

# Comparison of spring-loaded, loss of resistance and hanging drop techniques in lumbar epidural blocks

## *Lomber epidural bloklarda spring-loaded, direnç kaybı ve asılı damla tekniklerinin karşılaştırılması*

Güven GÜLEN,<sup>1</sup> Taylan AKKAYA,<sup>2</sup> Derya ÖZKAN,<sup>2</sup> Mehmet KAYDUL,<sup>3</sup> Orhan GÖZAYDIN,<sup>4</sup> Haluk GÜMÜŞ<sup>2</sup>



### Summary

**Objectives:** The spring-loaded syringe is a loss of resistance syringe that provide a more objective sign that the epidural space has been entered compared with the traditional techniques. The aim of this study was to compare the time required to locate the epidural space and the backache incidence with the spring-loaded (SL), loss of resistance (LOR) and the hanging drop (HD) techniques for epidural blocks in patients undergoing transurethral resection procedure.

**Methods:** Sixty patients undergoing transurethral resections were enrolled in the study. The patients were randomly assigned to one of three groups. Epidural block was performed in the first group with a spring-loaded syringe (n=20), in the second group with loss-of-resistance syringe (n=20), and in the third group with the hanging drop technique (n=20). The required time to locate the epidural space, the number of attempts, the incidence of dural puncture and the backache incidence were assessed during the procedure and for four weeks after the procedure in all patients.

**Results:** The required time to locate the epidural space was 29.1±9.16 seconds in Group 1; 45.25±19.58 seconds in Group 2, and 47.35±11.42 seconds in Group 3 (p<0.001). In Group 1 this was significantly shorter than the other two groups. There was no significant difference in the number of attempts, the incidence of dural puncture and backache incidence between the three groups (p>0.05).

**Conclusion:** The use of SL syringe was found to have a shorter time period to locate the epidural space when compared with the LOR syringe and hanging drop technique.

**Key words:** Hanging drop technique; loss of resistance; epidural block; spring loaded.

### Özet

**Amaç:** Spring-Loaded enjektör (SL), epidural aralığa girildiğinde diğer geleneksel tekniklere göre daha objektif bulgu veren bir direnç kaybı enjektörüdür. Bu çalışmanın amacı, elektif transüretral rezeksiyon prosedürlerinde epidural blok uygulanan hastalarda SL enjektör, konvansiyonel direnç kaybı (DK) enjektörü ve asılı damla (AD) tekniklerini epidural aralık bulma süresi ve postepidural bel ağrısı sıklığı açısından karşılaştırmaktır.

**Gereç ve Yöntem:** Bu çalışmada elektif transüretral rezeksiyon yapılacak olan 60 hasta yer aldı. Hastalar randomize olarak üç gruba ayrıldı. Epidural blok birinci grupta SL enjektörü ile (n=20), ikinci grupta DK enjektörü ile (n=20), üçüncü grupta AD ile (n=20) uygulandı. Tüm hastalarda epidural aralığı bulma süresi, girişim sayısı, dural ponksiyon sıklığı ve bel ağrısı insidansı operasyon boyunca ve operasyon sonrası 4 hafta boyunca değerlendirildi.

**Bulgular:** Epidural aralığı bulma süresi grup 1'de 29.1±9.16 sn, grup 2'de 45.25±19.58sn; grup 3'de 47.35±11.42sn idi (p<0.001). Girişim sayısı, dural ponksiyon sıklığı ve bel ağrısı sıklığı açısından gruplar arasında anlamlı fark bulunamadı (p>0.005).

**Sonuç:** Konvansiyonel DK enjektörü ve AD teknikleriyle karşılaştırıldığında SL enjektörü kullanıldığında epidural aralık bulma süresinin daha kısa olduğu bulunmuştur.

**Anahtar sözcükler:** Asılı damla tekniği; direnç kaybı; epidural blok; spring-loaded.

<sup>1</sup>Department of Anesthesiology and Reanimation, Harput State Hospital, Elazığ;

<sup>2</sup>1st Department of Anesthesiology and Reanimation (Pain), Diskapi Training and Research Hospital, Ankara;

<sup>3</sup>Department of Anesthesiology and Reanimation, Iğdır State Hospital, Iğdır;

<sup>4</sup>Department of Anesthesiology and Reanimation, Semdinli State Hospital, Hakkari, all in Turkey

<sup>1</sup>Harput Devlet Hastanesi, Anesteziyoloji ve Reanimasyon Kliniği, Elazığ;

<sup>2</sup>Dışkapı Yıldırım Beyazıt Eğitim ve Araştırma Hastanesi, 1. Anesteziyoloji ve Reanimasyon (Ağrı) Kliniği, Ankara;

<sup>3</sup>Iğdır Devlet Hastanesi, Anesteziyoloji ve Reanimasyon Kliniği, Iğdır;

<sup>4</sup>Semdinli Devlet Hastanesi, Anesteziyoloji ve Reanimasyon Kliniği, Hakkari

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**Correspondence (İletişim):** Dr. Taylan Akkaya. Angora Cad., 187. Sok., Özbek Sitesi 60-a/17, 06810, Beysuğent, Ankara

**Tel:** +90 - 312 - 596 25 51 **e-mail (e-posta):** taylanakkaya@yahoo.com

## Introduction

A variety of techniques and modifications have been described for identifying the epidural space. The loss-of-resistance (LOR) technique is the most commonly used technique for finding the epidural space.<sup>[1]</sup> The hanging drop (HD) technique is also used to identify the epidural space.<sup>[2]</sup> A new spring-loaded (SL) syringe with a coaxial compression spring supplying constant pressure on the plunger is also used.<sup>[3]</sup> The advantage of the spring-loaded syringe is that both hands can be used to advance and steady the epidural needle. One application for this syringe may be to facilitate teaching of the epidural technique to clinicians providing a visual signal.<sup>[4]</sup> Backache is a significant complaint following epidural procedures. The etiology of post-epidural backache may be due to localized trauma leading to aseptic periosteitis, tendonitis, inflammation of the ligaments, and osteochondritis.<sup>[5]</sup> There is a significant association between post-epidural backache and multiple attempts at placement of the epidural needle and the longer time required to locate the epidural space.<sup>[6]</sup>

The aim of this study was to compare the time required to locate the epidural space, the number of attempts, the incidence of dural puncture, and the rate of backache with the new SL syringe (Episure®, Indigo Orb, Santa Clara, CA), the conventional LOR syringe (B. Braun, Germany) and the hanging drop techniques.

## Materials and Methods

With approval of the Ethics Committee of the Ministry of Health Diskapi Yildirim Beyazit Training and Research Hospital (Ankara, Turkey) and with informed written consent from the patients, 60 patients undergoing transurethral resection procedures with ASA physical status I-II were enrolled in the study. The study was planned in advance using computer-based random numbers.

The primary outcome was the time required to locate the epidural space. A pilot study was performed first with three groups of 11 patients each. The One-way ANOVA was used in the analysis. The total sample of 33 subjects provided a 80% power to detect a relative difference among the means versus

the alternative of equal means using an F test with a significance level of 0.05.

The exclusion criteria were patients that rejected epidural anesthesia, and those with a history of peripheral neuropathy, neuromuscular or neuropsychiatric disease, alcohol or drug abuse, Body-mass-index (BMI) >29 kg/m<sup>2</sup>, hypersensitivity to local anesthetic medications, scoliosis, backache and history of operation in the low back, bleeding and clotting disorders, infection and history of frequent analgesic use.

The patients were hydrated with 500 mL crystalloid solution one hour prior to the operation and 0.01mg/kg IV midazolam 20 minutes before the operation in the premedication room after an 18-gauge catheter was placed. Monitoring consisted of non-invasive arterial blood pressure, ECG, and peripheral oxygen saturation (SPO<sub>2</sub>) with the pulse oximeter in the operating room.

All blocks were performed by the same anesthesiologist. All blocks were performed in the sitting position. The site of puncture was disinfected using 10% povidone-iodine antiseptic solution and covered with a sterile drape.

Before the procedure, 20 mg of 2% lidocaine was injected subcutaneously for local anesthesia. Epidural block was performed using an 18-gauge Tuohy needle (B. Braun, Germany) in the L3-L4 or L4-L5 intervertebral space with the patients in the sitting position and the needle tip cephalically directed via a midline approach. The Tuohy needle was moved forward through the subcutaneous tissue until an increase in the tissue resistance was felt (approximately 2-3 cm from the skin). The needle was cephalically directed and the plunger was pulled back. The study groups were as follows:

### 1. Group: SL syringe (n=20)

SL syringe (Episure®, Indigo Orb, Santa Clara, CA) filled with saline was attached to the hub of the Touhy needle. The Touhy needle was advanced cautiously towards the epidural space using both hands. As soon as the tip of the needle entered the epidural space, there was a sudden loss of resistance and the content of the syringe was automatically discharged. This was accepted as location of the epidural space.

**2. Group: Conventional LOR syringe (n=20)**

A LOR syringe (B. Braun, Germany) filled with saline was placed on the Tuohy needle. While slowly advancing the needle, resistance to injection of saline was evaluated constantly until clear loss-of-resistance identified the epidural space.

**3. Group: HD technique (n=20)**

The needle was filled with saline and advanced until a clear inward movement of saline was observed as a sign of reaching the epidural space. Fifteen ml (75 mg) of 0.5% levobupivacaine were injected for epidural block following 3 ml of 1.5% lidocaine with epinephrine 1:200,000 as a test dose in three groups.

The level of sensory block was checked every 2 minutes using a bilateral “pin-prick” test on the midclavicular line and the level of motor block was checked using modified Bromage scale after injection of the local anesthetic. The duration of sensory block was recorded. The interval between the introduction of the epidural needle and test dose injection was recorded as “the required time to locate the epidural space”. The required time to locate the epidural space (seconds), the number of attempts, and the incidence of dural puncture were recorded for all patients.

Successful epidural placement was assumed if the level of sensorial block reached the T10 level. Then the patients were positioned in the lithotomy position. Administration of fentanyl 50 mcg IV was planned if it would be required during the operation when the VAS score was  $\geq 4$ . Hypotension was described as  $>20\%$  decrease in the initial systolic arterial pressure and the infusion rate of crystalloid would be increased and ephedrine 5 mg IV would be administered if required. Bradycardia was described as a heart rate of  $<50$  beats/minutes and atropine 0.5 mg IV administration was planned. Patients with a postoperative VAS score of  $\geq 4$  were designated to receive paracetamol 500 mg tablet orally.

On postoperative day one, patients were instructed to touch their toes after standing erect and were asked to assess their backache. If they have backache, it was recorded with VAS. The VAS consisted of a 10cm line labeled with “no backache” at 0 and “intense backache” at 10.

Patients were questioned by phone again at week 1, 2, 3 and 4 postoperatively by an independent blinded investigator. Any patient complaining of any backache, was recorded as having post-epidural backache.

Statistical analysis was performed using the SPSS for Windows 11.5 software (SPSS Inc., Chicago, IL, United States). The Shapiro Wilk test was used to determine whether the continuous variables were normally distributed or not. Continuous data were shown as mean  $\pm$  standard deviation or median (25th - 75th) percentiles, where applicable. Nominal data were presented as the number of cases and percentages. The means were compared using the One-Way ANOVA. The differences among repeated VAS measurements within groups were evaluated by Friedman test. Nominal data were evaluated using the Pearson Chi-square test. A p value of less than 0.05 was considered statistically significant.

**Results**

The demographic data of patients in the study group were found to be similar (Table 1). The required time to locate the epidural space was  $29.1 \pm 9.16$  seconds in Group 1 and this time in Group 1 was significantly shorter than the other two groups ( $p < 0.001$ ) (Table 2). The number of attempts for locating the epidural space was compared between the groups and it was found that the first attempt was successful in 18 (90%) patients in Group 1. The second attempt was successful in 2 (10%) patients and there was no need for the third attempt in Group 1. The third attempt was required in one patient in Group 3 (Table 3). However, this was not statistically significant ( $p = 0.311$ ).

There was no significant difference between the groups in the immediate post-operative period VAS scores for backache of patients (Table 4). The VAS

**Table 1.** Demographic data

Variables	Group I (n=20)	Group II (n=20)	Group III (n=20)	p
Age (year)	62.0 $\pm$ 8.8	64.4 $\pm$ 7.9	66.1 $\pm$ 8.4	0.323 <sup>a</sup>
Body mass index (kg/m <sup>2</sup> )	26.9 $\pm$ 3.0	27.3 $\pm$ 3.8	27.3 $\pm$ 4.3	0.917 <sup>a</sup>

<sup>a</sup>One-way variance analysis.

**Table 2.** Anesthesia and surgery times

Variables	Group I (n=20)	Group II (n=20)	Group III (n=20)	p <sup>a</sup>
Time required for locating the epidural space (seconds)	29.1±9.16	45.25±19.58 <sup>b</sup>	47.35± 11.42 <sup>b</sup>	<0.001
Duration of surgery (min)	63.0±8.2	65.3±7.8	62.5±8.2	0.326
Duration of sensory block (min)	351.9±28.56	355.2±28.83	356.3±29.49	0.910

<sup>a</sup>One-way ANOVA test; <sup>b</sup>Significant difference with Group I (p<0.001).

**Table 3.** The number of attempts for epidural blocks in different groups

The number of attempts for epidural blocks	Group I (n=20)	Group II (n=20)	Group III (n=20)	p <sup>a</sup>
One attempt	18 (90%)	17 (85%)	15 (75%)	0.311
Two attempts	2 (10%)	3 (15%)	4 (20%)	
Three attempts	–	–	1 (5%)	

<sup>a</sup>Pearson chi-square test.

**Table 4.** The severity of low back pain in different groups (VAS)

The severity of low back pain (VAS)	Group I (n=20)	Group II (n=20)	Group III (n=20)	p <sup>a</sup>
Just after the procedure	3.6±0.82	3.8±1.06	4.1±1.00	0.157
First day	0.6±1.23	0.8±1.53	0.8±1.75	0.917
First week	0.6±1.23	0.6±1.23	0.6±1.23	–
Second week	0	0	0	–
Third week	0	0	0	–
Fourth week	0	0	0	–

<sup>a</sup>Friedman test.

**Table 5.** The Bromage scores of the groups

Score	Group I (n=20)	Group II (n=20)	Group III (n=20)	p <sup>a</sup>
0	–	–	–	0.997
1	3 (15%)	3 (15%)	3 (15%)	
2	6 (30%)	7 (35%)	6 (30%)	
3	11 (55%)	10 (50%)	11 (55%)	

<sup>a</sup>Pearson chi-square test

score of backache at week 2, 3 and 4 was 0 in all patients. The Bromage scores of patients were found to be similar (Table 5).

There was no dural puncture in any group. No patients required perioperative ephedrine or fentanyl administration. Postoperative total consumption of paracetamol tablets was 2 (median) in all groups.

## Discussion

Epidural anesthesia was performed successfully in all patients in this study. The required time to locate the epidural space in the SL syringe group was shorter than the two groups. The epidural space was identified in the first attempt in 90% in the SL syringe group; the rates were 85% and 75% in the second and third groups, respectively. Comparison studies of epidural techniques have emphasized “attempts at lumbar epidural needle placement”, but “required time to locate the epidural space “was not measured.<sup>[3]</sup> There was no significant difference between the groups in terms of backache of patients in any follow-up period.

Complete failure of epidural analgesia typically results from failure to identify the epidural space correctly. Higher failure rates occur with inexperienced practitioners.<sup>[7]</sup> The LOR technique is most frequently used. But this technique can be difficult to perform, and is accompanied by minor or major complication is also time-consuming.<sup>[8]</sup> Several attempts have been made to facilitate the LOR technique by adding a visual or an acoustic signal.<sup>[9]</sup> Despite the advantages claimed, none of these techniques are used widely, probably because they have no clear additional value. The HD technique is another method that allows more control in handling the epidural needle and also it is visual. The SL syringe is reliably detected the epidural space visually and it may be preferred by the resident of anesthesia as it provided the possibility of using both hands.<sup>[2]</sup> In our study, all block procedures were performed by the same anesthetist so that the success and the required time of epidural block would be assessed more objectively.

It was suggested that the spring-loaded syringe would be associated with fewer accidental dural



punctures than a standard LOR syringe.<sup>[3]</sup> It is widely considered that the “whoosh” of saline on passing through the ligamentum flavum may push the dura away from the Tuohy needle and hence reduce the risk of accidental dural tap. During intermittent needle advancement, there is a risk that even with small incremental advancement, overshooting into the subarachnoid space may occur.<sup>[10]</sup> Habib et al.<sup>[4]</sup> compared the spring loaded syringe with the standard glass syringe and found that the incidence of dural puncture was similar in both groups. Evron et al.<sup>[11]</sup> demonstrated that loss of resistance with 3 ml of air was associated with more difficulties in epidural catheter insertion and increased frequency of dural puncture than the use of 3 ml of lidocaine to locate the epidural space. We think that as we could apply constant pressure with the spring-loaded syringe and as we could use it with saline, the frequency of dural puncture would be lower. In our study there was no dural puncture in any group.

The incidence of immediate localized postoperative backache is 2-31%.<sup>[5]</sup> In a prospective randomized study with 1000 patients, Wang et al.<sup>[6]</sup> demonstrated that there was a significant association between postepidural backache and multiple attempts at epidural needle insertion may be due to localized trauma and inflammation. However, prospective and randomized studies in laboring patients indicate no difference in the incidence of postpartum backache between women who received epidural anesthesia and women who did not.<sup>[12,13]</sup> Backache is a common symptom during pregnancy and the prevalence has been reported to vary from 24% to 90% in different studies.<sup>[14,15]</sup> Therefore, selecting patients for non-obstetric surgery may be more appropriate in the assessment of backache due to epidural block. The present study on backache was carried out in a group of patients who underwent non-obstetric surgery. However, it could not be possible to evaluate backache thoroughly because of the limited number of patients in our series.

Obesity and abnormal spinal anatomy correlated with technical difficulty in neuraxial blocks.<sup>[16]</sup> SL syringe may provide easier intervention in this patients. Further studies with this technique in patients with BMI  $\geq 29$  or spinal deformity may be helpful.

In conclusion, the use of the SL syringe is associated with a shorter time for locating the epidural space compared to conventional loss-of-resistance and hanging drop techniques. It can be useful for residents with limited experience in epidural block.

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