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ORIGINAL STUDY

Comparison of loss of resistance syringe technique versus balloon technique for identification of epidural space: a prospective, randomized controlled study

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Abstract

Context: Epidural anaesthesia has an important role in modern anaesthetic practice due to its safety and efficacy, and its success depends on the technique used for identification of epidural space.

Aims: In this study we compared the of loss of resistance (LOR) technique versus the balloon technique for identification of the epidural space in terms of number of attempts and time taken. Also the efficacy of the two techniques in the hands of experienced and inexperienced anaesthesiologists was compared and complications noted.

Settings and design: Tertiary care hospital. A prospective randomized controlled study.

Methods and material: 164 ASA I and II patients undergoing elective surgery under epidural anaesthesia were randomly allocated into two groups of 82 each. In Group A- LOR Syringe technique was performed and in Group B- Balloon technique was performed for localization of epidural space. On half of the patients in each of the group i.e. 41 patients, the procedure was performed by experienced anaesthesiologist and on the other 41 patients, the procedure was performed by inexperienced anaesthesiologist.

Statistical analysis used: Data were statistically described in terms of mean (\pm SD), frequencies and percentages when appropriate. Comparison of variables between the study groups was done using Student t test and Chi square test. A probability value (*P* value) less than 0.05 was considered statistically significant. All statistical calculations were done using computer programs Microsoft Excel 2007 and SPSS vs21.

Results: Both groups were demographically comparable. The epidural space was identified in first attempt in 95% patients in group B (epidural balloon technique) versus 89% in group A (LOR technique). The mean time taken for the procedure was 31.3 s in group B which was significantly less than in group A –57 s. Also in group B the inexperienced anaesthesiologist took less time (34.2 s) similar to that taken by experienced anaesthesiologist (28.5 s). There were two failures in the group A and none in the group B. There were four dural punctures in the group A and one in the group B.

Conclusions: The epidural balloon is a simple, easy to use device especially useful for the inexperienced anaesthesiologists for the accurate identification of the epidural space in short time, without any increase in complications.

Keywords: Epidural anaesthesia, Epidural balloon, Localisation of epidural space, Loss of resistance technique

1. Introduction

Neuraxial anaesthesia expands the anaesthesiologist's armamentarium and has an important role in modern anaesthetic practice because of its safety and efficacy. It has been commonly used since its introduction in 1885 by Corning [1]. It has become popular because of advantages like slow

onset of action, controlled hypotension and segmental blockade. Epidural can be used as a sole plan of anaesthesia for surgeries, along with general anaesthesia and for postoperative pain relief. Improvements in the equipment, drugs and techniques, has made it a popular and versatile anaesthetic technique.

Acceptance of epidural blockade is limited because of the fear of failure, slow onset and

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neurological complications. As the identification of epidural space is a blind procedure, it requires skill to accurately identify the epidural space. Also there is always the fear of inadvertent puncture of duramater and unintentional injection into the subdural, intravascular and subarachnoid space. This has resulted in an increasing apprehension to the use of this excellent technique of anaesthesia. The key for success of epidural anaesthesia is correct identification of epidural space. Hence, choosing a correct method is important.

Researchers have suggested various methods for identification of the epidural space. Apart from commonly used loss of resistance (LOR) technique, there are various other techniques like Macintosh [2] balloon technique, hanging drop technique of Gutierrez [3], the Odom capillary tube [4] and Odom manometer indicator, syringe technique of Sicard and Forestier [5], the modified pressure technique, drip infusion technique and many more.

Studies are inconclusive with regards to the superiority of one technique over the other. Also identification of the epidural space is highly dependent on the anaesthesiologists experience and is susceptible to technical errors.

Therefore we conducted a study to compare the two techniques for identification of epidural space – the LOR technique and balloon technique. The aim of the study was to compare the ease and efficacy of the two techniques for identification of the epidural space.

2. Subjects and Methods

After Hospital Ethics Committee approval and written informed consent, 184 ASA I and II patients of 19–65 years posted for elective surgery under epidural anaesthesia were selected. Patients belonging to grade ASA III and IV, requiring emergency surgery and those refusing were excluded from our study.

Study design: A prospective randomized controlled study consisting of 164.

Patients were randomly allocated into either group by sealed envelope technique.

On Group A- LOR Syringe technique was performed and in Group B- Balloon technique was performed. On half of the patients in each of the group i.e. 41 patients, the procedure was performed by experienced anaesthesiologist and on the other 41 patients, the procedure was performed by inexperienced anaesthesiologist. They were again randomly chosen by picking a sealed envelope which contained a chit mentioning either 'Experienced' Or 'Inexperienced'.

All the selected patients were explained about the purpose, procedure and side effects of the study. Patients were fasted overnight before surgery.

After obtaining informed written consent standard monitors like pulse oximeter, non-invasive blood pressure monitor, electrocardiogram, temperature, capnograph were attached, Intravenous access was secured, premedication given and intravenous Ringer lactate was started. In sitting position, with all aseptic precautions 18/16 G Tuohy's needle was inserted by midline approach in a suitable space according to the extent of surgery.

In group A- The stylet was removed, LOR syringe attached and needle advanced further for identification of space by LOR.

In group B- The stylet was removed. A Y-shaped device was attached to which a balloon is attached to one arm and a syringe to inflate the balloon is attached to the other arm. The balloon is inflated with air and then the needle is advanced. Space is identified by deflation of the balloon.

Once the space was identified, the epidural catheter was inserted. And the space was confirmed by meniscus sign.

The following were noted:

Number of attempts taken, Time taken and Complications if any.

Epidural balloon (vygon) (Fig. 1).

3. Results

Data were statistically described in terms of mean (\pm SD), frequencies and percentages when appropriate. Comparison of variables between the study groups was done using Student t test and Chi square test. A probability value (*P* value) less than 0.05 was considered statistically significant. All statistical calculations were done using computer programs Microsoft Excel 2007 and SPSS vs21 Table 1.

Data of all 82 patients enrolled in the study were included in the analysis. The mean age, sex, weight



Fig. 1. Vygon epidural balloon.

and height of the subjects were comparable in both groups (Table 2).

The epidural space was identified in first attempt in 73 patients out of 82 patients (89% of patients) in LOR technique group whereas in the epidural balloon technique 78 patients out of 82 patients (95.1% patients) needed one attempt. The epidural balloon technique when done by inexperienced anaesthesiologists needs less number of attempts compared to the LOR technique done by the experienced anaesthesiologists. Though the number of attempts needed were less in the epidural balloon technique group compared to the LOR technique group, the difference was not statistically significant (P value = 0.233). (Tables 3, 4).

The time taken for epidural space localization was significantly less in the epidural balloon technique even in the hands of inexperienced anaesthesiologists. The epidural balloon technique when done by inexperienced anaesthesiologists need less time compared to the LOR technique done by the experienced anaesthesiologists (with P value= <0.01).

There were two failures in (2.4%) the group A (LOR technique group) and none in the group B (balloon technique group), which was not statistically significant (P value of 0.497).

There were four dural punctures (4.9%) in the group A (LOR technique group) and one (1.2%) in the group B (P value of 0.367). And also in our study, there were no nerve injuries in either of the group.

4. Discussion

Ever since the introduction of the epidural anaesthesia, various techniques have been suggested for the identification of the epidural space. The methods of identifying the epidural space depends upon the recognition of the passage of the needle tip from the tissues of high resistance to those of low resistance. Correct identification of the epidural space is the key to success of epidural anaesthesia.

There are three methods to identify the epidural space as suggested by Massey Dawkins (1963) [6] - the tactile [7], the visual and the mechanical device. The traditional LOR technique remains the choice of many experienced anaesthesiologists because of its

Table 1. Distribution of patients as per study group.

Procedure performed by	Group		Total
	A Number of patients	B Number of patients	
Experienced anaesthesiologist	41	41	82
Inexperienced anaesthesiologist	41	41	82
Total	82	82	164

Table 2. Demographic profile.

Variables	Group	Number of patients	Mean	Standard deviation	P value
Age (in years)	A	82	46.85	8.09	0.494 (NS)
	B	82	45.95	8.76	
Weight (in kgs)	A	82	58.49	6.49	0.851 (NS)
	B	82	58.28	7.62	
Height (in cms)	A	82	162.09	6.69	0.768 (NS)
	B	82	162.38	5.97	

simplicity but there is a risk of failed epidural because of false LOR.

In our study we have compared the traditional LOR technique and the balloon technique. The epidural balloon (VYGON) is a simple device consists of the 3 parts-an inflatable balloon (5 ml capacity) which is plugged to one end of the device, one way valve through which balloon is inflated and free end of the device which attaches to the touhys needle.

We compared these two techniques in terms of the number of attempts taken, the time taken for epidural space identification and incidence of complications among these two techniques. Also the efficacy of these two techniques in the hands of experienced anaesthesiologists and inexperienced anaesthesiologists.

In group A the epidural space was identified in first attempt in 73 out of 82 patients (89% of patients) of which, 40 were done by experienced anaesthesiologists and 33 by inexperienced anaesthesiologists. Out of the 9 patients who needed 2 or more attempts- 8 patients were performed by inexperienced anaesthesiologists. In the group B 78 out of 82 patients (95.1% patients) needed one attempt and only 4 patients (4.9% of patients) needed two attempts. Among the 4 patients who needed two attempts, 2 were performed by experienced and 2 were performed by inexperienced. Therefore less number of attempts were needed to identify the epidural space

Table 3. Number of attempts taken.

Number of Attempts taken	Group		Total Number of patients
	A Number of patients	B Number of patients	
One	73 89.0%	78 95.1%	151 92.1%
Two	5 6.1%	4 4.9%	9 5.5%
Three	2 2.4%	0 0.0%	2 1.2%
Four	2 2.4%	0 0.0%	2 1.2%
Total	82 100.0%	82 100.0%	164 100.0%
P value - 0.233 (NS)			

Table 4. Number of attempts taken by experienced and inexperienced anaesthesiologist.

Number of attempts taken	Group A Number of patients		Group B Number of patients		Total Number of patients
	Done by Experienced anaesthesiologist	Done by Inexperienced anaesthesiologist	Done by Experienced anaesthesiologist	Done by Inexperienced anaesthesiologist	
1	40	33	39	39	151
2	1	4	2	2	9
3	0	2	0	0	2
4	0	2	0	0	2
Total	41	41	41	41	164

in balloon technique even in the hands of inexperienced anaesthesiologists. Also, epidural balloon technique when done by inexperienced anaesthesiologists needs less number of attempts compared to the LOR technique done by the experienced anaesthesiologists. Though the number of attempts needed were less in the epidural balloon technique group compared to the LOR technique group, the difference was not statistically significant (P value = 0.233).

Mustafa and Milliken *et al.* (1982) [8], concluded that using a visual indicator, epidural space was identified in first attempt in 487/500 (97.4%) patients and in second attempt in 13 (2.6%) patients. In the study by Fyनेface Ogan S and Mato CN [9] conducted on fifty parturients, twenty-two women in the epidural balloon group had a successful localisation at first attempt as compared to fourteen women in the LOR to air group ($P < 0.0126$). The possible explanation for less number of attempts needed in balloon technique is because it is objective i.e. inflation or deflation of the balloon is

obvious to anyone regardless of experience. The device is light weight so both hands can be used to hold the needle allowing slow controlled movement of the needle.

In our study, the mean time taken for the procedure was 31.3 ± 4.28 s among the group B which was significantly less than the mean time taken among the group A which was 57.55 ± 8.4 s. Also in group B the inexperienced anaesthesiologist took less time (with mean time 34.24 ± 3.13 s) which was similar to that by experienced anaesthesiologist (with mean time of 28.51 ± 3.24 s) (Refer Fig. 2). The epidural balloon technique when done by inexperienced anaesthesiologists needs less time compared to the LOR technique done by the experienced anaesthesiologists (with P value= <0.01). Similarly in the study by Fyनेface Ogan S, Mato CN [9] and Suresh Singhal *et al.* [10] time taken was less in epidural balloon group than the LOR to air group ($P < 0.0001$). The study also showed that the third year resident anaesthesiologist took significantly less time as compared to first and second year

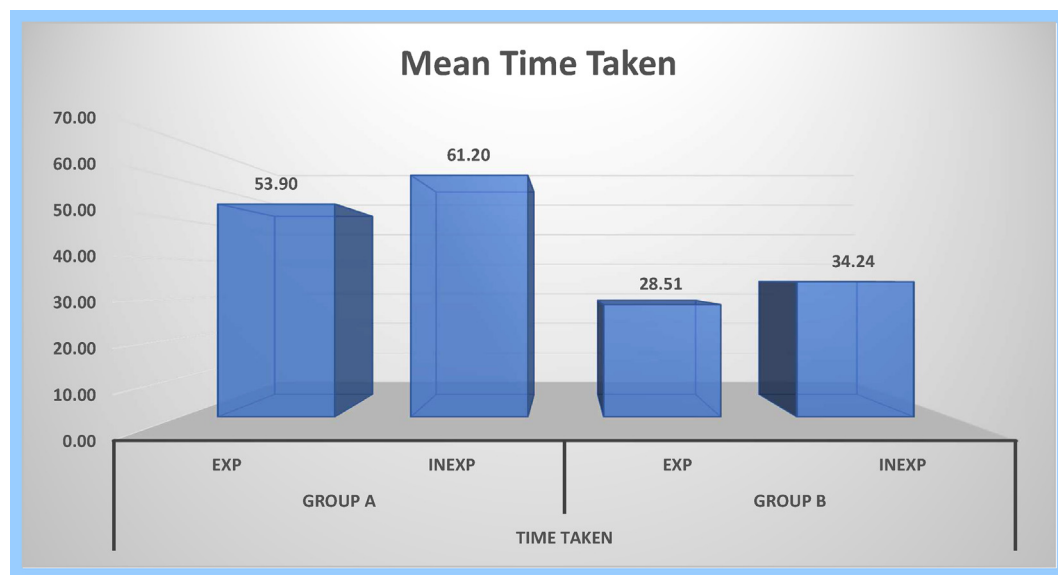


Fig 2. Comparison of Time taken for epidural space identification between group A (LOR technique) and group B (epidural balloon technique) according to performance by experienced and inexperienced anaesthesiologists (s).

residents. The findings of our study are comparable and similar with above studies.

The possible reason for this could be that the deflation of the inflated epidural balloon is clearly visible and objective whereas the LOR to air is many a times subjective and needs rechecking again to confirm the LOR; especially becomes more difficult in inexperienced hands. Also in epidural balloon technique both hands are used to hold the needle allowing controlled movement whereas in the LOR technique holding the needle in one hand only and applying pressure with the other hand becomes difficult for an inexperienced anaesthesiologist.

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.

In our study, there were two failures in the group A and none in the group B. There were four dural punctures in the group A and one in the group B. In the study conducted by Mustafa and Milliken(1982) [8], using visual indicator there was 100% success rate with no dural puncture. In the study by Fyreface Ogan S and Mato CN [9] there were more accidental dural punctures and failed blocks in the LOR group. Suresh Singhal et al. [10], reported single dural puncture reported in Group II (epidural balloon group) and no bloody tap or root irritation was observed in either of the groups. The findings of our study are comparable and similar with all above studies (REFER Table 5). The possible reason for a higher incidence of dural puncture in the LOR technique could be that it is a subjective technique, the onward movement of the needle may not be checked in time and the space could be missed. Also in elderly patients with partially ossified ligaments incidence of dural puncture is higher as compared to younger patients.

In our study there were no nerve injuries in either of the group.

Table 5. Comparison of incidence of complications in the study groups.

	Group		P value
	A Number of patients	B Number of patients	
Failure	2 2.4%	0 0.0%	0.497
Dural puncture	4 4.9%	1 1.2%	0.367
Nerve injury	0 0.0%	0 0.0%	—
P- value - 0.497(NS)			

5. Conclusion

We conclude that the time taken for the identification of the epidural space is significantly less with the epidural balloon technique compared to the LOR technique. Also the mean time taken by inexperienced anaesthesiologists is significantly reduced using epidural balloon technique.

The number of attempts needed for identification of the epidural space and the incidence of complications are comparable in both the techniques.

We conclude that the epidural balloon is a simple, easy to use device especially useful for the inexperienced anaesthesiologists for the accurate identification of the epidural space in short time.

Conflicts of Interest

There are no conflicts of interest.

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