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LOCALIZATION OF EPIDURAL SPACE USING LOSS OF RESISTANCE TECHNIQUE, A DOUBLE-BLINDED COMPARATIVE STUDY COMPARING AIR VS SALINE AS A MEDIUM

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ABSTRACT

Background: Loss of resistance epidural technique is the most popular technique for localizing epidural space in anesthesia, yet the medium used in this technique still a matter of debate. Epidural anesthesia has a wide range of applications in both obstetric and non-obstetric settings. **Aim of the study:** To compare between the use of air or saline medium to locate epidural space in loss of resistance technique. **Patient and Methods:** A double-blind clinical trial study carried out at Baghdad Medical City during a period of one year from January 2022 to January 2023. It included 40 patients with ASA class 1,2 and 3 undergoing lower limb orthopedic and plastic surgeries. They were randomly assigned in two groups; air group used 3 ml air and saline group used 3ml saline 0.9% as a medium in loss of resistance technique for identification of epidural space. **Results:** Difficult epidural space identification and two attempts occurred in 60% of saline group which was significantly higher than that in air group. No significant difference in pain score in all times, onset of sensory, motor block and difficulty in epidural catheter insertion. Adverse outcomes like; accidental intravascular, intrathecal catheter insertion, accidental dural puncture, unilateral block was not encountered in both groups. **Conclusion:** Using air as a medium for loss of resistance technique to locate epidural space has better success rates with fewer number of attempts. We recommend further studies with a larger number of cases.

KEYWORDS: Loss of resistance, epidural space, saline, air, anesthesia, analgesia.

INTRODUCTION

Epidural techniques are widely used for surgical anesthesia, obstetric analgesia, postoperative pain control, and chronic pain management.[1]It remains the most effective way of alleviating labor pain, as it increases patient comfort and quality of patient-personnel cooperation during labor.[2] The epidural space is composed of a series of discontinuous compartments that become continuous when the potential space separating the compartments is opened by injection of air or liquid.[3] Epidurals can be used as a single shot technique or with a catheter that allows intermittent boluses, continuous infusion, or both.[4] The procedure of epidural anesthesia involves three crucial steps: Identification of vertebrae level, selection of desired puncture site and angle, and needle insertion into epidural space between ligamentum flavum and dura mater covering a spinal cord.[5] Identification of epidural space, which is only several millimeters, is the key element and the necessary prerequisite of effective epidural anesthesia.[6] Any techniques identifying the epidural space should be simple and straightforward, effective, safe, and reliable to minimize the number of complications associated with it.[7] Various methods have been used in identifying the epidural space. Most of these traditional methods of locating the epidural space depend on the negative pressure exhibited during the introduction of the epidural needle into the space.[8] The loss of resistance (LOR) technique is preferred by most clinicians. The needle is advanced through the subcutaneous tissues with the stylet in place until the interspinous ligament is entered, as noted by an increase

in tissue resistance.[9] The stylet or introducer is removed, and a glass syringe filled with approximately 2 mL of saline or air is attached to the hub of the needle.[10] Air and saline are widely used and accepted in syringes attached to epidural needles for determination of the LOR during the insertion of an epidural needle.[11] Some complications are observed using loss of resistance to air. They are pneumocephalus, air embolism, insufficient analgesia, delayed onset, higher incidence of dural puncture, nerve root compression, and subcutaneous emphysema.[9,12] Normal saline or injectable 0.9% saline is accepted as a physiologic solution for parenteral administration within the human body. Saline with local anesthetic molecules is accepted widely to dilute the strength of local anesthetic drugs but not alter or degrade them.[13] The aim of this trial is to compare air vs saline to locate epidural space in loss of resistance technique and which may give a better knowledge for the better medium used.

PATIENTS AND METHOD

Study design, setting, and time: This was a double-blind clinical trial study carried out at Baghdad Medical City during a period of one year from January 2018 to January 2019.

Study population and sample size: The study population included 40 adults aged between 18 - 60 years undergoing lower limp orthopedic or plastic surgery, urological, or inguinal surgeries with ASA 1 - 3. They were divided randomly into two groups.

- **Air group:** Included 20 patients for using air to detect epidural space.
- **Saline group:** Included 20 patients for using normal saline to detect epidural space.

A computer-generated randomization process was used to assign patients in each group. The sequence of the patient with the assigned group was written on a pack of papers folded together on their blank side so, the performer knows the assigned group for the current patient. The patient, staff and data collector were blinded to the patient group. The performers and data collectors were final grade anesthesia residents, each of whom has experience of at least 20 epidural blocks. All procedures were performed under the supervision of an experienced senior anesthesiologist. Patients with morbid obesity (BMI above 40), severe hemorrhage, anticoagulation therapy, those with coagulopathy, with bleeding tendency disorders, previous spinal surgery, local site of entrance infection or any other contraindication for neuraxial anesthesia, and patients who refused to neuraxial Anesthesia emergency operations were excluded from this study.

Data collected from the patients includes demographic information (age, gender, weight, and height), onset of analgesia, pain score, Bromage score and adverse outcomes. All patients were well informed and gave written consent to conduct the study.

The onset of analgesia is defined by one of the following criteria: (1) Patients report of subjective feeling of tingling increasing in intensity with subsequent paresthesia in their lower limps (2) Difference in cold sensation between upper chest and lower limps elicited by the examiner.

Workup

- All blocks in the study were managed by a standard uniformed protocol with strict aseptic technique in the sitting position.
- Patients were sedated during the procedures with iv 0.04mg/kg midazolam (maximum 2mg total).
- The "Perifix®" B braun epidural set was used for all patients participated in the study, {Tuohy beveled needle 18G, 80mm, Perifix® Standard, Soft-Tip catheter 1000 mm, Luer Lock LOR syringe, Pressure resistant epidural-flat filter 0.2 µm L4-L5 interspinous space at the lumbar region at the level of the line joining the two iliac crests (tuffier`s line) was identified, after skin preparation with antiseptic solution time was given to complete dryness then 2ml of 2% lidocaine local anesthetic injected subcutaneously to minimize pain associated with the procedure.
- Filter and catheter primed with local anesthetic solution, Tuohy needle advanced with the plastic stylet inside, for 2 cm then the stylet was removed, the LOR syringes were filled with ether 3ml of air or 3ml of saline according to the patient assignment group, lost air or saline before identification of the epidural space is replaced so that the amount of the fluid/air injected is constant.
- Identification of the epidural space is achieved by advancing the Tuohy needle slowly 1mm by 1mm and checking by application of pressure on the syringe plunger. After identification of the epidural space 1.5% of lidocaine local anesthetic solution with adrenaline (1:200000) installed as a test dose (3ml).
- Catheter threading follows (2-6cm inside the epidural space), and the number of attempts was recorded.
- A local anesthetic dose of 1.5% lidocaine was given in incremental doses until a volume of 1-2 ml per segment is achieved, typically a volume of 10 to 14 ml was used for most of the cases. Follow up Time 30 minutes after the test dose of local anesthetic had been administered.

Visual analogue score (VAS) is used to assess pain in both groups at 30 minutes after taking the standard dose of local anesthetic via the catheter. The VAS consists of a straight line with the endpoints defining extreme limits such as 'no pain at all' and 'pain as bad as it could be'. The patient was asked to mark his pain level on the line between the two endpoints. The distance between 'no pain at all' and the mark then defines the subject's pain.

The adverse outcomes, which is a combination comprises one or more of the following: failed epidural anesthesia, difficult epidural space identification, difficult catheter insertion, asymmetry of the block, inadvertent intravascular catheter and inadvertent intrathecal catheter.

Failed epidural is defined by absence of surgical anesthesia after 30 minutes of giving the maximum dose and volume of local anesthetic, conversion to other mode of anesthesia is necessary to perform the intended surgery or accidental dural puncture. Difficult catheter insertion is defined by abnormal resistance preventing catheter threading inside the epidural space. Difficult epidural space identification is defined by inability to locate the epidural space or more than one attempt needed to locate it, the number of attempts was also recorded. Symmetry of the block was identified by absence of analgesia in one limp by the patient report or by ability to sense a cold object in more than three segments in one inadequately covered side or limp. Inadvertent intravascular catheterization is identified by an increase in heart rate of more than 20% of the baseline after adrenaline containing local anesthetic solution administration (test dose). Inadvertent intrathecal catheterization is identified by immediate (within less than 5 minutes) dense motor and sensory anesthesia after test dose administration (3ml of 1.5% lidocaine).

Statistical analysis: The data analyzed using Statistical Package for Social Sciences (SPSS) version 26. The data presented as mean, standard deviation and ranges. Categorical data presented by frequencies and percentages. Independent t-test (two tailed) was used to compare the continuous variables accordingly. Qui square test (X^2) was used to compare categorical variables accordingly. A level of P – value less than 0.05 was considered significant.

RESULTS

Study patients' age ranged from 20 to 72 years with a mean of 42.9 ± 15.95 years. The knife on skin time was significantly higher in saline group than in air groups (P= 0.001). There were no significant differences (P ≥ 0.05) in age, gender, BMI, onset of block time, Bromage score 30 mints. after start of epidural, and level of pain at induction and after 30 mints between study groups (Table 1).

Table 1: Comparison between study groups by certain characteristics.

Variable	Study group		P- Value
	Air Mean ± SD	Saline Mean ± SD	
Age (Year)	42.6 ± 17.42	43.2 ± 14.78	**0.907**
BMI (kg/m^2)	27.42 ± 6.18	27.38 ± 2.85	**0.977**
Gender (%)	14 (70.0)	18 (90.0)	**0.113**
Onset of block (Mints.)	9.1 ± 2.07	8.4 ± 3.5	**0.446**
Knife on skin time (Mints.)	18.6 ± 2.56	23.7 ± 3.64	**0.001**
Bromage Score (30 Mints. after Start of epidural)	2.3 ± 0.92	2.6 ± 0.5	**0.21**
Pain score at induction	1.2 ± 1.64	1.8 ± 2.14	**0.326**
Pain score after 30 mints	0.2 ± 0.61	0.6 ± 0.94	**0.12**

In this study, 70% of air group and 60% of saline group were graded II by ASA classification. Regarding type of surgery, 70% of patients underwent lower limp orthopedic surgery in air group and 50 % of patients in saline group were underwent skin graft operation. Concerning difficulty in epidural space identification, all patients in the air group showed easy epidural space identification and 60% of patients in the saline group showed difficulty in epidural space identification. About number of attempts, 80% of patients in air group needed one attempt, while 60% of patients in saline group needed two attempts. Regarding difficulty in epidural catheter insertion, the insertion was easy in the highest proportion of patients in air and saline groups (80% and 70% respectively). Concerning the entrance level, the highest proportion of study patients in air group was at level L3/L4 and it was 50% in saline group for both L3/L4 and L4/L5 levels (Table 2).

Table 2: Distribution of the study patients' groups by clinical information.

	Study Groups		Total (%) n= 40
	Air (%) n= 20	Saline (%) n= 20	
ASA			
I	0 (0)	2 (10.0)	2 (5.0)
II	14 (70.0)	12 (60.0)	28 (65.0)
III	6 (30.0)	6 (30.0)	12 (30.0)
Type of surgery			
Lower Limp Orthopedic	14 (70.0)	6 (30.0)	20 (50.0)

Gluteal Abscess	4 (20.0)	0 (0)	4 (10.0)
Inguinal	2 (15.0)	0 (0)	2 (5.0)
Skin Graft	0 (0)	10 (50.0)	10 (25.0)
Diabetic Foot	0 (0)	4 (20.0)	4 (10.0)
Difficulty in epidural space identification			
Yes	4 (20.0)	12 (60.0)	16 (40.0)
No	16 (80.0)	8 (40.0)	24 (60.0)
Number of attempts			
1	16 (80.0)	8 (40.0)	24 (60.0)
2	4 (20.0)	12 (60.0)	16 (40.0)
Difficulty in epidural catheter insertion			
Difficult	4 (20.0)	6 (30.0)	10 (25.0)
Easy	16 (80.0)	14 (70.0)	30 (75.0)
Entrance Level			
L3/L4	16 (80.0)	10 (50.0)	26 (65.0)
L4/L5	4 (20.0)	10 (50.0)	14 (35.0)

We noticed that difficult epidural space identification and two attempts had occurred in 60% of saline group which was significantly higher (P= 0.009) than that in air group (20%) as shown in table (3).

Table 3: Comparison between study groups in difficulty in epidural space identification and number of attempts.

Variable	Study group		Total (%) n= 40	P - Value
	Air (%) n= 20	Saline (%) n= 20		
Difficulty in epidural space identification				
Yes	4 (20.0)	12 (60.0)	16 (40.0)	**0.009**
No	16 (80.0)	8 (40.0)	24 (60.0)	
Number of attempts				
1	16 (80.0)	8 (40.0)	24 (60.0)	**0.009**
2	4 (20.0)	12 (60.0)	16 (40.0)	

DISCUSSION

Epidural anesthesia is a neuraxial technique with a wide range of uses in anesthesia, analgesia and chronic pain management. The loss of resistance technique pioneered by Achille Mario Dogliotti in 1933 is preferred by most anesthesiologists.[14] Using air or saline as a medium has been a matter of debate. However, it is necessary to establish which technique is more effective, reliable and safe than the other. In this study we examined which is the better medium in terms of ease of epidural space identification, onset of sensory and motor block, pain scores and adverse outcomes such as accidental dural puncture, inadvertent intravascular/intrathecal catheterization, and patchy block.

In current study, we didn't find difference between study groups in pain score at induction and after 30 mints. These findings are compatible with Brogly N et al study in 2017 which confirmed that the technique used to locate the epidural space does not influence the overall quality of analgesic block 30 minutes after puncture.[15] Another agreement found in Norman D et al study in 2006 which also came up with the same results.[16] Different findings seen in Beilin Y et al study in 2000 when they suggested that using 0.9% saline for the LOR technique is associated with better analgesia as compared with air for labor analgesia. These results can be explained by the difference in time taken to observe analgesic effect which was significantly shorter (15 mints.), conversely in our study we evaluated local anesthetic effect after 30 minutes. Additionally, Beiling Y used a fixed dose of a different local anesthetic (13 mL of bupivacaine 0.25%) in divided doses for all patients, on the other hand in our study we used 1.5% lidocaine 1-2 ml per segment. After diffusion of air through the cell membrane of the nerve ending, receptor sites would become available for local anesthetic action, air may also act competitively with local anesthetics, as advocated by the authors in case reports.[17]

In this study, we didn't find difference between study groups in terms of onset of sensory and motor block. In the UK, 37% of anesthesiologists were using air as a medium to locate epidural space, while 53% were using saline as their medium of choice for LOR. Among operators with a preference for one medium, use of the preferred technique was associated with fewer attempts, and fewer unintentional dural punctures, however "no significant difference between air and saline when used at the performer preference for detection of epidural space using loss of resistance technique.[18]

Knife on skin time was significantly higher in saline group than that in air group. This can be explained by the increasing incidence of difficult epidural space identification and the number of attempts. Regarding

difficulty in epidural catheter insertion, the insertion was easy in the highest proportion of patients in air and saline groups (80% and 70% respectively). Adverse outcomes like; accidental intravascular, intrathecal catheter insertion, accidental dural puncture, unilateral block was not encountered in this study. One case of epidural failure due to patchy block, however, was confronted and the patient was transformed into a different mode of anesthesia (general anesthesia). The case was excluded from our statistical evaluation due to my inability to collect the remaining information.

In conclusion, our study found better outcomes using air as a medium in LOR technique in locating epidural space with fewer attempts, however no difference was found between air or saline with respect to anesthetic effect or onset of action of motor and sensory block, however, this study was limited by the number of participants and the populations being investigated; further studies are recommended.

CONCLUSION

Our study was Performed on patients of non-pregnant population found better outcomes using air as a medium in loss of resistance technique in locating epidural space with fewer attempts, however no difference was found between air or saline with respect to anesthetic effect or onset of action of motor and sensory block, however This study was limited by the number of participants and the populations being investigated; further studies are recommended.

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