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Radiodiagnosis

Role of Magnetic Resonance Imaging in Evaluation of Lumbar Plexus Screening Using 3D Sequences

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Abstract **Original Research Article**

An observational study of 50 patients was conducted on Siemens Magnetom VIDA Magnetic Resonance Imaging (3Tesla) for evaluation of lumbar plexus screening using 3D sequences. Out of total 50 patients, 23(46%) males and 27(54%) females (all age groups). Our study has shown the utility of the 3 sequences- VIBE, DESS and 3D SPACE in lumbar plexus screening. The lumbar plexus may be locally involved by extrinsic compression or infiltration or associated with systemic conditions such as metabolic, autoimmune, ischemic, vasculitis and inflammatory disorders. Local involvement occurs in neoplasms such as peripheral nerve sheath tumors, mesenchymal tumors, cervical cancer, uterine cancer, colorectal cancer and metastatic infiltration, tumor variants, such as perineuroma and amyloid, entities related to the psoas major muscle or greater sciatic notch, such as hematoma, abscess, endometriosis and aortic aneurysm.

Keywords: Magnetic Resonance Imaging; MR Neurography; Lumbar plexus; VIBE; 3D SPACE; DESS.

INTRODUCTION

The lumbar plexus is a series of nerve convergences and divergences that ultimately combine into larger terminal nerves that supply the pelvis and lower extremities. It is subject to a variety of insults that may lead to lumbar plexopathy, a clinical syndrome that includes motor and sensory disturbances. Differentiating lumbar plexopathy from spine-related abnormalities is a clinical dilemma. Medical history, clinical findings and electro diagnostic test results, such as electromyography (EMG) were used to diagnose lumbar plexus pathology traditionally [1]. Because of the deep location of nerves and the variable innervations of regional muscles electro diagnostic testing provides limited evaluation of the lumbar plexus. Depiction of the exact location, extent, cause, and character of plexus pathology is often possible only at high-resolution MR neurography. High-resolution MR neurography has been increasingly used to evaluate patients with suspected or established lumbar plexopathy and help confirm the diagnosis or provide anatomic information should surgical intervention be necessary [2]. Hence this study is undertaken to assess the Role of Magnetic Resonance Imaging in evaluation of lumbar plexus using 3D sequences:

1. VIBE
2. 3D SPACE
3. DESS

PATHOLOGIC CONDITIONS AND CLINICAL FINDINGS

The lumbar plexus may be locally involved by extrinsic compression or infiltration or associated with systemic conditions, such as metabolic, autoimmune, ischemic, and inflammatory disorders and vasculitis. Compared with the brachial plexus, which is vulnerable to blunt injury, the lumbar plexus is relatively protected by the axial skeleton; thus, direct trauma is an uncommon cause of plexopathy. However, the lumbar plexus may be indirectly affected by lumbar spinal injuries, pelvic fractures, and hip fractures or dislocations and directly affected by iatrogenic injuries resulting from surgical gynecologic or anesthetic procedures, compression, traction, and vascular insults.

Inflammatory and systemic causes of lumbar involvement include hereditary neuropathies like Charcot-Marie-Tooth disease, inflammatory neuritis like Guillain-Barre syndrome, diabetes mellitus, ischemic conditions, sarcoidosis, connective tissue disorders and radiation neuropathy [3].

CLINICAL INDICATIONS FOR MR NEUROGRAPHY:

The clinical indications for MR neurography of the lumbar plexus include:

- Evaluation of the lumbar plexus in patients with indeterminate results at MR imaging of the lumbar spine.
- Confirmation of lumbar plexus involvement and definition of the extent of disease in patients with a tumor or tumor like condition.
- Exclusion of a mass lesion in patients with unilateral abnormalities at EMG.
- Evaluation of peripheral branch nerve abnormalities and associated lesions such as piriformis syndrome, meralgia paresthetica, pudendal neuralgia and nerve entrapments after hernia repair.
- Confirmation of lumbar plexitis or plexopathy in patients with clinically confusing findings and underlying known systemic conditions.
- Planning for MR imaging–guided administration of pain medication [4].

MATERIAL AND METHODS

This is an observational study of 50 patients conducted for a period of two years (July 2017 to September 2019) at "Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pimpri, Pune". This study was carried out on Siemens Magnetom VIDA Magnetic Resonance Imaging (3Tesla). The aim of the study was "Role of Magnetic Resonance Imaging (MRI) for evaluation of lumbar plexus screening using 3D sequences." The patients who were fulfilling the inclusion and exclusion criteria were included in the study and the study group comprised 50 patients. Institutional Ethical Committee (IEC) clearance was obtained before the start of the study. Informed and written consent was obtained from all the patients. Patients of all age and both the sex group were included.

Magnetic Resonance Imaging (MRI) was performed using Siemens Magnetom VIDA Magnetic Resonance Imaging (3Tesla). Three sequences were used- VIBE, 3D SPACE, DESS. The patient was positioned in supine position with head pointing towards the magnet (head first supine). The body coils are placed over the pelvis and abdomen. The body coils were securely tightened to prevent respiratory artefacts.

Table-1: Showing various sequences and their respective parameters

Image Plane	TR (time to repeat) in milliseconds	TE (time echo) in milliseconds	Slice Thickness	Field of View (FoV)	Flip Angle
3D-VIBE	10	4.9	1	350	10
3D-SPACE	3200	188	1	350	120
DESS	15	5.1	1	350	25

OBSERVATIONS AND RESULTS

Mean (SD) age was the participants was 51.8 (11.7) years with the minimum of 30 years and maximum of 74 years.

Age Categories

Table-2: Shows age categories of study participants

Age categories (years)	Frequency	Percentage
30-44	15	30.0
45-59	18	36.0
60 and above	17	34.0
Total	50	100

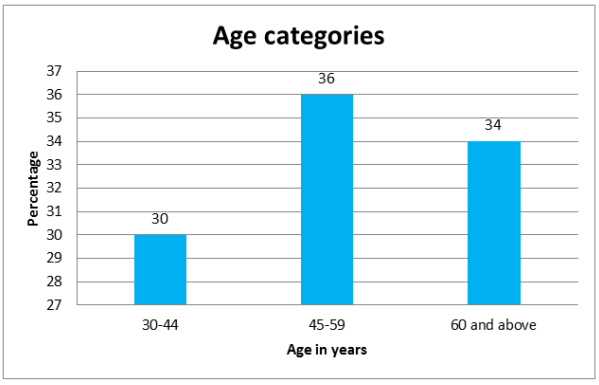


Fig-1

Figure-1 shows age categories of study participants. Out of which 30 were of age group 30-44, 36 of age group 45-59 and 34 of age group above 60.

Gender Distribution

Table-3: Shows gender distribution of study participants

Gender	Frequency	Percentage
Male	23	46.0
Female	27	54.0
Total	50	100

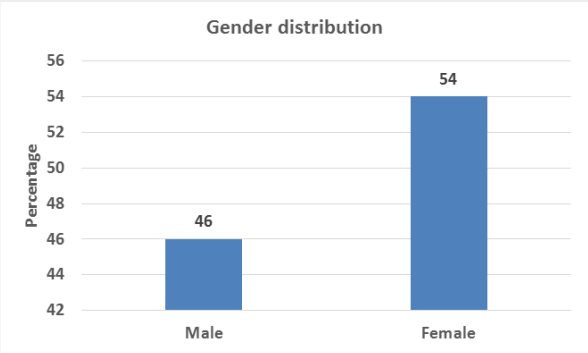


Fig-2

Figure-2 shows gender distribution of study participants. 46% were male and 54% were female in our study.

Radiographic Findings

Table-4: Shows radiographic findings of study participants

Radiograph	Frequency	Percentage
Abnormal	25	50.0
Normal	19	38.0
ND	6	12.0
Total	50	100

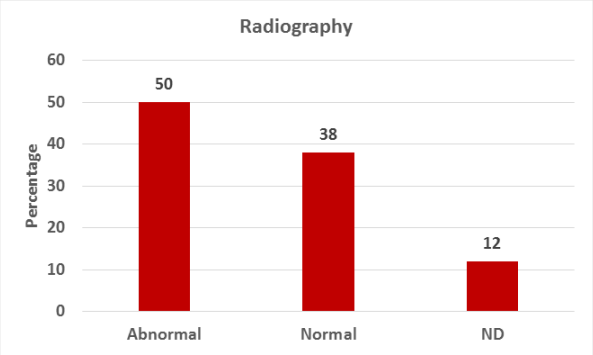


Fig-3

Figure-3 shows radiographic findings of study participants. 50 were abnormal, 38 were normal and for 12 participants X ray was not done.

Iliohypogastric Nerve Findings

Table-5: Shows the utility of the 3 sequences in evaluating iliohypogastric nerve

Iliohypogastric nerve	Frequency	Percentage
DESS	24	48.0
3D SPACE	15	30.0
3D VIBE	11	22.0
Total	50	100

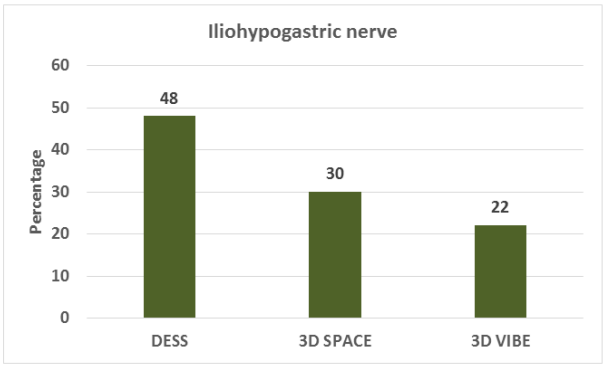


Fig-4

Figure-4 shows the utility of the 3 sequences in evaluating iliohypogastric nerve. The nerve was best seen in DESS sequence in 48% participants, 3D SPACE sequence in 30% of participants and 3D VIBE sequence in 22% of participants.

Ilioinguinal Nerve Findings

Table-6: Shows the utility of the 3 sequences in evaluating ilioinguinal nerve

Ilioinguinal nerve	Frequency	Percentage
3D SPACE	28	56.0
DESS	12	24.0
3D VIBE	10	20.0
Total	50	100

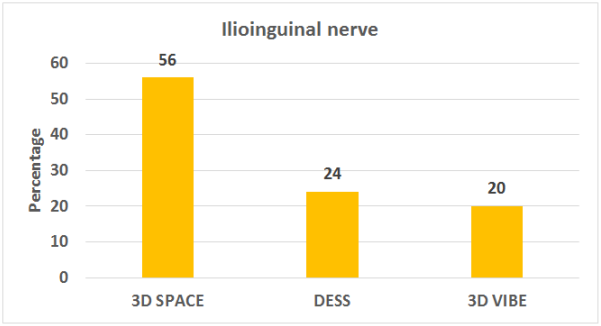


Fig-5

Figure-5 shows the utility of the 3 sequences in evaluating ilioinguinal nerve. The nerve was best seen in 3D SPACE sequence in 56% of participants, DESS sequence in 24% participants and 3D VIBE sequence in 20% of participants.

Lateral Femoral Cutaneous Nerve Findings

Table-7: Shows the utility of the 3 sequences in evaluating lateral femoral cutaneous nerve

Lateral femoral cutaneous nerve	Frequency	Percentage
3D SPACE	21	42.0
DESS	15	30.0
3D VIBE	14	28.0
Total	50	100

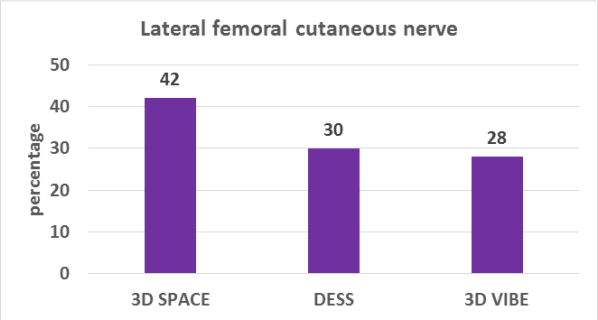


Fig-6

Figure-6 shows the utility of the 3 sequences in evaluating lateral femoral cutaneous nerve. The nerve was best seen in 3D SPACE sequence in 42% of participants, DESS sequence in 30% participants and 3D VIBE sequence in 28% of participants.

Genitofemoral Nerve Findings

Table-8: Shows the utility of the 3 sequences in evaluating genitofemoral nerve

Genitofemoral nerve	Frequency	Percentage
DESS	18	36.0
3D VIBE	16	32.0
3D SPACE	16	32.0
Total	50	100

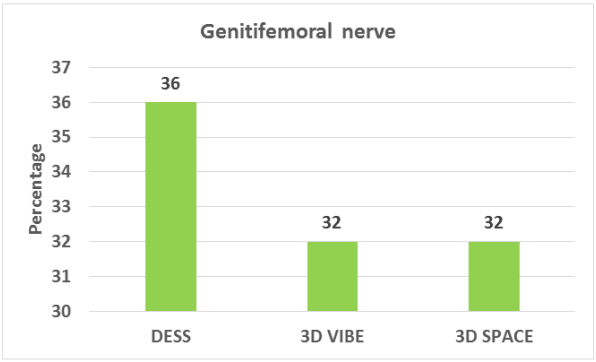


Fig-7

Figure-7 shows the utility of the 3 sequences in evaluating genitofemoral nerve. The nerve was best seen in DESS sequence in 36% participants, 3D VIBE in 32% of participants and 3D SPACE sequence in 32% of participants.

Obturator Nerve Findings

Table-9: Shows the utility of the 3 sequences in evaluating obturator nerve

Obturator nerve	Frequency	Percentage
3D SPACE	22	44.0
3D VIBE	15	30.0
DESS	13	26.0
Total	50	100

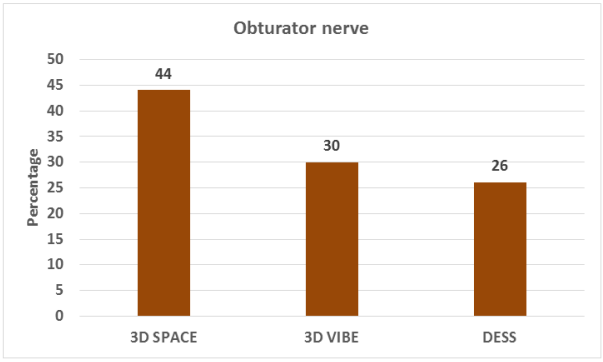


Fig-8

Figure-8 shows the utility of the 3 sequences in evaluating obturator nerve. The nerve was best seen in DESS sequence in 44% participants, 3D SPACE sequence in 30% of participants and 3D VIBE sequence in 26% of participants.

Femoral Nerve Findings

Table-10: Shows the utility of the 3 sequences in evaluating femoral nerve

Femoral nerve	Frequency	Percentage
3D VIBE	20	40.0
DESS	16	32.0
3D SPACE	14	28.0
Total	50	100

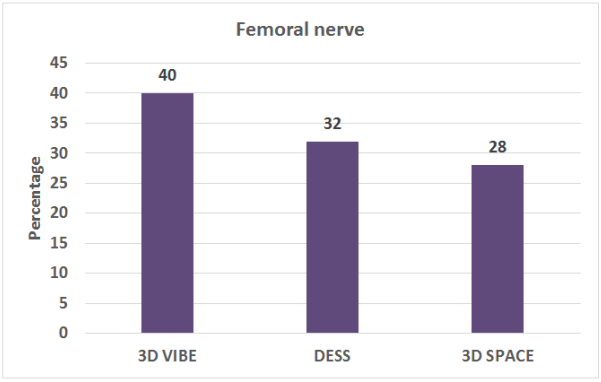


Fig-9

Figure-9 shows the utility of the 3 sequences in evaluating femoral nerve. The nerve was best seen in 3D VIBE sequence in 40% of participants, DESS sequence in 32% participants and 3D SPACE sequence in 28% of participants.

Ganglions of Lumbar Plexus Findings

Table-11: Shows the utility of the 3 sequences in evaluating ganglions of lumbar plexus findings

Ganglions of lumbar plexus	Frequency	Percentage
DESS	21	42.0
3D SPACE	15	30.0
3D VIBE	14	28.0
Total	50	100

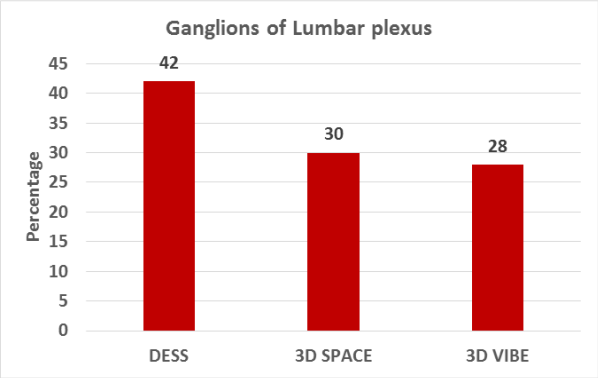


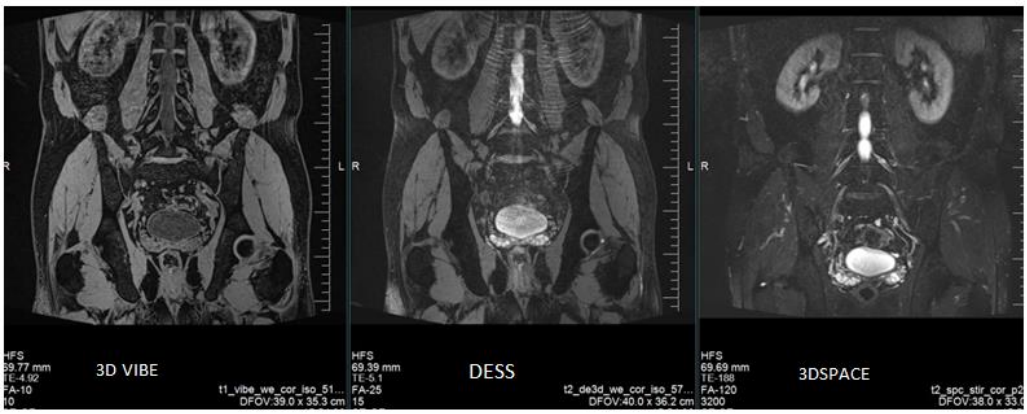
Fig-10

Figure-10 shows the utility of the 3 sequences in evaluating ganglions of lumbar plexus. The nerve was best seen in DESS sequence in 42% participants, 3D SPACE sequence in 30% of participants and 3D VIBE sequence in 28% of participants.

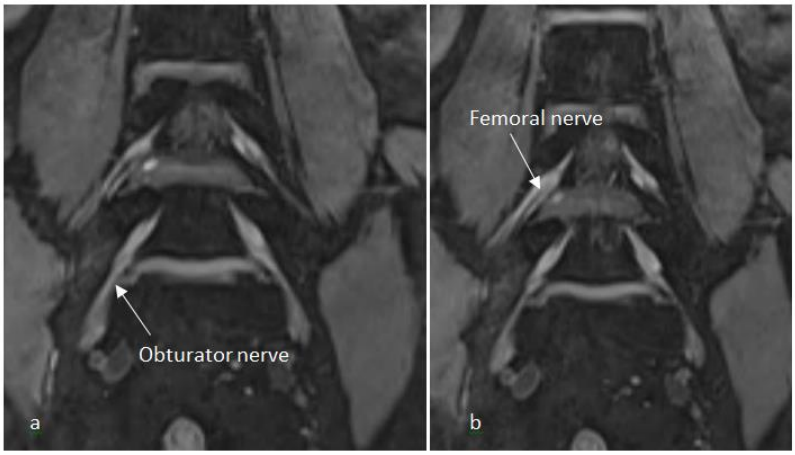
CASE GALLERY

Case-1

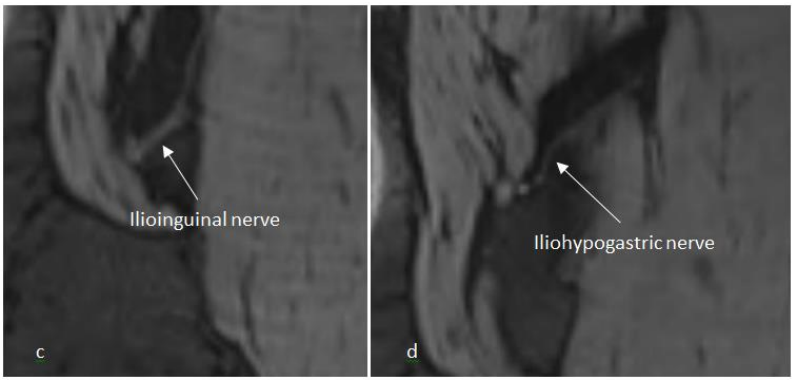
45year old male patient with complaints of low back ache. MRI lumbosacral spine revealed disc compression. MRI lumbar plexus screening was done using the 3 sequences.



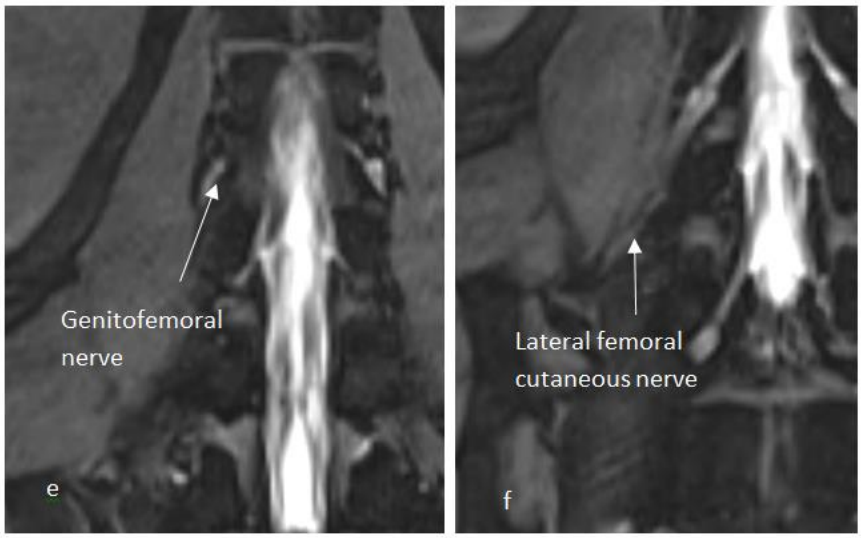
MRI Coronal view shows the 3 sequences- 3D VIBE, DESS and 3D SPACE in comparison



DESS sequence showing the (a) obturator nerve and (b) femoral nerve



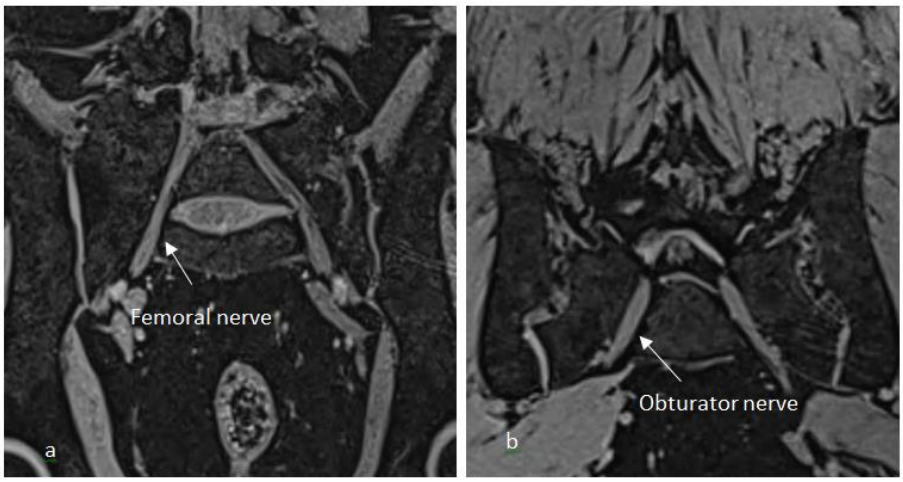
DESS sequence showing the (c) ilioinguinal nerve and (d) iliohypogastric nerve



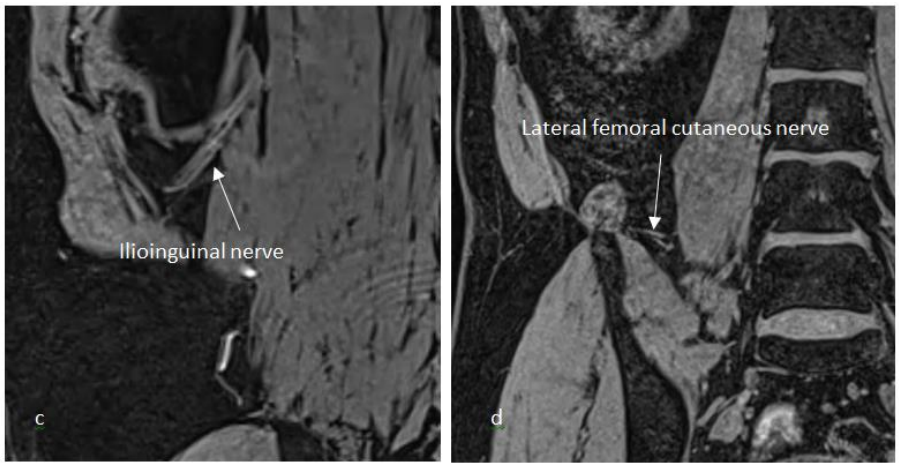
DESS sequence showing the (e) genitofemoral nerve and (f) lateral femoral cutaneous nerve

Case-2

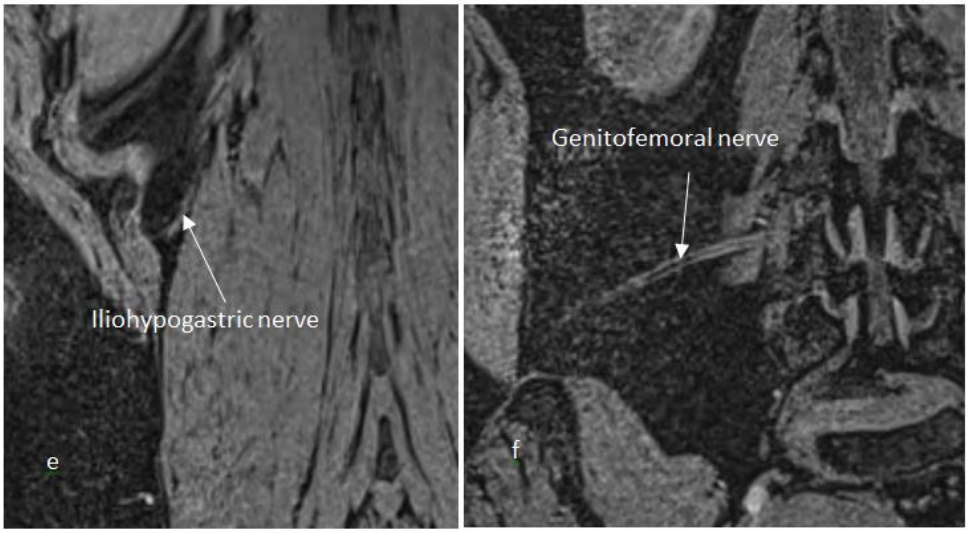
69 year old male patient with complaints of low back ache and pain radiating to left lower limb. MRI lumbosacral spine revealed degenerative changes of spine. MRI lumbar plexus screening shows the nerves of lumbar plexus in VIBE sequence.



VIBE sequence showing the (a) femoral nerve and (b) obturator nerve



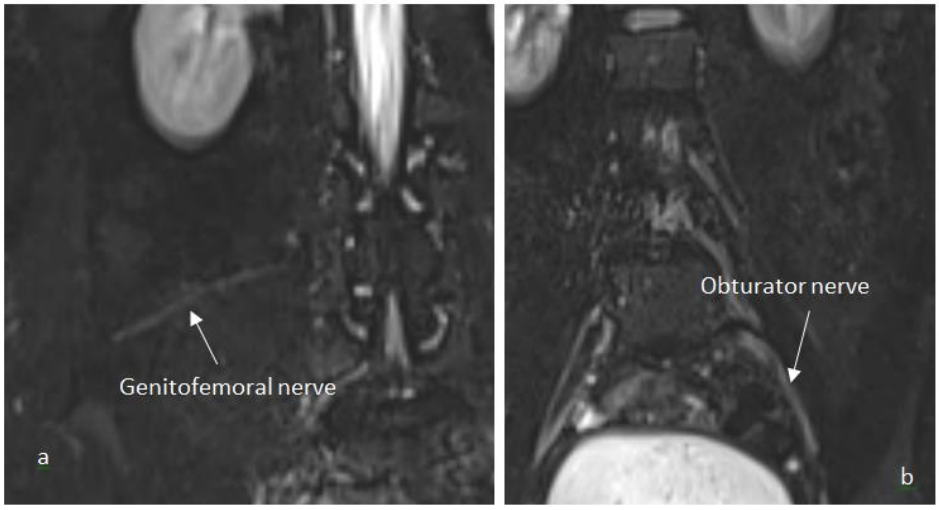
VIBE sequence showing the (c) ilioinguinal nerve and (d) lateral femoral cutaneous nerve



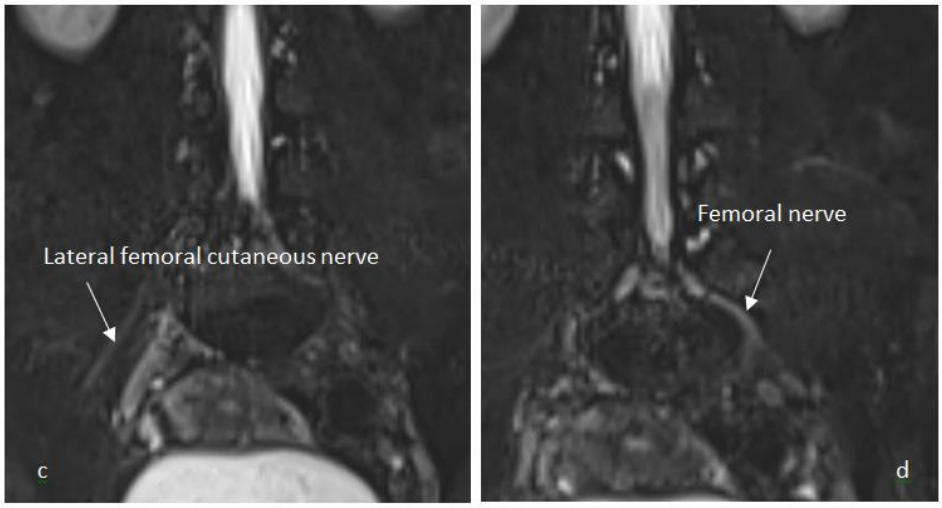
VIBE sequence showing the (e) iliohypogastric nerve and (f) genitofemoral nerve

Case-3

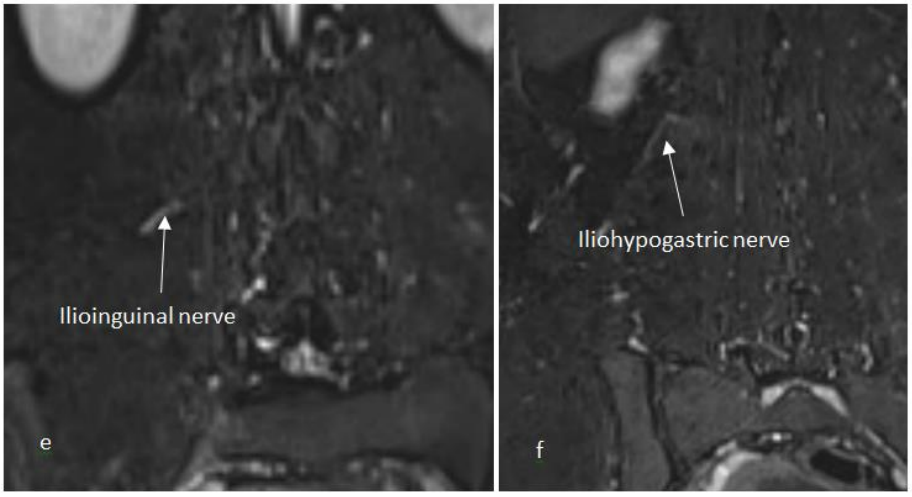
51 year old female patient with history of trauma. MRI lumbosacral spine was done. The patient was diagnosed with post traumatic disc bulge. MRI lumbar plexus screening shows the nerves of lumbar plexus in 3D SPACE sequence.



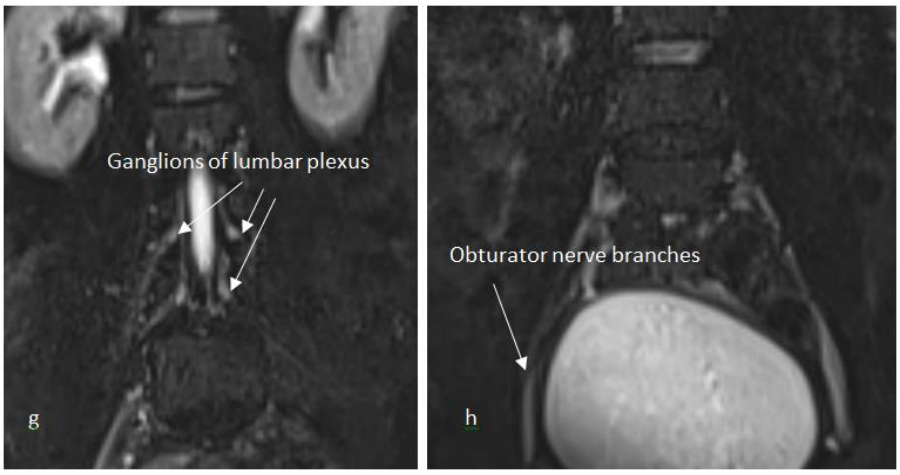
3D SPACE sequence showing the (a) genitofemoral nerve and (b) obturator nerve



3D SPACE sequence showing the (c) lateral femoral cutaneous nerve and (d) femoral nerve



3D SPACE sequence showing the (e) ilioinguinal nerve and (f) iliohypogastric nerve

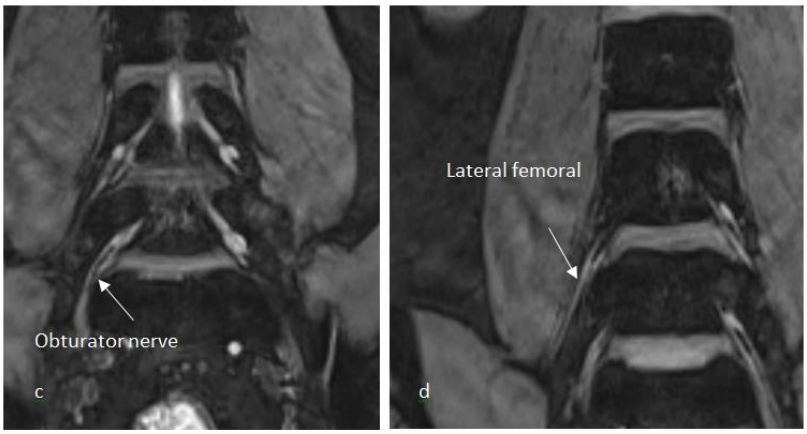


3D SPACE sequence showing the (g) ganglions of lumbar plexus and (h) branches of obturator nerve

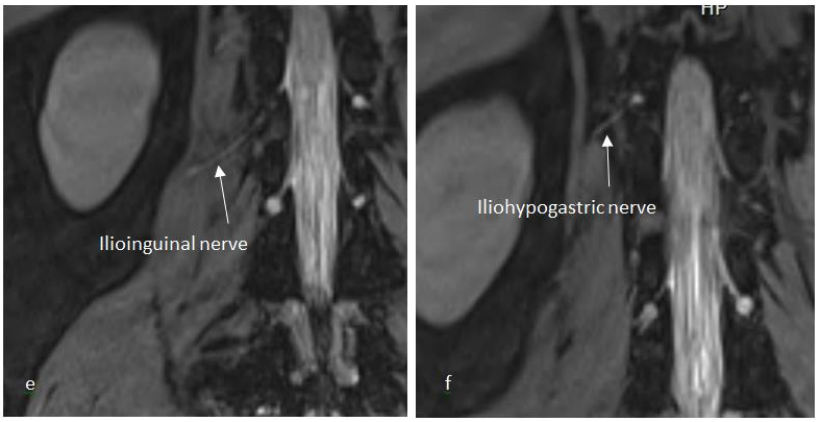
Case-4

40 year old female patient, who was a known case of polio. MRI lumbar plexus screening shows the nerves of lumbar plexus in DESS sequence.

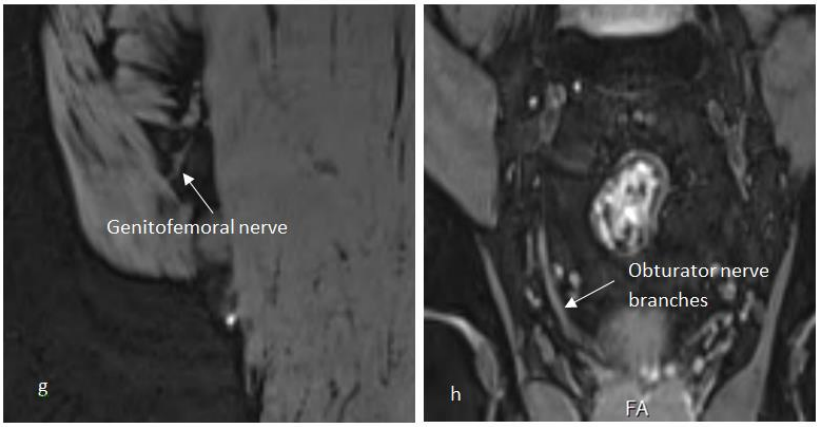
DESS sequence showing the (a) ganglions of lumbar plexus and (b) femoral nerve



DESS sequence showing the (c) obturator nerve and (d) lateral femoral cutaneous nerve



DESS sequence showing the (e) ilioinguinal nerve and (f) iliohypogastric nerve.



DESS sequence showing the (g) genitofemoral nerve and (h) obturator nerve

DISCUSSION

Our study was done on 50 patients who were referred for Magnetic Resonance Imaging of the lumbosacral spine. Patients were evaluated using Siemens Magnetom VIDA Magnetic Resonance Imaging (3Tesla).

Age

In our study, 30 were of age group 30-44, 36 of age group 45-59 and 34 of age group above 60. 30 year old female was the youngest patient in the study and 74 year old female was the oldest patient in the study group.

Gender

Total 50 participants were evaluated, out of which there were 23(46%) males and 27(54%) females (all age groups).

Findings

The lumbar plexus was evaluated using the 3 MRI sequences- 3D VIBE, DESS and 3D SPACE. The utility of each sequence in evaluating the nerves was studied. From our study, the following findings were seen.

Iliohypogastric Nerve

The nerve was best seen in DESS sequence in 48% participants , 3D SPACE sequence in 30% of participants and 3D VIBE sequence in 22% of participants,.

Ilioinguinal Nerve

The nerve was best seen in 3D SPACE sequence in 56% of participants, DESS sequence in 24% participants and 3D VIBE sequence in 20% of participants.

Lateral Femoral Cutaneous Nerve

The nerve was best seen in 3D SPACE sequence in 42% of participants, DESS sequence in 30% participants and 3D VIBE sequence in 28% of participants.

Genitofemoral Nerve

The nerve was best seen in DESS sequence in 36% participants, 3D VIBE in 32% of participants and 3D SPACE sequence in 32% of participants.

Obturator Nerve

The nerve was best seen in DESS sequence in 44% participants, 3D SPACE sequence in 30% of participants and 3D VIBE sequence in 26% of participants.

Femoral Nerve

The nerve was best seen in 3D VIBE sequence in 40% of participants, DESS sequence in 32% participants and 3D SPACE sequence in 28% of participants.

Ganglions of lumbar plexus:

The nerve was best seen in DESS sequence in 42% participants, 3D SPACE sequence in 30% of participants and 3D VIBE sequence in 28% of participants.

Table-12: Shows summary of nerves of lumbar plexus and the best sequence to evaluate the nerves

S. No	Nerves of lumbar plexus	Best sequence
1.	Iliohypogastric nerve	DESS
2.	Ilioinguinal nerve	3D SPACE
3.	Lateral femoral cutaneous nerve	3D SPACE
4.	Genitofemoral nerve	DESS
5.	Obturator nerve	DESS
6.	Femoral nerve	3D VIBE
7.	Ganglions of lumbar plexus	DESS

CONCLUSION

Magnetic Resonance Imaging using 3D sequences- 3D VIBE, DESS and 3D SPACE were extremely useful in evaluating lumbar plexus. The lumbar plexus comprises a network of nerve roots and peripheral nerves. Lumbar plexus pathology can lead to sensory loss, debilitating pain and motor weakness. Hence, understanding the anatomic distribution of the nerves is essential for proper interpretation. It may be locally involved by extrinsic compression or infiltration or associated with systemic conditions, such as metabolic, autoimmune, ischemic, and inflammatory disorders and vasculitis. With the improvement of the available technology, MRN should be appreciated to diagnose pathologies of the lumbar plexus, especially in patients with persistent nerve-related symptoms despite normal or equivocal routine spine or pelvic imaging, or even electromyography. MRN is useful to localize the lesion, to provide direct and noninvasive evidence of neuromuscular pathologies, guiding therapy, and additional studies. Hence, from our study we conclude that MRN is effective in evaluating lumbar plexus and is a valuable adjunct because it provides anatomic information that is not obtainable with other modalities and is useful for assessing lesions.

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