International Journal of Pain & Relief

Research Article

The Comparison of Loss of Resistance Technique, Automatic Loss of Resistance Syringe and Hanging Drop Technique for Identifying Epidural Space -

Asiye Demırel[1], Mevlut Comlekci[2], Gokcen Basaranoglu[3]*, Haluk Ozdemir[1], Nuriye Beril Bozkurt[4], Mahmut Gokhan Teker[5], Kerem Erkalp[2], Nalan Muhammedoglu[6] and Leyla Saidoglu[7]

[1]Vakif Gureba Training Hospital, Istanbul
[2]Bagcilar Training Hospital, Istanbul
[3]Bezmialem Vakif University, Istanbul
[4]Medical student Bezmialem Vakif University, Istanbul
[5]LIV Hospital, Istanbul
[6]Istanbul Training Hospital, Istanbul
[7]Kanuni Sultan Suleyman Training Hospital, Istanbul

***Address for Correspondence:** Gokcen Basaranoglu, Adnan Menderes Boulvard, Fatih Istanbul, Tel: 05325899871; E-mail: gbasaranoglu@hotmail.com

Submitted: 29 October 2017; **Approved:** 05 December 2017; **Published:** 07 December 2017

Cite this article: Demırel A, Comlekci M, Basaranoglu G, Ozdemir H, Bozkurt NB, et al. The Comparison of Loss of Resistance Technique, Automatic Loss of Resistance Syringe and Hanging Drop Technique for Identifying Epidural Space. Int J Pain Relief. 2017;1(1): 031-035.

ABSTRACT

Background: The automatic resistance loss injector technique using for identifying epidural space is a relatively new technique. In this study, we aimed to compare conventional techniques using for identifying epidural space with this new technique

Methods: Randomly selected total of 60 ASA physical status I-III patients ranging in age from 18 to 60 who are going to undergo lumbar epidural anesthesia or analgesia, have been applied to study. 20 patiens have been applied resistance loss technique group I, 20 patients have been applied resistance loss technique by automatic resistance loss injector (Epi-jet®)Group II and 20 patients have been applied hanging drop technique Group III. In these patients, access time to epidural space (technical practice time), ordinal number of trial lumbar epidural space was entered at, skin-epidural distance value (cm), whether dural damage occurred, evaluation of the sense of ligamentum flavum in epidural space access, skin-epidural distance values considering body mass index were recorded.

Results: In Group II, the rate of epidural space access was found significantly low. ($p < 0.05$). In Group III, rate of epidural space access was found significantly high ($p < 0.05$). The rate of sense of ligamentum flavum belong the patients in Group I, was found low ($p < 0.01$). When the groups were compared by epidural space access trials, no significant difference was observed in terms of skin-epidural distance value and dural injury.($p > 0.05$).

Conclusions: The automatic resistance loss injector technique using for identifying epidural space is preferable comparing to conventional methods.

INTRODUCTION

Nowadays, the importance given to regional anesthesia methods is increasing and in our daily practice, regional blocks are applied more frequently. Epidural anesthesia method is preferred in numerous fields of surgery and for patients of all ages for both peroperative anesthesia and postoperative analgesia.

Especially in recent years, the increase in the interest for regional anesthesia, development of regional anesthesia equipments together with widespread use of ultrasound and inurement of new local anesthetics, bring about the improvements in this area.

The success of epidural anesthesia and analgesia is depends on the correct identification of the epidural space and successful placement of epidural catheters [1]. There have been new technological developments in sets (loss of injector and epidural catheter) used in epidural anesthesia practices. For this purpose, automatic resistance loss injectors (EPİ-JET®), optimum constant and low pressure resistance loss device (EPİDRUM®), flexible and soft tip catheters, and catheters having more than one orifices on the catheter tip have been developed.

Two important frequently used methods in establishing epidural space are negative pressure technique (hanging drop) and resistance loss technique.

In this study, we aimed to compare three techniques; classic resistance loss technique by loss of injector, resistance loss technique applied by automatic resistance loss injector and hanging drop technique in terms of superiority and complications for identifying epidural space.

MATERIAL AND METHOD

This study was carried out Anesthesiology and Reanimation Department prospectively after having approval of Vakif Gureba Education and Research Hospital ethics committee. Total of 60 ASA physical status I-III patients ranging in age from 18 to 80 from Urology, General Surgery, Orthopedics and Cardiovascular Surgery Clinics, who were to be applied epidural anesthesia and/or postoperative epidural analgesia for abdominal surgery, pelvic surgery and lower extremity surgery, were included. The patients were informed about the method to be applied and written informed consent were taken from all patients to be participated in the study. The patients were divided into three groups equally number and randomly (Groups I, II and III). Epidural space was identified by applying resistance loss technique by loss of injector to the patients in Group I (n = 20), resistance loss technique by automatic resistance loss injector (Epi-jet®) to the patients in Group II (n = 20) and hanging drop technique to the patients in Group III (n = 20).

In all groups, after the patients were made to sit, L4-5 space were established under sterilized conditions and 2 ml (40 mg) lidocaine 2 % was injected into subcutaneous tissue. After epidural space was entered in all groups and having determined that there was no blood or cerebrospinal fluid flow from the epidural needle, 3 ml 2 % lidocaine was given as a test dose in 15 seconds. Through the Tuohy needle, epidural catheter (Perifix® Standart Epidural Catheter B/Braun) was inserted into epidural space. Catheter was placed cephalically by pushing forward 3 cm in epidural space.

In Group I, by applying resistance loss technique by midline access method, epidural space is entered by loss of injector consisting of 6 ml saline.

In Group II, by applying automatic resistance loss injector (Epi-jet® Automatic Loss Of Resistance Syringe / Egemen, Istanbul, Turkey) of 10 ml consisting of 6 ml saline epidural space is entered by establishing control on the Tuohy needle with both hands.

In Group III, after skin and subsurface skin were passed with Tuohy needle and it was made to push forward to the supraspinous ligament, plunger of the needle was pulled and one drop of saline was inserted on the tip of the needle. Through the midline access, the needle was pushed forward till the ligamentum flavum was felt. After ligamentum flavum was passed, by the effect of negative pressure in epidural space, it was observed that saline drop was absorbed.

2ml radio-opaque substance lohexol (Omnipague/Opakim), was given to the epidural space belong each patient taking part in each 3 groups. The distribution of radio-opaque substance through the epidural space was monitorized by the Opescope 50 N/Shimadzu fluoroscopy device. After catheter determination procedure, the patients were made to lay down in supine position by upholding their heads by 30°.

Some of the patients undergoing abdominal surgery, pelvic and lower extremity surgery operations were given 10 ml = 50 mg 0.5 % Levobupivacaine and 8 ml = 160 mg 2% Lidocaine mixture to their epidural space at the beginning of the operation.

For each patient, technical application time (access time to epidural space), skin-epidural distance values in sitting position, skin-epidural distance values according to body mass index, whether dural damage occurred or not, whether the sense of ligamentum flavum existed or not, and the ordinal number of trial lumbar epidural space was entered at were recorded.

In patients who were applied epidural anesthesia, sensorial blockade level was evaluated as dermatome level by pin-prick method and motor blockade was evaluated at 5-minute intervals after epidural injections by 'Bromage Scale' These patients were evaluated for 30 minutes for anesthesia to be settled.

The 30 % decrease of measured basal mean arterial pressure values presurgery and postoperative period, was accepted as hypotension. These patients were given 5 ml/kg additional crystalloid fluid and 5-10 mg intravenous (IV) efedrine. The heart rate dropped down below 50 beat / min was accepted as bradycardia and 0.50 mg atropine was given.

Peroperative hemorrhages were replaced with crystalloid fluids, colloids and blood products so that hematocrit level was maintained not lower than 30 %.

During the first postoperative 48 hours, the patients were observed regarding hypotension, bradycardia, pruritus, headache, respiratory depression, backache, hypoesthesia, paraesthesia, transient neurologic symptoms and cauda equina syndrome. The patients whose catheter was taken 48 hours after the operation, were observed for 5 days regarding headache, meningitis and neurological complications.

SPSS (Statistical Package for Social Sciences) for Windows 15.0 program was used for statistical analysis. While evaluating study data, besides descriptive statistical methods (mean, standard deviation, frequency, percentage), distribution test was applied in order to examine normal distribution. In comparing quantitative data, in the event that there were two groups, independent samples t test was used for comparing parameters having normal distribution between groups, Mann-Whitney U test was used for comparing parameters not having normal distribution between groups. In comparing quantitative data, in the event that there were more than two groups, single direction variance analysis, in determining the group causing distinction, Tukey HSD test was used. Moreover in comparing qualitative data, chi-square test was used. The results were evaluated in confidence interval of 95 %, at the level of significance $p < 0.05$.

RESULTS

This study was applied on total of 60 patients, consisting of 10 women (16,7%) and 50 men (83,3%), ranging in age from 18 to 80.

Demographical features of 60 patients taking part in 3 groups, were shown in table 1.

When such personal characteristics as sex, age, weight, height, ASA score and Body Mass Index (BMI) of the patients were compared among groups, no significant difference was determined statically ($p > 0.05$).

In our study; technical practice time (access time to epidural space), skin-epidural distance value, the sense of ligamentum flavum, dural damage and epidural space access trials were evaluated in table 2.

When the groups were compared by dural damage, statistically no significant difference was observed among groups ($p > 0.05$).

Table 1: The demographic datas distribution by the age.

		Group I		Group II		Group III		p
		Mean ±	SD	Mean ±	SD	Mean ±	SD	
Age		60.6	11.6	59.55	12.8	57.6	19.9	0.819
Height		170	5.89	168.8	7.95	171.8	7.8	0.428
Weight		75.5	12.4	69.4	11.1	71.95	8.64	0.209
BMI		26.17	4.19	24.4	3.85	24.43	2.56	0.215
		N	%	N	%	N	%	
Gender	Male	18	90	15	75	17	85	0.432
	Female	2	10	5	25	3	15	
ASA	I	10	50	10	50	11	55	0.950
	II	8	40	8	40	6	30	
	III	2	10	2	10	3	15	

No significant differences was determined in demographic characteristics of these three groups.($p > 0.05$).

Table 2: Access time to epidural space, skin-epidural distance value, ordinal number of trial lumbar epidural space was entered at, dural damage, the sense of ligamentum flavum.

	Group I	Group II	Group III	P
Access time to epidural space (sec) (Mean ± SD)	53.80 ± 26.50	26.65 ± 51.13	64.70 ± 51.94	0.028*
Skin-epidural distance value (cm) (Mean ± SD)	5.25 ± 0.88	5.03 ± 0.81	5.03 ± 0.60	0.574
Ordinal number of trial lumbar epidural space was entered at (Mean ± SD)	1.45 ± 0.60	1.15 ± 0.37	1.50 ± 0.69	0.119
Dural damage exists(n)	0	0	2	0.126
The sense of ligamentum flavum exists (n)	12	19	18	0.008

Dural damage was 0 % (0/20) in Group I, 0% (0/20) in Group II and 10 % (2/20) in Group III.

When epidural space is identified, the sense of ligamentum flavum was evaluated in each group. While the sense of ligamentum flavum was positive in 12 (60%) patients in Group I, the sense of ligamentum flavum was positive in 19 (95 %) patients in Group II and 18 (90%) patients in Group III. The rate of the sense of ligamentum flavum belong the patients in Group I was found low ($p < 0.01$).

When the groups were compared by epidural space access trials, average of epidural space access trial was low in Group II; however statistically no significant difference was observed among groups ($p > 0.05$). The number of trial was approximately 1.45 in Group I, 1.15 in Group II and 1.50 in Group III. In Group I, 12 (60 %) cases, in Group II 17 (85 %) cases and finally in Group III 12 (60%) cases achieved epidural space access in the first trial.

When the skin-epidural space distance values of the groups are compared with their BMI, a significant relationship was found between them ($p < 0.05$). Considering BMI measurements skin-epidural space distance values of the obese people are higher than that of thin people or people have healthy weight. Positive significant relationship of 32.7 % between BMI and skin-epidural space distance values was found ($p < 0.05$). The more BMI values, the more skin-epidural space distance values exist.

DISCUSSION

Automatic resistance loss injector Epi-jet®, is an easy-to-use and practical new injector to define the epidural space. By using resistance loss technique by Epi-jet®, epidural space can be identified. Thus, there is no need to learn a new technique. It is an ideal material for the resident physicians, who are not experienced in epidural anesthesia.

As both hands are on the Tuohy needle, while epidural structure is being passed, it makes them feel throughly. In this study we aspired to indicate advantage and superiority of Epi-jet®. However as the studies, carried out by Epi-jet® are not sufficient, we think that more clinical studies should be carried out. The studies performed at adult population reveals that the method was a practicable alternative [2].

In our study we found that in Group I technical practice time (access time to epidural space) is approximately 53.80 ± 26.50 sec, in Group II it is 26.65 ± 51.13 sec and in Group III it is 64.70 ± 51.94 sec. In Group II, the rate of epidural space access was found significantly low. ($p < 0.05$). In Group III, rate of epidural space access was found significantly high ($p < 0.05$) .

The reason why this time was found high in Group III, could be that operator was inexperienced on this technique.

Likewise, Habib, et al. found the access time to epidural space 27 ± 35 seconds by using resistance loss technique by automatic resistance loss injector in their study and they found the access time to to epidural space 42 ± 23 sec by using resistance loss technique by glass injector [2]. Our findings are similar. Habib et al. noticed that residents could define epidural space in a shorter time by using resistance loss injector compared to glass injector.

The distance between the skin and epidural space is approximately 4- 6 cm. This distance can be vary to 3 cm in thin people and to 8 cm in fat people [3].

Riley and Carvalho recorded skin-epidural distance values in their study carried on 30 pregnant women who wanted to take epidural anesthesia. They found skin-epidural distance value 5 ± 1 cm in this study [4].

Habib et al recorded skin-epidural values on 325 pregnant women to be applied epidural analgesia for birth. In both groups, by using resistance loss technique by both automatic resistance loss injector and glass injector, they found skin-epidural distance value 6 ± 1 cm [2].

Hoffmann et al. recorded skin-epidural distance values on 40 patients by using resistance loss and hanging drop technique in their study. They found skin-epidural distance value approximately 5.4 cm by resistance loss technique and approximately 5.4 cm by using hanging drop technique [5].

In our study, in Group I, we found skin-epidural distance value approximately 5.25 cm and in Group II and III approximately 5.03 cm. Skin-epidural distance values were a little high in Group I; however no statistical significant difference was determined among 3 groups ($p > 0.05$). As the distribution of height and weight among three groups is not equal, skin-epidural distance value can be high in Group I.

Accidental dural perforation and total spinal blockade are complications which occur when required conditions are not complied with. There is a relationship between the experience of the anesthesiologist and dura perforation. The more the experience, the less dural perforation incidence occurs [6]. It is an incidence that can occur during locating the needle in epidural space. Habib et al. found dural mater perforation 0 % by using automatic p resistance loss injector in their study of 168 cases, and found dura mater perforation 2.54 % (4 in 157 patients) by using glass injector in their study of 157 cases. Although dural perforation is never experienced with automatic resistance loss injector, in this study no significant difference was determined statically regarding dural perforation.

It is put forward that dural puncture incidence decreases when resistance loss technique is used together with normal saline and when constant pressure is exerted on the plunger [7,8]. Through this technique, when epidural space is found, the needle being pushing forward should be stopped and as soon as pressurized saline enter the epidural space since it pushes dura away from tip of the needle [9] .While the needle is being pushed forward at intervals, there is a risk; as transition can be seen in subarachnoid even at short intervals. In this study, the tendency that there is less dural puncture by automatic resistance loss injector is the result of the fact that while making the needle push forward, the operator can exert constant pressure by a new injector. Riley and Carvalho, found dura perforation 0 % in 30 patients applied resistance loss technique by automatic resistance loss injector and indicated that automatic resistance loss injector (spring injector) is less related with dura perforation compared to standard pressure loss injector . However, they also indicated that it was difficult to say that; because dural damage had low incidence and more patients were required for this study to have sufficient effect [4].

In our study, no dural damage occured in Group I and Group II. In Group III, 10 % of the patients suffered from dural damage with Tuohy needle; however between groups there was no statistically significant difference ($p > 0.05$). The reason why the number of the dural perforation was considerable is that, operator had not apply hanging drop technique before.

Postdural puncture headache, is a common complication of neuroaxial techniques. It has 3 % incidence. Frequently, teenagers, women and pregnant women suffer from it. It occurs within 15-48 hours after dural puncture and generally 72 % regresses within 7 days [10].

Two patients whose duras had been punctured during hanging drop technique were kept under observation postoperatively for 48 hours and they did not suffer from headache.

Some studies indicated that dural puncture risk triples in people whose skin-epidural distance value are lower than 4 cm [11]. Hoffmann, et al. indicated that lumbar epidural space could be applied successfully by both hanging drop and resistance loss technique; however when compared with hanging drop, dural damage was less than that of resistance loss technique [5]. In our study we attributed the fact that there was more dural damage by hanging drop technique to the inexpertness of the operator.

In our study, we recorded that whether we felt ligamentum flavum or not through each 3 technique. While the sense of ligamentum flavum was positive in 12 (60%) patients in Group I; it was positive in 19 (95%) patients in Group II and in 18 (90 %) patients in Group III.

In Group I, the rate of the sense of ligamentum flavum was statistically low ($p < 0.01$). This may be regarded to operators ability to use both hands while using epidural needle. It helps resident physcians who will apply epidural anesthesia for the first time to seize and feel the structures to be passed while entering epidural space.

When automatic resistance loss injector is attached to Tuohy needle, tip of the needle is of subcutaneous tissue; as subcutaneous tissue causes least resistance, false resistance loss can occur. So that, in order to prevent false resistance loss, manufacturer suggests that before locating spring injector, tip of the needle should be made to push forward to the interspinous ligament [2]. In this regard, the

number of the epidural access trials can be reduced.

In most studies, a relationship between Body Mass Index (BMI) and skin-epidural distance value was found. [11-16]. Hamza et al. found the average skin-epidural distance depth 4.3 ± 0.7 cm in situations in which BMI is lower than 25 kg/m² , 4.3 ± 0.7 cm in situations in which BMI is higher than 30 kg/m². They indicated that in predicting epidural depth, BMI had higher predictive value than conventional bodily parameters (weight/height rate, and/or weight) [15].

Chad M. et al. found a positive relationship between BMI and epidural depth [16].

Our study also found positive relationship of 32.7 % between the BMI and skin-epidural distance values of the patients. ($p < 0.05$) The more the BMI values of the cases, the more skin-epidural distance values exist. Considering BMI measurement, skin-epidural distance values of the obese patients are higher than that of thin patients or patients have healthy weight ($p < 0.05$). When establishing epidural needle length, BMI of the patient can be helpful so that wrong and unnecessary positions are avoided.

It is ambiguous whether experienced operator will use spring injector. Anesthetists, well-versed in special technique are unwilling to make changes. According to an epidural technical research, only 48% of the anaesthetists said that they would try an alternative way in case of they had difficulty in the technique they preferred [4].

In our study, we considered that lumbar epidural space could be defined by both hanging drop and resistance loss method; however when compared to hanging drop, dural damage is less by resistance loss method. The reason is that, epidural space access is directly depended on defining subarachnoid pressure in spinal canal. While the subatmospheric pressure is more distinct in cervical and thoracic region; it is not safer in lumbar region.

Consequently, we consider that compared to other standard resistance loss injector, automatic resistance loss injector does not have major disadvantages and it also has advantages. As the spring in the injector exerts continual and constant pressure, when the serum in the plugger finds an epidural space, it will flow into the epidural space; so that this situation reduces the risk of dura perforation. We came to a conclusion that it will develop the sense as it helps inexperienced residents to use both hands when making the epidural needle push forward between tissues.

REFERENCES

1. Saberski LR, Kondamuri S, Osinubi OY. Identification of the epidural space: is loss of resistance to air a safe technique? A review of the complications related to the use of air. Reg Anesth. 1997; 22: 3-15. https://goo.gl/ngzFky
2. Habib AS, George RB, Allen TK, Olufolabi AJ. A pilot study to compare the Episure Autodetect syringe with the glass syringe for identification of the epidural space in parturients. Anesth Analg. 2008 ; 106: 541-543. https://goo.gl/zpr9q7
3. Bevacqua BK, Haas T, Brand F. A clinical measure of the posterior epidural space depth. Reg Anesth. 1996; 21: 456-460. https://goo.gl/ri8Ryv
4. Riley ET, Carvalho B. The Episure™ Syringe: A novel Loss of Resistance Syringe for Locating the Epidural Space. Anesth Analg. 2007; 105: 1164-1166. https://goo.gl/py8Ytr
5. Hoffmann VL, Vercauteren MP, Vreugde JP, Hans GH, Coppejans HC, Adriaensen HA. Posterior epidural space depth: safety of the loss of resistance and hanging drop techniques. Br J Anaesth. 1999; 83: 807-809. https://goo.gl/vNXjiJ
6. Crawford JS. The second thousand epidural blocks in an obstetric hospital practice. Br J Anaesth. 1972; 44: 1277-1287. https://goo.gl/JorQqh
7. Stride PC, Cooper GM. Accidental dural puncture rates in UK obstetric practice. Int J Obstet Anesth. 1998; 7: 242-246. https://goo.gl/FUmVLq
8. Gleeson CM, Reynolds F. Dural taps revisited. A 20-year survey from Birmingham Maternity Hospital. Anaesthesia. 1993; 48: 247-255. https://goo.gl/MJsQ1m
9. Scrutton MJ, Kinsella SM. Continuous or intermittent loss of resistance for identifying the epidural space. Anaesthesia. 2000; 55: 497-498. https://goo.gl/CmLJUi
10. Wong CA. Spinal and epidural anesthesia, 1th edition, The McGraw-Hill Companies, 2007; 161.
11. Sutton DN, Linter SPK. Depth of extradural space and dural puncture. Anaesthesia. 1991; 46: 97-98. https://goo.gl/gYuZUe
12. Bahk JH, Kim JH, Lee J, Lee SC. Computer tomographic study of lumbar (L3-4) epidural depth and its relationship to physical measurements in young adult men. Reg Anesth Pain Med. 1998; 23: 262-265. https://goo.gl/siBFuC
13. Segal S, Beach M, Eappen S. A multivariate model to predict the distance from the skin to the epidural space in an obstetric population. Reg Anesth. 1996; 21: 451-455. https://goo.gl/fDjEm3
14. D Alonzo RC, White WD, Schultz JR, Jaklitsch PM, Habib AS. Etnicity and the distance from skin to the epidural space in parturients. Reg Anesth Pain Med. 2008; 33: 24-29. https://goo.gl/xVrkD6
15. Hamza J, Smida M, Benhamou D, Cohen SE. Parturient's posture during epidural puncture affects the distance from skin to epidural space. J Clin Anesth. 1995; 7: 1-4. https://goo.gl/GfDJ5V
16. Chad M. Brummett, Bryan S. Williams, Robert W. Hurley, Michael A. Erdek. A prospective, observational study of the relationship between body mass index and depth of the epidural space during lumbar transforaminal epidural steroid injection. Reg Anesth Pain Med. 2009; 34: 100-105. https://goo.gl/HsFUfE