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Case Report

Using "Baudhayana Theorem" for a Novel Paramedian Approach of Spinal Anesthesia in Morbidly Obese Patients with Difficult Sonoanatomy: A Case Report and Narrative Review

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ABSTRACT

Spinal anesthesia is traditionally performed using landmark technique to identify the level and point of needle insertion. However use of ultrasonography (USG) has emerged among anaesthesiologists to guide neuraxial blockade. The views that are of utmost importance are "transverse spinous view", "transverse interspinous view" and "longitudinal parasagittal oblique view". For in-plane technique and real time imaging longitudinal parasagittal oblique view is used while transverse views are used for visualizing spinous level, epidural and subarachnoid space, posterior complex (PC), anterior complex (AC) and depth of canal. In patients with deformed spine like kyphoscoliosis or morbid obesity obtaining optimum views is not possible. We discuss a morbidly obese patient with very poor ultrasonographic views of spine. We describe a novel technique to estimate depth of spinal canal using only bony shadows in a single transverse view.

Traditionally, spinal anesthesia was performed using blind approach. The number of pricks, number of passes and/or failure rates are high in patients with kyphoscolisis, operated cases of spine and patients with high body mass index (BMI). Neuroaxial ultrasound (USG) acts as a useful complement to clinical examination when performing lumbar central neuroaxial blocks. It helps to locate the appropriate level, identify the approach (median /paramedian) and also estimate depth of spinal space. USG has been used as a preoperative tool and also as a real time assistant to spinal anesthesia in difficult cases. Despite extensive data and techniques of administering spinal using USG we came across an obese patient with BMI= 52.9, where identifying structures under USG guidance was not feasible. We used a novel technique using "baudhyana theorem" to estimate the depth of spinal canal for paramedian approach of spinal blockade.

Case Report

A 56 year old morbidly obese ASA- 3 female was scheduled for vaginal hysterectomy. Her BMI was 52.9, with weight and height of 132 kilograms and 158 centimeters respectively (Figure 1).

On preanesthetic checkup, she was a known asthmatic, hypertensive from last 15 years. Airway examination showed adequate mouth opening, thyromental distance only 2 finger breadth, Mallampati class 4 and short neck. On spine examination it was difficult to palpate spine. Posterior iliac spines were barely palpable on deep pressure. Spines were counted roughly from iliac spine levels. 2D echocardiography showed global hypokinesia with ejection fraction of 50%. Patient had declined surgery at other centre for the fear of general anesthesia. She was counseled for difficulty of spinal as well as general anesthesia. Informed consent was taken from the

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patient explaining all risks. A preoperative USG of the spine was performed, in which none of the structures could be identified. The machine was changed from sonosite edge 2 to GE and an anesthesiologist specializing in regional anesthesia at our institute was called for help to assist in scanning. In the transverse spinous view, what we presumed was L3 level, "spinous process" and "laminae" were visible. In the transverse interspinous view at this level, only "articular process" and "transverse processes" on each side could be identified (Figure 2).

AC or PC could not be identified. Other views were tried to visualize the anatomy. Due to extensive fat and artifacts we could not identify "laminae" or "transverse process" or "AC" or "PC" in the longitudinal parasagittal oblique view and it was not helpful at all. As the patient was adamant for subarachnoid block, we thought of estimating the approach and technique from the images available. Multiple pricks would make the patient uncomfortable. Visible shadows of bony structures seemed to be placed such that we thought of using the "baudhyana theorem" to estimate the depth of spinal canal for paramedian approach. Presuming the depth of transverse process to be the depth of spinal canal, perpendicular distance of transverse process from skin was measured using USG which was 7.08 cm. An imaginary parallel line equal to depth of transverse process from skin was drawn from the midpoint of transverse interspinous view (point X). It was considered to be the approximate depth of spinal canal (Line A) from mid-line. The articular structure was identified and its corresponding point on the skin was marked Y. Now, a line was drawn on the skin from midpoint of interspinous view i.e point X to this point Y and was labelled Line B which was 1.75 cm in length. Using baudhyana also known as pythogoras theorem (C2= A2+ B2), the third side of the triangle line C (joining line B to line A) was calculated i.e . 7.4 cm (Figure 3).

Inside the OR, though we tried using median approach to reach the spinal canal, we ended up hitting bony structure each time. However, paramedian approach when attempted as planned with a 25 G 10 cm standard quincke's needle from point Y and subarachnoid space was encountered at the depth of 7.4 cm as estimated from our preoperative scan (Figure 4). Subarachnoid block was successful in a single attempt and single pass (defined as the number of forward advancements of the spinal needle in a given interspinous space, i.e., withdrawal and redirection of spinal needle without exiting the skin).

Figure 1- Morbidly obese female with BMI=52.9

Figure 2- Transverse inter-spinous view Expected (left side); Our view (right side)

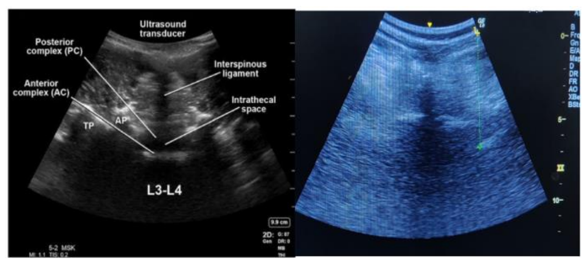

Figure 3- USG figure to measure the angulation, depth to approach the subarachnoid space using "baudhyana theorem"

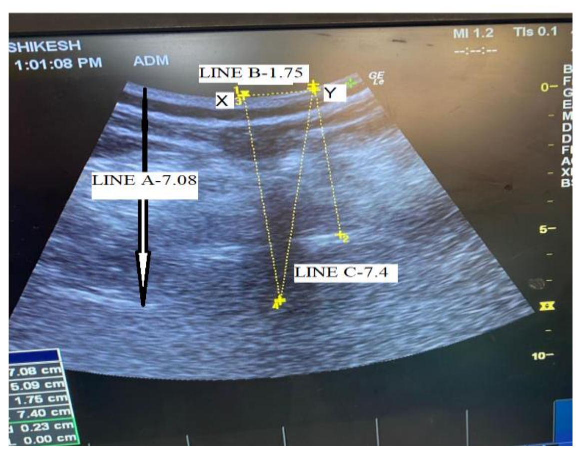

Figure 4- Marking the point of entry (left); visible CSF flow (right)

Discussion

Central neuraxial blockade is performed as a blind technique using anatomical landmarks since time immemorial. Ultrasonography was first used for lumbar puncture in 1971 by Bogin and Stulin. Since then various researchers have described structures seen and methods to perform central neuraxial blocks using spine USG. Both preprocedural ultrasonography and real time USG of the spine provide anatomical information pertinent to central neuraxial blockade, including the location of the neuraxial midline and interlaminar spaces, and the depth to the epidural space and intrathecal space [1]. Real time USG has an advantage of needle visualization and seems an attractive choice but is not popular as the landmark based blind technique has a high success rate [2]. This may be because, aseptic preparation of the ultrasound probe takes time and the ultrasonic anatomy of the lumbar spine is relatively complex. The intrathecal space is surrounded by bones, which makes real-time ultrasound guidance more difficult [3]. Although, USG is invaluable in patients with abnormal spinal anatomy or poor surface landmarks [4-5]. Most commonly longitudinal parasagittal oblique view is used to visualise the two laminae and perform spinal anesthesia. Chin et al, pointed out shortcomings of preprocedural scan like the inaccuracy in marking the needle insertion point on the skin and that the degree of cephalad-to-caudad and or lateral-to-medial angulation required to enter the vertebral canal cannot be marked. Real time visualization of needle overcomes both these issues [6]. Chin et al in 2011, however used USG for preprocedural estimation of entry point of spinal needle and concluded that the first-attempt success rate was twice as high in USG group than in landmark group, even number of attempts were less in USG group. They also concluded that the ultrasound-guided technique reduces the technical difficulty of spinal anesthesia in the older non-obstetric patient population with difficult surface anatomic landmarks compared with a conventional surface landmark-guided techniques [7]. Real time USG was then used on cadavers to describe taylor's approach of subarachnoid block at L5-S1 level and this was then translated on 10 patients posted for knee arthroplasty. Here also the view of USG used was longitudinal parasagittal oblique [8]. Water phantom model was described by karmakar et al, which showed beautiful images of "camel hump sign", "trident sign" and images of parasagittal oblique view. The posterior complex, anterior complex and intrathecal space is described and this model is still used for demonstration and training purposes at workshops [9]. A new approach was then described by Conroy et al, placing the paramedian oblique transducer orientation (rotated by 45 degrees) and using real-time scanning for central neuroaxial block. This maneuver affords a view of the spinous process of the upper vertebral body and the lamina of the lower vertebral body simultaneously. The angle between these two structures represents the paramedian window into the spinal canal. He reported a success rate of 97 % on first attempt [10]. Preprocedural use of USG in obese patient was done by Lebbi,et al who used both interspinous transverse view and longitudinal oblique view to administer spinal anesthesia from the midline in a morbidly obese patient [11]. In 2015, a study compared midline landmark guided spinal anesthesia with pre-procedural paramedian ultrasound guided spinal block and concluded that a routine use of pre-procedural USG significantly decreases the number of passes and attempts needed to enter the subarachnoid space [12]. A metaanalysis on pre-procedural USG for lumbar neuroaxial blocks concluded increased accuracy of identification of lumbar interspaces (grade B recommendation, IIa level of evidence), accurate measurement of the depth of the epidural and intrathecal space (grade A, Ia), Improved efficacy (grade A, Ia) and safety of neuraxial anesthesia (grade B, level II) [13]. Lui et al, in 2018 published a transverse paramedian approach under real time USG. They achieved high first pass success rate with acceptable procedure time and concluded effectiveness and safety of this approach need further investigation by comparing it with blind technique and other ultrasoundguided techniques with well-designed randomized controlled trials [14]. Our case was morbidly obese, during pre-anesthetic check-up, we realised that administering spinal anesthesia to this patient may be difficult due to central obesity. But general anesthesia seemed trickier in view of obesity, asthma, uncontrolled hypertension as comorbidities and a high risk cardiac profile. We did a pre-procedural USG due to lack of good longitudinal oblique view, we used transverse view to calculate depth of spinal canal. Baudhyana theorem ($c2= a2+b2$) was used to calculate the third side of the triangle. The estimated depth of central canal was similar to the needle insertion depth. We did not encounter bony structures while approaching spinal canal, but we believe that is possible, as angulation of needle can hit articular process and superior or inferior movement of needle can hit the lamina. For this reason, an oblique parasagittal view is helpful but in such cases with morbid obesity, where spine anatomy is difficult to appreciate, a transverse view can be used to estimate depth and perform spinal anesthesia through para median approach keeping in mind the acute angle with which one should proceed. Also in real time USG, to visualize the needle three hand, two person approach is needed. The added benefit of our technique is that it can be performed by single person without assistance and is relatively simpler. The use of this technique should be encouraged in trainees and anesthesiologist who have basic knowledge of USG but lack sophisticated skills. This technique is very useful in patients with difficult ultrasonography where structures are not visualised properly like morbidly obese and kyphoscoliosis. However, we believe that Prospective studies in future can consolidate the use of “baudhyana theorem” for performing spinal anesthesia.

Conclusion

As we are advancing use of USG will be indispensible in coming times thus all anaesthesiologists should have basic knowledge of ultrasonography techniques. Performing spine USG is considered as a sophisticated task and needs thorough knowledge. While we encourage anaesthetists should learn all techniques and views of USG spine, our method is easy to practice. A pre-procedural scan with only bony shadows visible in transverse view is enough to calculate depth of canal and guide needle position and angulation. One person alone can perform this technique and it is very helpful in patients with deformed spine and difficult sonoanatomy.

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