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ORIGINAL RESEARCH ARTICLE

# Pre Procedural Ultrasound Scan as an Adjunct to Blind Conventional Technique for Lumbar Epidural Neuraxial Blockade in Obese Patients Undergoing Abdomen and Lower Limb Surgery: Randomised Controlled Study

**[1]Dr. Veereshkumar Gobburkar, [2]Dr. Mithali V, [3]Dr.Shilpa H. L, [4]Dr. Rameshkumar P B, [5]Dr. Parakash L Kotre**

[1]Junior Resident, Department of Anesthesiology, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India.

[2]Assistant Professor, Department of Anesthesiology, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India.

[3]Professor, Department of Anesthesiology, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India.

[4]Head of Department, Department of Anesthesiology, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India.

[5]Consultant Anesthesiologist, Department of Anesthesiology, Nisarga Multi-Speciality Hospital, Raibag, Karnataka, India.

**Corresponding Author**

Dr. Veereshkumar Gobburkar, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India.

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## ABSTRACT

### BACKGROUND

Ultrasound guidance has revolutionized regional anaesthesia. Ultrasound facilitate the accurate identification of the inter vertebral level and helps in predicting epidural depth in lumbar epidural in obese individuals. Ultrasonography helps in identification of epidural space and helps in measuring epidural space depth.

### AIMS AND OBJECTIVES

To compare the efficacy of use of pre procedural ultrasound scan with the conventional blind technique for lumbar epidural neuraxial blockade in terms of technical difficulties and safety. Secondary objective is to correlate the ultrasound estimated depth of the epidural space with actual epidural depth.

### MATERIALS AND METHODS

After ethical committee approval and informed written consent, this prospective randomized controlled study was done on 100 patients belonging to ASA category 1 to 3 undergoing elective lower abdomen and lower limb surgeries under lumbar epidural blockade, between the age of 18

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to 70 years with BMI more than 30kg/$m^2$. Then the patients were randomised either to group A or group B.

Group A (n=50) Anatomical surface landmark group.

Group B (n=50) Ultrasound scan group.

The number of attempts, passes, the number of anaesthesiologists required to complete the procedure, duration of the procedure, complications were noted in both groups. Ultrasound depth of the epidural space and the actual needle depth of same space was measured and noted in ultrasound group (group B).

**RESULTS**

The number of attempts (p=0.0277), passes required (P=0.030) and the duration of the procedure (p ≤0.001) were less in the ultrasound group. The difference between two groups was statistically significant. Complications (p=0.494) were less in ultrasound group which was statistically insignificant. The measured ultrasound depth of the epidural space was lesser than actual needle depth in ultrasound group.

**CONCLUSION**

The use of preprocedural ultrasound increased the first pass success rate and decrease the incidence of complications without increase in procedural time in patients undergoing abdomen and lower limb surgeries.

**KEY WORDS**

Pre Procedural Lumbar Ultrasound Scan, Obesity, Technical Difficulty.

## INTRODUCTION

Epidural anaesthesia or analgesia is a widely employed regional technique during the perioperative period, with its success hinging on the precise identification of the epidural space. [1] Traditionally, practitioners use palpation of bony landmarks, such as the iliac crest and spinous processes, along with tactile feedback during needle insertion is a traditional method of performing a Central Neuraxial Blockade. However, these anatomical references can be challenging to locate in patients with altered anatomy, including those who are obese, age related changes, or have had prior spinal surgeries.[2]

Obesity is a growing global epidemic, presenting numerous comorbidities that necessitate careful anaesthetic management. Regarding anaesthesia management in obese individual proper prior planning is required .Regional anaesthesia, particularly epidural anaesthesia, is increasingly favored for high BMI patients who may have anticipated difficult airways.[3] The World Health Organization(WHO) estimates that there are 1.6 billion overweight individuals and 400 million obese adults, classifying obesity based on BMI (BMI = weight in kg / height in $m^2$).[4]

Despite the advantages of regional anaesthesia over general anaesthesia, increased amount of subcutaneous adipose tissue can complicate the procedure. Challenges leading to failed epidural anaesthesia include difficulties in guiding the needle through the interspinous ligament, misidentifying the epidural space due to fat, and issues related to needle advancement, ligament calcification, or catheter malposition. Complications such as post-dural puncture headache (PDPH), unintended dural or subdural puncture, and epidural hematoma are also concerns, with PDPH contributing to longer hospital stays.[4]

The prevalence of obesity continues to rise globally, with projections suggesting that by 2025, obesity rates will reach 18% in men and over 21% in women. Furthermore,Obesity significantly (depending on the degree, duration, and the distribution of the excess weight/ adipose tissue) can exacerbates a range of health issues, including type 2 diabetes, hypertension (HTN), cardiovascular diseases, and increase the risk of certain types of cancers.[5]

Ultrasound guidance has transformed regional anaesthesia, particularly in peripheral nerve blocks, but its application in neuraxial blockade remains limited.[6] The challenges of using ultrasound on the adult spine and the efficacy of traditional landmark techniques have hindered its broader adoption. Nonetheless, ultrasound can accurately locate intervertebral levels and measure the depth of the epidural space, which may help reduce accidental dural punctures.[7] In January 2008, the National Institute for Health and Clinical Excellence (NICE) recommended the use of ultrasound to aid in catheterizing the epidural space.[8] Pre-procedural ultrasound is now increasingly utilized for patients undergoing abdominal and lower limb surgeries with a BMI over 30 kg/m².

## MATERIALS AND METHODS

### Source of Data

Patients scheduled for abdominal and lower limb surgeries at BGS Global Institute of Medical Sciences, Bangalore

**Methods of Data Collection Study Design**:
Randomized controlled trial.

**Study Period** 18 months.

**Place of Study** patient undergoing abdominal and lower limb surgeries at the BGS GLOBAL INSTITUTE OF MEDICAL SCIENCES, Bangalore.

### Sample Size

For an outcome variables total complications in proportion for a two group clinical randomized study derived from previous literature, with minimum difference of proportion of 6.0%, 90% statistical power, and 5% level of significance, the sample size of 100 (50 in each group) is adequate.

### Inclusion Criteria

- Participants with ASA grade I to III
- The body mass index more than 30 kg/m2
- Age 18 to 70 years
- Patients who are willing to give consent. (ANNEXURE 1).

**Exclusion Criteria**

- Patients on anticoagulants, spinal trauma and previous spine surgery, local edema, neurological diseases.
- History of neurological diseases.

**Procedure**

The study, approved by the ethical committee, study conducted from March 2021 to October 2022, focusing on patients belonging to age 18 to 70 years with a Body Mass Index(BMI) over 30 $kg/m^2$, patient belonging to American Society of Anaesthesiologists category 1 to 3 undergoing elective abdominal and lower limb surgeries. Participants were screened for eligibility and provided informed consent.

Patients with contraindications for central neuraxial blockade and hypersensitivity to local anaesthetics were excluded.

After confirming the nil per oral status participants were taken to operating theatre, which was prepared with emergency drugs and equipment's, intravenous lines were secured and standard ASA monitors including pulse oximeter, NIBP(non invasive blood pressure), and ECG( electrocardiography) were connected.

Patients were randomly assigned to two groups: the ultrasound group (Group B), which received a pre-procedural ultrasound scan to guide epidural placement, and the control group (Group A), which used traditional landmark techniques.

In control group (Group A), the landmark used was Triffier's line and conformation of epidural space done by Loss of Resistance (LOR) to air.

In the ultrasound group (Group B), the L3–L4 space was identified using a curvilinear probe, and the depth of the epidural space was measured. The needle insertion site was marked based on ultrasound imaging, followed by local anaesthesia (2ml 2% lignocaine with adrenaline) before inserting the Touhys Needle (18G).

The term 'attempts' referes to the process inserting a Needle into patients skin followed by completely removing the needle from the patients skin, 'passes' refers to either needle insertion or redirection attempts.

Identifying the epidural space by Loss of Resistance (LOR) technique .The Touhy's Needle was marked at the level of skin.

Both groups recorded the number of needle insertion attempts, passes, and time taken to complete the procedure, as well as any adverse effects like accidental dural puncture.

**Statically Analysis**

Chi square test, Fisher exact test, student t test or any other suitable method at the time of data analysis.

**RESULTS**

| Variables | Group A | Group B | Total | P Value |
|---|---|---|---|---|

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| | | | | |
|---|---|---|---|---|
| BMI | 32.39±1.19 | 33.1±2.07 | 32.74±1.71 | 0.47 |

***Table 1: Mean BMI***

Mean BMI among the two groups were compared as shown in the below graph and the table. The differences between two groups were statistically insignificant.

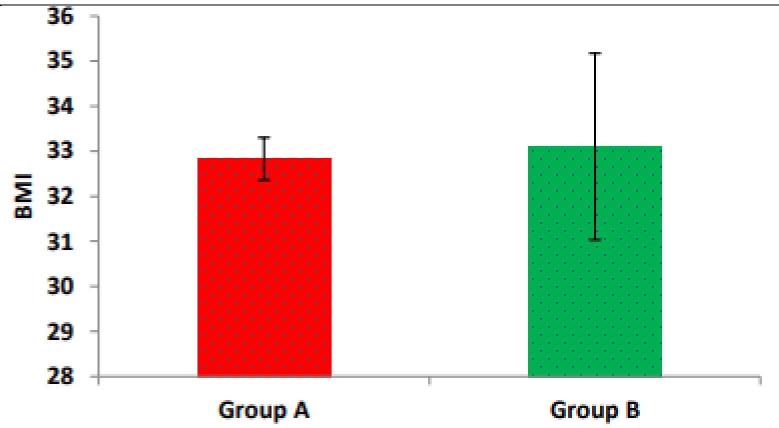


***Figure 1: Mean BMI***

| Exp. of Anaesthesiologist (Yrs) | Group A | Group B | Total |
|---|---|---|---|
| 3-6 | 15(30%) | 20(40%) | 35(35%) |
| 7-12 | 35(70%) | 29(58%) | 64(64%) |
| >12 | 0(0%) | 1(2%) | 1(1%) |
| Total | 50(100%) | 50(100%) | 100(100%) |
| Mean ± SD | 7.48±1.61 | 7.04±2.38 | 7.26±2.03 |

***Table 2: Exp. of Anaesthesiologist (Yrs)- Frequency Distribution in Two Groups of Patients Studied***

P=0.283, Not Significant, Student t Test

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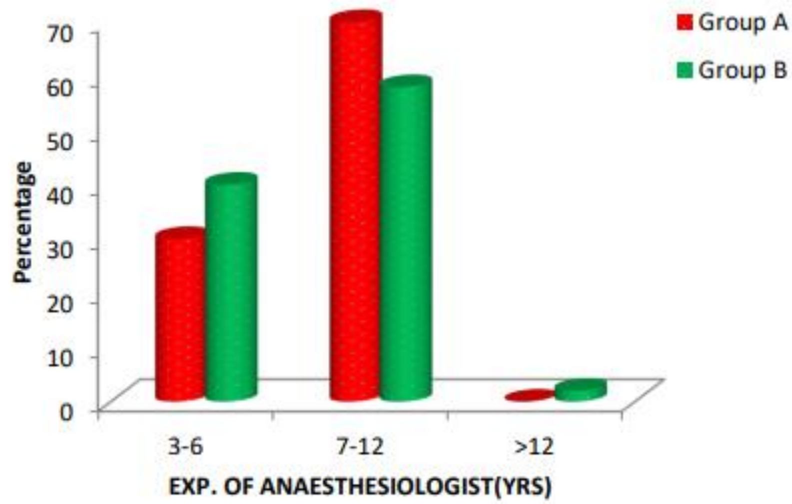


*Figure 2: Exp. of Anaesthesiologist (Yrs)*

| Number of Anaesthesiologist | Group A | Group B | Total |
|---|---|---|---|
| 1 | 47(94%) | 49(98%) | 96(96%) |
| 2 | 3(6%) | 1(2%) | 4(4%) |
| Total | 50(100%) | 50(100%) | 100(100%) |

*Table 3: Number of Anaesthesiologist- Frequency Distribution in Two Groups*

P=0.617, Not Significant, Fisher Exact Test

In group A, in 94% of the patients the epidural space was identified by a single anaesthesiologist. In 6% of the patients, assistance of the second anaesthesiologist was needed. In group B the second anaesthesiologist was required only in 2% of the patients. The differences between the two groups was found to be insignificant. (P=0.617)

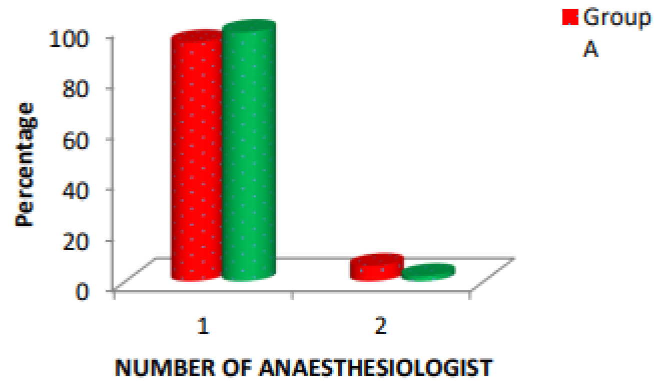


*Figure 3: Number of Anaesthesiologists*

The frequency distribution of anaesthesiologist based on experience is as shown in the table above and the graph below. The statistical analysis showed their difference among the two to be insignificant (P=0.283)

| Complications | Group A | Group B | Total |
|---|---|---|---|
| DP(Dural Puncture) | 2(4%) | 0(0%) | 2(2%) |
| N(No complications) | 48(96%) | 50(100%) | 98(98%) |
| Total | 50(100%) | 50(100%) | 100(100%) |

*Table 4: Complications- Frequency Distribution in Two Groups of Patients Cohort Studied*

In group A incidence of accidental dural puncture was 4%. No incidence of dural puncture in group B. The difference among the two groups was found to be insignificant. (p=0.494)

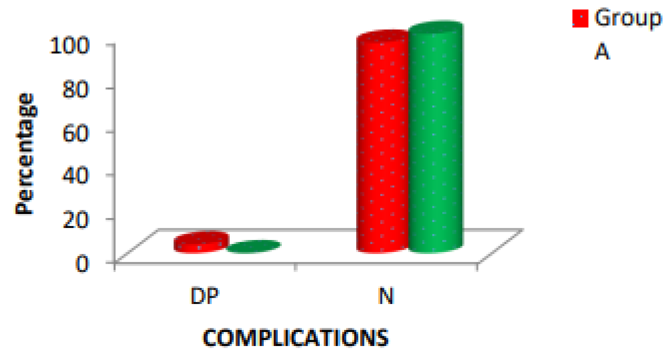


*Figure 4: Incidence of Complications*

| Duration of the Procedure (Min) | Group A | Group B | Total |
|---|---|---|---|
| 6-12 | 10(20%) | 47(94%) | 57(57%) |

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| | | | |
|---|---|---|---|
| 13-18 | 38(76%) | 3(6%) | 41(41%) |
| >20 | 2(4%) | 0(0%) | 2(2%) |
| Total | 50(100%) | 50(100%) | 100(100%) |

***Table 5: Duration of the Procedure (Min)- Frequency Distribution in Two Groups of Patients***

P≤0.001**, Significant, Fisher Exact Test

In group A the mean time for procedure was 13.86 minutes with a standard deviation of 1.76 minutes. In group B the mean time for procedure was 9.04 minutes with a standard deviation of 2.19 minutes. The difference in between both the groups with regards to time of the procedure was found to be statistically significant (p value ≤0.001)

| Variables | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|
| Ultrasound Depth (MM) | 46.000 | 65.000 | 50.818 | 3.700 |
| Needle Depth (MM) | 46.000 | 65.300 | 51.258 | 3.826 |

***Table 6 : Descriptive Statistics***

In group B the mean pre procedural ultrasound epidural space depth measured was 50.818mm with standard deviation 3.700mm. The actual needle depth measured was 51.258 mm with standard deviation of 3.826 mm. the measured ultrasound epidural space depth was less than the actual needle depth.

## DISCUSSION

The introduction of ultrasound imaging in regional anaesthesia has marked a significant advancement, particularly in lumbar epidural neuraxial blockade. Our study compared the technical difficulty and safety of pre-procedural ultrasound scans against conventional blind techniques.

Previous studies have demonstrated to be helpful in a number of ways, including localising the proper interspace[9-12] decreasing the risk of traumatic puncture,[13] and minimising the number of needle insertions and the procedure's overall duration.[14-15] In the current study, we are comparing the technical difficulty, and safety of using a routine pre-procedural ultrasound scan with a conventional blind technique for lumbar epidural neuraxial blockade, as well as the accuracy of the ultrasound-estimated depth of the epidural space.

The demographic characteristics, including age, weight, height, and BMI, were comparable between the groups, indicating no significant statistically differences.

We found that in Group A (blind technique), the epidural space was successfully identified on the first attempt in 80% of patients, compared to 96% in Group B (ultrasound-guided). The difference in first-attempt success rates was statistically significant (P=0.0277), corroborating findings from previous studies showing reduced puncture attempts and improved success rates with ultrasound guidance.

In terms of procedure attempts, In the study conducted by Tanya Mital et al[16] more number of passes were required in the landmark group, in our study 94% of Group B required only one

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pass to locate the epidural space, compared to 74% in Group A, with no complications such as dural punctures observed in the ultrasound Group . This aligns with prior research demonstrating similar improvements in technical outcomes, the results compared with study conducted by kompal Jain et[17] regarding dural puncture.

In Group A, the epidural space was identified by one Anaesthesiologists in 94% of the patients and second Anaesthesiologists was required in 6% of the patients whereas in Group B, only 2% of the patients required for the second Anaesthesiologists . The difference between the two groups was found to be insignificant (P= 0.677). The results were similar to study conducted by Kompal Jain et al[17] but in contrast to the results Wang et at [18] when the successful insertion rate was 100% by single Anaesthesiologists.

The mean procedure time was significantly shorter for the ultrasound group (9.04 minutes) compared to the blind technique (13.86 minutes, $P \leq 0.001$). This efficiency reflects the benefits of using ultrasound to accurately assess anatomical landmarks. The study conducted by Tulay Sahin et al[19] showed that less time is required to insert the catheter in ultrasound group.

We also assessed the accuracy of ultrasound in estimating the depth of the epidural space, finding a mean difference of 0.44 mm between ultrasound estimates and actual needle depth. The slight discrepancy could be attributed to variations in ultrasound beam trajectories or tissue compression.

Notably, our study did not evaluate the effectiveness of real-time ultrasound guidance, nor did it include obstetric patients, which may limit the generalizability of our findings.

## CONCLUSION

In the study, the use of pre procedural ultrasonography in obese patients reduced both the number of attempts and passes required to identify the epidural space. The difference between the two groups in terms of number of attempts and passes required were statistically significant and we conclude that ultrasound helps in correct identification of the epidural space. It significantly reduces the technical difficulty, duration of the procedure complications.

We conclude that the use of preprocedural ultrasound scan in obese patients undergoing abdomen and lower limb surgeries increased the first pass success rate and decreased the incidence of complications without an increase in procedural time.

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