DOES LUMBAR ULTRASONOGRAPHY IMPROVE EPIDURAL CATHETERIZATION FOR LABOR ANALGESIA? A RANDOMIZED CONTROLLED STUDY

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Abstract

Background: Palpation of anatomic landmarks is difficult in pregnant patients due to physiological changes. This can complicate epidural catheterization and determination of needle insertion site to place an epidural catheter. The purpose of our study was to compare prepuncture lumbar ultrasonography and palpation method for epidural needle insertion among pregnant.

Methods: Forty parturients scheduled for labor analgesia were randomized into two groups: Ultrasound group (n=20) and control group (n=20). Needle insertion point was identified by lumbar ultrasonography in ultrasound group and by palpation in control group. We recorded number of puncture attempts, number of necessary puncture levels, epidural catheterization time and complications during epidural catheterization.

Results: Number of puncture attempts was 1.35±0.58 in ultrasound group and 1.2±0.4 in control group. Number of puncture levels was 1.05±0.22 in ultrasound group and 1.10 ±0.3 in control group. Duration of epidural procedure was 93 seconds in ultrasound group and 88 seconds in control group. No statistically significant differences were found between the two groups. Sudden low back pain during needle insertion was significantly lower in ultrasound group (p=0.03).

Conclusions: Pre-puncture lumbar ultrasonography lowered sudden back pain during needle insertion. Ultrasound guidance did not reduce number of puncture attempts, necessary puncture levels and time of epidural catheterization among normal weight pregnant.

Keywords: Labor analgesia, epidural catheterization, pre-puncture ultrasonography.

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Introduction

Labor pain is considered one of the most severe pain that a human being could suffer. Epidural analgesia is accepted to be the most effective method for labor pain relief[1]. However, Konrad et al[2] reported that epidural analgesia technique is one of the most difficult anesthesia methods. Palpation of anatomic landmarks is difficult in pregnant women due to gestation-related physiological changes: hyperlordosis, progressive pelvic rotation over the long axis of the spinal column, weight gain, and edema[3-5]. This adds more difficulty to determine the correct needle insertion site for epidural labor analgesia[5,6]. The rate of complications increases with increases in the number of puncture attempts and number of puncture sites[7].

Lumbar ultrasonography for neuraxial blocks started with investigations published in the 1980s and has gained popularity in recent years[8]. The anatomical structures of the lumbar spine have been found hard to visualize by ultrasonography because of the anatomical fact that bones interfere with ultrasound[9]. However, with the increase in image quality as a result of technological progress, ultrasound is promising more detailed and accurate images for regional anesthesia[10-12]. Ultrasonography has been used for determination of the puncture site as well as measurement of the skin-epidural space distance before epidural catheterization[13]. Also advancement of the epidural needle and distribution of local anesthetic drugs can be seen in real time during the procedure with the help of ultrasound[6].

The primary aim of this study was to assess the effect of pre-puncture lumbar ultrasonography in parturients for reducing total number of puncture attempts and puncture levels. Secondary aim was comparison of lumbar ultrasonography and palpation method in terms of epidural catheterization time and complications during epidural catheterization.

Methods

This is a prospective and randomized study approved by Kocaeli University Ethics Board (Project No: KKAEK 2010 / 8, Decision No. 1 / 13). Forty pregnant women in 37-42 gestational week, 18-40 years old, with ASA I-II, nulliparous, who were under follow up by Obstetrics and Gynecology Department and eligible for vaginal delivery were enrolled in the study. The parturients were informed about labor analgesia previously. Written informed consent was obtained from all of the patients. Exclusion criteria included coagulopathy, congestive heart failure, coronary artery disease, severe cardiac valve disease and anticoagulant drug usage.

Using a sealed envelope method, the parturients were randomized to two groups; ultrasound (US) group and control group.

Ultrasonographic Examination

Lumbar ultrasonographic examination was performed for parturients in the ultrasound group before epidural catheterization (Esaote Mylab 30, Florence, Italy). A 3.5 MHz frequency convex transducer was used. The scans were performed in left lateral position with legs flexed. Tuffier's line was identified by palpation and noted as a horizontal line joining left and right crista iliaca by a skin marker pen. Area starting from sacrum to Tuffier's line was scanned in longitudinal paramedian sagittal plane moving the ultrasound transducer caudad. The transducer was placed 2-3 cm laterally from midline. The angle of the transducer was 70-80 degrees from the skin so that the US beam could reflect the spinal canal. Once the sacrum was visualized as a flat hyperechoic body, L4-L5 interspinous space was determined by counting the lamina up from the sacrum. The midpoint of the US transducer was placed over the L4-L5 interspinous space and the intervertebral level was marked on the skin by a marker pen with a transverse line passing from the midpoint of the transducer (Figure 1).

Afterwards, the vertebral column was scanned in transverse plane starting from the marked line of L4-L5 intervertebral level. The US transducer was moved left, right, caudal, cephalad and tilted slightly until the acoustic shadow of processus spinosus was viewed. When midline of the transducer and processes spinosus intersected, the transducer was kept still and the median line was marked with a longitudinal line passing from the midpoint of the transducer which was determined as the midline of the vertebral column

Fig. 1
Identification of L4-L5 intervertebral space in paramedian sagittal plane and sonographic view of anatomical structures in paramedian sagittal plane.

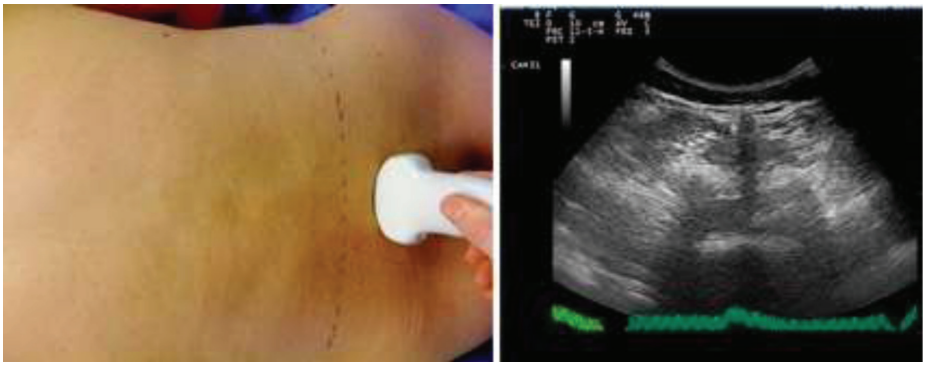

Fig. 2
Identification of median line with the help of ultrasound and sonographic view of anatomical structures in transverse plane.

Fig. 3
Identification of the needle insertion point with the help of ultrasound. Intersection of the two lines determines the needle insertion point.

(Figure 2). The intersection point of two lines was identified as the puncture site.

In the control group, needle insertion site was determined by palpation of crista iliaca and processus spinosus. The intervertebral level that corresponds to the Tuffier's line was considered as L4-L5 interspinous space and the puncture site. Needle insertions were performed using the blind technique after determination of insertion point in both groups.

Epidural Catheterization Procedure

Antisepsis of catheterization area was achieved with 10% povidone iodine. After infiltration of local anesthetic to the skin using 2% lidocaine, epidural catheter (Perifix ®, Braun, Melsungen, Germany) was placed via 18G Tuohy needle using loss of resistance to saline method in left lateral position with legs and spine flexed.

If the epidural space could not be identified after two needle redirections (one caudad, one cephalad direction), the needle was removed and reinserted for another attempt from the same intervertebral level. If the epidural space could not be found at second attempt after two needle redirections, the needle was then removed and inserted from the upper intervertebral

Table 1
Demographic data and obstetric characteristics. Data expressed as number, percentage, or mean ± standard deviation.

	Ultrasound Group (n=20)	Control Group (n=20)	p-value
ASA[a] (I/II) (n)	19/1	18/2	0.50
Age (year)	25.2±3.	26.1±4.2	0.45
Height (m)	1.61±0.04	1.62±0.05	0.42
Weight (kg)	74± 11	73±12	0.75
BMI[b] (kg/m$^{2)}$	28±3.67	27±4.54	0.53
Gestational week (wks)	38.3±1.21	38.7±1.16	0.24
Cervical Dilatation (cm)	3.3±0.97	3.4±1.04	0.75
Effacement (%)	61	61	0.96
Preeclampsia (n)	3	2	0.50

[a] ASA: American society of anesthesiologists, [b] BMI: Body mass index

level which was identified by US in US group and by palpation in control group. Total number of puncture attempts and total number of punctured intervertebral levels were recorded.

The time period starting from the insertion of the Tuohy needle until the placement of the epidural catheter and removal of the needle was recorded as the epidural procedure time. Dural puncture, sudden low back pain, paresthesia of lower extremity and vascular cannulation were recorded.

All punctures and ultrasonographic examinations were performed by the same obstetric anesthesiologist (O.B.) who is experienced about lumbar ultrasonography and labor analgesia epidurals.

Statistical Analysis

Sample size was determined with the use of NCSS 2007, PASS and GESS (Utah, USA). As this is a preliminary study, sample size was calculated based on our pilot study. We estimated a 30 % reduction in the number of puncture attempts in the ultrasound group. We found the median value of puncture attempt as 1.35 ± 0.57 in US group and as 1.76±0.3 in control group in the pilot study. Based on these results, sample size estimation required 40 patients, n1=20 ve n2=20 were were enrolled in each groups.

SPSS 13.0 (Chicago, IL) program was used for statistical evaluation of data. Chi-square test was used for evaluation of categorical data. Student's t test was used for the numerical data in normal distribution. The normality distribution of continuous variables were tested using Shapiro Wilk test. Skewed continuous variables were compared using Kruskal-Wallis test. $p < 0.05$ value was considered as significant.

Results

Data was obtained from a total of 40 parturients (ultrasound group: n=20 patients and control group: n=20). Age, weight, height, gestational week and ASA classification were similar in both groups (Table 1).

Number of puncture attempts was 1.35±0.58 in US group and 1.2±0.4 in control group (p=0.35). Number of necessary puncture levels was 1.05±0.22 in US group and 1.10 ±0.3 in control group (p=0.56). There was no significant difference between groups (Table 2).

Duration of epidural procedure was 93 seconds in US group, 88 seconds in control group. No significant difference was found between groups (p=0.24). The epidural catheter was correctly placed on the first attempt in 14 parturients of the ultrasound group and 16 parturients in the control group. The epidural catheter was successfully placed on the second attempt in 5 parturients of the ultrasound group and 4 parturients of the control group. Success rate on first puncture attempt was 70% in US group and 80% in control group. The results were similar between the groups (Table 2).

In the US group, none of the parturients had sudden low back pain during epidural procedure, whereas 3 parturients had sudden low back pain in

Table 2

Comparison of data related to the quality of epidural procedure. Data expressed as number, mean ± standard deviation, median (minimum-maximum) or percentage.

	Ultrasound Group (n=20)	**Control Group (n=20)**	**p-value**
Number of puncture attemps	1.35±0.58	1.2±0.41	0.35
(1/2/3)(n)	14/5/1	16/4/0	0.44
Rate of success on first puncture attempt (%)	70%	80%	0.24
*Epidural procedure time (sec) *Median(minimum-maximum)*	93(30-300)	88(38-240)	
Number of puncture levels	1.05±0.22	1.10 ±0.3	0.56
(1/2) (n)	19/1	18/2	0.50

* Time period starting from insertion of the Tuohy needle until removal of the needle after placement of the epidural catheter.

the control group. Low back pain incidence was 15% in control group. The difference was statistically significant (p = 0.03). None of the parturients had dural puncture in both groups (Table 3).

Two parturients had paresthesia of the lower extremities during epidural procedure in the US group and 4 parturients in control group. The incidence of lower extremity paresthesia was 10% in US group and 20% in control group. There was no significant difference between the two groups (p = 0.37) (Table 3).

Vascular cannulation rate was 5% in ultrasound group and 10% in control group. The difference was not statistically significant. (p = 0.54)

Discussion

The only remarkable outcome in the current study was the reduction of sudden low back pain during epidural procedure by using pre-puncture ultrasonography. The results of our study showed that pre-puncture US-guidance did not reduce number of puncture attempts, puncture levels and time for catheterization among normal weight pregnant. Although pre-puncture lumbar ultrasonography provides useful information about lumbar spine anatomy, detection of epidural space is still based on the feeling of loss of resistance.

We had 70% success rate on the first attempt in the US group. This result is consistent with the meta analysis[14] which shows the rate of successful catheterization on the first puncture attempt in US-guided neuraxial blocks as 71%. We had 80% success rate without pre-puncture ultrasonography. Epidural catheterization is a safe procedure when applied by experienced and skillful hands.

Grau et al[4] placed epidural catheters for pregnant women who underwent cesarean section or labor analgesia in two groups. In the US group, the patients had pre-puncture lumbar ultrasound scan. They found that the number of puncture attempts in the US group was significantly lower than control group. The researchers concluded that pre-puncture lumbar ultrasonography was effective for reducing number of puncture attempts and necessary puncture levels. However, the researchers considered needle redirectons as new puncture attempt in contrast to our

Table 3

Incidence of complications during epidural procedure. Data expressed as numbers.

	Ultrasound Group (n=20)	**Control Group (n=20)**	**p-value**
Sudden low back pain	0	3	0.03
Paresthesia of lower extremity	2	4	0.37
Epidural venous cannulation	1	2	0.54
Dural puncture	0	0	1.0

study. We could not prove a significant reduction in the number of puncture attempts and puncture sites. In our study, the number of puncture attempts and puncture levels in the control group was similar to those r of the US group.

There are few reports in the literature related to the duration of epidural catheterization procedure. Habib et al[15] defined epidural procedure time as "time period starting from application of the syringe to the Tuohy needle until sense of loss of resistance had been acquired". Leeda et al[16] compared paramedian and median approach for epidural catheterization in their study. They defined epidural procedure time as "the duration starting from the insertion of the Tuohy needle until sense of loss of resistance had been felt". The mean epidural procedure time was 21.1 seconds using paramedian approach and 13.2 seconds using median approach in their study. The researchers also investigated the time required for epidural catheter placement. The epidural catheter placement time was defined as "the duration starting from insertion of catheter through the Tuohy needle until removal of the Tuohy needle after 5 cm advancement of the catheter in the epidural space". The mean epidural catheter placement time was found to be 9 seconds in paramedian approach and 18.2 seconds in median approach.

The definition of epidural catheterization time in our study is similar to the sum of epidural procedure time and catheter placement time as defined in the study of Leeda et al, which was 31.4 seconds using paramedian approach. Our mean catheterization time in both US and control groups was longer than was previously reported. A possible reason of elongation of catheterization time may be related to the potential difficulty of the epidural procedure among pregnant. Pre-insertion ultrasound guidance did not reduce the time needed for epidural catheterization procedure of pregnant in our study.

The time needed for epidural catheterization would include the preparation and scanning time of ultrasonography and palpation time of anatomic landmarks before the epidural puncture. The palpation and feeling of anatomical landmarks is a subjective sensation and duration of palpation may vary according to the patient. Also duration of pre-puncture lumbar ultrasonography may vary according to the patient and the operator's experience. In our experience, the needed time for preparation of ultrasound and scanning added 3 to 5 minutes to the epidural catheterization procedure in the non-palpation group. This was in agreement with a previous study[6]. Our study was about the efficacy of ultrasonography reducing the number of puncture attempts, epidural catheterization time and complications during epidural puncture. Comparison of the duration times of ultrasonographic examination and palpation of landmarks before epidural puncture may be subject of further studies.

Major complications related to epidural puncture such as epidural venous cannulation, paresthesia of lower extremity, accidental dural puncture, sudden low back pain may occur during epidural catheterization[17,18].

Unintended epidural vein injury complicates as many as 9% of lumbar epidural catheter placements, with higher rates reported in pregnant patients compared with non-pregnant patients[18]. Similar to previous studies, a 7.5% incidence of epidural venous cannulation was reported in the current study. The occurrence rate of epidural venous injury was 5 % in the US group in our study which was lower than reported in the literature, whereas it was 10% in control group.

Placement of epidural catheters can often cause lower extremity paresthesia which is most often ascribed to contact between nerve roots and the needle or the epidural catheter. This is typically characterized as a transient and intense burning pain radiating to the hip or leg caused by needle or an indwelling epidural catheter, which can be relieved by partial withdrawal of the epidural catheter[18].

Previously reported rates of paresthesia with epidural catheter placement range from 20% to 44%[19]. In one large study, two thirds of serious neurologic complications (radiculopathy, cauda equina syndrome, or paraplegia) were associated either with a paresthesia during needle placement or with injection of the drug[20]. In our study, occurrence rate of lower extremity paresthesia in the ultrasound group was lower than the previously reported which was found as 10 %. In the control group, the occurrence rate was found as 20 % and was similar to the incidence reported in previous studies. The overall occurrence of lower extremity paresthesia in our study was 15 % which also was

found lower than the previous reports. However, we could not verify a significant reduction of paresthesia using pre-puncture US guidance.

Accidental dural puncture (ADP) rates in the obstetric population have been reported between 0 and 6.5%. Previous evidence supports that multiple attempts to locate the epidural space increase the risk of ADP[22]. In our study, we did not see dural puncture in both groups as it is a rare complication. Further studies with larger number of subjects and meta-analysis are needed to prove ultrasonography a reducing number of complications which are rarely seen. Limitations of the study are based on the small number of patients enrolled.

Sudden low back pain occurs when the needle contacts the articular facet joints. The needle may prick the facet joints if inserted and advanced laterally to the midline. Needle trauma of the facets causes a sudden, severe back pain and spasm of paravertebral muscles[22].

We conclude that correct needle insertion under ultrasound guidance should reduce contact to facet joints and that sudden low back pain caused by needle trauma can be reduced with the help of ultrasonography as an identification tool for finding the correct needle insertion site.

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