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Original Research Article

Magnetic Resonance Myelography in Evaluation of Degenerative Disc Disease of Lumbar Spine in Comparision with Conventional Magnetic Resonance Imaging of Lumbar Spine

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ABSTRACT
Back pain can result from a number of causes including degenerative and congenital spinal stenosis, infection, trauma, neoplasm and inflammatory arthritic processes. Acquired spinal stenosis due to degenerative joint and disc disease accounts for vast majority of cases. In many centers the use of myelography is steadily declining. Additionally in today's ever changing medical economic climate the cost of imaging study requested must be considered. Taking this into account the present study was done to assess how specific Magnetic Resonance Myelography is, in identification of Degenerative Disc Disease of Lumbar Spine in comparision to routine MRI of lumbar spine in both axial and sagittal T1 and T2 weighted images. in the department of Radio-Diagnosis & Imaging, Mamata Medical college & Hospital, Khammam between November 2007 – October 2009 over 100patients. Out of 100,70 patients had multiple level of disc prolaps. Degenerative disease is more common in the age group of 41-51 (30%).the most common level of degenerative disease was at L4 –L5(42%) In evaluation of Diffuse Disc Bulge MR Myelography alone is sufficient but in case of suspected intra spinal lesion Conventional MRI of spine is the gold standard technique.
Key Words: *Degenerative disc disease, L4-L5,myelography, Mri.*

INTRODUCTION

Back pain resulting from degenerative disc disease of the spine is one of the most common causes of disability in working age adults suffering from low back pain in their lives. Medical costs resulting from low back pain exceed fifty billion dollars per year and could be as high as hundred billion dollars(1).

Back pain can result from a number of causes including degenerative and congenital spinal stenosis, infection, trauma, neoplasm and inflammatory arthritic processes. Acquired spinal

stenosis due to degenerative joint and disc disease accounts for vast majority of cases[2].

Degenerative spinal stenosis can be of vertebral base origin (spondylolisthesis, osteophytosis, and facet hypertrophy), ligamentous origin (hypertrophy of spinal ligaments particularly of ligamentum flavum) or of discogenic origin. Most often acquired narrowing of spinal canal is due to ligaments and disc disease. The most common location for these changes is the lumbar spine followed by cervical spine. Thoracic disc herniation, formerly thought to be rare is now being recognized with increasing frequency with the advent of Magnetic Resonance Imaging (MRI)[3].

Before the advent of computed tomography scans plain films of spine, spinal tomography, myelography and discography were the prime imaging modalities for spinal stenosis and disc herniation. Computed Tomography (CT) scans provided non-invasive, non-operator dependent method of directly imaging the spinal cord without injecting intrathecal contrast. It was superior to myelography in visualizing lateral foraminal stenosis, disc protrusions and lateral recess stenosis. In addition it overcame the myelographic limitation of visualizing the lower lumbar narrowing. In the latter, abundant epidural fat may prevent displacement of the myelographic column by a protruding disc. Finally and most importantly, myelography does not delineate the cause of narrowing – that is disc versus ligament versus bony hypertrophy. Computed Tomography scans directly image the cause of the pathology. Post myelography Computed Tomography scans provide an even more sensitive modality by increasing the contrast between thecal sac, nerveroots and soft tissues of the spinal column[4].

With the development of Magnetic Resonance Imaging, the debate over Computed Tomography scans versus myelography became moot. Magnetic Resonance Imaging has become the modality of choice in the evaluation of spinal degenerative disease. Magnetic Resonance Imaging is superior to even post contrast Computed Tomography scans in distinction of bone, disc, ligament, nerves, thecal sac and spinal cord. Magnetic Resonance Imaging provides multi planar imaging capability. Pulse sequences can be adjusted to evaluate specific areas of interest or to better define pathology. Its main disadvantage is lack of bone detail available on Computed Tomography scans. Computed Tomography scans and myelography will remain important in those patients who for technical reasons cannot enter the MRI scanner (for example patients with pacemakers, implants, claustrophobics) or in patients whose MRI findings do not co-relate with clinical symptoms.

Imaging of lumbar spine had advanced significantly since the time when only radiography and myelography were available. Today the most commonly used imaging techniques include CT, MRI, Discography and CT Discography. In many centers the use of myelography is steadily declining. Additionally in today's ever changing medical economic climate the cost of imaging study requested must be considered. Taking this into account the following study was done to assess how specific Magnetic Resonance Myelography is, in identification of Degenerative Disc Disease of Lumbar Spine in comparision to routine MRI of lumbar spine in both axial and sagittal T1 and T2 weighted images.

AIMS AND OBJECTIVES

1. To assess the sensitivity and specificity of Magnetic Resonance Myelography in identification of Degenerative Disc Disease of lumbar spine in comparision with conventional Magnetic Resonance Imaging of lumbar spine in both axial and sagittal T1 and T2 weighted images.
2. To identify whether or not Magnetic Resonance Myelography was a cost effective and time effective independent investigative modality and could be used to replace conventional Magnetic Resonance Imaging of lumbar spine.

MATERIALS AND METHODS

STUDY PLAN

Hundred patients were selected for this study who presented with clinical symptoms and signs pertaining to degenerative disc diseases and were positive on conventional MRI of lumbar spine.

INCLUSION CRITERIA

1. Any patient with clinical symptoms and signs of degenerative disc disease.
2. Patients who were positive on conventional MRI.

EXCLUSION CRITERIA

1. Patients with known contraindications for MRI.
2. Patients who were not cooperative during study(claustrophobic)
3. Patients who presented with clinical symptoms and signs of degenerative disc disease and were negative on conventional MRI.

MATERIALS AND METHODS

The study was performed on 0.35Tesla Siemens Magnetom Magnetic Resonance Imaging scanner. The scanner is capable of moderate speed as well as 3D imaging. All the studies were done in a Six element circularly polarised phased array RF coil designed for spine imaging with high resolution and signal to noise ratio.

MR TECHNIQUE

- No specific patient preparation was required prior to study.
- All patients were imaged in supine position with knee rest.
- No contrast injection was used.
- The duration of study was approximately - minutes

TECHNIQUES IN EACH PATIENT

- Conventional MRI of spine in axial & sagittal
- Heavily T2 weighed 2D single shot turbospin echo(2D myelography)
- T2 weighed 3D Gradient echo sequence FISP(3D myelography)
- 3D axial reformat

CONVENTIONAL MRI OF LUMBAR SPINE

Imaging in sagittal and axial planes was done. Axial sections are taken through the mid vertebral body and aligned along each inter vertebral disc (IVD).

T1 WEIGHTED IMAGES TAKEN USING TURBO SPIN ECHO SEQUENCE

TR - 780 to 800 mSec
TE - 17 to 20 mSec
Flip angle - 180o
Matrix - 256x256
FoV - Axial – 240x240
Sagittal – 400x400
Section Thickness – 5 to 6 mm.

T2 WEIHTED IMAGES USING TURBO SPIN ECHO SEQUENCE

TR - 3500 to 3600 mSec
TE - 135 to 140 mSec
Section Thickness - 5.0 to 6.00 mm
Matrix – 256x256
FoV Sagittal – 400x400
FoV Axial – 254x280.

2D SINGLE SHOT TURBO SPIN ECHO

This sequence had following parameters
TR - 6000 mSec
TE - 1100 mSec
Echo train length - 240
Matrix - 256 X 256
FOV - 280mm X 280mm
Frequency selective fat supression was also used.
Spatial resolution = 10 mm X 8mm
Scan time = 1 min (CORONAL AND SAGITTAL)
A single thick slab(50mm)was imaged yielding a single 2D projection images in coronal and sagittal planes.

3D GRADIENT ECHO MYELOGRAPHY

TR - 7400 mSec
TE - 200 mSec

Flip angle-180o
Matrix - 256 x 256
FoV - 400x400
Scan time - 7.0 mins
3D volume thickness = 5 cm
Number of portions with in 3D volume = 32
Thickness of each portion = 1.0mm
CSF artifact induction – Gradient Motion Rephasing (GMR) was used to reduce CSF pulsation artifacts.
Frequency selection for Fat supression was used.
The 3D slab is oriented in the sagittal plane.

DATA PROCESSING

The 2D single shot TSE image data did not require special programming. The myelographic images could be directly viewed. In case of 3D Gradient echo myelography the following information was available:-

1. The individual thin sagittal position images with in the 3D volume could be directly viewed.
2. The raw data on entire 3D volume was subjected to Maximum Intensity Projection (MIP) algorithm. This yielded projected views of spinal column, discs, thecal sac and nerve root sleeves from any desired angle.
3. The volume data was also subjected to Multi Planar Reformation (MPR) algorithm. This generated high resolution Axial T2weighted section at any derived level.
4. The MIP processing and MPR processing were performed on the main console of the MRI system using special software packages.

OBSERVATION AND ANALYSIS

The sensitivity is calculated by the number of disc levels involved. The total number of patients involved in the study is hundred, out of which seventy patients had multiple levels of disc prolapse. The number of levels at which disc prolapse was noted is two hundred and nine.

Table 1:- Age distribution of degenerative disc disease in 100 patients

Sl. No	Age	Number of patients	Percentage
1	11-20	02	02
2	21-30	14	14
3	31-40	27	27
4	41-50	30	30
5	51-60	10	10
6	61-70	13	13
7	71-80	04	04
	TOTAL	100	100

It was found that degenerative disease is more common in the age group 41-50 yrs (30 %) followed by 31-40years (27%).

Table 2:- Sex distribution of degenerative disc disease in 100 patients

Sl no	Sex	No. of patients	Percentage
1	Female	51	51
2	Male	49	49

It was found that the Degenerative Disc Disease of lumbar spine has nearly equal sex distribution. In our study of hundred patients with positive findings in MRI the number of female patients was 51 compared to 49 male patients.

Table 3 :- Level of degenerative disc disease at 209 Levels

Sl no	Level	No of Levels	Percentage
1	L1-L2	09	4.31
2	L2-L3	19	9.09
3	L3-L4	41	19.62
4	L4-L5	88	42.11
5	L5-S1	52	24.88
	Total	209	100

The most common level for degenerative disc disease to occur was found to be at L4-L5 level (42% of the 209 levels involved) followed by L5-S1 level (25% of the total levels at which disc prolapse was seen).

Table 4:- Types of disc prolapsed seen in 209 Levels of 100 patients

Sl.No	Type of Disc Herniation	No. of Levels	Percentage
1	Only Diffuse Disc Bulge	120	57.42
2	Central and Paracentral protrusion	51	24.40
3	Only central protrusion	07	3.35
4	Only paracentral protrusion	07	3.35
5	Lateral	12	5.74
6	Foraminal	02	0.90
7	Extrusion	09	4.31
8	Sequestration	01	0.45
	Total	209	100

It was observed that the most common disc herniation was Diffuse Disc Bulge seen at 120 levels (57% of the total number of levels) followed by Central and Paracentral type of Disc Protrusion seen at 51 levels (24% of the total levels at which Degenerative Disease of Lumbar Spine was noted)

Table 5 :- Other Degenerative Changes of Spine and Nerve Root Compression

Sl no	Other Degenerative Changes of Spine	No of Levels	Percentage
1	Vertebral Body Signal Changes	47	22.49
2	Spondylolisthesis	16	7.66
3	Spinal Canal Stenosis	40	19.14
4	Lig. Flavum Hypertrophy	22	10.53
5	Nerve Root Compression	137	65.55

The most frequently associated finding along with Degenerative Disc Disease of Lumbar Spine was nerve root compression (seen at 65% of levels with disc herniation) followed by signal changes in the vertebral body (seen at 20% of the total number of levels involved).

The Comparative Study Between Routine Mri Of Spine With That Of Mr Myelography Was Done And The Following Observations Were Obtained.

Table 6: Accuracy of MR Myelography in the evaluation of diffuse disc bulge which was found in conventional MRI of spine

Sl. No	Total number of disc bulges in Conventional MRI of spine	Total number of disc bulges in MR Myelography of spine	Percentage of accuracy
01	**120**	**120**	**100**

MR Myelography is equally accurate in identification of diffuse disc bulge in comparision to the conventional MRI of lumbar spine.

Table 7 : MR Myelography in the evaluation of Central and paracentral disc prolapse which was found in conventional MRI of spine.

Sl.No	Total number of central and paracentral disc bulges in conventional MRI of spine	Total number of central and paracentral disc bulges in MR Myelography of spine	Percentage of accuracy
01	**51**	**51**	**100**

MR Myelography is equally accurate in identification of central and paracentral disc prolapse in comparision to conventional MRI of spine.

Table 8:- MR Myelography in the evaluation of central disc prolapse which was seen in conventional MRI of spine.

Sl.No	Total number of central disc prolapsed in conventional MRI of spine	Total number of central disc protrusions in MR Myelography	Percentage of accuracy
01	**7**	**7**	**100**

MR Myelography is equally accurate in identification of central disc prolapse with that of conventional MRI of spine.

Table 9:- MR Myelography in the evaluation of paracentral disc prolapse which was seen in conventional MRI of spine.

Sl.No	Total number of para central disc prolapsed in conventional MRI of spine	Total number of para central disc protrusions in MR Myelography	Percentage of accuracy
01	**7**	**7**	**100**

MR Myelography is equally accurate in identification of para central disc prolapse with that of conventional MRI of spine.

Table 10:- MR Myelography in the evaluation of foraminal type of disc prolapse which was seen in conventional MRI of spine.

Sl. No	Total number of foraminal type of disc prolapse in conventional MRI of spine	Total number of foraminal type of disc prolapse in MR Myelography	Percentage of accuracy
01	2	2	100

MR Myelography is equally accurate in identification of foraminal type of disc prolapsed in comparision to conventional MRI of spine.

Table 11 :- MR Myelography in the evaluation of Lateral type of disc prolapse which was seen in conventional MRI of spine.

Sl.No	Total number of lateral type of disc prolapse in conventional MRI of spine	Total number of lateral type of disc prolapse in MR Myelography	Percentage of accuracy
01	12	12	100

MR Myelography is equally accurate in identification of lateral type of disc prolapsed in comparision to conventional MRI of spine.

Table 12 :- MR Myelography in the evaluation of Extrusion of disc which was seen in conventional MRI of spine.

Sl.No	Total number of Extrusion of discs in conventional MRI of spine	Total number of Extrusion of discs in MR Myelography	Percentage of accuracy
01	9	9	100

MR Myelography is equally accurate in identification of Extrusion of disc in comparision to conventional MRI of spine.

Table 13 :- MR Myelography in the evaluation of Sequestration of disc which was seen in conventional MRI of spine.

Sl. No	Total number of Sequestration of disc in conventional MRI of spine	Total number of Sequestration of disc in MR Myelography	Percentage of accuracy
01	1	1	100

MR Myelography is equally accurate in identification of Sequestration of disc with that of conventional MRI of spine.

OTHER PATHOLOGICAL CHANGES NOTED IN ASSOCIATION WITH DEGERATIVE DISC DISEASE :-

MR Myelography in the evaluation of Degenerative changes of the vertebral body which were found in conventional MRI of spine

The total number of degenerative changes of vertebral body in Conventional MRI of Spine was forty seven. The type of degenerative changes can be specified by Conventional MRI of spine. The changes of the vertebral body can be seen by MR Myelography but the type of degeneration cannot be specified because only heavily weighted T2 images are used, whereas in Conventional MRI of lumbar spine we use both T1 and T2 weighted image.

Table 14:- MR Myelography in the evaluation of Spondylolisthesis noted in conventional MRI of spine.

Sl.No	Total number of Spondylolisthesis noted in conventional MRI of spine	Total number of Spondylolisthesis noted in MR Myelography	Percentage of accuracy
01	20	20	100

MR Myelography is equally accurate in identification of Spondylolisthesis in comparision with conventional MRI of spine.

Table 15:- MR Myelography in the evaluation of Nerve root compression noted in conventional MRI of spine.

Sl.No	Total number of Nerveroot compression noted in conventional MRI of spine	Total number of Nerveroot compression noted in MR Myelography	Percentage of accuracy
01	132	132	100

MR Myelography is equally accurate in identification of Nerveroot compression in comparison with conventional MRI of spine.

Table 16:- MR Myelography in the evaluation of Spinal stenosis noted in conventional MRI of spine.

Sl. No	Total number of Spinal stenosis noted in conventional MRI of spine	Total number of Spinal stenosis noted in MR Myelography	Percentage of accuracy
01	40	40	100

MR Myelography is equally accurate in identification of Spinal canal stenosis in comparison with conventional MRI of spine.

DISCUSSION

The number of patients selected in the study is Hundred, out of which seventy patients had multiple levels of disc prolapse and the total number of disc herniations was two hundred and nine. In the study, patients under went routine MRI of spine in both axial and sagittal T1 and T2 weighted images. Then 2D MR Myelography and 3D MR Myelography were done and the Axial images were reformatted from the 3D data using special program on the console unit.

In the study it was found that the degenerative disc disease was more common in the age group 41-50 years (30% of the hundred patients) followed by 31-40years (27%) and 21-30years (14%) age group.

The incidence of Degenerative Disease of Lumbar spine was more or less equal in both males and females. (Females 51% and males 49%).

The level of lumbar Inter Vertebral Disc(IVD) where the disc herniation was more common was found to be at L4-L5 (42% of the total 209 levels involved) followed by L5-S1 (24%).

Phillipe et al used TE of 850 milliseconds. In our study we used TE of 1100 milliseconds. Therefore in our study the thecal sac visualization and background suppression were good. Also the matrix used in our study was a larger one compared with that of Phillipe et al, so the spatial resolution was better in our study[(5)].

The T2* weighted 3D Gradient echo sequence (FISP- Fast Imaging with Steady state Precision) which we used was more or less the same which was used by Eberhardt KE et al[(6)].

The most common type of Degenerative Disc Disease in lumbar spine was Diffuse Disc Bulge which was noted at one hundred and twenty levels(57%of the total levels involved), followed by central and paracentral protrusion which was noted at fifty one levels. The associated nerve root compression was noted at one hundred and thirty two levels(seen at 65% of total levels involved in degenerative disc disease). The other degenerative changes that were commonly noted in association with disc herniation were vertebral body signal changes, seen at forty seven levels (22.5% of the total levels at which herniation is seen).

The total number of disc bulges that were noted on conventional MRI of spine was one hundred and twenty. The patients underwent the routine MR Myelography sequence (2D, 3D Myelography and Axial reformation). It was found that on 2D Myelography only fifty six of disc bulges produced mild indentation over the thecal sac and 2D Myelography was normal at remaining levels. The percentage of sensitivity using 2D Myelography was only 45.8%. 3D Myelography showed the level and mild degree of disc bulge in 3D sagittal sections. The axial image which was obtained from the 3D data could show the loss of posterior concavity of the disc. Hence the combination of 2D, 3D and axial reconstruction can increase the sensitivity of MR Myelography in identifying diffuse disc bulge.

In conventional MRI, central and paracentral disc protrusions were noted at 51 levels, out of which 45 discs produced indentation over thecal sac on 2D Myelography and hence the sensitivity in identification of central and paracentral disc protrusions was 88 percent. However the level of disc protrusion could not be localized in 2D Myelography. This was because 2D Myelography was done using TSE (Turbo Spin Echo) technique which displayed only the fluid filled thecal sac but not the vertebral bodies. 3D Myelography using gradient echo sequence was able to show the disc protrusion in all the 51 levels in sagittal section. But the type of disc herniation could not be identified by 3D Myelography. Since the vertebral

bodies are also displayed , the level of localization can be identified on 3D Myelography. The sensitivity is increased by using 3D axial reconstruction data and the central type of disc herniation can be identified. Hence the combination of 2D Myelography, 3D Myelography and axial reconstruction can increase the sensitivity of MR Myelography in identifying the central and paracentral disc protrusions with accuracy similar to that of conventional MRI of lumbar spine.

The number of Paracentral disc protrusions noted were seven on conventional MRI. 2D Myelography could show the lateral indentation on the thecal sac at all the seven levels but could not depict the level of paracentral disc herniation. The 3D Myelography could depict the level of disc herniation. 3D axial reconstruction confirmed the paracentral disc herniation. The combination of 2D Myelography, 3D Myelography and axial reconstruction yielded the necessary information.

The conventional MRI showed foraminal type of disc prolapse at two levels out of total of two hundred and nine levels, the 2D Myelography did not show any indentation on the thecal sac. However 3D Myelography showed the disc prolapse and the level. The type of disc prolapse could not be identified. The 3D axial reformat could identify the type of disc prolapse. The combination of 2D Myelography, 3D Myelography and axial reconstruction can increase the sensitivity af MR Myelography.

Conventional MRI noted lateral type of disc prolapse at twelve levels, out of which at eight levels 2D Myelography could show the indentation on the nerve root. However in the other four cases far lateral type of disc prolapse was identified only with 3D axial reformatted images and the level was identified by 3D Myelography. The combination of 2D Myelogr-aphy, 3D Myelography and axial reconstruction can increase the sensitivity of MR Myelography in evaluation of far lateral type of disc herniation.

Nine patients with extruded disc and one patient with sequestrated disc were identified in conventional MRI of spine. The 2D Myelography could show the indentation on the thecal sac. However the differentiation between extruded and sequestrated disc was impossible. The 3D Myelography in sagittal section was able to identify extruded and sequestrated disc. 3D axial images were useful in extruded disc but were less informative for sequestrated disc. Hence the combination of 2D, 3D and axial reconstruction can increase the sensitivity of MR Myelography in identification of extruded and sequestrated discs and in their differentiation.

Thomton MJ et al compared 2D Myelography in coronal view with coronal MRI of spine in both T1 and T2 weighted images. They found only sixty percent of disc herniations were diagnosed on MR Myelography[7]. But in Our study we found that combined use of 2D Myelography, 3D Myelography and axial reformatted images could increase the sensitivity of MR Myelography upto hundred percent.

Zisch et al using 3D Myelography found that all the medial and medio lateral disc herniations causing thecal sac compression could be identified and this correlated with our study[8]. They stated that three out of eight intra foraminal discs could be identified, but in our study only two cases of intra foraminal disc herniation were identified which are inadequate to specify the sensitivity of MR Myelography in evaluation of intra foraminal disc herniation.

Soarabino T et al stated that 3D Myelography confirmed the diagnosis of disc herniation made on conventional MRI in T1 and T2 images[9]. Ross et al stated that RARE sequences can replace conventional T2 weighted spin echo sagittal studies for degenerative disc disease[10]. In our study MR Myelography was able to identify degenerative disc disease with accuracy nearing hundred percent.

Nerve root compression was noted at one hundred and thirty two levels (63% of the total inter vertebral disc levels involved). 2D Myelography and 3D Myelography were very informative in identification of nerve root compression. Axial

reformatted images also showed nerve root compression and hence MR Myelography was as informative as conventional MRI of lumbar spine in identification of nerve root compression.

Thornton MJ in his study found that 63.6 percent of nerve root compression were identified[7]. In our study, a combination of 2D Myelography, 3D Myelography and axial reformatted images increased the sensitivity to hundred percent. Rose et al stated that the nerve root details were better on turbo spin echo in comparision with that of conventional MRI[10]. El Gammal et al stated that it was possible for preoperative localization of herniated disc and to know its relationship with the nerve root sleeves[11].

Spinal stenosis and spondylolisthesis were identified on 3D Myelography. Both axial reformatted images and 2D Myelography showed some changes in the thecal sac in spinal stenosis but spondylolisthesis was not identified in 2D Myelography and 3D axial reformatted images. The same information that was noted on 3D Myelography was also noted on conventional MRI.

Freund et al used 3D Myelography (FISP) in 25 patients with spinal stenosis and He found that it was hundred percent sensitive[12]. These findings were correlated and confirmed with intra operative findings. He also stated that in cases of spinal stenosis 3D Myelography is especially useful in comparision with conventional Myelography, where there is lack of contrast media distal to the stenosis. In our study the MR Myelography identification of spinal stenosis was hundred percent.

The vertebral body signal changes that were noted on conventional MRI of spine were also noted on 3D Myelography. However the type of changes of the vertebral bodies and endplates could not be identified on 3D Myelography. The degenerative changes could not be visualized on 2D and axial reformatted images. The loss of disc hydration could be identified on 3D Myelography, However 2D and axial reformatted images could not add much information.

Ligamentum flavum hypertrophy was identified at twenty two levels in conventional MRI of spine which were confirmed on MR Myelography. 2D and 3D Myelography images showed indentations over thecal sac posteriorly indicating the hypertrophy of ligamentum flavum. 3D Myelography was further helpful in identification of the level and 3D axial reformatted image showed the hypertrophied ligament.

SUMMARY

2D MYELOGRAPHY

- Forty six percent of disc bulges seen in conventional MRI of lumbar spine were identified on 2D Myelography. Central type of disc prolapse was identified in 88% of cases and Paracentral disc prolapse in 67% of the cases found on conventional MRI of lumbar spine.
- Differentiation between extruded, sequestrated disc not possible.
- Level of disc prolapse could not be pin pointed.
- Other degenerative changes of spine could not be identified.
- Nerve root compression could be identified.
- Much information on spinal stenosis and spondylolisthesis not obtained.

3D MYELOGRAPHY

- Level of disc herniation is obtained.
- It can differentiate between extruded, sequestrated disc.
- Vertebral body degenerative changes could be identified but the type of degeneration cannot be evaluated.
- Type of herniation cannot be identified.
- Spinal stenosis and spondylolisthesis could be identified.
- Identification of nerve root compression could be done with great accuracy.

3D AXIAL REFORMAT

- Type of disc herniation can be identified.
- Intraforaminal type of disc herniation can be identified on 3D Axial reformatted data.

CONCLUSIONS

1. A combination of 2D Myelography, 3D Myelography and Axial reformatted images can increase the sensitivity of evaluation of Degenerative Disc Disease of spine to about hundred percent.
2. In evaluation of Diffuse Disc Bulge MR Myelography alone is sufficient.
3. The cost of MR Myelography is less in comparision with conventional MRI of spine.
4. The time taken for MR Myelography is less compared with conventional MRI of spine.
5. However, in case of suspected intra spinal lesion Conventional MRI of spine is the gold standard technique.

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