอดจนข้อมูลที่เกี่ยวข้องกับข้าพเจ้าแก่ผู้อื่นได้รับทราบ

ลงชื่อ……ผู้ให้ความยินยอม/ผู้แทน

( ) โดยชอบธรรม(ระบุความเกี่ยวข้อง)

ลงชื่อ……หัวหน้าโครงการวิจัย

( )

ลงชื่อ…… .....พยาน

( )

ลงชื่อ……พยาน

( )

APPENDIX 3

QUESTIONNAIRE (Roland disability score)

แบบสอบถาม

ID……..

วันที่ทำการตรวจ.....

แบบสอบถามผู้เข้าร่วมโครงการวิจัยเรื่อง การวินิจฉัยโรคหมอนรองกระดูกส่วนเอวยื่นกดทับรากประสาทโดยใช้ภาพเอมอาร์ไอท่าเดียว

ชื่อ.....เพศ.....อายุ.....HN……

ที่อยู่.....โทรศัพท์ที่ติดต่อได้.....

กรุณาทำเครื่องหมาย √ หน้าข้อที่ท่านเห็นว่าตรงกับอาการของท่านในขณะนี้ ส่วนข้อที่ท่านเห็นว่าไม่ตรงกับอาการของท่านให้ข้ามไป

☐ 1. ฉันมักอยู่ที่บ้านส่วนใหญ่เพราะอาการปวดหลัง
☐ 2. ฉันต้องเปลี่ยนท่าทางบ่อยครั้งเพื่อที่จะทำให้รู้สึกสบายหลังขึ้น
☐ 3. ฉันเดินช้ากว่าปกติเพราะอาการปวดหลัง
☐ 4. เพราะอาการปวดหลังทำให้ฉันไม่สามารถทำงานบ้านประจำได้
☐ 5. เพราะอาการปวดหลังทำให้ฉันต้องเกาะราวบันไดขณะขึ้นบันได
☐ 6. เพราะอาการปวดหลังทำให้ฉันต้องนอนลงเพื่อพักบ่อยขึ้น
☐ 7. เพราะอาการปวดหลังทำให้ฉันต้องยึดบางสิ่งบางอย่างเพื่อที่จะลุกขึ้นจากเก้าอี้
☐ 8. เพราะอาการปวดหลังทำให้ฉันต้องหาผู้อื่นมาทำสิ่งต่างๆแทนฉัน
☐ 9. ฉันแต่งตัวช้าลงกว่าปกติเพราะอาการปวดหลัง
☐ 10. ฉันสามารถยืนได้ไม่นานนักเพราะอาการปวดหลัง
☐ 11. เพราะอาการปวดหลังฉันจะพยายามไม่โค้งหรือก้มตัวลง
☐ 12. ฉันรู้สึกลำบากขึ้นในการที่จะลุกจากเก้าอี้เพราะอาการปวดหลัง
☐ 13. ฉันปวดหลังอยู่ตลอดเวลา
☐ 14. ฉันรู้สึกลำบากขึ้นในการที่จะพลิกตัวบนเตียงขณะนอนเนื่องจากอาการปวดหลัง
☐ 15. ความรู้สึกอยากอาหารของฉันลดลงเพราะอาการปวดหลัง
☐ 16. ฉันมีความลำบากในการใส่ถุงเท้าเพราะอาการปวดหลัง
☐ 17. ฉันเดินได้เป็นระยะทางสั้นลงเพราะอาการปวดหลัง
☐ 18. ฉันนอนไม่ค่อยหลับเพราะอาการปวดหลัง
☐ 19. เพราะอาการปวดหลังทำให้ต้องมีคนมาช่วยฉันแต่งตัว
☐ 20. ฉันจะนั่งทั้งวันเพราะอาการปวดหลัง
☐ 21. ฉันต้องหลีกเลี่ยงงานบ้านประจำที่หนักๆเพราะอาการปวดหลัง
☐ 22. เพราะอาการปวดหลังทำให้ฉันหงุดหงิดและอารมณ์เสียง่ายกว่าปกติ
☐ 23. เพราะอาการปวดหลังทำให้ฉันขึ้นบันไดได้ช้ากว่าปกติ
☐ 24. ฉันต้องนอนบนเตียงทั้งวันเพราะอาการปวดหลัง

ท่านมีอาการปวดหลังมานานเท่าไร.....วัน.....เดือน.....ปี(ตอบเท่าที่ได้)

ลงชื่อ.....ผู้ให้ข้อมูล

ผู้เก็บข้อมูล.....(ตัวบรรจง)

Questionnaire(English version)

Check √ against the sentence(s) that describe(s) you today.

1. I stay at home most of the time because of my back.
2. I change position frequently to try to get my back comfortable.
3. I walk more slowly than usual because of my back.
4. Because of my back, I am not doing any of the jobs that I usually do around the house.
5. Because of my back, I use a handrail to get upstairs.
6. Because of my back, I lie down to rest more often.
7. Because of my back, I have to hold on to something to get out an easy chair.
8. Because of my back, I try to get other people to do things for me.
9. I get dressed more slowly than usual because of my back.
10. I stand up only for short periods of time because of my back.
11. Because of my back, I try not to bend or kneel down.
12. I found it difficult to get out of a chair because of my back.
13. My back is painful almost all the time.
14. I find it difficult to turn over in bed because of my back.
15. My appetite is not good because of my back pain.
16. I have trouble putting on my socks (or stockings) because of the pain in my back.
17. I walk only short distances because of my back pain.
18. I sleep less well because of my back.
19. Because of my back pain, I get dressed with help from someone else.
20. I sit down for most of the day because of my back.
21. I avoid heavy jobs around the house because of my back.
22. Because of my back pain, I am more irritable and bad tempered with people than usual.
23. Because of my back, I go upstairs more slowly than usual.
24. I stay in bed most of the time because of my back.

How long have you had back pain?.....

From Roland M, Morris R:A study of the natural history of back pain : I. Development of a reliable and sensitive measure of disability in low-back pain. Spine 1983;8:141-4.

APPENDIX 4

CASE RECORD FORM

ID.....

Form number.....

Case record form for MRI

(Limited MRI in HNP)

Name..... .Sex ☐ male ☐ female

Age.....years HN.....

MRI images ☐ Sagittal T2wi ☐ Full protocol (sag.T1wi, T2wi, axial T2wi.)

Level	side	Disc				Nerve root compression	
		Normal	Bulging	Herniation	Sequestration	No	Yes
L 1-2	Left						
	Right						
L2-3	Left						
	Right						
L3-4	Left						
	Right						
L4-5	Left						
	Right						
L5-S1	Left						
	Right						

Other Abnormality.....

.....

.....

Radiologist.....

ID…… ….

Form number……..

Case record form for Surgery

(Limited MRI in HNP)

Name……..Sex……Age……..years

HN……

Preoperative diagnosis……

Date of surgery (D/M/Y)……..Surgeon……..

Findings *ตอบเฉพาะข้างและระดับที่ผ่าตัด*

Operated Level	side	Disc*				Nerve root compression	
		Normal	Protrusion	Extrusion	Sequestration	No	Yes
L 1-2	Left						
	Right						
L2-3	Left						
	Right						
L3-4	Left						
	Right						
L4-5	Left						
	Right						
L5-S1	Left						
	Right						

Other significant findings……

Postoperative diagnosis……

* คำจำกัดความ

Disc protrusion = Protrusion of disc out of the vertebral body margin BUT still **within the annulus fibrosus.**

Extrusion = Extrusion of disc out of the annulus fibrosus but still within the posterior longitudinal ligament.

Sequestration = The extruded disc has no connection with the mother disc or migrated from the level of mother disc.

Nerve root compression = Evidence that the nerve root is displaced from its usual position
and (surgeon's opinion) the cause or disc exert pressure on the nerve.

Recorder…… (ตัวบรรจง)

APPENDIX 5

FIGURES

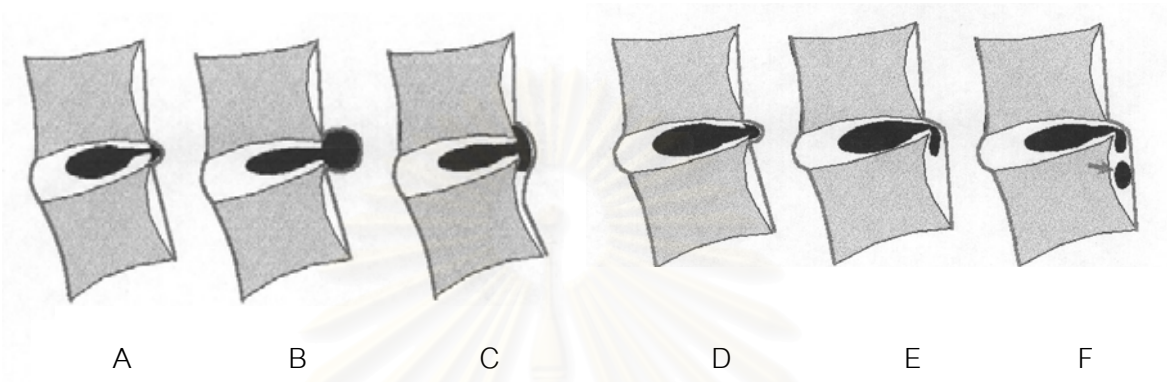


Figure 1 : Diagram drawing of the definition of disc herniation in sagittal view : (A,D) bulging, (B,C) herniation, (E) extrusion, herniation, (F) sequestration, herniation

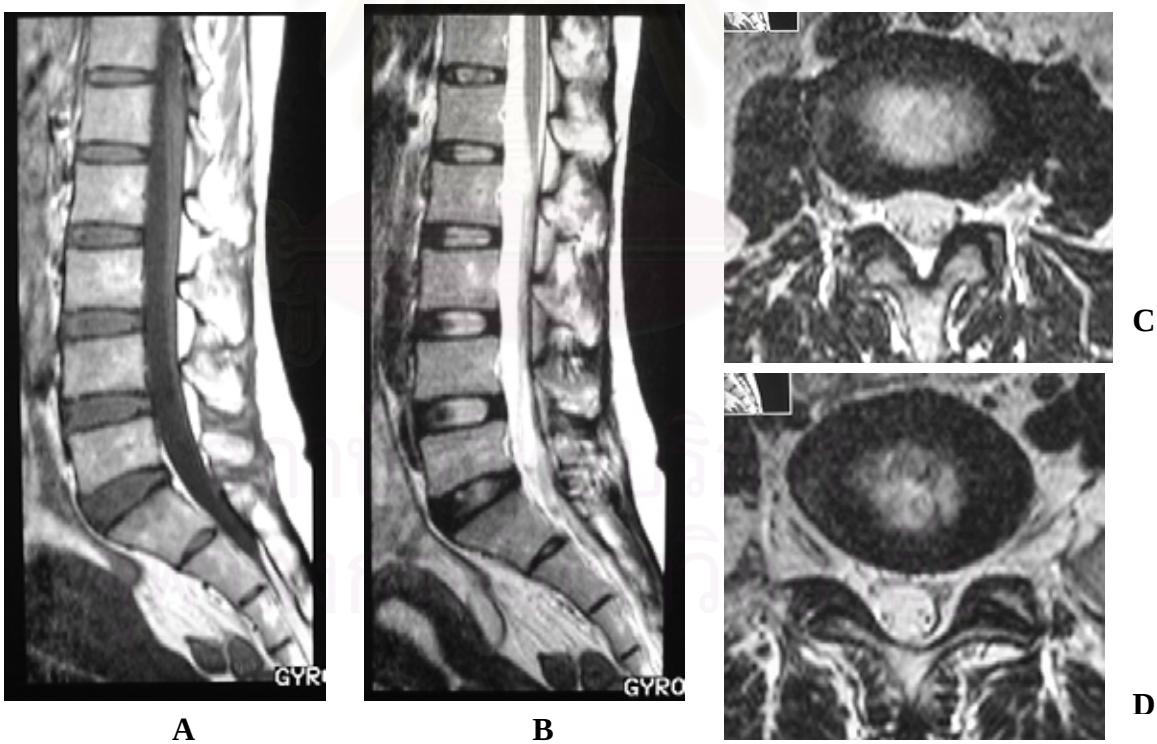
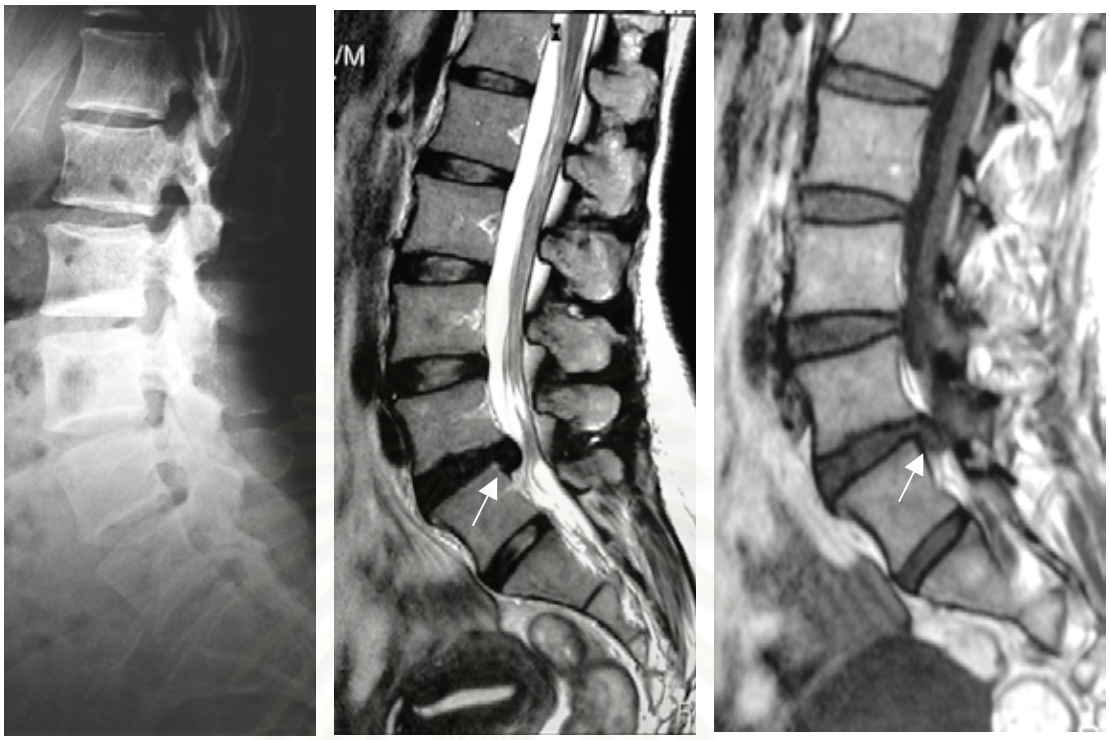


Figure 2 : MRI lumbar spine in full protocol (A) sagittal T1wi, (B)sagittal T2wi, (C,D)axial T2wi. This patient had low back pain with suspected herniation of nucleus pulposus. The MRI demonstrates mild bulging of the L5-S1 disc (D) and normal L4-5 disc (C).



A B C

D

Figure 3 : Lumbar disc herniation.
(A)The lateral roengenogram of lumbar spine shows questionable decreased height of the L4-5 intervertebral disc space. The MRI in sagittal T2wi(B) and sagittal T1wi(C) clearly demonstrate lumbar disc herniation at L4-5 level(arrows). The axial T2wi(D) shows herniated disc(arrow) compressing the right nerve root.

VITAE

Dr. Orasa Chawalparit was born on February 25, 1959 in Bangkok. She was graduated her medical school from Faculty of Medicine Ramathibordee Hospital and Thai board of general radiology from Faculty of Medicine Siriraj Hospital. She has worked as an instructor in diagnostic radiology since 1989 in Department of Radiology, Faculty of Medicine Siriraj Hospital. She is now an associated professor of radiology specialized in neuroradiology.

Since June 2001, she has been admitted in the Master degree Program of Health Development in Thai-CERTC, Faculty of Medicine, Chulalongkorn University, as funded by the Faculty of Medicine Siriraj Hospital. During this course, she has conducted a clinical research to assess the possibility of using limited protocol MRI in diagnosis of lumbar disc herniation.