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"PROSPECTIVE OBSERVATIONAL STUDY OF COMPARISON BETWEEN PRE-PROCEDURE ULTRASOUND EXAMINATION SCORING VERSUS MANUAL SCORING TO PREDICT DIFFICULT SPINAL ANESTHESIA IN INDIAN PATIENTS"

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INTRODUCTION

Subarachnoid block /spinal anaesthesia is one of the most important anaesthetic techniques in the 21st century even though it was first introduced 100 years ago by August bier in 1861.

It is the anaesthetic technique of choice for most lower limb orthopedic cases, urological cases, lower abdominal surgeries, and caesarian sections as it is technically easy to perform and economically feasible. Also, the incidence of complications are reduced and the associated difficulties of general anaestheisa like difficult airway management, intraoperative awareness, extubation, polypharmacy, postoperative nausea and vomiting are avoided.

Subarachnoid block blunts the surgical stress response and has been shown to reduce intra-operative blood loss. The patient's airway reflexes are preserved, unlike general anaesthesia. Thus spinal anaesthesia is an indispensable part of modern anaesthesia and every anaesthetist must be adept in performing spinal anaesthesia and its intraoperative management.

A major drawback in performing subarachnoid block is post-dural puncture headache(1), trauma to neural structures(2,3,4), spinal hematoma (5), and the patient discomfort that can be caused by multiple prick attempts which can be painful leading to a vasovagal response and also an aversion in undergoing further subarachnoid blocks for future procedures due to the unpleasant experience.

Predicting the difficulty of subarachnoid block ensures a higher success rate in delivery as done by the manual scoring system. It is similar to the mallampati scoring system that predicts the difficult airway. A relatively simple, easy, and

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economical scoring system is devised preoperatively to assess the technical difficulty of performing the subarachnoid block. The characteristics of the patients have been classified according to their age, BMI, spinal bony landmarks to assess interspinous space, and any spinal bony deformity like kyphosis or scoliosis. With these characteristics, a difficult score for a subarachnoid block is developed preoperatively.

The value of ultrasound images to identify spinal anatomy prior to subarachnoid block was first described by a Russian anaesthesiologist in 1971. Almost 30 years later Grau et al(6) published a series of articles describing the use of ultrasound to guide epidural anaesthesia in the early 2000s.

An ultrasound scan of the spine gives us a whole new layer of information like distance between skin and ligamentum flavum, the depth of the ligamentum flavum and also the most suitable interspinous space can also be selected. Knowing these details prior to administering spinal anesthesia can help in anticipating the depth of needle insertion or whether a paramedian approach can be preferred.

Similar studies highlight the importance of identifying the posterior longitudinal ligament. This is important as it might imply an open acoustic window meaning an easy path for dural puncture. In this study, we have evaluated whether ultrasound scans that produce poor images of the posterior longitudinal ligament can predict technically difficult spinal injections and compare them to the manual scoring to predict difficult subarachnoid block.

AIMS-

To compare pre procedure ultrasound examination score and manual scoring to predict difficult spinal anesthesia

OBJECTIVE-

1) To study ultrasound examination of spinal anatomy and to identify difficult or easy spinal injection using the ultrasound scoring.

2) To study manual scoring of spinal anesthesia

3) To compare ultrasound with manual scoring

MATERIALS AND METHODS

Study was carried out at Department of Anesthesiology and Critical Care,

Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pimpri, Pune

on 200 patients belonging to ASA (American Society of Anaesthesiologists)

grade I/II/III, aged more than 20years, including either gender and meeting all

inclusion exclusion criteria scheduled for elective orthopaedic or urological

procedures under spinal anesthesia. Institute Ethics Committee Clearance was

obtained before start of study Assuming the mean SD of Group A and Group B

from different studies and mean difference between both groups and entering the details in the WINPEPI Application and using the reference Article[(7)]: Weed

JT, Taenzer AH, Finkel KJ, Sites BD. Evaluation of pre- procedure ultrasound

examination as a screening tool for difficult spinal anaesthesia*. Anaesthesia.

2011 Oct;66(10):925-30.The sample size comes out to be 200.

INCLUSION CRITERIA

- ASA grade I/II/III patients.
- More than 20 years of age male and female patients.
- Patients undergoing orthopedic or urological procedures under spinal anaesthesia.
- Obese patients.
- Patients of previous spinal surgeries.
- Availability of informed consent.

EXCLUSION CRITERIA

- Patients with contraindication for regional anesthesia.
- ASA grades IV and V

- Allergy to local anaesthetic
- Patient refusal
- Local infection at the site of the planned puncture
- Septicemia
- Increased intracranial pressure
- Neurological disorder
- Coagulation defects/medicated with anti coagulants
- Pregnant patients

MATERIAL REQUIRED

1) Standardised anaesthesia machine (Boyle's apparatus).
2) Monitoring equipment like pulse oximeter, ECG monitor, non- invasive blood pressure (NIBP) apparatus,etc
3) Anaesthesia trolley with normal saline, gauze pieces, plaster for i.v. sticking.
4) Intravenous cannula 20G or 18G.
5) Intravenous fluids-Crystalloids & Colloids.
6) Disposable syringes, disposable sterile gloves, sterile dry hand towel, sterile gown and dressing.
7) Sterile spinal tray having sterile gauze pieces, sponge holding forceps, fenestrated drape, preparation solution, sterile disposable syringes, 26 G Quincke's Babcock spinal needle .
8) USG machine- Arietta Hitachi S70

PROCEDURE

Pre-Anesthetic checkup was conducted on the previous day of surgery. General and systemic was done. Routine laboratory investigations were done. Patients were kept nil by mouth from midnight prior to surgery. Informed consent was taken.

Manual Scoring -

Patient were assessed for parameters like age, Body mass index (BMI)

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,spinal landmarks (good=easily palpable dorsal spinous processes, poor=difficult to palpate spinous processes) to assess the inter-spinous space and any spinal deformity (like scoliosis and kyphosis).

The needle type, needle gauge, spinal level used, and approach (midline or paramedian) was recorded. All spinal blocks were performed with the patient in the sitting position. There was no time limit for completing the spinal anesthesia.

Table 1 – Manual scoring

Patient Characteristics	0	1	2	3
Age (yr.)	20-40	41-60	>60	
BMI	<22	22-27	>27-34	>34
Spinal bony landmarks	Clear	Unclear		
Spinal bony deformity	No	Yes		

Based on these a predictive score is derived -As shown in table 1
Each patient was given a score from 0-7 according to patient characteristics. This score is calculated before the performance of subarachnoid block. A score of 4 and > 4 indicates a difficulty in performance of the subarachnoid block.

Ultrasound Scoring –

Patients underwent a pre-operative ultrasound scan of the lumbar spine using a USG machine (Arietta Hitachi) by a skilled anaesthetist with experience of more than 5 years and more than 50 ultrasound examinations of spine. Sensitivity, specificity, positive and negative predictive values was calculated for the manual exam to assess its use as a tool to predict a difficult spinal injection.

TECHNIQUE-

The transducer was placed approximately 2 cm lateral to the midline in

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a longitudinal paramedian orientation with a slight medial tilt. Positioning the transducer in this manner created an image that resembles a 'sawtooth' pattern as the ultrasound waves are reflected off of the laminae

Each level of lumbar spine was identified and our ability to see the sawtooth pattern was confirmed .The quality of the image of the posterior longitudinal ligament at each level was recorded as absent, hazy, or clear with assigned numerical values of 0, 1, and 2, respectively. A total posterior longitudinal ligament score (0–16) for each patient was calculated by adding the right and left posterior longitudinal ligament values at all four levels (L1-L2, L2-L3, L3-L4, L4-L5).

Posterior longitudinal ligament scores (0–16) was divided into two groups by splitting it's visibility in half. The low score group consist of PLL scores of 0–8; the high score group of PLL scores from 9-16.

Assessment of Procedure – (Easy or Difficult Spinal block)

Preoperative pulse, non-invasive blood pressure, ECG and oxygen saturation were be noted in the performa sheet. Peripheral venous access was established and intravenous (IV) fluids given, preloading the patient with 500 ml of Ringer's lactate.

A lumbar subarachnoid block was performed by another anaesthetist (with an experience of 2-5years) under strict aseptic precautions with the patient in sitting position. Lumbar puncture was initially done in L3-L4 interspace with 26G Quincke's needle, if not successful, then changed to L2-L3 space. If using 26 G Quinke's spinal needle, the procedure is unsuccessful,23 G Quinke's spinal needle was used as an alternative.The number of attempts made and number of new skin pricks made for a successful flow of clear CSF was noted and spinal anesthesia was graded as easy or difficult by the anaesthetist.

Two measures was used to assess the difficulty encountered in performing the block-

First, the needle placement at the initial spinal level will be termed as

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first-level success.

Second, we recorded the number of attempts required for successful needle placement. Each new skin puncture was considered another attempt, whether at the initial spinal level or at a second level. Simply redirecting the needle without a new skin puncture was considered an additional attempt.

Finally, the success or failure of the blockade was recorded. The neuraxial block was considered a failure if local anesthetic supplementation, a second neuraxial block, or general anesthesia was required.

Table 2 - criteria for easy or difficult spinal anaesthesia

EASY	DIFFICULT
Successful block in first space	Successful block in Second or Third space
Successful block with redirection in first space	Incomplete anesthesia or Failure of block
L3-L4 space	Any Other space than L3-L4
26G spinal needle	23G Spinal needle
Midline approach with or without redirection	Paramedian approach

As shown in table 2 – criteria for easy or difficult spinal

Blinding-

MANUAL SCORE-The assessment of the manual score was done by an anaesthetist with an experience of 2-5 years.

ULTRASOUND SCORE-Patients underwent a pre-operative ultrasound scan of the lumbar spine using a USG machine (Arietta Hitachi S70) by a skilled anaesthetist with experience of more than 5 years and more than 50 ultrasound examinations of spine.

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PROCEDURE-A lumbar subarachnoid block was performed by another anaesthetist with an experience of 2-5years.

Anaesthetists assessing manual score, ultrasound score and performing the spinal block were not aware of each other's assessment of the patient.

STATISTICAL ANALYSIS

The presentation of the Categorical variables was done in the form of number and percentage (%). On the other hand, the quantitative data were presented as the means ± SD and as median with 25th and 75th percentiles (interquartile range). The data normality was checked by using Kolmogorov-Smirnov test. The cases in which the data was not normal, we used non parametric tests. The following statistical tests were applied for the results:

1. The association of the variables which were qualitative in nature were analysed using Chi-Square test.
2. Sensitivity, specificity, positive predictive value and negative predictive value was calculated of total manual score and ultrasound score for predicting difficult spinal anesthesia. McNemar test was used for comparison of sensitivity and specificity.
3. Inter-rater kappa agreement was used to assess strength of agreement between total manual score, total ultrasound score and easy/difficult spinal anesthesia.

The data entry was done in the Microsoft EXCEL spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, ver 25.0.

For statistical significance, p value of less than 0.05 was considered statistically significant.

OBSEVATIONS AND RESULTS

The study was conducted in Department of Anesthesiology and Critical Care,

Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pimpri, Pune. 200 male and female patients of age >20 years who had undergone orthopedic or urological procedures under spinal anaesthesia were included in the study. Manual and ultrasound scoring was done and results are as follows.

table 3:-Distribution of manual score of study subjects.

Manual score	Frequency	Percentage
Age(years)		
20-40	71	35.50%

41-60	75	37.50%
>60	54	27.00%
Mean ± SD	48.12 ± 16.4	
Median(25th-75th percentile)	47(34.75-63)	
Range	20-80	
Body mass index(kg/m²)		
<22 kg/m²	4	2.00%
22-27 kg/m²	122	61.00%
>27-34 kg/m²	71	35.50%
>34 kg/m²	3	1.50%
Mean ± SD	26.07 ± 2.51	
Median(25th-75th percentile)	26.15(24.2-27.8)	
Range	19-35.4	
Spinal bony landmarks		
Clear	166	83.00%
Unclear	34	17.00%
Spinal bony deformity		
No	198	99.00%
Yes	2	1.00%
Assessment of total manual score		
Difficult	37	18.50%
Easy	163	81.50%
Total manual score		
Mean ± SD	2.47 ± 1.22	
Median(25th-75th percentile)	2(1.75-3)	
Range	0-6	

75(37.50%) patients belonged to age group 41-60 years followed by 20-40 years [71(35.50%)]. Age group was >60 years of only 54 out of 200 patients (27.00

In majority [166(83.00%)] of patients, spinal bony landmarks was clear. Spinal bony landmarks was unclear in only 34 out of 200 patients (17.00%).

In majority [198(99.00%)] of patients, spinal bony deformity was absent. Spinal bony deformity was present in only 2 out of 200 patients (1.00%).

In majority [163(81.50%)] of patients, according to total manual score, spinal block was easy. According to total manual score, spinal block was difficult in only 37 out of 200 patients (18.50%). Mean value of total manual score of study subjects was 2.47 ± 1.22 with median(25th-75th percentile) of 2(1.75-3).

table 4:-Distribution of total ultrasound score of study subjects.

Total ultrasound score	**Frequency**	**Percentage**
Assessment of total ultrasound score		
Difficult	56	28.00%
Easy	144	72.00%
Total ultrasound score		
Mean ± SD	10.49 ± 3.26	
Median(25th-75th percentile)	11(7-13)	
Range	3-16	

In majority [144(72.00%)] of patients, according to total ultrasound score, spinal block was easy. According to total ultrasound score, spinal block was difficult in only 56 out of 200 patients (28.00%).

Mean value of total ultrasound score of study subjects was 10.49 ± 3.26 with median(25th-75th percentile) of 11(7-13)

Easy/difficult spinal anesthesia	**Assessment of total manual score**	**Assessment of total ultrasound score**
Sensitivity (95% CI)	35%(20.63% to 51.68%)	70%(53.47% to 83.44%)
Specificity (95% CI)	85.62%(79.22% to 90.66%)	82.5%(75.71% to 88.05%)
AUC (95% CI)	0.6(0.53 to 0.67)	0.76(0.70 to 0.82)

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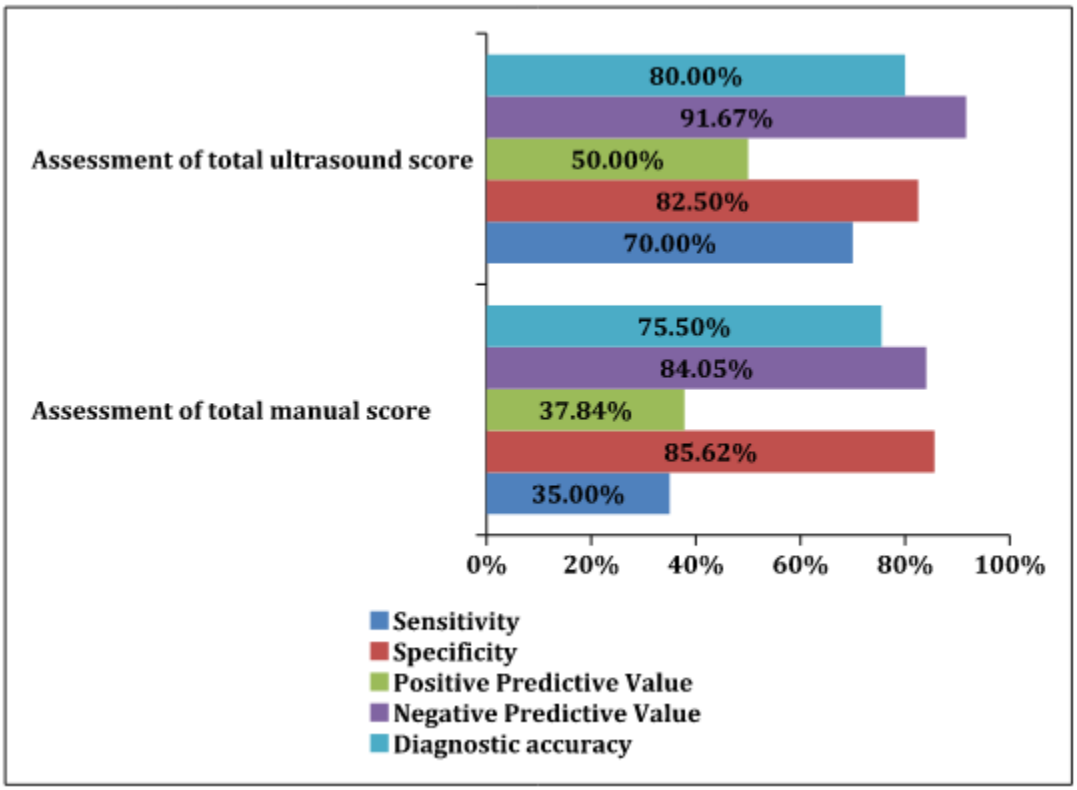
Positive Predictive Value (95% CI)	37.84%(22.46% to 55.24%)	50%(36.34% to 63.66%)
Negative Predictive Value (95% CI)	84.05%(77.51% to 89.31%)	91.67%(85.90% to 95.62%)
Diagnostic accuracy	75.50%	80.00%
p value of sensitivity	0.001	
p value of specificity	0.511	

table 5:-Sensitivity, specificity, positive predictive value and negative predictive value of total manual score and ultrasound score for predicting difficult spinal anesthesia.

Figure 1



Total ultrasound score had sensitivity of 70.00% followed by total manual score (35.00%). On the other hand, total manual score had specificity of 85.62% followed by total ultrasound score (82.50%). Highest positive predictive value was found in total ultrasound score (50.00%) and highest negative predictive value was found in total ultrasound score (91.67%).

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No significant difference was seen in specificity between total manual and ultrasound score. (p value=0.511) Sensitivity of total ultrasound score was significantly higher than total manual score (p value=0.001)

Table 6:- Inter-rater kappa agreement between total ultrasound score and total manual score.

Assessment of total manual score	Assessment of total ultrasound score		Total	P value	Kappa
	Easy(n=144)	Difficult(n=56)			
Easy	126 (63.00%)	37 (18.50%)	163 (81.50%)	0.0005	0.239
Difficult	18 (9.00%)	19 (9.50%)	37 (18.50%)		
Total	144 (72.00%)	56 (28.00%)	200 (100.00%)		

Fair agreement exist between assessment of total ultrasound score and assessment of total manual score with kappa 0.239 and p value 0.0005.

Among 144 patients diagnosed as easy via total ultrasound score, 126 patients had similar findings in total manual score. Among 56 patients diagnosed as difficult via total ultrasound score, 19 patients had similar findings in total manual score. Overall concordance rate was 72.50% and overall discordance rate was 27.50% between Assessment of total ultrasound score and Assessment of total manual score.

It is shown in table 13

Variables	Total ultrasound score
Total manual score	
Correlation coefficient	-0.601
P value	<0.0001

Table 7:-Correlation of total manual score with total ultrasound score.

DISCUSSION

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Difficulty in performing spinal anaesthesia /subarachnoid block due to various factors like age, deformity, landmark, and body habitus can be major factors in administering spinal anaesthesia and have been studied extensively. Similarly, recent advances in the use of ultrasound guidance and availability in the last 30 years have opened a newer area for research in assessing the difficulty of administering spinal anaesthesia as per ultrasound assessment of the spine.

Accurate preoperative assessment using a manual scoring technique that is both easy to perform and feasible has been used previously to increase accuracy. Due to the development of ultrasound use in anaesthesia a preoperative ultrasound spinal assessment has also been studied to identify the landmarks and to assess the ease of giving spinal anaesthesia thereby further trying to increase the accuracy of a single-shot spinal blockade.

The characteristics of the patients have been classified according to their age, BMI, spinal bony landmarks to assess interspinous space, and any spinal bony deformity like kyphosis, or scoliosis.

Similarly, for ultrasound examination, a posterior longitudinal ligament clarity from intravertebral levels L1-L5 on each side is calculated and tabulated.

MANUAL SCORING:

In this study, 75(37.50%) patients belonged to the age group 41-60 years followed by 20-40 years [71(35.50%)]. The age group was >60 years of only 54 out of 200 patients (27.00%). The mean value of age(years) of study subjects was 48.12 ± 16.4 with a median(25th-75th percentile) of 47(34.75-63.

Comparing to a study done by Atallah et al[8] on 300 patients subjected for urological procedures to assess the difficult predictors for performing a successful subarachnoid block. He found that age is not an independent predictor for difficult spinal anesthesia.

BMI:

In this study, a total of 200 patients were randomly selected and their BMI was calculated. In majority [122(61.00%)] of patients, body mass index(kg/m²) was 22-27 kg/m² followed by >27-34 kg/m² [71(35.50%)] and <22 kg/m² [4(2.00%)]. Body mass index(kg/m²) was >34 kg/m² of only 3 out of 200 patients (1.50%). Mean value of body mass index(kg/m²) of study subjects was 26.07 ± 2.51 with median(25th-75th percentile) of 26.15(24.2-27.8).

In a study done by Atallah et al[8] on 300 patients undergoing urological procedures, there was a positive correlation between the increase in BMI and the

difficulty in performing a successful subarachnoid block. BMI was an independent predictor for the difficulty in the subarachnoid block.

SPINAL LANDMARK:

In this study, a total of 200 patients were randomly selected and their spinal landmark was assessed. In the majority [166(83.00%)] of patients, spinal bony landmarks were clear. Spinal bony landmarks were unclear in only 34 out of 200 patients (17.00%). An increase in BMI also increased the nonpalpability of the interspinous space.

Observations made by Sprung et al[(81)] showed that interspinous landmark is an independent predictor of a difficult subarachnoid block.

De Oliveira et al[(9)] have concluded in their study that the successful location of the subarachnoid block at the first attempt is largely influenced by the quality of the patient's anatomical landmark, the adequacy of patient positioning and the provider's level of experience.

Karzzan M[(10)] has also observed that the spinal landmark is an important predictor of the difficult subarachnoid block.

In the majority [198(99.00%)] of patients, spinal bony deformity was absent. Spinal bony deformity was present in only 2 out of 200 patients (1.00%).

ULTRASOUND SCORING:

Mean value of L1-L2 left, L2-L3 left, L3-L4 left, L4-L5 left, L1-L2 right, L2-L3 right, L3-L4 right and L4-L5 right of study subjects was 1.64 ± 0.49, 1.35 ± 0.56, 1.19 ± 0.64, 1.06 ± 0.69, 1.52 ± 0.53, 1.43 ± 0.54, 1.22 ± 0.65 and 1.06 ± 0.65 with median(25th-75th percentile) of 2(1-2), 1(1-2), 1(1-2), 1(1-2), 2(1-2), 1(1-2), 1(1-2) and 1(1-1)respectively.

In the majority [160(80.00%)] of patients, spinal anesthesia was easy. Spinal anesthesia was difficult in only 40 out of 200 patients (20.00%).

The total ultrasound score had a sensitivity of 70.00% followed by a total manual score (35.00%). On the other hand, the total manual score had a specificity of 85.62% followed by the total ultrasound score (82.50%). The highest positive predictive value was found in the total ultrasound score (50.00%) and the highest negative predictive value was found in the total ultrasound score (91.67%). There is always a trade-off between sensitivity and specificity (any increase in sensitivity

will be accompanied by a decrease in specificity) so we choose that variable as best in which combination of sensitivity and specificity gives the maximum predictive value i.e. maximum diagnostic accuracy so overall total ultrasound score was the best predictor of difficult spinal anesthesia.

No significant difference was seen in specificity between total manual and ultrasound scores. (p value=0.511) The sensitivity of the total ultrasound score was significantly higher than the total manual score (p value=0.001)

Harsha H N and Deepa K (2019)[(11)] conducted a prospective observational cohort study on 60 patients more than 65 years of age to compare landmark-guided midline and ultrasound-guided midline techniques. In the ultrasound-guided group, successful dural puncture on the first needle insertion attempt was 90% compared to the anatomical-guided group with 50%.The study concluded that pre-procedure ultrasound imaging is a very useful tool to facilitate the performance of central neuraxial blockade in patients with difficult anatomical landmarks, especially in elderly patients.

CONCLUSION

As studied above the sensitivity of the total ultrasound score in assessing spinal anaesthesia is 70% with a specificity of 82.5% and the sensitivity of the total manual score is 35% with a specificity of 85.62%.

The highest positive predictive value was found in the total ultrasound score (50.00%) and the highest negative predictive value was found in the total ultrasound score (91.67%).

This indicates that the total ultrasound scoring system is a more sensitive marker for the ease and difficulty in performing spinal anaesthesia compared to manual scoring with a negative predictive value of 91.67% indicating that it is a valuable tool that can be used for the estimation of ease or difficulty in administering spinal anaesthesia via a preprocedural ultrasound examination.

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