The Egyptian Journal of Hospital Medicine (July 2021) Vol. 84, Page 2060-2064

Preprocedure Ultrasound-Guided Midline Spinal Anaesthesia versus Conventional Landmarks Technique: Efficacy and Safety

Mohamed Anwer Rifky[1], Mohamed Mowafy Khattab[1], Ayman Fathy Zeid[2], Ahmed Sobhy Hegab[1], Basmah Ahmed Abdelrahman Alrobaa*[1]

Departments and [1]Anaesthesia and Surgical Intensive Care and [2]Radiodiagnosis, Faculty of Medicine, Zagazig University, Egypt.

***Corresponding Author:** Basmah Ahmed Abdelrahman, **Mobile:** (+20) 01060640084, **E-mail:** basma.robaa@gmail.com

ABSTRACT

Background: Comparison between spinal anaesthesia with conventional land mark (blind) technique and with preprocedural ultrasonographic guidance technique. Ultrasound (US) can be used effectively and accurately to identify the anatomical landmarks of neuraxial blockade, in order to improve the safety and efficacy of spinal anaesthesia.

Objective: To assess the effectiveness and safety of US to improve the technique of spinal anaesthesia, and decrease it's complications in comparison to the conventional landmarks technique.

Patients and Methods: The study was performed in Zagazig University Hospital. Hundred and four ASA classes I and II adult cooperative patients of both sexes were scheduled for surgery in the lower part of the body under neuraxial blockade. They were randomly allocated into two equal groups, preprocedure ultrasonography guided spinal anaesthesia (PS) group, and conventional landmark group (CL).

Results: It was found that there was a statistically significant difference between PS and CL groups regarding the number of attempts, number of needle pass (bone hitting), successful dural puncture after the first attempt, and total time for technique performance.

Conclusion: ultrasound guidance improves the success rate of midline spinal anaesthesia. It reduces the number of attempts required, improves the success rate of a single needle pass, and shortens the time to dural puncture. Further trials can be done to establish the role of ultrasound-guided neuraxial block among high-risk groups, such as obese, elderly, and patients with spinal deformity.

Keywords: Spinal anaesthesia landmark technique, Ultrasound.

INTRODUCTION

Spinal anaesthesia is widely performed using a surface landmark-based technique "blind technique". Thus, multiple passes and attempts while administering spinal anaesthesia are associated with many complications [(1)]**.** Failure of spinal anaesthesia, cardiovascular side effects like hypotension and bradycardia, nausea and vomiting are often associated with hypotension, disturbances of micturition**,** transient neurologic symptoms, dysesthesia, and lastly, postdural puncture headache (PDPH) can be considered as the most common side effects [(2)].

The use of preprocedural ultrasound (US) has been shown to increase the first pass success rate for spinal anaesthesia compared with a conventional landmark based midline approach [(3,4)]**.** It provides preprocedure scanning of anatomical structures as location of neuraxial midline, interlaminar space, ligamentum flavum (FL), dura mater (D), and posterior vertebral body (PVB). Ultrasound can estimate the depth from the skin to intrathecal space, allowing selection of needle length. Also, it may prevent a lot of side effects.

In addition, it can identify the intervertebral levels by counting spinous processes or laminae**.** It will be most helpful in patients with poor or abnormal anatomical landmarks, as in obesity, previous spinal surgery and spinal deformity [(5,6)]**.** US is a useful preoperative assessment tool for assessing the feasibility of central neuraxial blockade when technical difficulty is anticipated [(7)]**.The aim of this study** was to assess the effectiveness and safety of US to improve the technique of spinal anaesthesia, and decrease it's complications in comparison to the conventional landmarks technique.

PATIENTS AND METHODS

This comparative prospective study was performed in surgical operation rooms of Zagazig University Hospitals, in Egypt. Sample size was taken as number of attempts in patients who assessed with conventional landmarks (group CL); 1.98 (1.66), and in patients who assessed with preprocedure ultrasound (group PS); 1.28 (0.7). At 80 % power and 95 % confidence interval (CI), the estimated sample size will be 52 patients in each group (Open EPI programs).

In this study, 104 patients were allocated randomly into two groups: preprocedural US guided technique (PS) (n=52), and conventional landmark group (CL) (n=52). Two patients from PS group refused to participate, and two other patients from CL group had failed spinal anaesthesia.

Received:12 /4 /2021
Accepted:8 /6 /2021

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study, and also for general anaesthesia in case of failed spinal anaesthesia. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria:

- ASA classification I and II whom underwent elective surgery in the lower part of the body as: Orthopedic surgery, lower limb vascular surgery, or urology.
- Age: adult more than 21 years, and less than 60 years of both sex.

Exclusion criteria:

- Patient refusal.
- Hypersensitivity to local anaesthetics.
- Local infection at the site of lumbar puncture.
- Bleeding disorders.
- Severe hypotension.
- Space occupying lesions of the brain.
- Hypovolemia.
- Pregnancy.
- Deformity of the vertebral spine.

Obesity (Body Mass Index > 35).**Study Technique:**

- All investigations was checked before the procedure as; normal coagulation profile, organs functions, and complete blood picture. Clinical examination of both groups was done, and explaining the procedure for all patients of both groups.
- Patients of both groups (CL and PS) were monitored preoperatively (i.e. blood pressure, heart rate, ECG, oxygen saturation with pulse oximetry and respiratory rate).
- All patients were supported by volume loading with 10 ml/kg Ringer lactate to compensate for expected venous pooling of spinal anaesthesia.
- All precautions against bradycardia and hypotension were prepared with atropine and vasopressors respectively, also all planes for general anaesthesia with endotracheal tube were also prepared in case of failed spinal anaesthesia.
- Patients in both groups were in the sitting position, and given a pillow to hug to flex the back. Strict asepsis and full scrubbing of the area of manipulation was also done.

Conventional landmark group:

Technique preparation in both groups included:

- Mask and caps, sterile gloves, gauze pads, chloraprep, and spinal kits.
- Needles: typically a 25 gauge beveled tips (Whitacre), 88 mm length. Agents: Bupivacaine 0.5% (3 ml) for spinal anaesthesia, and no adjuvant was given.
- Local anaesthetic agent: Lidocaine 0.25% (2-5 ml) was prepared to be infiltrated at the site of needle entry.

Surface Anatomy:

Patients were in the sitting position, the spinous process in the midline was identified, then the iliac crests was also identified, in which the line crossing both highest points on each side was considered as interspace of L3-L4 or L4-L5 which was selected as a needle insertion site (according to the widest and best space). The skin was then prepared with full scrubbing, and strict asepsis. Infiltration of the local anaesthetic at the selected site was done, and then, the spinal needle was introduced in the midline, remaining perpendicular to the patient's back (parallel to the spinous processes), the needle was slowly inserted, piercing the skin, subcutaneous tissue, supraspinous ligament, interspinous ligament, ligamentum flavum, dura matter, subdural space, then the arachnoid mater, into the subarachnoid space, which was confirmed by dripping of CSF. The needle was fixed on the patient's back and then connected to a syringe containing the local anaesthetic. Aspiration tests was done to detect if inadvertent vascular injury occurred and the syringe contents was injected.

The level and onset of neuraxial anaesthesia was confirmed by temperature changes which was detected with a wetted alcohol swab, and the level of sensory loss was evaluated by ability to detect sensation for sharpen object, and skeletal muscle relaxation was evaluated by the Bromage scale sings.

Preprocedure ultrasonography guided Group:

Technique Preparation:

- Needle and Agents: As in conventional land mark group.
- Equipment: Ultrasonography Machine (FUJIFILM SonoSite M. Turbo 2017).
- Curvilinear probe (Low Frequency 2-5 MHz probe). Skin marker.

The patient was positioned similar to the landmark group, with all precautions taken as before. The scanning was performed initially in the left paramedian longitudinal plane (Fig. 1). With the top of the buttock crease as a starting point, the ultrasound probe was moved to midline then in a cephalad direction in order to identify the upper end of the sacrum (L5-S1 interspace), and to determine the level of each lumbar interspace above. When a proper interspace was detected with the centre of the screen, the midpoint of the probe was marked on the skin.

Once targeted intervertebral levels was marked on the skin, the ideal insertion point for the interspace was detected by switching the probe to the transverse plane. The insertion point was the intersection of the midline and the interspace.

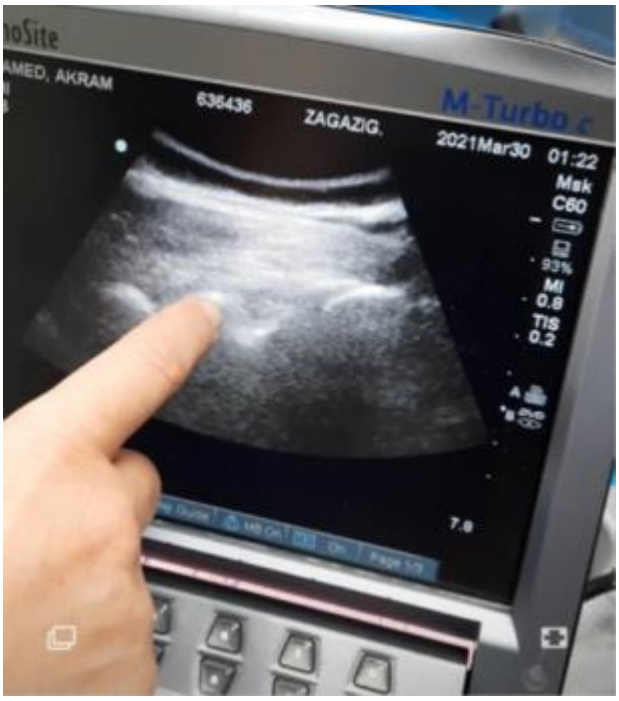

Figure (1): The sonogram of the sacrum and multiple interspace in the longitudinal plane

The midline was identified in the transverse plane by visualizing the spinous process, which was seen as a small hyperechoic structure, continuing as a long, vertical, somewhat "triangular" hypoechoic shadow.

With the image centred on the screen, a dot was marked on the skin at the midpoint of the probe then the probe slowly was tilted in a caudal or cephalad direction, to capture the best acoustic window of an interspace, including the ligamentum flavum, the dorsal dura mater, the ventral dura mater, the posterior longitudinal ligament, and the vertebral body, as well as the articular, and the transverse processes.

We kept in our mind that the angle of ultrasound probe tilting to be our guide in blind spinal needle path. Once the best image of the interspace was captured, the transducer was held stationary, and the image was frozen. Later, the skin was marked at the midpoint of the width of the probe, this point represented the interspace.

By connecting a vertical line intersecting the midline point, and a horizontal line intersecting the interspace point, the ideal insertion point was determined.

The skin distance till the depth to the interathecal space was also measured with the aid of US. The insertion point was easily and accurately determined in the transverse plane. The midline and the interspace were determined as outlined, and points were marked on the skin as illustrated. Horizontal and vertical lines were drawn intersecting these points; the intersection of the lines determined the insertion point (Fig. 2). Strict antisepsis was taken to complete the procedure, exactly as landmark group. Any complications during the procedure was recorded and treated immediately.

Figure (2): Intersection of both planes.

Statistical analysis

All data were collected, tabulated and statistically analyzed using SPSS 20.0 for windows (SPSS Inc., Chicago, IL, USA) and MedCalc 13 for windows (MedCalc Software bvba, Ostend, Belgium). Quantitative data were expressed as the mean± SD and median (range), and qualitative data were expressed as absolute frequencies (number) and relative frequencies (percentage). To test the normality of data distribution, Shapiro-Wilk test was done. Chi-square test was used to compare qualitative data. Any difference or change showing probability (P) less than 0.05 was considered statistically significant.

RESULTS

The demographic characteristics, duration, previous lumbar spine surgery, and type of surgery are shown in table 1. There were no statistically significant differences among the studied groups.

Table (1): Demographic and surgical data

	Landmark Group n=50	US Group n=50	P-value
Age (year)	41.98±12.41	45.66±7.96	0.081
BMI (kg/m^2)	26.68±4.01	27.54±3.43	0.254
Sex: Male Female	 29 (58.0%) 21 (42.0%)	 34 (68.0%) 16 (32.0%	0.300
Smoker	8 (16%)	10 (20%)	0.603
DM	2 (4%)	1 (2%)	0.558
Hypertension	5 (10%)	2 (4%)	0.240
ASA (I/II)	40/10	38/12	0.629
Previous lumbar spine surgery.	4 (8%)	7 (14%)	0.338
Duration of surgery (min.)	77.40±22.75	81.00±24.43	0.448
Type of surgery: General surgery Orthopedic Urology	 8 (16%) 29 (58%) 13 (26%)	 11 (22%0 26 (52%) 13 (26%)	0.727

Data are presented as mean±SD or n (%).

There was a statistically significant difference in US in number of attempts and number of needle pass. The first attempt success rate was significantly higher in PS group than in CL group. The second attempt success rate was significantly lower in the PS group than in CL group (Table 2).

Table (2): Spinal anaesthesia and successful dural procedure data

	Landmark Group n=50	US Group n=50	P-value
Number of attempts	2.28±1.12	1.36±0.63	**<0.001***
Number of needle passes (bone hitting)	4.42±3.20	2.96±1.93	**0.007***
Time for identification of landmarks (S.)	10 (7-20)	65 (45-116)	**<0.001***
Total time for spinal anaesthesia performance (S.)	120 (84-240)	87 (65-155)	**0.047***
Successful Dural puncture: After 1st attempt Within 2 attempts Within 3 attempts	 19 (38%) 27 (54%) 4(8%)	 35 (70%) 13(26%) 2 (4%)	 **0.001*** **0.004*** 0.400

Data are presented as mean±SD, median (IQR) or n (%).
* Significant difference.

There were insignificant differences among both groups regarding paresthesia, radicular pain, blood tapping and intraoperative incidence of complications among both groups (Table 3).

Table (3): Unpleasant effects of spinal anaesthesia and complications

	Landmark Group n=50	US Group n=50	P-value
Paresthesia during needle insertion	5 (10%)	3 (6%)	0.461
Radicular pain	1 (2%)	0 (0%)	1
Blood tapping	6 (12%)	1 (2%)	0.051
Complications: Nausea Vomiting Vasovagal attack	 3 (6.0%) 2 (4.0%) 1 (2.0%)	 2 (4.0%) 1 (2.0%) 2 (4.0%)	 1 0.091 0.091

Data are presented as n (%).

DISCUSSION

Spinal anaesthesia has been traditionally performed using landmark guided technique. Ultrasound helps in identifying the insertion point, depth, as well as angle of the needle advancement by visualisation of the neuraxial structures, thus, increasing the probability of successful dural puncture [8, 9].

In our study, the average number of skin-puncture attempts in the landmark group was more than that of ultrasound group, and the mean number of needle passes (hitting the bone) in the landmark group was more than that of the ultrasound group with a statistically significant difference. Similarly, **Ansari *et al.*** [10] study comparing the use of ultrasound to the landmark method in patients with no anticipated technical difficulty, presenting for caesarean delivery under spinal anaesthesia, found that preoperative ultrasound examination prior to spinal anaesthesia decreased the number of skin punctures required. In the same way, another study by **Li *et al.*** [11] assessed ultrasound-assisted technology versus the conventional landmark location method in spinal anaesthesia for caesarean delivery in obese parturients and found that, the average number of skin-puncture attempts in the landmark group was approximately 3 times that of ultrasound group, and the mean number of needle passes in the landmark group was approximately 7 times more that of the ultrasound group.

Urfalioğlu *et al.* [12] compared ultrasound examination versus conventional spinal anaesthesia in obese pregnant, and found that the numbers of skin punctures and needle passes were significantly decreased with ultrasound use**.** The number of passes

was lesser in our conventional group compared with the referenced study by **Srinivasan *et al.* [13].** Moreover, in accordance to these findings, **Ansari *et al.* [10]** found that the number of skin punctures, and number of needle passes were significantly less in their ultrasound group compared with the landmark group ($P<0.05$).

In our present study, there was a statistically significant difference in the time taken to identify the needle insertion site between the two groups which was significantly shorter in land mark group. **Abdelhamid and Mansour's [14]** in their study comparing the utility of preoperative ultrasound and landmark methods, reported that there was a significantly more time needed to establish landmarks and complete spinal anaesthesia in (ultrasonography guided group) compared to (surface landmark group), which support the result of our work.

In the current study, the first attempt success rate was significantly higher in the ultrasound group versus landmark group. In contrary with our present results, **Ansari *et al.* [10]** reported that the successful spinal anaesthesia after one puncture was not statistically significant between both groups.

In the present study, there was no significant differences among both groups in paresthesia, blood tap, and radicular pain. Similarly, **Srinivasan *et al.* [13]** reported radicular pain or paresthesia during needle placement and conventional group had blood in spinal needle. In the present study, there was no significant difference in the intraoperative incidence of nausea, vomiting or vasovagal attack in the landmark group versus US group, which was similar to findings of **Urfalioğlu *et al.* [12].**

CONCLUSION

In conclusion, preprocedure ultrasonography guided midline spinal anaesthesia improves the efficacy of the technique, increases the success rate of the first trial and decreases the complications. Importantly, there are no reports showing that ultrasound is inferior to blind technique. So, we hope, that we can incorporate ultrasound into everyday practice rather than performing separate ultrasound examination.

REFERENCES

1. **Auroy Y, Narchi P, Messiah A *et al.* (1997):** serious complications related to regional anaesthesiaL:results of a prospective survey in France. Anesthesiology, 87:479-86.
2. **Tarkkila P, Isola J (1992):** Identification of patients in high risk of hypotension, bradycardia and nausea during spinal anesthesia with a regression model of separate risk factors. Acta Anaesthiol Scand., 36:554-558.
3. **Kim J, Song S, Kim B (2011):** Predicting the difficulty in performing a neuraxial blockade. Korean J Anesthesiol., 61:377-81.
4. **Kallidaikurichi Srinivasan K, Iohom G, Loughnane F (2015):** Conventional landmark-guided midline versus preprocedure ultrasound-guided paramedian techniques in spinal anesthesia. Anesth Analg., 121:1089-96
5. **Chin K, Chan V (2010):** Ultrasonography as a preoperative assessment tool: predicting the feasibility of central neuraxial blockade. Anesthesia and Analgesia, 110:252-253.
6. **Minville V, Lavidalle M, Bayoumeu F *et al.* (2010):** Ultrasound-assisted spinal anesthesia in obstetric patient with corrected scoliosis. Ann Fr Anesth Reanim., 29:501-2.
7. **deFilho G, Gomes H, da Fonseca M *et al.* (2002):** Predictors of successful neuraxial block : A prospective study. Eur J Anaesthesiol., 19:447-51.
8. **Kumar A, Thakur P, Wason R (2020):** Ultrasound guided paramedian versus landmark guided midline technique for spinal anaesthesia-A randomised clinical trial. Journal of Clinical and Diagnostic Research, 14(12): 5-9.
9. **Millington S, Restrepo M, Koenig S (2018):** Better with ultrasound: lumbar puncture. Chest, 154(5): 1223-1229.
10. **Ansari T, Yousef A, ElGamassy A *et al.* (2014):** Ultrasound-guided spinal anesthesia in obstetrics: is there an advantage over the landmark technique in patients with easily palpable spines? Int J Obstet Anesth., 23:213–216.
11. **Li M, Ni X, Xu Z *et al.* (2019):** Ultrasound-assisted technology versus the conventional landmark location method in spinal anesthesia for cesarean delivery in obese parturients: a randomized controlled trial. Anesthesia and Analgesia, 129(1): 155-161.
12. **Urfalioğlu A, Bilal B, Öksüz G *et al.* (2017):** Comparison of the landmark and ultrasound methods in cesarean sections performed under spinal anesthesia on obese pregnants. The Journal of Maternal-Fetal and Neonatal Medicine, 30(9): 1051-1056.
13. **Srinivasan K, Iohom G, Loughnane F *et al.* (2015):** Conventional landmark-guided midline versus preprocedure ultrasound-guided paramedian techniques in spinal anesthesia. Anesthesia and Analgesia, 121(4): 1089-1096.
14. **Abdelhamid S, Mansour M (2013):** Ultrasound-guided intrathecal anaesthesia: Does scanning help? Egypt J Anaesth., 29:389–394.