Application of Intra Operative Ultrasound in Spine Surgery

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Abstract

Objective: Intra operative ultrasound is a real-time imaging modality. Though it was introduced in 1980s, not widely used. It is applicable for Intradural lesions and pathology ventral to cord, while making a posterior approach and helps make surgery safer. We aim to share technique and our experience of intra operative ultrasound by sharing illustrative cases.

Method: Our Surgical cases were reviewed, and we identified cases where we used intra operative ultrasound. Illustrative cases were selected and compiled.

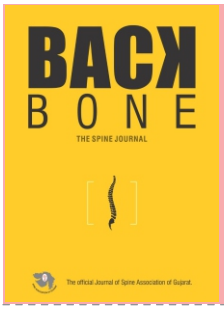
Results: This article describes technique of intra operative ultrasound and demonstrates several illustrative cases.

Conclusion: Intra operative ultrasound is a real time imaging tool and can be used for various indications especially for intra dural lesions and addressing ventral pathology from posterior routes.

Keywords: Intra operative ultrasound, Real time imaging, Intra operative adjunct

Introduction

Intra operative ultrasound is a real time, on table imaging technique. [1, 2, 3] It's easy, available at most hospitals, reliable and gives excellent images on table. In 1982, Dohrmann and Rubin reported using intra operative ultrasound during spine surgery on ten patients with varying diagnoses including syringomyelia, spinal cord cysts, intramedullary and extramedullary tumors. [1] following that many publications were produced where intra operative ultrasound was used to guide the resection of intra and extramedullary tumors, drainage of spinal cysts and placement of syringo subarachnoid shunts. [4,5, 6, 7, 15] Intra operative ultrasound was also used to identify and confirm decompression of pathology, ventral to the thecal sac such as central disc herniation or retropulsed bone fragment. [4,6,11,12,13,14,16,17] Despite many applications and advantages, this imaging technique is not widely. used We share our experience of using intra operative ultrasound in Spine Surgery. We are using it since 2007 and found it a convenient and reliable imaging technique.



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Ultrasound Machine & Technique:

We are using GE LOGIQ E with 12 MHz probe. On table; after Laminectomy is done. A cavity is filled with saline, and the probe is placed dorsal to the dura over laminectomy defect. After applying jelly over the probe, the probe is covered with a sterile disposable transparent camera cover, and image is visualized on screen. It is not necessary to touch the dura or spinal cord with the probe to obtain images. [6, 7, 15]

We can see sagittal as well as axial images of cord and ventral or intradural pathology.

On ultrasound, the dura appears as an echogenic membrane surrounding a space of anechoic spinal fluid. The spinal cord is located within the dura. It appears as a homogenous structure with low echoes surrounded by an echogenic rim that represents physical change in density from spinal fluid to spinal cord parenchyma. There is also a bright central echo representing the central canal. [6]

Application of Intra operative Ultrasound:

Intra operative ultrasound has various application. It is useful to visualize area ventral to spinal cord without retraction.

Cervical Myelopathy:

In cervical myelopathy, when compression is anterior and posterior or a case with long segment OPLL, only ventral compression is there and one decides to do posterior decompression. After Laminectomy; an ultrasound is done to confirm the adequacy of decompression. [12, 14, 15, 16, 17]

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Figure 1: GE Logiq E ultrasound machine

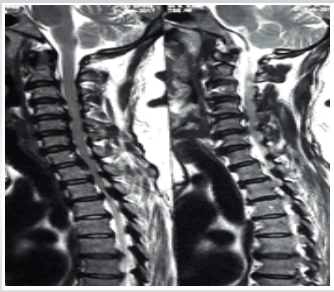

Figure 2: Pre op MRI showing Multilevel cervical OPLL with cord compression and signal change

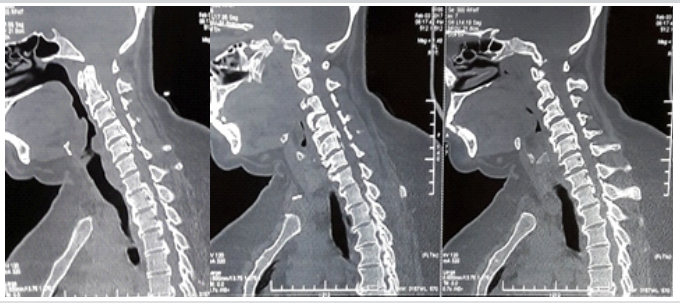

Figure 3: Pre op CT demonstrating Multilevel cervical OPLL

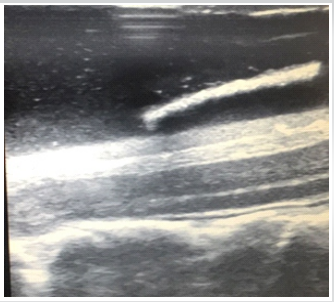

Figure 4: Intra op ultrasound showing good decompression of cord following laminectomy

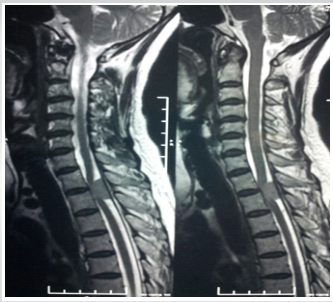

Figure 5: MRI T2 sagital image showing T2 level dural based meningioma

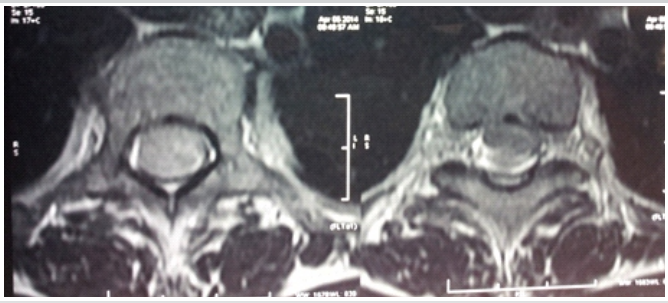

Figure 6: MRI T2 axial image showing dural based meningioma

Illustrative Case:

A 43-year-old lady presented with progressive bilateral hand weakness and balance trouble of 6 months duration and clinically evident; spasticity in lower limbs, ataxia and positive Rhomberg's sign.

Her MRI showed significant cervical & upper dorsal canal stenosis with OPLL and signal change. Cervical and upper dorsal laminectomy with cervico dorsal fixation done. Post laminectomy ultrasound demonstrated adequate decompression.

Intradural tumors:

In cases of Intradural tumors, ultrasound is done after laminectomy to ensure; adequacy of laminectomy and location of tumor prior to opening dura. [1, 6, 7, 9, 10, 15]

Illustrative case:

A 52-year-old lady with progressive paraparesis. MRI demonstrated T2 intradural extramedullary dural based lesion likely Meningioma. T2 laminectomy done. Intraoperative ultrasound done, demonstrated adequacy of exposure. Followed by complete excision of lesion.

Lesion ventral to spinal cord:

In thoracic spine pathology, when compression is ventral and one wants to do decompression from posterior approach without spinal cord retraction. Ultrasound is done after laminectomy; ventral compression is noted. Then under continuous ultrasonic monitoring, ventral decompression is done, and adequate ventral decompression is confirmed under ultrasound. This technique is applicable for Thoracic disc, thoracic spinal Koch's, thoracic trauma with retropulsed fragment as well as thoracic vertebral tumors; metastasis/hematological malignancy with ventral compression. [4, 6, 11-17]

Illustrative Case:

A 62-year-old lady presented with spastic paraparesis. She was a known case of Carcinoma Thyroid. MRI showed T4 vertebral body metastasis with spinal cord compression. T4 laminectomy; intra operative ultrasound guided ventral decompression and pedicle screw fixation was done.

Spinal vascular Malformation:

In spinal dural AV fistula and spinal vascular malformation, ultrasound is helpful to locate fistula and confirmation of complete obliteration of fistula by demonstrating absence of high flow channels post occlusion of AV fistula. [8, 15, 16, 17]

Illustrative case:

A 60-year-old old gentleman presented with Progressive left leg weakness and urinary urgency with urge incontinence. MRI showed L3/4, L4/5 canal stenosis with Flow voids and spinal cord edema in lower dorsal cord. Spinal angio confirms Filum AV fistula at L3/4. L3/L4 laminectomy done intraoperative ultrasound done, demonstrated extensive large vessels with flow voids, Fistula and filum excised, post procedural ultrasound demonstrated absence of flow voids.

Figure 7: Intraop ultrasound image of dural based meningioma

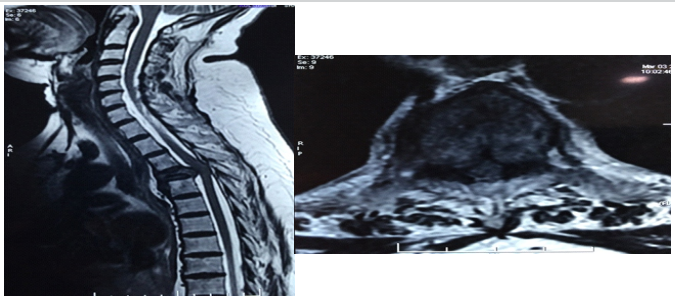

Figure 8: MRI T2 sagital & axial mages showing T4 level pathological fracture with spinal cord compression

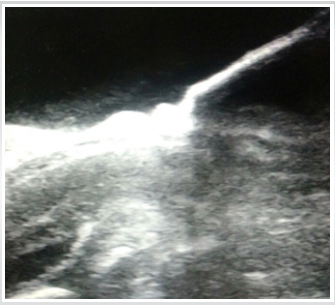

Figure 9: Intra op ultrasound showing significant ventral compression

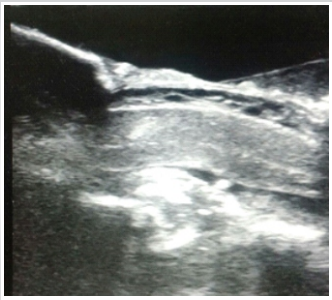

Figure 10: Intra op ultrasound confirming adequate ventral decompression

Figure 11: MRI showing severe L3-4,4-5 canal stenosis

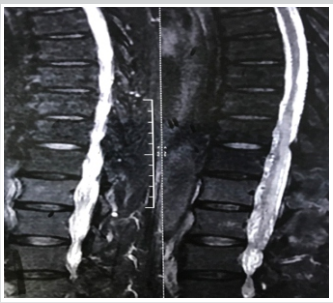

Figure 12: MRI showing lower thoracic cord edema with significant flow voids

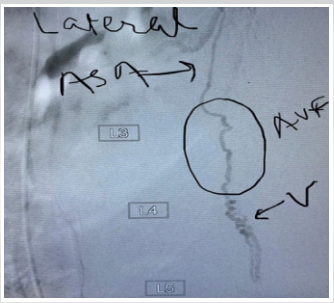

Figure 13: Spinal DSA showing AV fistula at L3-4 level with engorged veins

Figure 14: Intra op ultrasound showing engorged intradural vessels

Figure 15: Specimen of Excised filum with engorged veins

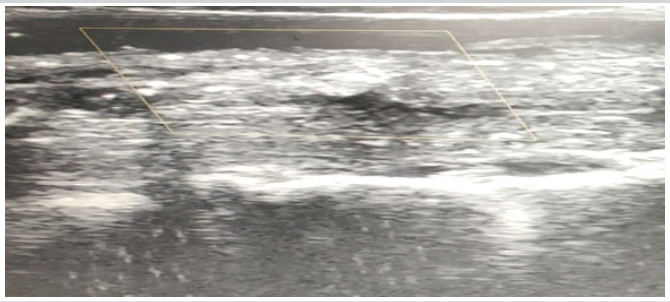

Figure 16: Intra op ultrasound confirming adequate ventral decompression

Lumbar sequestrated disc herniation:

In cases of lumbar sequestrated disc herniation; when there are multiple sequestrated fragments; ultrasound is helpful to confirm adequacy of decompression and confirming removal of all the sequestrated fragment. [15, 16]

Conclusion

Intra operative ultrasound is an essential adjunct for successful spine surgery. It's easy to learn and interpret and a very reliable Imaging tool.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

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