Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i7.7028

VALIDATION OF ULTRASOUND FOR PERFORMING CAUDAL EPIDURAL STEROID INJECTIONS

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Abstract

Introduction: Primary aim of this study was to use ultrasound for performing caudal epidural injections, as ultrasound can provide the clear images of the sacral structures like sacral cornuas and sacral hiatus and can detect the anatomic variations of the sacrum and sacral hiatus that make caudal epidural injection difficult or impossible. And thus to validate ultrasound for performing caudal epidural injections. Performing Caudal epidural injections solely under the C-Arm guidance carries more risk of radiation hazard as many a times multiple X-Rays are required while performing this procedure. In this method we used ultrasound guidance to identify caudal structures and to insert and advance the needle in sacral hiatus, as well as to observe turbulence of the injected contrast agent in the sacral canal, but final confirmation of correct placement of needle and filling of contrast agent in epidural space was done in fluoroscopic view.

Materials and Methods: This was an observational case study. 32 patients (16 male and 16 female patients) with low back pain posted for caudal epidural steroid injection as per the inclusion criteria were included in this study. Ultrasound images of the sacral hiatus and bilateral cornua were obtained by a real-time linear array transducer. Under the ultrasonography guidance wede fined the procedure successful if the needle was visualised in sacral hiatus, and turbulence of injected contrast agent in the sacral canal observed and with fluoroscopic view correct placement of needle and filling of epidural space with contrast agent was confirmed.

Results: The epidurogram showed that the injection was successful in 31 out of 32 patients. In only 1 out of 32 patients filling of contrast agent was not seen in fluoroscopic view. The mean distance between bilateral sacral cornua of all 32 patients was found to be 18.30 ± 0.96 mm, the mean distance between anterior and posterior wall of sacral hiatus apex area of all 32 patients were found to be 2.93±0.42 mm. In 1 patient in which the filing of contrast agent in epidural space was not seen on fluoroscopic view, distance between the anterior and posterior wall of sacral hiatus in apex area was 1.80 mm which was smallest among all 32 patients. And the distance between bilateral sacral cornua were 18.60 mm. The mean of Body Mass Index (BMI) was found to 26.79± 3.54.

Conclusion: In conclusion, ultrasound could be safe and reliable modality to observe anatomic variations of sacral hiatus and to perform caudal epidural injections.

Keywords: Caudal epidural, ultrasound, sacral hiatus, sacral cornua, low back pain, fluoroscopy.
Introduction: In the recent years ultrasound has been widely used for the regional blocks. Ultrasound guided injections have shown advantages over the traditional techniques for the performance of regional anaesthesia. By performing regional anaesthesia with the help of the ultrasound guidance, less chances of vascular puncture, reduced dose of local anaesthetic and overall increased success rate of the blocks seen.[1] Usually the low back pain which last for more than 3 month duration is called chronic low back pain. Common causes of the low back pain are herniated intervertebral disc, degenerative disc disorder, spinal stenosis and compression fracture of the lumbar spine.[2]
The pain usually begins in the lower back, radiating to the sacroiliac region and buttocks. The pain can radiate down the posterior thigh. Radicular pain usually extends below the knee and follows the dermatome of the involved nerve root.In the patients with chronic low back pain, epidural injection of local anaesthetics like lignocaine, and bupivacaine with or without corticosteroids has been used as an accepted non surgical method to manage chronic low back pain. Epidural steroids are believed to act by inhibiting the synthesis or release of the inflammatory substances thereby, reducing the intra-neural edema and venous congestion.[3] [4] Various approaches like interlaminar approach, transforaminal approach, caudal epidural approach is used for this purpose of epidural injections. Caudal epidural approach is technically easier as compared to transforaminal approach. Caudal epidural injection is the safe and easy way to administer drug with a lower risk of the thecal sac puncture. In the caudal approach the epidural space is entered via the sacral hiatus, so the abnormalities of the sacral hiatus and the anatomic variations of the sacrum remains the challenges during the caudal injections, making it difficult to locate the sacral hiatus. High missing rate of blind injection is the major limitation to caudal approach. But with the help of fluoroscopy it is easier to confirm that needle is in correct place and the medications are properly injected into the epidural space, but it poses more radiation exposure to both patients and the interventionist. Ultrasound has been widely used in the recent years for the assessment of anatomy of the nervous system as well as for regional blocks, as it imparts better visualization of anatomical structures in real time without hazards of radiation and iodinated contrast agent.[5] With the use of ultrasound for caudal epidural injection, ultrasound can provide the clear images of the sacral hiatus and detect the anatomic variations of the sacrum and the sacral hiatus that make caudal epidural injection difficult or impossible.
Aim- main aim of this study is '' Validation of ultrasound for performing caudal epidural steroid injections''**.**

Materials and Methods –
Inclusion Criteria
1. Patients between age group 25-75 yrs.
2. Patients with American Society of Anesthesiologist (ASA) grading I, II, III.
3. Patients fulfilling any of the below criteria.

(A)Patients with low back pain with or without unilateral or bilateral radicular pain (Visual Analogue Scale) ≥3 not responding to conservative treatment (medical treatment and physiotherapy) for more than 6 weeks and refuse surgery or unfit for surgery.

(B)Patients with MRI findings of disc protrusion and disc bulge at various levels of lumbar spine and impingement of exiting and traversing nerve roots.
(C) Patients with neurogenic claudication (Lumbar canal stenosis).

Exclusion Criteria
1. Patients not willing for procedure
2.Local Infection at the injection site
3.Coagulopathy

4. Known hypersensitivity to injecting drugs.
5.Patients with rapidly progressive neurological deficit, cauda equina syndrome requiring emergency spine surgery.

Study Design – It was an observational case study.

Study Duration - May 2021-Dec 2021

Study Population - Patients posted for Caudal Epidural injection as per the inclusion criteria were included in the study.

Sample size- 32 patients were included in this study.

Sample size formula- $n = Z^2 (\alpha/2)\ p\ q\ d^2$
Where,

$Z^2 (\alpha/2) = 1.96$ for 95% Confidence interval
p = 95.83%
p = Prevalence of success of caudal epidural injection by ultrasound
q = 100- p
d = 7 % allowable error

Sampling Technique - It was convenience sampling method.

Methodology-Approval from the College Ethical committee was taken for the study. In patients who were included in this study as per the inclusion criteria, clinical assessment was correlated with the radiological data available. Total32 patients were included in this study. Patients were fully informed about the procedure as well as the risks and expected benefits of caudal epidural injection. A valid, informed and written consent was taken from patients. In patients posted for caudal epidural injection, from each patient age, gender, weight, height, symptoms duration data was collected. Routine pre-anaesthesia evaluation was done as per proforma. Along with routine lab investigations, blood coagulation profile, renal function test, fasting and postprandial blood sugar level investigation as well as Electrocardiogram (ECG) were done. Patient posted for caudal epidural injection was kept nil orally for 6 hours prior to procedure. In the operation theatre, ECG, non-invasive blood pressure cuff (NIBP), pulse oximeter probe was attached and baseline ECG, SPO_2, NIBP were noted. Intravenous access was established in the upper limb, intravenous infusion with the normal saline was started, i.v. antibiotic dose was given, injection Ondansetron 4mg i.v. was given 10 min prior procedure. Patient was kept in prone position with a pillow under the abdomen. The bony landmarks of the sacral hiatus located between bilateral sacral cornua were palpated by hand and were marked subsequently. Then using ultrasound with 10 Mhz linear-array transducer two sacral cornua were identified as two hyperechoic reverse U shaped structures (as shown in figure 1) and the distance between the apex of one sacral cornua to the other was measured on the transverse view. (as shown in figure 2). The distance between the anterior wall and posterior
wall of the sacral hiatus was measured in the sacral hiatus apex area, in longitudinal view. (as shown in figure 3). The pain specialist set up the equipment needed for the injection on the table, and the ultrasound linear-array probe was covered with sterile plastic, a wide area of the skin at back from the iliac crest margin to lower buttock was cleansed with povidone iodine and then was covered with sterile drape. The skin at the injection site and subcutaneous tissue was infiltrated with inj. 2% lidocaine. A 18 G epidural needle was placed in line with and parallel to the transducer (ultrasound beam). The needle shaft was visualized and under the guidance of ultrasound needle was advanced into the sacral hiatus using the longitudinal section. Passage of the needle through the sacral hiatus was observed by the operator. (as shown in figure 4). With the confirmation of needle in the sacral hiatus by the operator, 2-3 ml of the non-ionic contrast agent was injected and the turbulence of the

injected contrast agent was observed in the sacral canal, under the ultrasound guidance. After this, the antero-posterior fluoroscopic view was obtained with C-arm, to check that filling of contrast agent in the epidural space and filling of the epidural space on the fluoroscopic view was defined as procedural success.(as shown in figure 5).

Images -

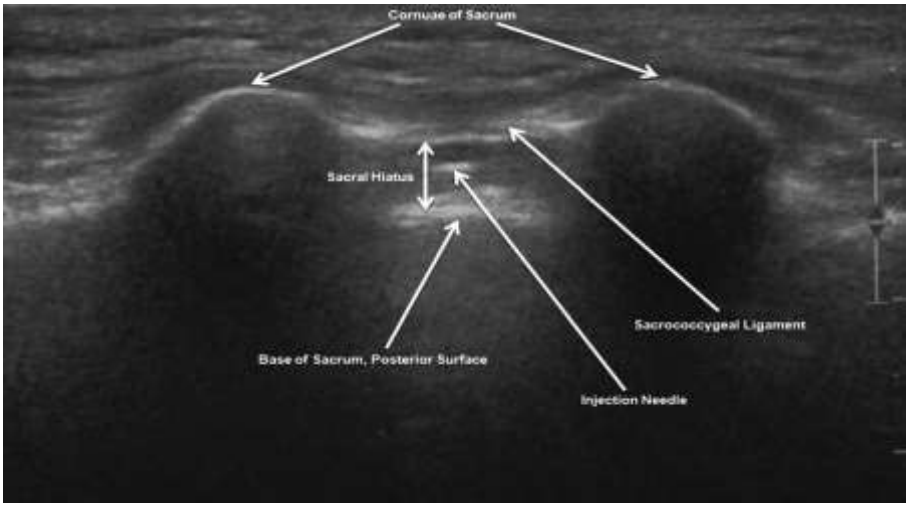

Figure 1- Transverse View of sacral hiatus by ultrasound.

Figure 2.- Transverse View of sacral hiatus by ultrasound.

Measurement of Distance between apex of bilateral sacral cornuas by ultrasound.

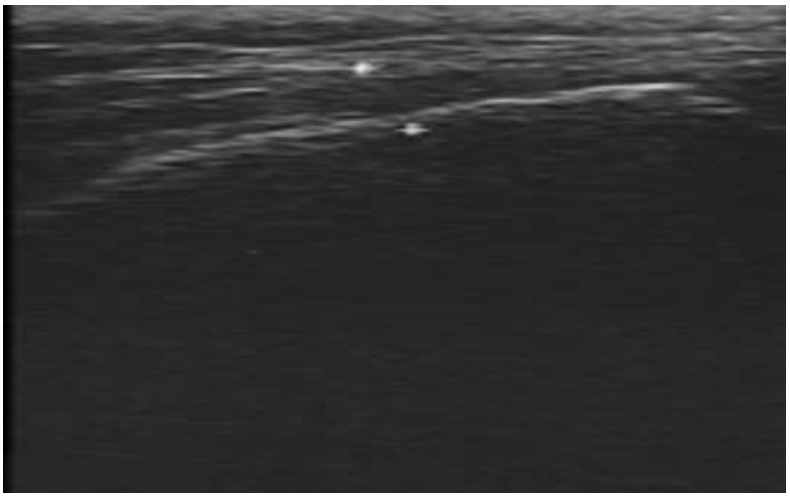

Figure 3.- Longitudinal View of the sacral hiatus by ultrasound, distance between the two white small arrows refers to the diameter of sacral canal at apex.

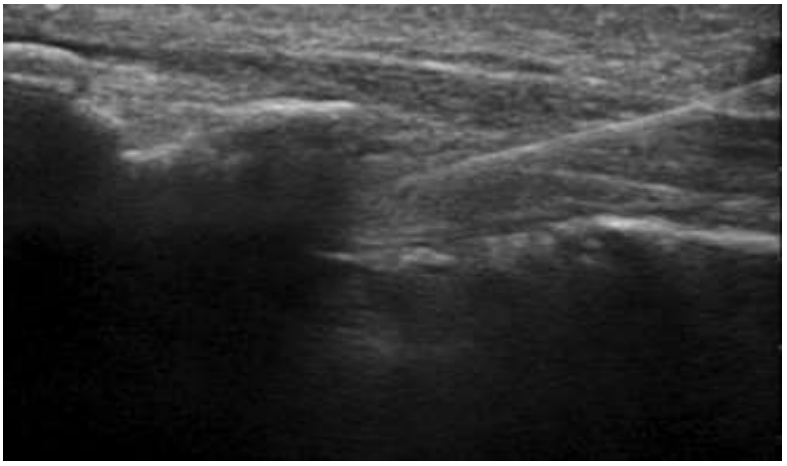

Figure 4.- Visualisation of needle in the sacral canal in longitudinal view under the ultrasound

Figure 5- Fluoroscopic Confirmation of Contrast agent Spread while performing Caudal Epidural injection.

Once the proper needle placement confirmed, 40 mg of Inj. Triamcinolone Acetonide mixed in total volume 15 ml of 0.125% Inj. Bupivacaine was injected. After that needle was removed and sterile dressing was applied at injection site and patient was made supine and was shifted to Post Anaesthesia Care Unit (PACU) and was monitored there for one hour and was also look for any immediate side effects here. After that if the patient was stable then patient was shifted to ward. After that patient was followed up in pain clinic opd as per their schedule. Pre-procedure we had noted the Age, sex, height, weight, Body Mass Index (BMI) of patient. Also we had noted whether the bony landmarks of the sacral hiatus were palpable or not, by ultrasound imaging sacral hiatus was identified or not, as well during procedure we measured the diameter of sacral canal at the apex of the sacral hiatus, also the distance between the apexes of the two sacral cornua was measured. During the procedure we had noted whether under ultrasound needle placed in the sacral hiatus visualized or not, the turbulence of the injected contrast agent in the sacral canal observed or not, also noted under the ultrasound guidance whether or not filling of epidural space with contrast agent on the fluoroscopic view with C-arm seen or not. We also noted if any adverse effects/complications post procedure.
For each patient the above details were arranged in tabulated form.

Age (Years)	
Sex	Male/ Female
Body Mass Index (BMI) kg/sq.mt	
Distance between bilateral sacral cornua (in mm)	
Distance between anterior and posterior wall of Sacral hiatus, in the sacral hiatus apex area (in mm)	
Visualisation of needle in sacral hiatus under ultrasound?	YES/NO
Turbulence of injected contrast agent in the sacral canal observed?	YES/NO
Filling of epidural space with contrast agent seen in fluoroscopic view	YES/NO
Any complications/ Adverse effects.	

With the help of above findings from collected data of all the patients we tried to find out if any co-relation is there or not between age, sex, Body Mass Index (B.M.I), bony structure at the sacral hiatus and the procedural success or failure. Also, we tried to analyse how much percentage of success or failure rate of the procedure was there with the ultrasound. Procedural Success includes visualisation of needle in sacral hiatus under ultrasound and observed turbulence of injected contrast agent in the sacral canal as well as filling of epidural space with contrast agent seen in fluoroscopic view. If any one or more than one of the above three findings were not present then it was called as procedural failure. Also, we tried to analyse how much percentage of success or failure rate of the procedure was there with the ultrasound.

Statistical Analysis- After data entry, data analysis was performed by using SPSS 25 (Statistical Package for Social Sciences). Quantitative data was documented and analysed using Mean and SD. Qualitative variables expressed using percentage. For comparison between two groups (Procedural

success and procedural failure) we have used Unpaired t-test/ Mann-Whitney test for comparing variables. Value < 0.05 was considered as significant.

Results

Total 32 cases were studied in which 16 (50%) were male patients and 16 (50%) were female patients. The mean age in years of these patients were found to be 54.13±10.71 years as shown in table no.1, The clinical diagnosis was lumbar disc herniation in 18 (56.25%) patients, spinal canal stenosis in 7 (21.87%) patients, degenerative joint disease in 5 (15.62%) patients and failed back surgery in 2 (6.25%) patients. As Shown in table no. 1, the mean of Body Mass Index (BMI) was of all 32 patients found to be 26.79± 3.54, The mean distance between bilateral sacral cornua of all 32 patients was 18.30 ± 0.96 mm. The mean distance between anterior and posterior wall of sacral hiatus apex area of all 32 patients was 2.93±0.42 mm. According to the BMI categorization for Asian population by WHO guidelines, nearly 68.7% of our patients were overweight or pre-obese (BMI >25). The BMI, sex, age of the patients was not significantly related to the procedural success of Ultrasound guided caudal injections. Bony landmarks of the sacral hiatus could be palpated in all 32 (100%) patients. The sacral hiatus was identified in all 32 (100%) patients by ultrasound images.

Table no-1

Label	N	Mean	Std Dev	Minimum	Lower 95% CL for Mean	Upper 95% CL for Mean	Maximum
Age (Years)	32	54.13	10.71	30.00	50.26	57.99	72.00
Body Mass Index	32	26.79	3.54	21.40	25.51	28.06	32.88
Distance between bilateral sacral cornua in mm	32	18.30	0.96	16.40	17.95	18.64	20.50
Distance between anterior and posterior wall of sacral hiatus apex area in mm	32	2.93	0.42	1.80	2.78	3.08	3.40

Table no-2

Filling of epidural space with contrast agent seen in fluroscopic view	N Obs	Label	N	Mean	Std Dev	Minimum	Lower 95% CL for Mean	Upper 95% CL for Mean	Maximum
No	1	Age	1	66.00	.	66.00	.	.	66.00
		(Years)	1	30.14	.	30.14	.	.	30.14
		Body Mass			.		.	.	
		Index			.		.	.	
		Distance between	1	18.60		18.60			18.60
		bilateral sacral cornua in mm	1	1.80		1.80			1.80
		Distance between							

		anterior and posterior wall of sacral hiatus apex area in mm							
Yes	31	Age (Years)	31	53.74	10.66	30.00	49.83	57.65	72.00
		Body Mass Index	31	26.68	3.54	21.40	25.38	27.98	32.88
		Distance between bilateral sacral cornua in mm	31	18.29	0.98	16.40	17.93	18.65	20.50
		Distance between anterior and posterior wall of sacral hiatus apex area in mm	31	2.96	0.37	2.10	2.83	3.10	3.40

In all the 32 patients Visualisation of needle in sacral hiatus under ultrasound was possible as well as turbulence of injected contrast agent in the sacral canal was observed. But, among the 32 patients in 31 patients filling of epidural space with contrast agent was seen in fluoroscopic view while in only one patient filling of contrast agent in epidural space was not seen in fluoroscopic view as shown in table no.2., So procedural failure was there in 1 (3.125%) patient out of 32 patients. The mean distance between anterior and posterior wall of sacral hiatus apex area in these 31 patients with procedural success was 2.96 ±0.37 mm, in which maximum antero-posterior distance was found to be 3.40 mm and minimum antero-posterior distance was found to be 2.10 mm. as shown in table no.2 And in 1 patient in which the filing of contrast agent in epidural space was not seen on fluoroscopic view. Distance between the anterior and posterior wall of sacral hiatus in apex area was 1.80 mm which was smallest among all 32 patients and distance between bilateral sacral cornua was 18.60 mm as shown in table no.2

Distance between the anterior and posterior wall of sacral hiatus in apex area was 1.80 mm which was smallest among all 32 patients and distance between bilateral sacral cornua was 18.60 mm as shown in table no.2

Table No.3

Sex	N Obs	Label	N	Mean	Std Dev	Minimum	Lower 95% CL for Mean	Upper 95% CL for Mean	Maximum
F	16	Age (Years)	16	52.38	11.58	30.00	46.21	58.54	70.00
		Body Mass Index	16	28.06	3.22	22.65	26.34	29.77	32.51
		Distance between bilateral sacral cornua in mm	16	18.43		16.80	17.81	19.05	20.50
		Distance between anterior and posterior wall of sacral hiatus apex area in mm	16	2.96	1.16 0.47	1.80	2.71	3.21	3.40
M	16	Age (Years)	16	55.88	9.83	40.00	50.64	61.11	72.00
		Body Mass Index	16	25.52	3.47	21.40	23.67	27.37	32.88
		Distance between bilateral sacral cornua in mm	16	18.16	0.72	16.40	17.78	18.55	19.30
		Distance between anterior and posterior wall of sacral hiatus apex area in mm	16	2.89	0.37	2.30	2.70	3.09	3.40

Discussion-

While performing caudal epidural steroid injection, sacral hiatus is the most important landmark and the success rate of caudal epidural injection depends on the correct placement of needle in the sacral canal and anatomic variations of the sacral hiatus. Under the ultrasound guidance anatomical details of the sacral hiatus, bilateral sacral cornua, apex of the sacral hiatus, anterior and posterior walls of the sacral canal and sacrococcygeal ligament can be clearly detected. In our study using ultrasound sacral hiatus details could be seen in all 32 (100%)of 32 patients and this indicates that ultrasound is the valuable tool for the assessment of bony landmarks in caudal injection. The mean distance between bilateral sacral cornua of all 32 patients was 18.30 ± 0.96 mm. The mean distance between anterior and posterior wall of sacral hiatus apex area of all 32 patients was 2.93±0.42 mm.In our study, in 1(3.12%) of 32 patients, filing of contrast agent in epidural space was not seen on fluoroscopic view. In this patient distance between the anterior and posterior wall of sacral hiatus in apex area was 1.80 mm, which was smallest among all the 32 patients. The mean of distance between anterior and posterior wall of sacral hiatus sacral hiatus in apex area of all 32 patients was 2.93±0.42 mm. In our study, gender, age, Body Mass Index (BMI) of the patients was not significantly related to the success of caudal injection.

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