

Identification of epidural space using loss of resistance syringe, infusion drip, and balloon technique: A comparative study

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ABSTRACT

Background and Objective: There are various techniques to identify epidural space but superiority of one technique over other has not been adequately studied. We conducted a study to Compare and evaluate the three techniques for epidural space localization that is, loss of resistance (LOR) syringe technique, balloon technique and drip infusion technique. **Materials and Methods:** Seventy-five patients of either sex, belonging to American Society of Anesthesiologists physical status Class 1 or 2, between 20 and 50 years of age, scheduled to undergo lower abdominal and lower limb surgeries were randomly allocated to one of the three groups ($n = 25$ each) depending upon epidural space localization. In Group I, epidural space localization was done with LOR syringe technique. In Group II Balloon technique and in Group III drip infusion technique was used. Distance of the epidural space from skin, number of attempts, time taken for epidural space localization and quality of the block were the parameter recorded during the study. **Results:** First attempt success rate for epidural space localization was highest in Group III (100%). The mean time taken for epidural space localization was least in Group III, and when compared with other groups it was found to be statistically significant with $P = 0.016$. Number of attempt for space localization and success rate of the block was better in the majority of patients of Group III, but the difference was found to be statistically nonsignificant. Complication rate was almost negligible in all three techniques. **Conclusion:** We conclude that the time taken to localize the epidural space was least in drip infusion technique. As for number of attempts, quality of the block and complications is concerned, all the three techniques are comparable.

Key words: Balloon technique, drip infusion technique, epidural space localization, loss of resistance syringe technique

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INTRODUCTION

Epidural anesthesia has been used in one form or another since its introduction in 1885 by Corning.^[1] Epidural anesthesia is a blind procedure, it is difficult to accurately identify the epidural space resulting into 1.5% failure rate because of excess fat, undue ossification or repeated puncture of the dura mater.^[2] To localize epidural space various techniques have been used. These techniques either

take advantage of potential negative pressure in the epidural space or use the sudden disappearance of resistance when ligamentum flavum is penetrated.^[3]

They are usually divided into two main categories.^[3] First negative pressure methods like the hanging drop of Gutierrez,^[4] the Odom capillary tube and the Odom manometer indicator.^[5] Second is the disappearance of resistance techniques. Syringe technique of Sicard and Forestier,^[6] the modified pressure technique,^[7] the balloon technique of Macintosh^[8] the mechanical devices like Ikle spring loaded syringe^[9] and Macintosh extradural space indicator^[10] are few such techniques. Apart from these techniques, drip infusion technique is also used frequently by anesthetists, which depends neither on the presence of negative pressure nor on the feeling of loss of resistance (LOR).^[11]

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Literature is inconclusive with regard to superiority of one technique over the other to identify the correct placement of the needle. Therefore, we conducted a study to compare and evaluate the three techniques for epidural space identification that is, LOR syringe technique, and balloon technique and drip infusion method.

MATERIALS AND METHODS

The study was approved by Hospital Ethical Committee and informed consent from all the participants was obtained. Seventy-five patients of either sex in the age group of 20-50 years belonging to American Society of Anesthesiologists physical status I or II, scheduled to undergo lower abdominal and lower limb surgeries where epidural block was required, were enrolled in the prospective randomized study. The patients with local infection, spinal column abnormalities, previous spine surgery, congenital or acquired coagulation disorders, were excluded from the study.

All the patients were randomly allocated to one of the three groups ($n = 25$ each) depending upon the method of the epidural space localization. In Group I epidural space localization is done with LOR (with saline) syringe (LOR syringe) technique. In Group II ($n = 25$) balloon technique (with saline) and in Group III ($n = 25$) drip infusion technique (with saline) was used.

Patients were examined preoperatively and were subjected to complete general physical as well as systemic examination. All routine investigations were carried out. Patients were kept fasting for 6 h and premedicated with oral alprazolam 0.25 mg at the previous night and 2 h preoperatively. In the operating room, after the establishment of intravenous line and attachment of standard monitors (noninvasive blood pressure, electrocardiography and pulse oximetry), using Philips IntelliVue MP50 monitor (Philips Medizin Systeme Boeblingen GmbH 71034 Boeblingen, Germany), epidural blocks were given to the patient in a sitting position by the same clinician, under all aseptic precautions using 18 G epidural needle (Romsons Scientific and Surgical Industries Pvt. Ltd) at the L3-L4 or L4-L5 interspace.

Epidural space localization was attempted with either of the above mentioned three techniques. Maximum three attempts were taken for epidural space localization by the given technique. After successful epidural space localization, a test dose of 3 mL of 2% lignocaine with adrenaline was given through the needle. Five minutes after the test dose, 18 mL of 0.5% of bupivacaine was administered in graded doses.

Patient's demographic data like age, sex, weight, height were noted. Distance of the epidural space from skin, number of attempts, time taken for epidural space localization (time taken for epidural space localization is the total time in seconds taken from skin puncture with epidural needle until the successful localization of the epidural space within three attempts) and quality of the block were other parameter recorded during the study. Sensory block was assessed by pinprick method using 21 G sterile hypodermic needle at 5 min interval up to 30 min.

Level of blocked dermatome was recorded and achieved level was graded as:

1. Good: Satisfactory block achieved without any unblocked segment in between
2. Incomplete: Patchy effect
3. Failure: No segment blocked.

Incidence of complication such as dural puncture, bloody tap and root irritation were recorded among three techniques. At the end of this study, the data collected during the study period was compiled and analyzed statistically by using ANOVA f -test for quantitative data and Chi-square test for qualitative data.

RESULTS

Data of all 75 patients enrolled in the study were included in the analysis. The mean age, sex, weight and height of the subjects were comparable in both groups [Table 1]. First attempt success rate for epidural space localization was highest in Group III (100%) but was comparable in all the groups with $P = 0.380$ [Table 2]. The mean time taken for epidural space localization was least in Group III, followed by Group II and maximum in Group I [Table 3]. It was

Table 1: Demographic profile

Group	Age (mean \pm SD) in years	Sex distribution		Weight (mean \pm SD)	Height (mean \pm SD) in centimeters
		Female %	Male %		
I ($n=25$)	31.84 \pm 8.79	24.0 (6)	76.0 (19)	63.60 \pm 6.90	166.48 \pm 5.37
II ($n=25$)	28.60 \pm 7.39	16.0 (4)	84.0 (21)	62.64 \pm 7.87	168.56 \pm 5.39
III ($n=25$)	30.88 \pm 8.05	24.0 (6)	76.0 (19)	63.08 \pm 8.08	168.04 \pm 5.33
	ANOVA f -test value=1.055 $P=0.354$	Chi-square test value=0.636 $P=0.728$ (NS)		ANOVA f -test value=0.09 $P=0.906$	ANOVA f -test value=1.017 $P=0.367$

SD: Standard deviation; NS: Nonsignificant

Table 2: Number of attempts taken for epidural space localization (%)

Attempts	Group I (n = 25) (%)	Group II (n = 25) (%)	Group III (n = 25) (%)
1 st attempt	24 (96.0)	22 (88.0)	25 (100)
2 nd attempt	1 (4.0)	2 (8.0)	0 (0)
3 rd attempt	0 (0)	1 (4.0)	0 (0)

$\chi^2 = 4.197$; $P = 0.380$

Table 3: Time taken for epidural space localization

Group	Time taken (in seconds)
I (n=25)	40.52±9.03
II (n=25)	38.40±12.57
III (n=25)	31.72±11.07

ANOVA *f*-test value = 4.365; $P = 0.016$

Table 4: Distribution of quality of blocks among three groups (%)

Group	Good %	Incomplete %	Failure %
I (n=25)	88.0 (22)	8.0 (2)	4.0 (1)
II (n=25)	80.0 (20)	4.0 (1)	16 (4)
III (n=25)	96.0 (24)	4.0 (1)	0.0 (0)

$\chi^2 = 6.064$; $P = 0.194$

statistically calculated by using ANOVA *f*-test, *P* value was 0.016, which was found to be significant.

Sensory blockade was assessed to define quality of the block and it was graded as good, incomplete and failure. Table 4 shows the quality of block in all the three groups. Though the success rate of the block was good in the majority of patients of Group III, but the difference was found to be statistically nonsignificant ($P = 0.194$).

Complications such as dural puncture, bloody tap and root irritation if any was recorded in all patients. There was one dural puncture seen in Group II however no other complication was seen in any of the patients among three groups.

DISCUSSION

Since the advent of epidural block many methods have been proposed to identify the epidural space. The majority of methods rely on the identification of the negative pressure in the epidural space or LOR encountered on entering the space.^[2] In our study, we compared three techniques of the epidural space localization that is, LOR syringe technique, balloon technique and drip infusion technique. Out of these, LOR syringe technique and balloon technique depends on LOR,^[12,13] but drip infusion

technique neither depends on LOR nor on negative pressure. We chose 2 mL of saline rather than air in LOR syringe and balloon technique to make it comparable to drip infusion technique. Saline has certain advantages over the air, as liquid is incompressible, so transition from complete resistance to LOR is immediate and convincing but an excess of saline may also dilute the local anesthetic solution and result in inadequate block.^[17,14] Air has disadvantages of being compressible, so that detection of the epidural space is more difficult and false positives are possible. Furthermore, there are a possibility of more unblocked segments, venous air embolism and cervical subcutaneous emphysema if large volumes of air are injected into the extradural space.^[15,16]

We compared number of attempts taken and time taken for epidural space localization, quality of the block, and incidence of complication among these three techniques. Epidural space was localized in first attempt in 100% patients in Group III, though the success rate was comparable in all three groups in our study. Roelants *et al.* conducted a study by using LOR to saline with a bubble of air to identify epidural space in 400 infants and children. The epidural space was identified on first attempt in >71.5% of cases. However, the epidural space was identified on first attempt in only 50% of cases in group weighing <5 kg because of difficulty to identify the narrow interspinous ligament.^[17] First attempt success rate was lower when compared to our study but this could be because of lower age group in the study of Roelants *et al.* Similarly, Fyneface-Ogan and Mato compared epidural balloon technique with the loss of resistance with air (LORA) technique in laboring parturient observed that epidural space was localized in first attempt in 22 women in epidural balloon technique group and in 14 women (out of 25) in the LORA group ($P < 0.0126$).^[18]

In our study, the time taken to localize the epidural space was least in Group III (drip infusion technique) followed by Group II (balloon technique) and maximum in Group I (LOR syringe technique) and this difference in space localization was found to be statistically significant ($P < 0.05$). Fyneface-Ogan and Mato also observed that the time taken to localize the epidural space was less in epidural balloon group as compared to LORA group and this difference was statistically significant with ($P < 0.001$).^[18] Michel and Lawes studied identification of the epidural space made by modified drip method in 100 pregnant patients. Accurate identification of the epidural space was accomplished in <1 min in 95% cases which is higher as compared to our study.^[19]

We graded quality of block as good, incomplete and failure. There was no statistical difference in quality of block among the three groups in our group of patients. Beilin *et al.*

observed that more patients in the LOR with air group had incomplete analgesia ($n = 27$, 36%) compared with LOR with saline group ($n = 14$, 19%). When both groups were compared with regard to analgesia, difference was found to be statistically nonsignificant with $P = 0.022$.^[20] Valentine *et al.* also found a better quality of epidural block with saline ($n = 25$) rather than air ($n = 25$) when used for LOR technique.^[21] Similarly, Leo *et al.* also observed that LOR to air technique was associated with a higher incidence of recurrent breakthrough pain compared to the saline group^[22] Fyneyface-Ogan and Mato concluded that the overall quality of the block was better in the epidural balloon group when compared to LORA group, which is in contradiction to our study; however they did not compare these two techniques with drip infusion technique.^[18] They used air in place of saline for LOR syringe technique, which might have led to more unblocked segments leading to decreased quality of block.

LOR syringe technique has the advantage of great simplicity as no special apparatus is required, but it may be clumsy as the anesthetist must divide attention between exerting pressure and introducing needle.^[2] Balloon technique has certain advantages like the method is objective because inflation or deflation of the balloon is obvious to anyone regardless of experience and ability to sense changes in resistance. However, it is also possible to obtain false positives results, since the balloon can collapse if the tip of the needle is inserted into the loose paravertebral tissue. Another disadvantage of the balloons technique is that they are fragile and cannot be autoclaved.^[12,13]

Drip infusion technique is also an objective method as dripping on the entry of the epidural space is obvious to everyone. Furthermore, in this technique anesthetist can advance the needle with both hands, thus making the grip more sensitive. But this technique also has certain disadvantages like slow dripping is sometimes observed even when the tip of the needle is in the loose interspinous ligaments. But false dripping is distinguished from true dripping by its slow dripping rate.^[11,19] Hence, every technique is having certain advantages and disadvantages.

In our study, there was only single dural puncture reported in Group II and no bloody tap or root irritation was observed in either of the groups. Our results are in contrast to the study of Fyneyface-Ogan and Mato who observed more accidental dural puncture in LOR with air group when compared to epidural balloon technique.^[18] Beilin *et al.* reported paresthesias in 12% of patients in LOR with air group when compared to 5% patients in LOR with saline group however this difference was statistically nonsignificant. They observed no dural tap in either of the groups.^[20] Leo *et al.* in their study have reported

statistically similar incidence of procedural complication like accidental dural puncture, accidental venous puncture and paresthesias in both LOR with air and LOR with saline group.^[22] Michel and Lawes documented no untoward dural puncture when modified drip infusion method.^[19]

CONCLUSION

We conclude that the time taken for epidural space localization is significantly less in drip infusion technique. However all the three methods of the epidural space localization that is, LOR syringe technique, balloon technique and drip infusion technique are comparable with respect to the number of attempts, quality of the block and complications.

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