

Role of Nonreal-time Imaging in Improving Success of Blind Interlaminar Epidural Injection for Treatment of Symptomatic Prolapsed Lumbar Intervertebral Disk

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ABSTRACT

Objective: To see effectiveness of measurements in plain roentgenograms of lumbosacral (LS) spine to guide needle placement into the epidural space.

Setting: Department of Physical Medicine and Rehabilitation.

Design: Cross-sectional study.

Materials and methods: A total of 56 consecutive diagnosed prolapsed intervertebral disk (PIVD) patients attending PMR OPD were enrolled. Length of the spinous process and skin thickness were measured using a caliper, which were converted to centimeter by using a calibration bar in a digital X-ray of the LS spine. A 22G Quincke needle was advanced to the expected depth given by digital X-ray measurement. One milliliter of Iohexol dye was injected, and the position of the needle was checked by C-arm X-ray. Two milliliters of methyl prednisolone acetate were injected into the space.

Main outcome measures: Depth measured by using digital X-ray and length of the spinal needle from the epidural space to the skin by C-arm X-ray in centimeters.

Results: Out of 56 subjects, 46 (73.1%) completed the treatment program. A needle was placed at proper depth in 36 cases by using X-ray measurement, giving success rate of 87.8%. Depth of the epidural space from the skin (mean 3.82 ± 0.74 cm) as measured from X-ray and actual measurement confirmed by fluoroscopy (mean 3.96 ± 0.81 cm) were compared using the Pearson's correlation coefficient ($=0.86$).

Conclusion: Measurement of depth of the epidural space using plain X-ray of the LS spine improves the success rate of blind midline interlaminar epidural steroid injection (MILES) from around 50–87.8%. This method of nonreal-time imaging is cost-effective in developing countries where C-arm X-ray facilities are not available.

Keywords: Lumbar interlaminar epidural injection, Nonreal-time imaging, Prolapse intervertebral disk.

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INTRODUCTION

Low back pain with or without lower extremity pain is one of the most common problems among chronic pain disorders with significant economic, societal, and health impact¹⁻³ both in rural and urban areas. The most common diagnoses of low back pain with leg symptoms are prolapsed intervertebral disk (PIVD), spinal stenosis, intervertebral disk degeneration without disk herniation, degenerative spondylolisthesis with stenosis, and postlumbar surgery syndrome.^{4,5} Although conservative management is the first line of treatment for these conditions,⁶ one of the most commonly employed methods of treatment for lumbar disk herniation with leg pain is epidural steroid injection.^{7,8} While the long-term benefit of epidural steroid is arguable, short-term benefit from weeks to months is accepted.⁹

There are three approaches for giving epidural steroid: interlaminar (IL), transforaminal (TF), and caudal (Ce). Among these approaches, IL being the most commonly used approach.⁷

The IL approach becomes a preferred method as needle entry can be directed more closely to the assumed site of pathology, requiring less volume than the Ce route and it is less risky compared to the TF approach. Transforaminal is considered to be a more target-specific approach requiring the smallest volume to reach the primary site of pathology¹⁰⁻¹² but is associated with more catastrophic complications like paraplegia due to intra-arterial injection.

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Earlier IL approaches were done without fluoroscopic guidance in which there may be extraepidural placement of the needle, which may go unrecognized. Other disadvantages of the IL approach without fluoroscopy include erroneous placement of the needle in wrong interspace, intravascular placement of the needle, deviation of the needle to the nondependent side, difficulty entering the epidural space, potential risk of dural puncture, and postlumbar puncture headache.¹³⁻¹⁷

Advocates of fluoroscopic guidance point to several studies that have shown that in as many as 30% of the lumbar epidural

injections by experienced injectionists, the epidural space was misidentified and while using the loss of resistance (LOR) technique we may find LOR to air in the other tissue plane before reaching the exact epidural space in about 20–30% of cases.^{14,18,19} Bartynski et al.¹⁴ opined that the probable cause of inaccuracy of the loss of air resistance technique is injection while the needle tip is positioned within the fat overlying the ligamentum flavum. To perform an accurate needle placement and successful interlaminar epidural steroid injection (ILESI), fluoroscopy guidance is necessary but C-arm may not be available easily in many of the rural health settings. So, we need to improve the success rate of blind ILESI.

We have not come across any study on procedures to improve the blind midline interlaminar epidural steroid injection (MILESI). To improve the success rate of needle placement in the “blind method” of ILESI, we have developed a technique of using digital X-ray of the lumbosacral (LS) spine, which is available universally nowadays, to measure the depth of the epidural space and level of the targeted intervertebral space. These measurements can be used to guide the needle to the proper epidural site more effectively. The procedure can be done in an outpatient setting. This also ensures the affordability and availability, which comes with effectiveness of the image-guided ESI.

OBJECTIVE

To see the effectiveness of measurements in plain roentgenograms of the LS spine to guide the needle placement into the epidural space in performing blind MILESI for conservative treatment of the prolapsed lumbar intervertebral disk.

MATERIALS AND METHODS

This study was done with prior approval of the institutional ethics committee of the institution. A cross-sectional study was done in the Department of Physical Medicine and rehabilitation (PMR), from May 2017 to February 2018. There were 56 patients recruited for the study, 24 males and 32 females. Mean age of patients was 50.89 ± 12.6 years. These patients were selected consecutively, based on inclusion and exclusion criteria, from those patients who had been treated by some other form of conservative management with medication, physical therapy, etc., for more than 2 months but without significant improvement and referred to us or patients directly attended PMR OPD. All patients were clinically diagnosed PIVD cases with leg pain and confirmed by MRI. Mean duration of symptoms at the time of presentation was 14.58 ± 3.8 weeks.

Inclusion criteria were patients with age between 18 years and 80 years who were clinically diagnosed PIVD cases with positive straight leg raising test (SLRT), presence of signs of lumbar radiculopathy, restriction of range of motion of the spine, presence of claudication pain, and confirmed by the MRI study. All the patients had already been treated in some other form of conservative treatment except ESI for more than 8 weeks without significant improvement. Exclusion criteria were patients who had received treatment with ESI before, severe uncontrolled diabetes or hypertension, suffering from myocardial infarction, stroke, malignancy, mental disorders, infection at lower back, and unwilling to give a written consent.

INTERVENTION

All the participants were explained properly about the procedure, made them understood, and a written consent was obtained from

each participant. A digital X-ray of the LS spine lateral view was used for measuring the depth of the epidural space. Length of the spinous process was measured using a caliper. Actual measurement by a caliper was converted to centimeter by using a calibration bar in the X-ray plate and distance between the spinous process and the skin was also measured in a similar fashion (Fig. 1). The anteroposterior film was used to determine the desired intervertebral disk level. The level was determined in relation to the iliac crest—whether the desired level was above or below the level of the iliac crest.

The patient was positioned in a lateral position with the affected side downward, with bent hips and knees. It was important to maintain the plane of back in strictly vertical and parallel to edge of the operating table. Under proper aseptic precautions, a 22G Quincke spinal needle was introduced at the mid-interspinous space at the level indicated in the AP view of LS spine X-ray. The needle was advanced to a depth that is 3 mm short of predetermined depth fixed by an artery forceps clamped on to the spinal needle. The patient was asked to cough to see that no spinal fluid came out. If spinal fluid flashback occurred, the procedure was considered as a failure. From this point onward, the needle was advanced cautiously with simultaneous pushing the plunger of the 2 mL glass syringe attached to the needle. If sudden LOR on pushing the plunger of the glass syringe occurred, it was possible that tip of the needle was in the epidural space. This was checked by injecting 1 mL of nonionic radiopaque dye (Iohexol). If tip of the needle was in the epidural space, an epidurogram with proper dye spread would be visible in the C-arm X-ray (Fig. 2). If not a blob of dye would be seen, which usually occur when the tip of the needle was in the fat overlying the ligamentum flavum, then the procedure was considered as a failure.

In some cases, sudden LOR might not happen at predetermined depth. In such cases, the needle tip was further advanced to a depth, which was not more than 1 mm of the predetermined depth. If LOR occurred, certainty of the epidural space was checked by injecting radio-opaque dye and taking X-ray as described before. If the epidurogram was visible, position of the needle tip in the epidural space was confirmed. Otherwise, the procedure was considered a failure.

Once position of the needle in the epidural space was confirmed, negative suction was applied to see if blood or fluid was aspirated. Then, 2 mL of methyl prednisolone acetate was injected into the epidural space. Steroid was injected without local anesthetic and volume-enhancing fluid. The patient was soon

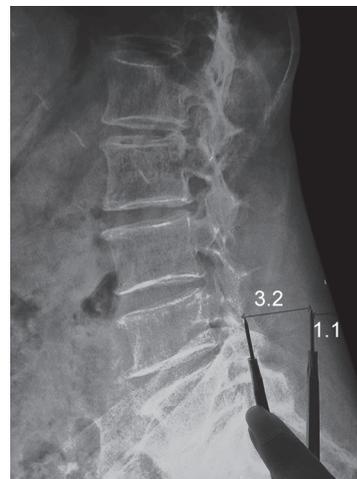


Fig. 1: Depth measurement in plain X-ray

turned to the prone position to help ventral spread of the injectate. This position was maintained for 3 minutes and the patient was monitored for hypotension, hypoventilation, and headache. The patient was allowed to assume erect position and walk to the postoperative room.

OUTCOME MEASURE

Depth measured by using digital X-ray in centimeters and length of the spinal needle from the epidural space to the skin as confirmed by C-arm X-ray fluoroscopy in centimeters were primary outcome measures.

To ascertain a clinical response, some outcome measures were also taken. Those were clinical parameters: pain by VAS, degree of straight leg rising test (SLRT) positivity, restriction of forward flexion of the spine expressed as inches, and claudication distance (CD) in meters. Functional assessment by the Oswestry disability index (ODI) was also used as a tool. Patients were assessed before injection using the above-mentioned tools, then after 1 week of injection and finally after 3 months.

RESULTS

Out of 56 subjects recorded for the study, only 46 (82.14%) completed the epidural injection treatment program. Of 46, there were 19

(41.3%) males and 27 (58.7%) females. Age ranged from 22 years to 80 years; mean age was 51.36 ± 14.9 years. Maximum number of patients belonged to the age group 40–59. There were 20 (43.4%) right-sided, 18 (39.1%) left-sided, and 8 (17.4%) both-sided sciatica cases. Duration of disease, which was the time elapsed between onset of symptom and inclusion in the study, was 14.58 ± 3.8 weeks.

Out of 46 cases who were subjected to MILESi, records of depth measurement were missing in 5 cases. The result of success of the spinal needle in epidural steroid was assessed using 41 cases. The needle were placed at proper depth in 36 cases by using X-ray measurement, giving success rate of 87.8%. Depth of the epidural space from the skin (mean 3.82 ± 0.74 cm), as measured from X-ray and actual measurement confirmed by fluoroscopy (mean 3.96 ± 0.81 cm), was compared using the Pearson’s correlation coefficient ($=0.86$). Figure 3 shows graphical representation of correlation of depths of the epidural space as measured by X-ray and C-arm: Pearson’s coefficient = 0.86 suggesting good correlation. Table 1 shows comparison of mean depths as measured by X-ray and C-arm fluoroscopy by the paired *t*-test. The test result, however, showed variance between two “means” with *p* value = 0.01. This dichotomy between the correlation coefficient and comparison of mean would be explained later.

Out of 46 patients who were subjected to ILESi, 5 were lost to follow-up and only 41 (89.1%) patients were available for second follow-up at 3 months. These were assessed for improvement by using clinical parameters: pain by VAS by 50%, increase in degree of SLRT by at least 10°, increase in forward flexion of the spine by decrease in distance of tip of the finger from the floor in inches, increase in claudication distance by 50%, and decrease in ODI by 50%. Comparison of mean values of VAS score, SLRT degree, forward flexion of spine, claudication distance, and ODI percentage was done by the paired *t* test. In all parameters, there were significant difference between initial and final values, with *p* value = 0.00 (Table 2). By using this assessment method, we found that out of 41 patients, 36 (87.8%) improved; 5 (12.2%) failed to improve.

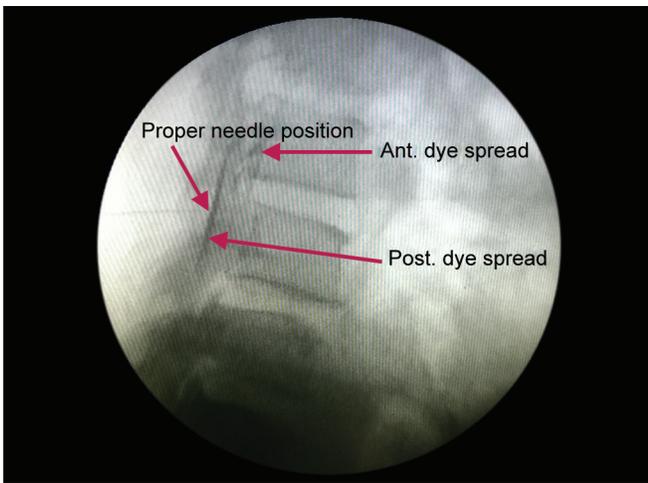


Fig. 2: Proper dye spread (epidurogram)

Table 1: Mean depth of X-ray and C-arm by paired *t* test

Method of measurement	Mean depth in cm	Standard deviation	Value of “t”	<i>p</i> value
C-arm	3.96	0.81	2.68	0.01
X-ray	3.82	0.74		

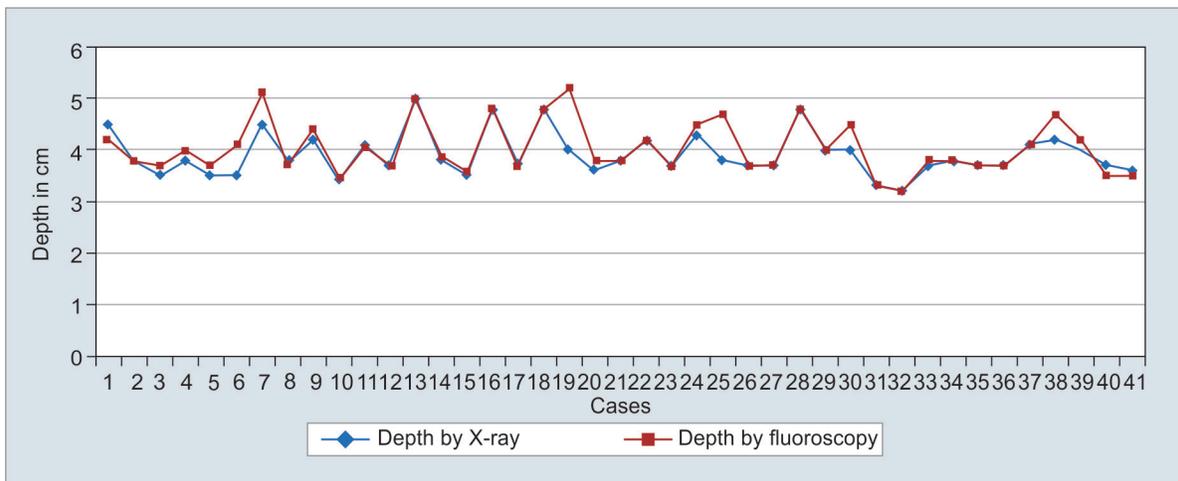


Fig. 3: Graphical representation of depth as measured by X-ray and C-arm: Pearson correlation coefficient = 0.86

Table 2: Mean changes in clinical parameters initial and follow-up

Name of parameter	Initial mean	Standard deviation	Follow-up mean	Standard deviation	p value
Pain VAS numbers	7.25	1.50	2.53	1.79	0.000
SLRT in degree	59.89	29.39	81.83	20.73	0.000
Forward flexion in inches	7.95	12.73	2.32	17.63	0.000
Claudication distance	70.05	148.97	385.86	169.46	0.000
ODI in percentage	57.84	19.39	18.17	17.63	0.000

DISCUSSION

Interlaminar epidural steroid injection is the most commonly employed approach for ESI,⁷ and blind epidural injections without fluoroscopy guidance, even in experienced hands misplacement of injectate occurs quite often, up to 30%. For a fluoroscopy guidance ILESI, we need C-arm. Nonavailability of an operation theater and C-arm is drawback for a successful ILESI in most of the health centers in the developing countries, especially in rural settings. Even if these are available, their usage is restricted due to competing demands by other specialties. Time taken to set up is another issue. Number of cases of interlaminar epidural steroid injection performed per hour is around five to six, thereby restricting number of cases per operating session. Whereas, ILESI given by the blind method is less time-consuming and can be completed in less than half of time. Because of these restrictions, blind ESI is used in many centers in India.

In terms of easily availability and avoidance of radiation hazards, ultrasound-guided spine procedures are becoming popular. Still there is no enough evidence of a safe procedure in respect of IL or TF epidural injection as there is no confirmatory measure to be sure of the site of needle position like use of radio-opaque dye in fluoroscopy guidance.²⁰

In our study method that might improve the blind ILESI, there was 87.8% success in placing a spinal needle in the epidural space by using nonreal-time imaging in the form of X-ray of the LS spine as described above; when means of measures of depth by X-ray and actual depth by using C-arm fluoroscopy were compared by using the paired *t* test, significance was that null hypothesis was rejected as $p = 0.01$, that meant "means" were different. This was due to the fact that the skin and the subcutaneous layer were difficult to measure in persons whose body mass index was above 30. Sometimes lateral-view X-ray was taken in oblique orientation and some images were not clear. This led to erroneous estimate of depth. Midline interlaminar epidural steroid injection is considered not site-specific; and its effectiveness was considered inferior to that of either lateral interlaminar ESI or transforaminal ESI.²¹ However, if injection was placed at the appropriate level and position of the patient is kept lateral with the affected side, down drug will gravitate down to the site of inflammation as shown in Figure 2. The issue of ventral spread of the drug is important in lateral ILESI. Although there were studies that showed that positioning and gravity did not influence the spread of medication in the epidural space,^{13,22,23} in our study, it was found that by prone positioning of patient for 3 minutes immediately after injection, ventral spread was present in significant number of cases. Out of five cases of failure, CSF flashback occurred in three cases, which were due to overestimation of depth using X-ray. There were two failures due to underestimation of depth of the needle. This was corrected after detection in fluoroscopy.

LIMITATIONS

Number of cases taken is small and it is not a case-control study. Obese and overweight patients who might result in erroneous

depth measurement were not excluded. Degree of severity of prolapse was not taken into account. Follow up should be at least 6 months.

CONCLUSION

This study shows that measurement of depth of the epidural space by using plain X-ray of LS improves the success rate of blind MILESI from less than 50% to nearly 90%. This method of nonreal-time imaging is successful in placing the spinal needle in the epidural space in 87.8% of cases. The method is cost-effective in developing countries where C-arm X-ray facilities are not available and avoids the radiation hazard that may occur during the C-arm-guided procedure.

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