Clinical-Radiological Correlation of Ultrasound Guided Dorsal Sacral Foramen Injection for Foot and Ankle Surgeries - A Case Report

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Abstract

Popliteal sciatic nerve block, supplemented by either a femoral nerve or an adductor canal block is the commonly used peripheral nerve block technique for foot and ankle surgeries. Dorsal sacral foramen injection has the potential to block the presacral nerve root, thereby the sciatic nerve. We present a series of five patients scheduled for foot and ankle surgery, who received ultrasound guided dorsal sacral foraminal injection (DSFI) at the level of second sacral foramina for postoperative analgesia. Primary anaesthetic for the surgery was spinal anaesthesia. Two patients of subtalar arthrosis received an additional adductor canal block as the incision involved medial part of the foot, innervated by the saphenous nerve. While performing the DSFI, needle tip was confirmed with fluoroscopy and radio-contrast was injected to reveal the spread. Postoperatively computerised tomography (CT) scan was performed on all five patients. Fluoroscopy and CT scan confirmed a spread in the epidural space and along the roots of the sacral plexus, which possibly is the mechanism of analgesia in lower limb surgical procedures. Clinically, all the patients remained pain free till 6 hrs following the block. The time to first analgesic were 11, 14, 8, 10 and 16 hours respectively.

Keywords: case report, Foot surgery: regional anaesthesia, Sciatic nerve block: anatomy, Ultrasound structures: echogenicity, Caudal space anatomy, Spread of epidural anaesthesia

Introduction

The popliteal sciatic nerve block, combined with the adductor canal block or the femoral nerve block (PSNB-Add/ FNB) is known to provide postoperative analgesia in foot and ankle surgery. Multiple puncture points and the possibility of persistent foot drop are some of the problems associated with it. The sacral foramina offer a potential passage between the dorsal and ventral aspects of sacrum. Several anatomical landmark based and fluoroscopic (FL) guided approach of injections into the dorsal second sacral foramen (DSF 2) for sacral spinal and epidural injection have been described[1-4]. We describe a series of five patients undergoing foot and ankle surgery who

received ultrasound guided dorsal sacral foramen injection (DSFI) at the level of the second sacral foramen (SF 2). The technique was coupled with fluoroscopic confirmation of needle position in anteroposterior (AP) and lateral views and post procedure computerised tomography (CT) scan to map the spread of the injected radiocontrast. Permission from institutional review board was obtained for accessing medical records. This article conforms to the ACRE guidelines.

Narrative

Five patients (ASA 1 and 2, male = 3, age 24, 36, 54 years; female = 2; age 22, 63 years), scheduled for foot and ankle surgeries (N = 2 Tendoachillis rupture; N=1 Fractures of calcaneum; N = 2 Subtalar arthrodesis) are reported in this series. All of the patients received spinal anesthesia as the primary anesthetic, and DSFI for postoperative analgesia. DSFI was administered postoperatively in prone position in 2 patients (Tendoachillis rupture) and in lateral position (N=1 Fractures of calcaneum; N = 2 Subtalar arthrodesis) in three patients. Patients were informed about the technique, use of ultrasound and fluoroscopy to image the needle and consent was taken for radiocontrast injection and CT scan studies. The two patients of subtalar arthrodesis received a mid-thigh ultrasound guided adductor canal block with 10 ml of 0.2% ropivacaine in addition to the DSFI.

DSFI Technique: The dorsal area below the iliac crest was prepared with antiseptic solution and draped. A linear probe (5-13 MHz M Turbo, Sonosite, Bothell, Washington, USA) was deployed on the spinous line and the L5-S1 spinous process and the dorsal sacral plate were identified. With a lateral shift of probe, the intermediate crest was located. Slight caudal and lateral shift revealed the break in the continuity (apertures) on the dorsal sacral plate. The first aperture was considered as the DSF 2. Hypoechoic structures were seen emerging from the apertures and coursing caudally. Colour mode did not pick up vascular structures. A 21 g short bevel insulated needle was inserted in plane from cephalad to caudal direction under ultrasound guidance through the sacral multifidus muscle (SMM) as far as the dorsal sacral plate. Slight manipulations were required for the needle tip to gain access to the brim of DSF 2 (Figure 1). A loss of resistance (click/pop) could be appreciated as the tip penetrated the fascial layer covering of DSF 2. The AP and lateral fluoroscopic images in 5 patients confirmed the needle tip position and excluded needle tip in the sacral epidural space. Following negative aspiration for blood and CSF, 5ml of 2% xylocaine with 1:2 lac adrenaline was injected. With no change in vital signs, 5ml of omnipaque (iohexol 300mg iodine/ml) and 15ml of 0.2% ropivacaine was injected in small boluses (Figure 1D). An initial cephalad spread in the sacral epidural space was identified along with a caudal spread. A fluoroscopic AP and lateral view was obtained to assess the extent of spread of the solution. Patients were turned supine and monitored for 15 minutes before they were shifted to recovery room.

CT scan was performed after one hour from the block. The ultrasound images and fluoroscopic pictures were analysed by two anesthesiologist (SD and AC) and CT scan images by a senior radiologist.

CT contrast studies (Figures 3, 4 and table 1) revealed a spread in the epidural space [5/5] from sacral to the lumbar in all planes [5/5], staining the sacral nerve roots [5/5] and contrast emerging in

the pre-sacral area [2/5]. The extent of contrast spread was S4 to T12, S3 to L3, S4 to L2, S3 to T12 and S3 to L1 in the first, second, third, fourth and the fifth patient respectively.

Perspective

In the postoperative period, pain was monitored by a numerical rating scale (NRS) at 0, 6, 12, 18, 24, 36, 48 hours from the block (Table 1). All patients received intravenous infusion of paracetamol 1 gm (100 ml) 8 hourly. Injection diclofenac sodium 75mg was injected intramuscularly when the pain score was reported 3 or more at the first time. Thereafter diclofenac sodium 75 mg was added to the 8 hourly paracetamol infusion. Additional data and images are available here.

Discussion

Ultrasound identification of DSF 2 and needle tip placement at the brim of the sacral dorsal foramina was possible in all patients. On injection of LA at the DSF 2, an initial cephalad spread in the sacral epidural space was identified under real time ultrasound, with a later caudal spread. The initial cephalad spread is possible because of 1) the larger internal width of upper sacral epidural space accommodating more LA than the narrower lower sacral epidural space and 2) the topographical arrangement of the sacral to lumbar epidural space. The needle tip could be introduced immediately beyond the brim of the dorsal SF, below the deep fascia[9] engulfing the dorsal sacral nerve as they emerge into the sacral multifidus. LA injections from this point travel ventrally, cephalad and caudal as observed in our study with real time ultrasound and followed by CT contrast study. CT contrast study revealed a cephalad spread as high as the 12th thoracic vertebral level (T12) and caudal until the fourth sacral vertebral level (S4) with egress of contrast through the foramina into the sacral nerve roots at the level of S2, 3 and 4. The mean time for first request of analgesic was 11.8 hrs (95% CI 9- 14.6 hrs).

Presacral nerve block[1] has been described as early as in 1928. The sacral dorsal foramina have been used as a gateway to the trans-sacral epidural anesthesia implemented for transurethral bladder surgery.[2] In 20 patients undergoing orthopaedic hip surgery sacral spinal anesthesia[3] was successfully administered through the SF 2. Sacral nerve stimulation[4] is a common treatment for various pelvic floor disorders, such as urinary and faecal incontinence and constipation.[4] The aforementioned techniques were based on anatomical landmark, fluoroscopy guidance and cadaveric anatomic study of the dorsal sacrum.

Bony landmarks[5] such as the sciatic notch, the midline sacral spinous processes, the iliac crest, the sacral hiatus and the tip of the coccyx help to identify a particular posterior sacral foramen. Palpable surface landmarks[6] like the median sacral crest and the posterior superior iliac spine (PSIS) have been used to localize the posterior sacral foramina. A major drawback of the landmark based technique is the high variability of the angles and distances between these anatomical landmarks.[7] Fluoroscopy,[8] though used successfully to circumvent this problem, leads to exposure to harmful

radiation to the patient, the proceduralist and the operating room personnel. Ultrasound, a non-radiation imaging modality is safe and reliable to identify the anatomical landmarks, the sacral foramina and the dorsal sacral roots with their accompanying vessels.

We used fluoroscopy in our series to register the accuracy of the ultrasound technique and obtained CT scan images to document the spread of the injectate. Both of these imaging modalities will not be necessary in the future to confirm ultrasound guided needle placement and spread of LA. A spectral Doppler ultrasound[9] was used to identify the dorsal rami emerging from the sacral foramen, with a success rate of 93.33%. The authors admit nerves with a calibre of less than 1mm may not be visualized. [9] In our cases with a BMI of less than 25 the dorsal sacral rami was visualized exiting the foramen as a hypoechoic structure. Alternatively, the SF 2 can be identified by the McGrath's method[10], where the PSIS is considered as an ultrasound reference point, and the SF 2 can be found on average at an angle of 45 degrees to the midline at a distance of 2–3 cm from the PSIS. The maximum width of the SF 2 has been measured at 0.76cm[10]. The inter-foraminal distance between the SF 2 and the SF 3 is reported at 1.3cm. [10]

Apart from a small case series, one of the major limitations was we did not monitor the motor and sensory block in all patients. Patients were exposed to fluoroscopy and CT-scan, a radiation hazard but were appropriately counselled for the same. The two patients of subtalar arthrodesis received a mid-thigh ultrasound guided adductor canal block because their surgical incision involved the medial part of the foot which is innervated by the saphenous nerve. Saphenous nerve has a root value of L2-4, which as we can see from our imaging analysis are inconsistently blocked by the DSFI. Three out of five patients in our series exhibited contrast in the L2-4 levels (60%).

DSFI technique is simpler than the ultrasound guided sacral plexus block and avoids injury to major vessels as often encountered with conventional sacral plexus block technique. We thus describe a potential non-radiation, non-neurostimulation ultrasound guided DSFI approach at the level of second sacral foramina to epidural space blocking the lumbosacral plexus.

Conclusion

Ultrasound guided DSFI provided postoperative analgesia for foot and ankle surgeries in our series. Further studies are needed to explore its role in lower extremity surgeries innervated by the lumbosacral plexus.

Acknowledgements

Published with the written consent of the patients.

References

1. Lundy JS. A method for producing block anaesthesia of the sacral nerves. *American Journal of Surgery*. 1928;43:262–70.

2. Tomoki N, Kazuo H, Youji O. The Median Approach to Trans-sacral Epidural Block. *Anesthesia & Analgesia*. October 2002 - Volume 95 - Issue 4 - p 1067-1070 doi: 10.1213/00000539-200210000-0005.

3. Paria R, Surroy S, Majumder M, Paria B, Paria A, Das G. Sacral spinal anaesthesia. *Indian J Anaesth*. 2014;58(1):80-82. doi:10.4103/0019-5049.126809.

4. Wexner SD, Coller JA, Devroede G et al. Sacral nerve stimulation for fecal incontinence—results of a 120-patient prospective multicenter study. *Annuls of Surgery. 2012;* 251:441–449.

5. Hasan TS, Shanahan DA, Pridie AK, Neal DE (1996) Surface localization of sacral foramina for neuromodulation of bladder function- an anatomical study. *European Urology*. 29:90–98.

6. Deveneau NE, Greenstein M, Mahalingashetty A et al (2015) Surface and boney landmarks for sacral neuromodulation: a cadaveric study. *Internaional Urogynecology Journal*. 26:263–268.

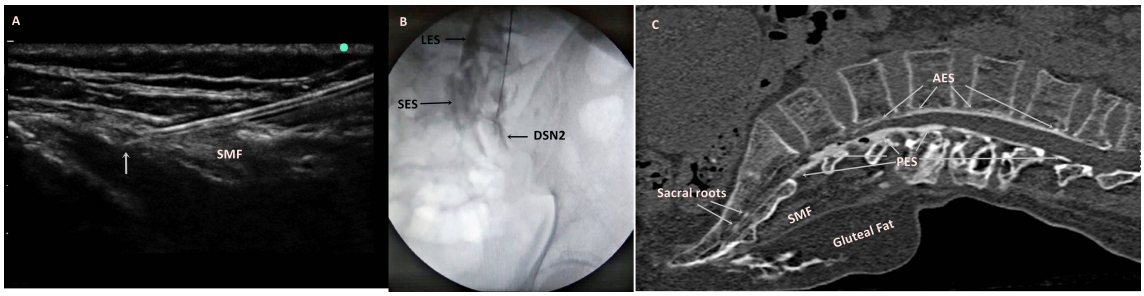
7. Povo A, Arantes M, Matzel KE, Barbosa J, Ferreira MA, Pais D, Rodríguez-Baeza A. Surface anatomical landmarks for the location of posterior sacral foramina in sacral nerve stimulation. *Techniques in Coloproctology*. 2016;20(12):859-864. doi: 10.1007/s10151-016-1543-2. Epub 2016 Nov 14. PMID: 27844258.

8. Kaul A, Bauer B, Bernhardt J et al (1997) Effective doses to members of the public from the diagnostic application of ionizing radiation in Germany. *European Radiology*; 7:1127–1132

9. McGrath MC, Jeffery R, Stinger MD. The dorsal sacral rami and branches: Sonographic visualisation of their vascular signature. *International Journal of Osteopathic Medicine*, 2012. 15 (1) 3-12. doi:10.1016/j.ijosm.2011.09.002

10. McGrath MC, Stringer MD. Bony landmarks in the sacral region: the posterior superior iliac spine and the second dorsal sacral foramina: a potential guide for sonography. *Surgical and Radiologic Anatomy*. 2011 Apr;33(3):279-86. doi: 10.1007/s00276-010-0735-0. Epub 2010 Nov 10. PMID: 21063707.

Attachments



A. Long axis ultrasound image showing block needle tip (Arrow) at the dorsal opening of the second sacral foramen (SF-2) B. Fluoroscopy showing block needle at the dorsal opening of the SF-2, the injected radiocontrast delineating the second dorsal sacral nerve (DSN2), sacral epidural space (SES) and lumbar epidural space (LES). C. CT scan image showing radiocontrast ventral to the sacrum at the sacral roots, at the anterior epidural space (AES) and at the posterior epidural space (PES).

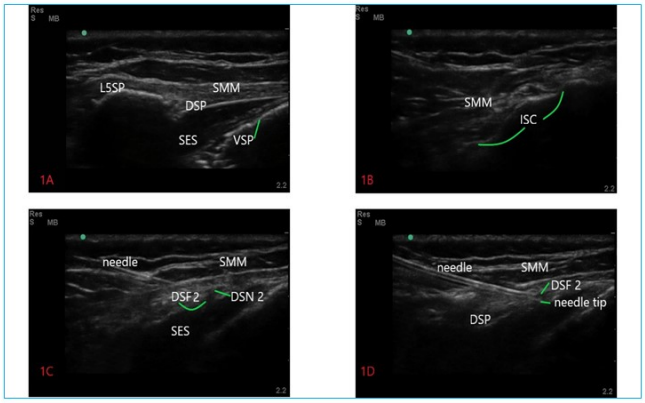


Figure 1
1A: Longitudinal image at the L5-S1 spinous process (SP); sacral multifidus muscle -SMM; dorsal sacral plate – DSP; sacral epidural space – SES; ventral sacral plate – VSP
1B : Longitudinal image at the intermediate sacral crest -ISC
1C : Longitudinal image at the 2nd dorsal sacral foramina -DSF 2; dorsal sacral nerve 2nd -DSN
1D : needle tip at the brim (outer border of the DSP) of the DSF 2

Figure 1 1A: Longitudinal image at the L5-S1 spinous process (SP); sacral multifidus muscle -SMM; dorsal sacral plate – DSP; sacral epidural space – SES; ventral sacral plate – VSP 1B : Longitudinal image at the intermediate sacral crest -ISC 1C : Longitudinal image at the 2nd dorsal sacral foramina -DSF 2; dorsal sacral nerve 2nd -DSN 1D : needle tip at the brim (outer border of the DSP) of the DSF 2

	1	2	3	4	5
Age	24	22	36	63	54
Gender	M	F	M	F	M
ASA	1	1	2	1	2
Type of Surgery	TAR	ORIF for # calcaneum	STA	TAR	STA
Type of Primary Anaesthesia	SA	SA	SA	SA	SA
Type of Analgesia	DFSB	DFSB	DFSB	DFSB	DFSB
Fluoroscopic confirmation	Yes	Yes	Yes	Yes	Yes
Postoperative Lumbosacral CT scan	Yes	Yes	Yes	Yes	Yes

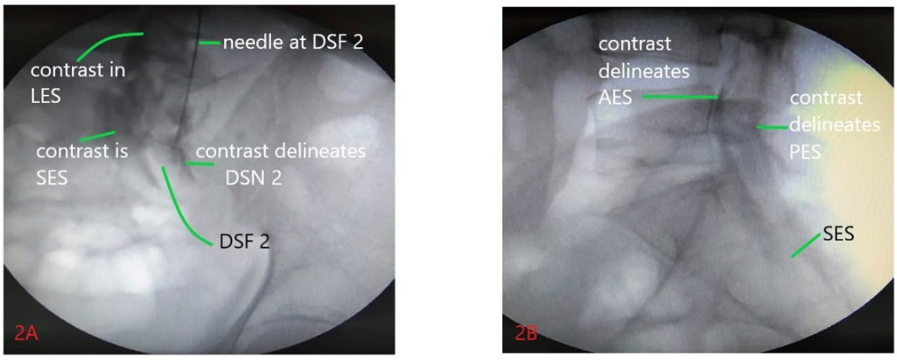


Figure 2
2A : Anteroposterior image depicting the needle tip at the DSF 2and contrast spread in the lower lumbar epidural space-LES and upper sacral epidural space – SES. Contrast delineates the DSN 2.
2B : Lateral view depicting the contrast delineating the anterio and posterior epidural space (AES and PES) respectively. Contrast extends into the SES.

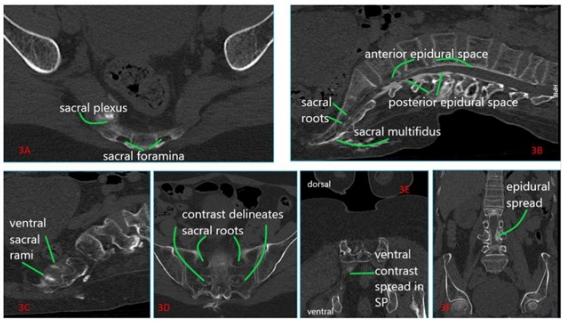


Figure 3:

3A : Axial section at the SF 3 level demonstrating the foramina and spread of the contrast in the sacral plexus

3B : Sagittal view depicting the contrast stained sacral roots and delineation of the anterior and posterior epidural space until upper portion of L1

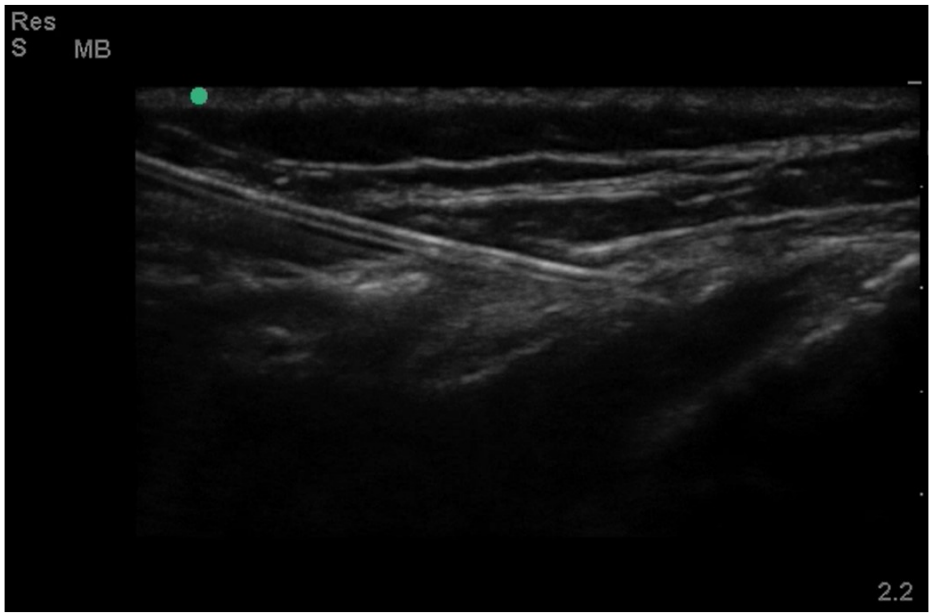
3C : Sagittal section with contrast delineating the lower sacral rami

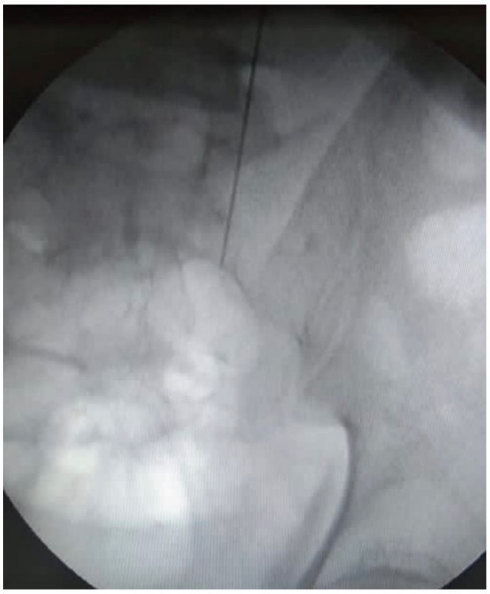
3D : Coronal view : Contrast delineates the sacral roots in the sacral foramina

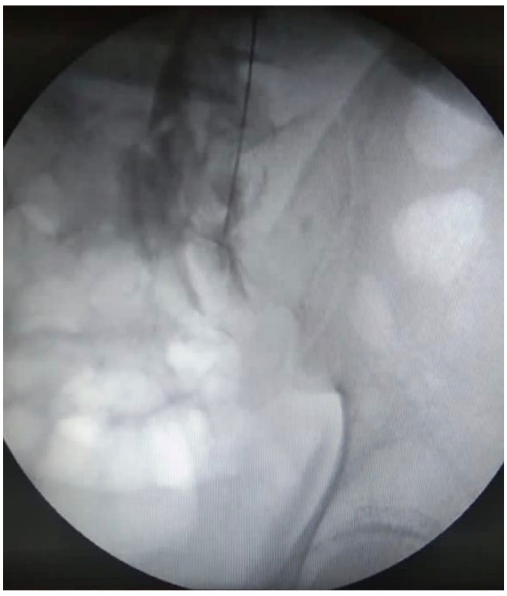
Contrast distribution of DSF 2 injection

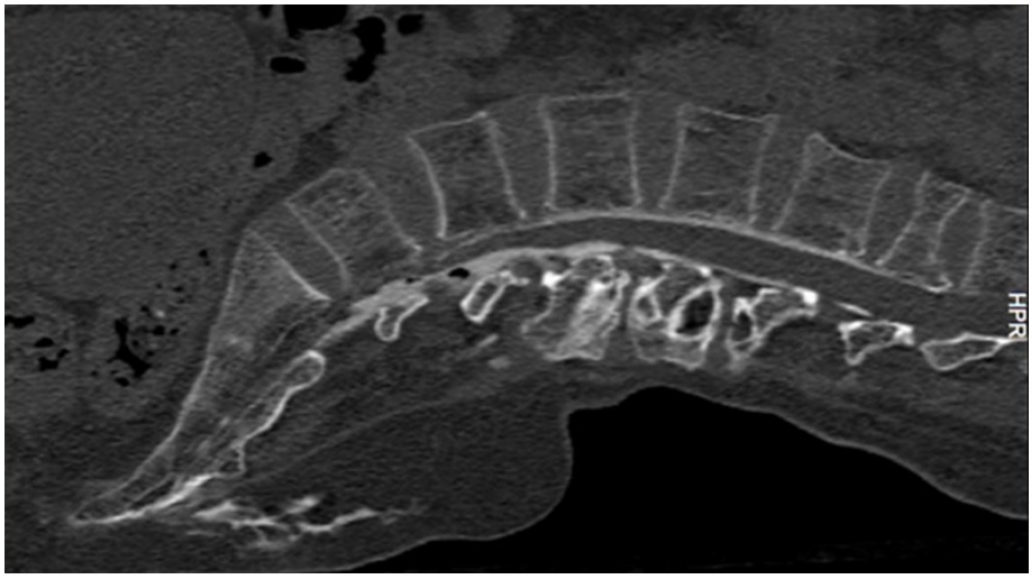
	S4	S3	S2	S1	L5	L4	L3	L2	L1	T12	Extent
Axial											
case 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	S4 -T12
case 2	N	Y	Y	Y	Y	Y	Y	N	N	N	S3-L3
case 3	Y	Y	Y	Y	Y	Y	N	N	N	N	S4-L4
case 4	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	S3-T12
case 5	N	Y	Y	Y	Y	Y	Y	Y	N	N	S3-L2
Sagittal											
case 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	S4 -T12
case 2	N	Y	Y	Y	Y	Y	N	N	N	N	S3-L4
case 3	N	Y	Y	Y	Y	Y	Y	Y	N	N	S3-L2
case 4	N	N	Y	Y	Y	Y	Y	Y	Y	Y	S2-T12
case 5	N	N	Y	Y	Y	Y	Y	Y	Y	N	S2-L1
Coronal											
case 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	S4 -T12
case 2	N	Y	Y	Y	Y	Y	Y	N	N	N	S3-L3
case 3	Y	Y	Y	Y	Y	Y	N	N	N	N	S4-L4
case 4	N	Y	Y	Y	Y	Y	Y	Y	N	N	S3-L2
case 5	N	Y	Y	Y	Y	Y	Y	Y	N	N	S3-L2

Figure 4: Contrast spread evident in different views of CT scan





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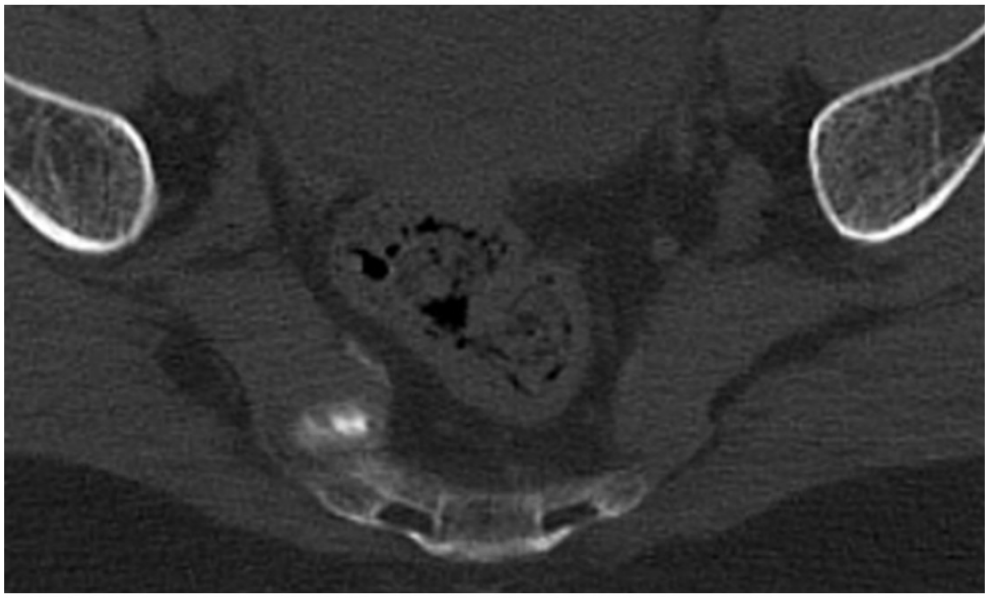

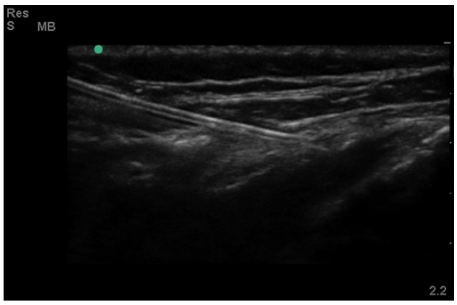
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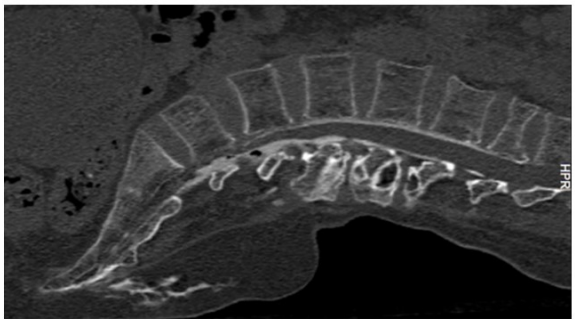
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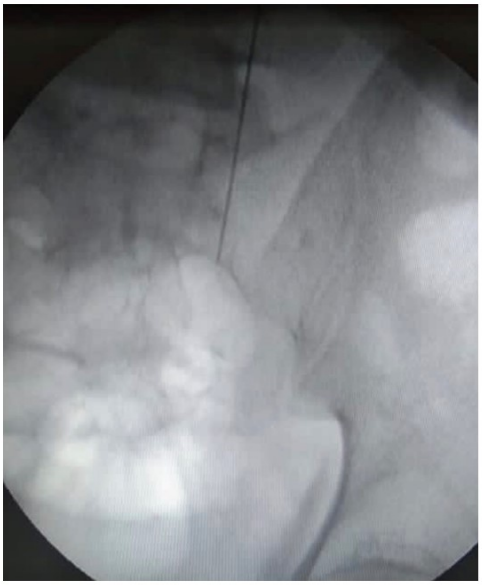

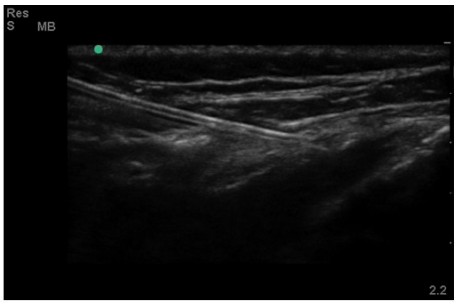
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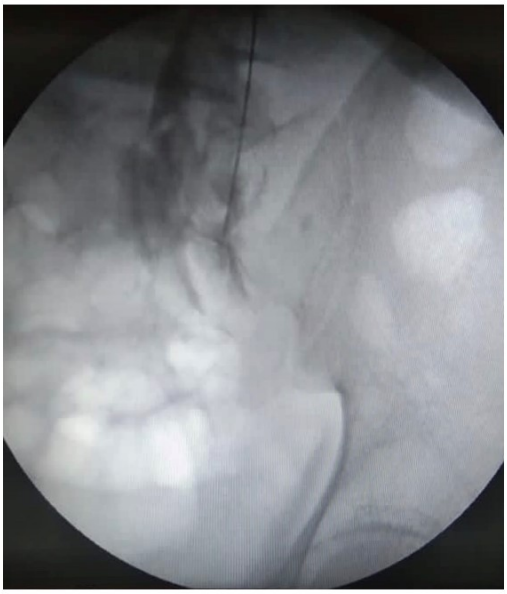

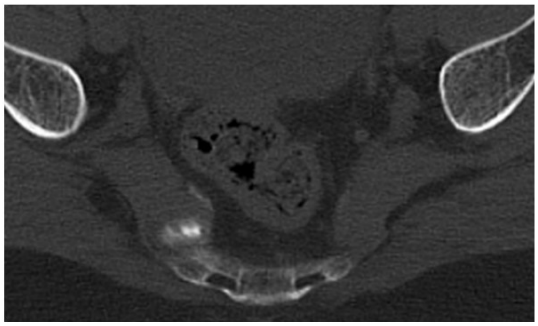

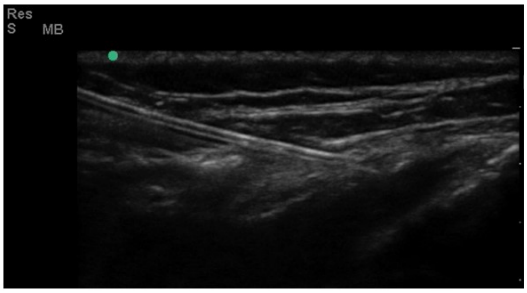
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