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Ultrasound Guided Landmark Identification for Spinal Anesthesia for Patients with Spinal Abnormality

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Abstract: ***Spinal anesthesia using a surface landmark–guided technique can be challenging in patients with anatomical abnormalities of spine. We assessed whether an ultrasound-assisted technique could reduce the number of needle passes required for block success compared with the landmark-guided technique in patients with abnormal spinal anatomy. Forty patients with abnormal spinal anatomy underwent spinal anesthesia either surface landmark–guided or preprocedural ultrasound–assisted. All spinal procedures were performed by 1 experienced anesthesiologist. The primary outcome was the number of needle passes required for successful dural puncture. Secondary outcomes included the success rate on the first pass, total procedure time, periprocedural pain scores, and the incidences of radicular pain, paresthesia, and bloody tap or any adverse effects during the neuraxial procedure. The number of needle passes was significantly lower in the ultrasound group than in the landmark group. First-pass success was achieved more in patients who underwent pre-procedural scan with ultrasound than in landmark guided technique. The total procedure time, defined as the sum of the time for identifying landmarks and performing spinal anesthesia, did not differ significantly between the two groups. The ultrasound group showed lower periprocedural pain scores compared with the landmark group. The incidences of complications during the procedure showed no significant differences between the two groups. The use of ultrasound significantly reduces the technical difficulties of spinal anesthesia in patients with abnormal spinal anatomy compared with the landmark-guided technique. Our results suggests the use of neuraxial ultrasonography for spinal anesthesia in such patients.***

Keywords: abnormal spinal anatomy, landmark-guided, spinal anaesthesia, ultrasound

1. Introduction

Landmark - guided technique has been traditionally used for giving spinal anaesthesia, however patients with spine abnormalities such as scoliosis, previous spine surgery or other factors such as obesity can possess technical difficulty in giving spinal anaesthesia due to indistinct surface landmarks.

As multiple needle insertion attempts and manipulation is associated with disastrous complications such as postdural headache, infection, hematoma, neural injury as well as patient dissatisfaction and discomfort due to pain. A pre - procedual ultrasound scan of the spine can ease the identification of desired inter - vertebral level and therefore, in a better technical performance of spinal anaesthesia. However, there is still limited study of use of ultrasound for patients with spinal abnormalities as landmark - guided technique is considered to be an efficient approach to spinal anaesthesia mostly in expert hands.

To date, only a handful of studies have been reported to compare the efficiacy of spinal anesthesia between the landmark - guided technique and ultrasound - assisted technique. A previous study stated that the technical difficulty of spinal anesthesia in patients with difficult surface landmarks was significantly reduced with the use of ultrasonography[1]. But, the utility of ultrasonography in patients with abnormal spinal anatomy still remains unclear because of lack of stuides[1].

In this study, the aim is to find whether an ultrasound - assisted technique could reduce the number of needle passes required for successful dural puncture in patients with spine abnormalities compared with the conventionally used landmark–guided technique. Along with the number of needle passes, we also compared the procedure time, periprocedural pain and discomfort scores, and the incidence of complications related to spinal anesthesia during the procedure between the 2 techniques in these patient populations.

2. Methods

2.1 Study Design

This was an observational study which was approved by institutional ethics committee of BV (DU) Medical College and Hospital, Sangli. The study took place between May 2, 2021 and Oct 2, 2021 at BV (DU) Medical College and Hospital, Sangli. All participants included in the study provided written informed consent.

2.2 Patient Population

Adult patients with American Society of Anesthesiologists physical status I/II/III scheduled to undergo elective surgery under spinal anesthesia were considered for eligibility if they had abnormalities in their lumbar spine, defined as one of the following: (1) documented mild to severe lumbar scoliosis in preoperative lumbosacral spine x - ray, defined as a Cobb angle ≥10°; (2) history of lumbar spinal surgery involving L2–L5 vertebrae (3) previous lumbar spine

surgery or (4) other factors such as obesity. Patients with contraindications to spinal anesthesia including allergy to local anesthetics, coagulopathy, or local infection at the puncture site were excluded from the study, as were those unwilling to participate or unable to communicate. Patients were assigned to receive spinal anesthesia using the surface landmark–guided (landmark group) or preprocedural ultrasound–assisted (ultrasound group) technique by the consultant anaesthesiologist. All spinal procedures were performed by 1 consultant anesthesiologist who is experienced regional anesthesiologist who skilled with the landmark - guided neuraxial technique, and having performed more than 30 ultrasound - assisted neuraxial blocks before this study.

In both groups, the consultant anesthesiologist reviewed the patient's history. Spinal anesthesia was administered with patients placed in the sitting or lateral decubitus position. Anti - emetics were given before the start of the procedure. Sedatives were not administered before or during the administration of spinal anesthesia to note the patient's satisfaction score.

Inconventional landmark - guided group, the spinal interspace was preferred as per convience [L2 - L3 OR L4 - L5]. In US guided spinal anesthesia, under all aseptic precautions, the spinal interspace and puncture site was identified with the help of low frequency curvilinear US probe by using both saggital and transverse planes.

In all patients, spinal anaesthesia was performed under all aseptic precautions by using 25G spinal needle under local anaesthesia [2cc of 1% xylocaine] and desired amount of 0.5% bupivacaine was injected in the subarachnoid space.
In the Transverse view, each spinous process tip was marked on the skin (Figure 1). The midline was drawn by connecting spinous process tips. The transverse interlaminar views (Figure 1) were obtained by visualizing the anterior and posterior complexes.18The sacrum was identified first and subsequently, the transducer was moved cephalad to identify individual interlaminar spaces from L5–S1 to L2.

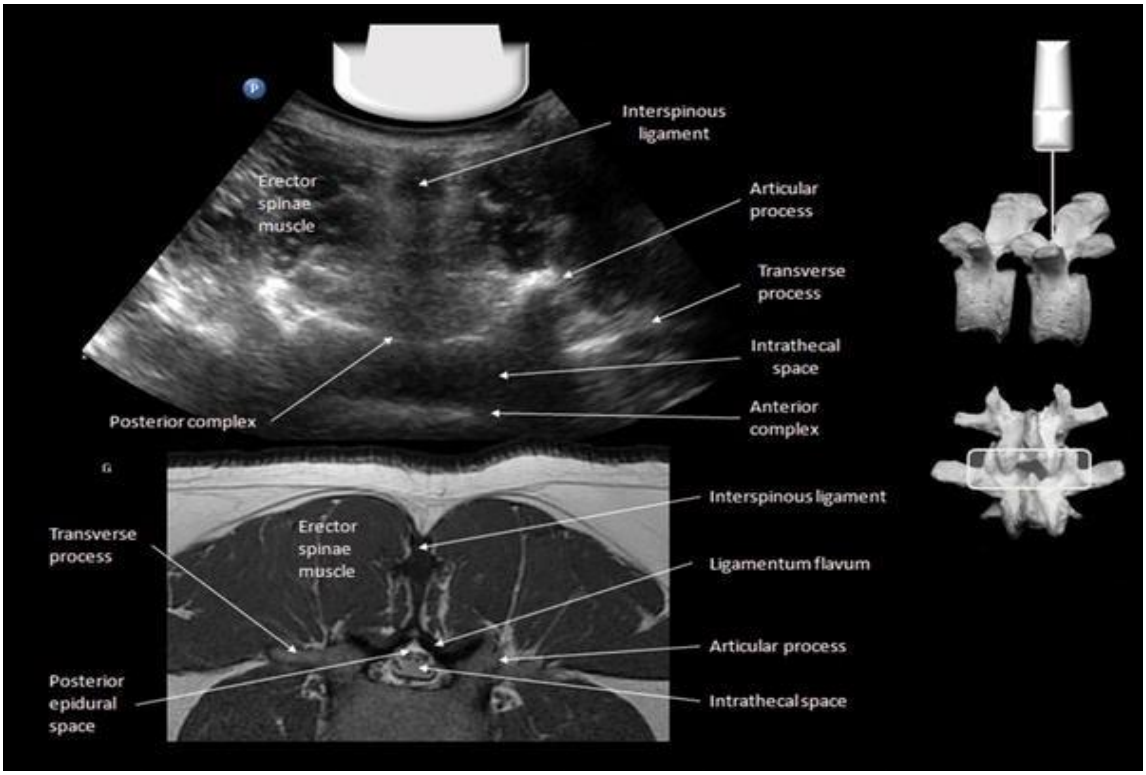

Figure 1

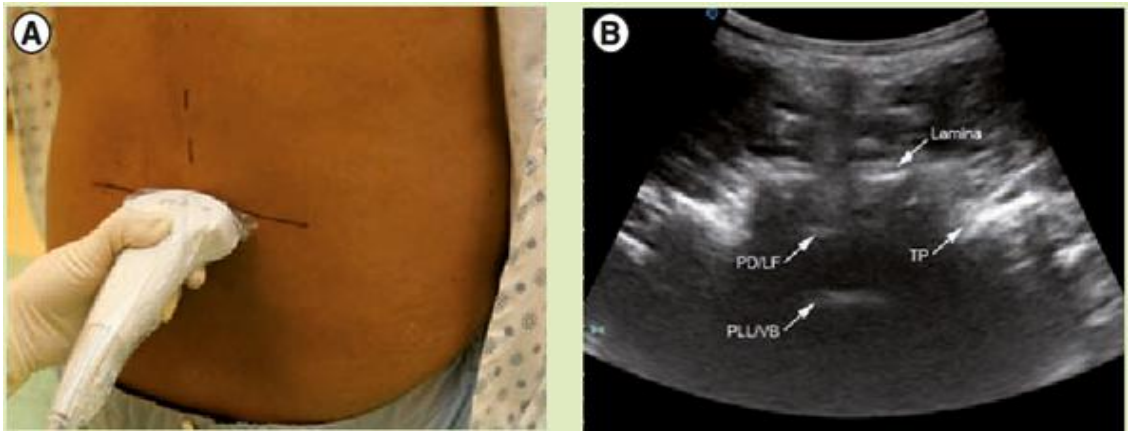

Figure 2

The interlaminar space, showing the posterior and anterior complexes18 as clearly as possible, was centered on the ultrasound screen (Figure 2). With the probe positioned to obtain the clearest image, the skin was marked at the midpoints of the probe (Figure 2).

The intervertebral level that provided the largest interlaminar space was selected as the site for the first attempt, and the skin was carefully marked at this level. The skin was additionally marked at other identified intervertebral levels in preparation, and these sites were used only if the first attempt was not successful. The required depth of needle insertion was estimated based on the distance from the skin to the posterior complex.

After the skin marking, the ultrasound gel was removed to ensure the needle - insertion site was free of gel. In the ultrasound group, the anesthesiologist did not palpate the surface anatomic landmarks until completion of spinal injection. The distance from the skin to the posterior complex was measured using ultrasound tool. In this technique, time for identifying landmarks was defined as time from which the ultrasound probe was placed on the skin to the anesthesiologist declaring that the skin markings were completed. Time taken to perform spinal anaesthesia was defined as the time from insertion of the spinal needle to completion of injection.

In the landmark group, spinal anesthesia was administered after direct palpation of surface landmarks.

In all patients, after three unsuccessful attempts, the other alternative methods was used when felt necessary. For patients undergoing conventional landmark guided spinal anaesthesia, another interspinous space was used or ultrasound employed. For patients undergoing US guided spinal anesthesia, a paramedian approach or a conventional landmark palpation technique was also used.

Time for identifying landmarks in conventional landmark guided technique was defined as time from which the anesthesiologist started palpating to identify the landmarks to completion of the process as declared by the anesthesiologist.

Primary outcome

To measure the number of passes [withdrawl and redirection of spinal needle without exiting the skin] required to enter the subarachnoid space in both groups.

Secondary outcome

1) To measure the number of spinal needle insertion attempts [number of times the spinal needle was withdrawn from the skin and reinserted.
2) First pass success rate [1 attempt and one pass].
3) Time required for identifying landmarks.
4) Time taken to administer spinal anesthetic,
5) Incidence of radicular pain, paraesthesia,
6) Incidence of blood in the spinal needle,
7) Incidence of peri - procedural pain and peri - procedural discomfort. [VERBAL RATING SCALE 0 to 10]

3. Statistical Analysis

All the data was collected and tabulated and with the help of statistician analysis was done. Data showing normal distribution were presented as mean (standard deviation [SD]), and data showing a nonnormal distribution were presented as median (interquartile range [range]). P values <.05 were considered statistically significant.

As compared with landmark - guided technique, ultrasound - assisted technique required more time to establish landmarks (Table 2). But, this difference was offset by the shorter time required for administering spinal anesthesia in the ultrasound group than in the landmark group. As a result, total procedure time did not differ significantly between the 2 groups (Table 2). The periprocedural pain scores were significantly lower in the ultrasound group than in the landmark group. However, the periprocedural discomfort scores showed no significant difference between the groups (Table 2).

Table 1: Demographic and Surgical Characteristics

	Landmark Group (n = 20)	Ultrasound Group (n = 20)
Age (y)	62.5 (13.2)	64.5 (8.8)
Height (cm)	168.4 (8.1)	160.2 (7.6)
Weight (kg)	60.2 (9.2)	65.9 (8.9)
BMI (kg/m^2)	26.9 (2.9)	25.1 (3.2)
Sex, female	12 (60%)	16 (80%)
Abnormalities of the lumbar spine		
Previous spinal surgery/ others	6 (30%)	2 (10%)
Scoliosis	14 (70%)	18 (90%)

In the landmark group, 5 patients required use of an alternative technique (ultrasound - assisted technique) for successful dural puncture None of the patients in the ultrasound group required use of an alternative technique. No patients in either group required general anesthesia, and every spinal block was adequate for the entire surgery.

Intergroup differences in the intervertebral level of anesthesia administration are presented in Table 2 (P =.080).

In the landmark group, surface landmarks were easily palpated in 39.8% of patients and landmarks were moderate or difficult to palpate in 60.2% of the subjects.

Table 2: Outcomes

	Landmark Group (n = 20)	Ultrasound Group (n = 20)	*P*	Difference in Medians (95% CI)
Number of passes	6 (2–9.3 [1–15])	1.5 (1–3 [1–5])	<.001	4.5 (1–8)
Number of attempts	2 (1–4 [1–5])	1 (1–1 [1–2])	<.001	1 (0–2)
Successful dural puncture at the first pass	2 (9.1%)	11 (50.0%)	0.007	5.5 (1.4–22.0)
Successful dural puncture within 2 passes	6 (27.3%)	15 (68.2%)	0.007	2.5 (1.2–5.2)
Successful dural puncture at the first attempt	9 (40.9%)	20 (90.9%)	0.001	2.2 (1.3–3.7)
Successful dural puncture within 2 attempts	12 (54.5%)	22 (100%)	0.001	1.8 (1.2–2.7)
Identifying time (s)	34 (26–49 [18–76])	95 (83–126 [30–305])	<.001	−61 (−83 to −49)
Performing time (s)	119 (48–268 [25–362])	44 (30–50 [25–151])	<.001	81 (14–175)
Total procedure time (s)	154 (90–295 [53–404])	146 (115–181 [101–336])	0.888	5 (−55 to 100)
Periprocedural pain score (NRS)	5.5 (3–8 [0–9])	3.5 (1–5 [0–7])	0.012	2 (−0.5 to 5)
Periprocedural patient discomfort score (NRS)	4 (2–6.3 [0–9])	3 (1–5 [0–6])	0.114	1 (−2 to 3.5)

4. Discussion

This study demonstrated that pre - procedural ultrasound scan helps the technical performance of spinal anesthesia in patients with spine abnormalities. In this study, we observed that ultrasound assistance significantly reduced the number of needle passes required for success and increased the first attempt success rate without significantly prolonging the total procedure time compared with the landmark - guided technique.

There are limited number of clinical studies demonstrating that use of ultrasound could increase the technical efficiency of spinal anaesthesia[1, 2, 3]. Although Chin et al[1] showed that the ultrasound assistance improved the efficacy of spinal anesthesia compared with the landmark guidance in adults with difficult surface landmarks in their randomized study, most subjects were obese and only a small proportion (21%) had abnormal spinal anatomy

Data collected through this study suggests that the use of ultrasonography can enhance the efficacy of spinal anesthesia in patients with spine abnormalities[4]. Bowens et al[5] previously developed an approach to neuraxial anesthesia for the scoliotic spine, and they recommended the providers to manage mild scoliosis with good positioning. Furthermore, ultrasound scan allowed the operator to identify the midline accurately and determine the optimal insertion angle in patients[6].

Patients with previous spine surgery are also at increased risk for technical difficulties[7, 8]. The spinous process can be indistinct or absent, and tissue adhesion or bone graft can hinder the neuraxial approach.6 Patient positioning can be limited, and skin scarring can disrupt the midline. However, we observed that dural puncture was achieved with a single needle pass in the patients with previous surgery in ultrasound group. Therefore, in accordance with previous reports[1, 9, 10] our results suggest the use of the ultrasound assistance in patients with previous spine surgery.

The overall procedure time is of concern to many anaesthesiologists. Previous studies suggests that the use of ultrasound increased the overall procedure time because of scanning time[1, 3, 11]. However, we observed no significant difference in total procedure time between the 2 techniques because the identifying time in the ultrasound group of our study was shorter than those in the previous studies[1, 3, 11]. Our results therefore encourage the use of ultrasonography in these patients without concerns about prolonging the procedure time.

An increasing number of evidence indicates that ultrasound can improve the efficacy of neuraxial techniques, insufficient evidence exists on its safety outcomes owing to very low baseline incidences of the disastrous complications of neuraxial techniques, namely <1 in 100, 000 cases[7, 12]. However, it has been suggested that neuraxial ultrasound may possibly reduce several mechanisms of injury related to neurologic complications[7].

In conclusion, for anesthesiologists with experience in neuraxial ultrasonography, the use of ultrasound can enhance the efficacy of spinal anesthesia in patients with anatomical alterations in the lumbar spine, including scoliosis and previous spinal surgery. We believe that these results can lead to practical suggestions that encourage the use of ultrasound for spinal anesthesia in patients with abnormal spinal anatomy.

5. Conclusions

The use of ultrasound significantly reduces the technical difficulties of spinal anesthesia in patients with abnormal spinal anatomy compared with the landmark - guided technique. Our result suggests the use of neuraxial ultrasonography for spinal anesthesia in such patients.

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