# High Success Rates Using Ultrasound for Neuraxial Block in Obese Patients

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**ABSTRACT:** **Background:** Successful neuraxial block performance relies on assessment and palpation of surface landmarks, potentially challenging in patients with a high body mass index (BMI).

**Objectives:** To evaluate the use of ultrasound-assisted neuraxial bock in a non-obstetric population with BMI above versus below 30 kg/m$^2$.

**Methods:** Healthy adult patients undergoing extracorporeal shock wave lithotripsy (ESWL) under neuraxial block were observed in this quality assurance study. Prior to the neuraxial block, an ultrasound examination was performed to identify the puncture site. Neuraxial anesthesia block was performed under aseptic surgical conditions with the patient in the sitting position. Following block placement, external landmarks were palpated. Our primary study outcome was the number of attempts (skin insertions with the needle) after pre-puncture ultrasound identification of the insertion point, comparing patients with BMI above versus below 30 kg/m$^2$. Our secondary outcome was assessment by palpation of external anatomical landmarks.

**Results:** Our study group included 63 consecutive patients undergoing neuraxial block for ESWL. Data were assessed according to BMI (above versus below 30 kg/m$^2$). An overall success rate at the first attempt of 90.5% (CI 0.8–0.95) was achieved using ultrasound-guided neuraxial block. This block placement success rate was similar for all patients, regardless of BMI above versus below 30 kg/m$^2$. In contrast, the ease of palpation of anatomic landmarks, $P = 0.001$, and the ease of palpation of iliac crest, $P < 0.001$, differed significantly between the patients above versus below 30 kg/m$^2$. The reported verbal pain scores (VPS) due to block insertion was similar among all patients regardless of BMI category (above versus below 30 kg/m$^2$).

**Conclusions:** We observed high success rates when ultrasound-assisted neuraxial block is performed, regardless of BMI above versus below 30 kg/m$^2$, despite expected differences in surface landmark palpation.

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**KEY WORDS:** ultrasound, epidural, obesity, neuraxial anesthesia, body mass index (BMI)

Successful neuraxial analgesia/anesthesia minimizes postoperative complications and provides optimal postoperative pain relief [1,2]. As such, neuraxial block is a frequently used peri-operative management tool [3].

The failure rate of neuraxial block due to incorrect identification of epidural space in the obstetric population ranges between 6% and 25% [4,5]. Neuraxial block for acute postoperative analgesia may suffer a failure rate as high as 30–50% [6,7]. Placement of the neuraxial block relies on precise assessment of the surface anatomy. Optimization of patient position and meticulous assessment of the anatomic landmarks may improve success rates [8]. Ideally, the first attempt should be successful since repeated attempts increase the complication rate [9].

Obesity is associated with neuraxial block failure [10]. This population benefits from adequate neuraxial block, due to the high prevalence of co-morbidities that can present from an early age [11]. Ultrasound is a tool described to aid neuraxial block placement, but reports of its use are mostly limited to the obstetric population [12].

Our prospective quality assurance study reports ultrasound-assisted neuraxial block. We compare patients with body mass index (BMI) above and below 30 kg/m$^2$ in a consecutive sample of obese adult patients.

## PATIENTS AND METHODS

This observational non-interventional study was performed in the extracorporeal shock wave lithotripsy (ESWL) unit at the Hadassah Medical Center, a single-site tertiary referral medical facility. Ethical approval for this quality assurance project was received (1-20/05/01), waiving requirement for patient consent.

We observed consecutive patients during the quality assurance period (men and women) who were anesthetized by one anesthesiologist (F.S.). Patients were scheduled for ESWL under neuraxial block, were ASA physical status I-III and were over 18 years old. Patients with the following conditions were not candidates for neuraxial block and are therefore not represented in the cohort: coagulopathy, thrombocytopenia, previous spine surgery or trauma, suspected or known neurological disease or anatomic malformation of neuraxial structures, or on anticoagulation drugs.

Patients were monitored in the ESWL unit with standard monitoring (electrocardiography, non-invasive blood pressure, pulse oximeter) prior to performance of the neuraxial block. All patients had intravenous access inserted and received a pre-load of 1 L Ringer's lactate solution. We prepared standard resuscitation drugs and equipment for use if required. The patient sat on the hospital gurney during block placement. Prior to the neuraxial block, an ultrasound examination was performed using a Sonosite Titan (USA) 2-5 MHz curved ultrasound probe. Two ultrasound images were identified: the longitudinal paramedian view and the transverse view [13]. A longitudinal paramedian scan was done to mark the interspace level; we mostly used the L3-L4 interspace. We then performed a transverse scan to identify the midline and the interspace optimum entry site. A transection line between the midline and the interspace was made and the entry point marked using the hub of a 22 g needle cap.

Neuraxial anesthesia was performed under aseptic surgical conditions with the patient in the sitting position. Following infiltration of the skin with 1% lidocaine, an epidural needle (Tuohy 18G, Braun, Germany) was inserted using the loss-of-resistance-to-air technique. A closed tip, multi-orifice catheter was advanced 4–5 cm into the epidural space. Initially a test dose of lidocaine 1% 5 ml was given through the catheter, followed 5 minutes later with the main dose (bupivacaine 0.25% 10–13 ml and fentanyl 25 μg) administered in increments until adequate sensory block was achieved. Once the neuraxial block was placed, the patient's back was palpated to identify external landmarks. The ease of palpation of the surface anatomy, spinous process and posterior superior iliac spine were documented.

Our primary study outcome was the number of attempts (new needle skin insertions) after pre-puncture ultrasound identification of the insertion point, comparing patients with BMI above and below 30 kg/m$^2$. We also recorded redirection (changing direction of the needle without further skin puncture), reinsertion (multiple skin punctures at the same level), and change of level [14].

Our secondary outcome was assessment by palpating external anatomic landmarks (spinous process and posterior superior iliac spine). We classified these as good or poor depending on whether the anatomic landmarks were palpable or not. The following patient characteristics were recorded: age, height, weight, and BMI.

Subjective patient pain during the epidural needle insertion was assessed by asking the patient how painful the procedure was on an 11-point verbal pain scale (VPS), 0–10 (0 = no pain and 10 = maximum pain).

### STATISTICAL ANALYSIS

Patients were analyzed in two groups according to the BMI: either BMI ≤ 30 or > 30 kg/m$^2$. Data were analyzed using IBM SPSS version 21.0.0 for Windows (IBM Corp. Armonk, NY, USA). Demographic data and baseline clinical characteristics were tabulated and compared between the two study groups. Continuous data parametric data are represented by mean and standard deviation and measured by means of *t*-tests. Non-parametric equivalents were noted and measured with the Mann-Whitney U test. Categorical data are presented as numbers and percentages and compared using the chi-square test or Fisher's exact test. $P < 0.05$ was considered significant and nominal *P* values were noted.

**Table 1.** Patient characteristics

| | BMI ≤ 30 kg/m$^2$ (N=37) | BMI > 30 kg/m$^2$ (N=26) | *P* value |
|---|---|---|---|
| Age (years) (mean ± SD)§ | 48.2 ± 14.3 | 47.5 ± 13.8 | 0.55 |
| Weight (kg) (mean ± SD)§ | 74.5 ± 9.9 | 101.7 ± 12.1 | 0.11 |
| Height (cm) (mean ± SD)§ | 170.8 ± 7.9 | 170.7 ± 8.4 | 0.93 |
| BMI kg/m$^2$ (mean ± SD)§ | 25.5 ± 2.6 | 35.0 ± 4.0 | 0.008* |
| ASA status median (IQR)‡ | 1 (1–2) | 2 (1–2) | 0.23 |

§Student *t*-test
‡Mann-Whitney U test
*$P < 0.05$
BMI = body mass index, ASA = American Society of Anesthesiologists

## RESULTS

Sixty-three patients were assessed from November 2009 to February 2010 in our ESWL unit. BMI was ≤ 30 kg/m$^2$ in 37 patients and > 30 kg/m$^2$ in 26. Patient characteristics were similar in both groups except for weight and BMI [Table 1]. An overall success rate of 90.5% at the first attempt (CI 0.8–0.95) was achieved with the use of ultrasound-guided neuraxial block. This success rate was similar for patients with a BMI above and below 30 kg/m$^2$, $P = 0.32$ [Table 2]. There was no difference in the number of attempts (1.2 ± 0.7 BMI ≤ 30 kg/m$^2$, 1.1 ± 0.7 BMI > 30 kg/m$^2$, $P = 0.818$) between the two groups. The reported pain measured by a verbal pain score was similar among patients with BMI above and below 30 kg/m$^2$ (2.9 ± 1.8 vs. 2.8 ± 1.2, $P = 0.96$].

The ease of palpation of anatomic landmarks differed; palpation was significantly more difficult in patients with a BMI > 30 kg/m$^2$. Palpation of the spinous process was easy for 28 of 37 (75.6%) in the BMI ≤ 30 kg/m$^2$ group versus 7 of 18 (38.9%) in the higher BMI group ($P = 0.001$). Palpation of the iliac crest was easy for 29/37 (78.3%) in the BMI ≤ 30 kg/m$^2$ group vs. 4/21 (19%) in the higher BMI group, $P < 0.001$ [Table 3].

## DISCUSSION

In our observational study of ultrasound-assisted neuraxial block, we found a comparable overall success rate for ultra-

**Table 2.** Epidural insertion outcomes according to BMI groups

| | BMI ≤ 30 kg/m2 (N=37) | BMI > 30 kg/m2 (N=26) | *P* value |
|---|---|---|---|
| Time for epidural (min) (mean ± SD)§ | 6.7 ± 4.6 | 7.1 ± 4.0 | 0.72 |
| Time for ultrasound (min) (mean ± SD)§ | 2.3 ± 1.1 | 2.8 ± 2.4 | 0.29 |
| No. of attempts, n (mean ± SD)§ | 1.2 ± 0.7 | 1.1 ± 0.7 | 0.82 |
| No redirections, n median (IQR)‡ | 1 (0–1) | 0 (0) | 0.31 |
| No reinsertions, n median (IQR)‡ | 0 (0) | 0 (0) | 0.74 |
| No level changes median (IQR)‡ | 0 (0) | 0 (0) | 0.34 |
| Pain during procedure (mean ± SD)§ | 2.9 ± 1.8 | 2.8 ± 1.2 | 0.96 |
| Needle depth (mean ± SD)§ | 4.7 ± 0.9 | 6.2 ± 1.4 | < 0.0001* |

§Student *t*-test
‡Mann-Whitney U test
**P* < 0.05
BMI = body mass index, IQR = interquartile range

**Table 3.** Anatomic landmark palpation according to BMI groups

| | BMI ≤ 30 kg/m2 (N=37) | BMI > 30 kg/m2 (N=26) | *P* value |
|---|---|---|---|
| Spinous processes palpable, n (%)§ | 28/37 (%) | 7/18 | 0.001* |
| Iliac crests palpable n (%)§ | 29/37 | 4/21 | < 0.0001* |

§Chi square
**P* < 0.05

sound-assisted neuraxial anesthesia block regardless of BMI above versus below 30 kg/m2.

In the adult population, reports of ultrasound-assisted neuraxial block have been limited to specific subgroups considered "difficult," or to case reports [7,12,14]. A recent meta-analysis observed that many prior studies were underpowered to draw meaningful conclusions [12]. We are aware of one small randomized control trial that reported ultrasound-guided neuraxial blocks in the general adult population in contrast to specific subgroups [15]. Unlike the studies looking at specific subgroups of the population, we did not find any significant difference between BMI above versus below 30 kg/m2 when ultrasound was used to identify insertion site. Hood and Derwan [16] reported an initial success rate of 42% when neuraxial block was performed for obese patients, versus an initial 94% success rate in a non-obese population. An observational study using ultrasound-assisted spinal anesthesia in orthopedic patients showed a first-attempt success rate of 86% in those with BMI ≤ 30 kg/m2 and 79% in those with BMI > 30 kg/m2 [14] . Ultrasound has been previously reported to improve neuraxial block success when landmark palpation is difficult. Patients with difficult palpation anatomy were randomized to receive neuraxial block either by palpation or ultrasound and the overall success rate was higher (65%) with ultrasound vs. 32% when surface landmarks alone were used. Such was the significance of these results ($P < 0.001$) that the study was terminated prematurely [7].

Our findings demonstrated an overall first-attempt success rate of 90.5%, which is higher than previous reports [7,8,13-15]. Our success rate was higher than those cited in studies reporting manual palpation alone, regardless of body habitus [7,12,14,15]. As with other studies, we required minimal needle redirections or changes of insertion level when ultrasound was used. With ultrasound assistance for neuraxial block placement there was no difference in success rate between the obese and non-obese population (1.1 ± 0.7 BMI > 30 kg/m2 vs. 1.2 ± 0.7 BMI ≤ 30 kg/m2, $P = 0.82$). This demonstrates the usefulness of ultrasound as a guide for placing neuraxial blocks for anesthesia in the general population and particularly in obese patients regardless of surface landmarks.

Neuraxial block success rate is generally assumed to be higher in the obstetric population and more challenging in the elderly (> 65 years) or those presenting for orthopedic procedures [7,17-19]. Previous studies, however, have shown that ultrasound-assisted neuraxial block is more successful than palpation-only techniques in the elderly population [7]. Age may be a factor in neuraxial block success. In our population, the mean age was 48 years and the elderly population (> 65 years) was too small for analyzing effects in this group. Thus, our results should be interpreted with caution for the elderly. In the obstetric population, use of ultrasound-assisted neuraxial block reduces the number of attempts needed to perform the procedure and the number of insertion level changes required. Furthermore, complication rates are lower and patient satisfaction higher when ultrasound is used [20]. The use of ultrasound to assist neuraxial block placement increases the initial procedural success rate when performed by a junior trainee and facilitates reaching a competent skill level earlier [6,21].

Ultrasound is a useful guide for neuraxial block placement; however, proficiency requires suitable equipment and training, and the estimated learning curve is 55–60 ultrasound-guided blocks [22]. Assessment of the ultrasound image involves accurate interpretation to identify the neuraxial block insertion point. Similar to our current study, previous studies utilized an experienced operator to mark the neuraxial block insertion point [6,7]. Our single experienced practitioner performed both the ultrasound scan and epidural insertion, and this may have reduced inter-user variability in the interpretation of images. Other potential problems with ultrasound-guided neuraxial block include limited images due to bony structures, changes in patient position after marking the insertion site, and movement of the skin during insertion [13]. The safety of ultrasound gel with regard to neurotoxicity has yet to be established and this has potential implications when attempting to perform neuraxial anesthesia under real-time imaging.

This was an observational study at a single-center performed by a single practitioner. The replicability of our data is limited; however, there is an advantage to a single-practitioner using a homogenous technique. Even with the strictest selection criteria for a randomized control trial, diverse practice introduces inherent differences in technique and skill level [23]. One pilot study of nearly 500 patients suggested that it would be extremely difficult to devise a large randomized control trial to assess the effects of neuraxial block, citing low recruitment rates and reluctance by patients to be subjected to invasive procedures as potential reasons [24]. Most prior studies reported a single ultrasound practitioner and attributed the neuraxial block success rates to the single-practitioner ultrasound [6]. There is some evidence that a well-designed observational study produces results that are analogous to randomized control trials or meta-analysis [23,25]. Bias could be introduced as the data were recorded by the practitioner. However, since our study hypothesis was drawn subsequent to the data recordings, at the time the data were colleced the study hypothesis did not exist. We can exclude selection bias since a consecutive population was observed. Because this is an observational study our results are likely to reflect everyday clinical practice, with the accompanying routine daily work pressures and patient variability [25]. Our findings should be confirmed by other practitioners in other settings in the adult non-obstetric population.

## CONCLUSIONS

This observational quality assurance study demonstrates high success rates when ultrasound-assisted neuraxial block is performed, despite significant differences in surface landmark palpations according to BMI. We suggest that for practitioners familiar with ultrasound-guided neuraxial block, ultrasound may be a useful adjunct to achieve high neuraxial block success rates in the non-obstetric population with BMI > 30 kg/m$^2$.

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**"You have not converted a man because you have silenced him"**

John Morley (1838-1923), British statesman, writer and newspaper editor