ULTRASONOGRAPHIC GUIDANCE IN THE PREDICTION OF DIFFICULT SPINAL ANAESTHESIA IN OLDER PATIENTSS. Sree Ranjini¹, A. C. Malarvizhi²**HOW TO CITE THIS ARTICLE:**

S. Sree Ranjini, A. C. Malarvizhi. "Ultrasonographic Guidance in the Prediction of difficult Spinal Anaesthesia in Older Patients". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 30, July 28; Page: 8340-8354, DOI: 10.14260/jemds/2014/3052

ABSTRACT: Spinal anesthesia can be difficult especially in geriatric patients, due to age-related changes in the lumbar spine. Traditionally, surface anatomical landmarks have been used as a guide for directing the spinal needle in to the subarachnoid space, but many a time, this may be difficult as the landmarks may be difficult to palpate. Hence we wanted to test the efficacy of pre-procedural ultra-sound imaging to locate the ideal space for placement of the spinal needle. Our study included one hundred patients at or above the age of 55yrs undergoing elective surgeries under spinal anesthesia. They were divided in to 2 groups of 50 each. One group was given spinal anesthesia based on clinical parameters, while the other group based on ultrasound parameters and findings. The statistical analysis was carried out using SPSS 16 software. We observed that the number of attempts and the need to change the space or needle was much lesser in the ultrasound group. Hence we concluded that a pre-procedural ultra-sound imaging predicts difficult spinal anesthesia in older patients and can be utilized to locate the ideal space for placement of the spinal needle.

KEYWORDS: Ultrasound, difficult spinal, older patients.

INTRODUCTION: Placement of the spinal needle in to the subarachnoid space can be a challenging task especially in patients who are in the geriatric age group. Traditionally, surface anatomical landmarks have been used as a guide for directing the spinal needle in to the subarachnoid space, but many a time, this may be difficult as the landmarks may be difficult to palpate in the geriatric patients. Landmark-based approaches do not take into account all anatomical variations or abnormalities, and frequently lead to incorrect identification of a given lumbar inter vertebral space.^[1]

In the geriatric patients, even if the space is palpable by surface landmarks, still there exists the possibility of inability to get a spinal tap due to the fact that the ligaments underneath – especially the ligamentum flavum may be highly thickened or calcified or even ossified entirely or at certain regions; and thus prevent entry of the spinal needle in to the subarachnoid space, when a spinal tap is attempted through that space. Some studies have stressed the fact that the performance of spinal anesthesia is marginally more difficult in the elderly.⁽²⁾

Also, in addition to causing discomfort to the patient, multiple attempts at spinal needle placement can cause other complications associated with spinal anesthesia, such as a Post Dural puncture headache, spinal hematoma, transient neurologic sequelae etc. Hence this calls for the need of other techniques which can be an aid in spinal needle placement.

Pre-procedural ultra-sound imaging can be utilized to locate the ideal space for placement of the spinal needle. Certain studies have shown that a preliminary scout scan of the spine is helpful.^[3]

Hence we wanted to test the efficacy of using ultrasound in the location of the ideal space for placement of the spinal needle in older patients.

ORIGINAL ARTICLE

AIM OF THE STUDY: To locate the ideal space for placement of the spinal needle using ultrasound in patients aged 55 yrs and above.

MATERIALS & METHODS: Ours was a study in one hundred patients aged 55yrs and above undergoing elective surgeries under spinal anesthesia between March and December 2013. The study was initiated after obtaining ethical committee approval from Tagore Medical College Hospital. Written informed consent was obtained from all the 100 patients involved in the study.

INCLUSION CRITERIA:

- Age 55 - 90 years.
- ASA I, II patients.
- Undergoing Elective surgeries.

EXCLUSION CRITERIA:

- Coagulopathy.
- Local Infection.
- Neurologic Disease.
- Allergy to Local Anaesthetics.
- Previous spine surgery.
- Abnormalities of lumbar spine.
- Patient Refusal.

METHODOLOGY: Informed consent was taken. Clinical assessment was done by an anaesthesiologist with an experience between 5-10 years. Patient details such as Name, Age, Gender, Height, Weight and Body Mass Index were recorded. Routine clinical examination and relevant blood and radiological investigations were carried out as required.

The patients were then equally divided into two groups of fifty each, the group allocation based on their Age group – 55 to 70yrs & 71–90yrs, BMI - <25 & >25, gender and Atallahs difficult spinal anesthesia score (4). It is common knowledge that spinal anaesthesia becomes more difficult in people beyond 70 yrs, compared to people less than 70yrs of age. Hence we wanted to have an equal number of such patients in both the groups.

- Group A or clinical group – In this group, the operator only performs clinical examination of the lumbar spine at L2L3, L3L4, or L4L5 and ease of palpation of surface landmarks noted as easy or difficult or impossible to palpate. The operator then attempts spinal anaesthesia in the space chosen by clinical examination.
- Group B or ultrasound group – Ultrasound examination of the spine is done at L2L3, L3L4, or L4L5 spaces by a trained sonologist and the ideal space chosen. The operator then performs the spinal anaesthesia in the space chosen by ultrasound.

SPINAL ULTRASOUND STUDY: Ultrasound study is carried out in the ultrasound room in the operation theatre complex. The patients were placed in the sitting position and ultrasound examination done in the sitting position as this is the position in which spinal anesthesia was going to

ORIGINAL ARTICLE

be administered. We used a curvilinear 2–5 MHz transducer as this gives a wide field of view and deeper penetration, thereby providing good visualization of the structures. An initial depth was set at 10 cms and further; focus, gain and depth were adjusted to optimize image quality. The lumbar spine was imaged in two views, i.e., parasagittal oblique view and transverse midline views.

The probe was first placed over the sacrum and a horizontal hyper echoic line seen. The intervertebral levels were then identified by counting upwards from the sacrum. The distance from skin to ligamentum flavum-duramater complex (termed posterior complex or PC); distance from skin to anterior duramater, posterior longitudinal ligament and posterior aspect of the vertebral body (termed anterior complex or AC); distance between posterior and anterior complexes (AC-PC); as well as the interlaminar distances were measured.

The various measurements as mentioned above were done using the inbuilt electronic caliper in the ultrasound machine, at L2L3, L3L4 and L4L5 intervertebral spaces. A special note was made of the posterior complex hyperechocyt. Time taken for Ultrasound examination was also noted.

With the above data, the “Ideal space” was chosen by ultrasound. This being that space in which the posterior complex is not abnormally hyperechoic and the anterior complex beyond it can be visualised; the interlaminar spaces are wide and depth to the intrathecal space is less. This space is marked using skin marking pencil.

Patient is then shifted to the operating theatre. Spinal anesthesia is attempted, under complete aseptic precautions, in the “ideal” lumbar intervertebral space, in the operating room.

PERFORMING SPINAL ANAESTHESIA: All patients had a good IV access and attached to ECG, NIBP, and pulse oximetry. After routine skin preparation and full aseptic precautions with gloves, gown and mask, spinal anesthesia was performed in sitting position, by an anesthesiologist between 5-10 years' experience, using a 25-gauge sprotte spinal needle and by the median approach.

Any space – L2L3, L3L4, or L4L5; as chosen either by clinical examination in Group A or by ultrasound examination in Group B; was used for attempting spinal anesthesia. Each redirection of the needle was also considered as an attempt. If the operator failed initially, he or she was allowed to attempt a different lumbar inter vertebral space, make changes in the needle gauge, reposition the patient, call for assistance or abandon the procedure if deemed necessary.

MONITORED OUTCOMES:

- Spaces in which Spinal Anaesthesia was initially attempted.
- Final space in which Spinal Anaesthesia was performed.
- Total No. of needle insertion attempts.
- Need to change the space.
- Need to change the needle.
- Change of operator.
- Abandoning the procedure.
- Time taken for procedure.

A needle insertion attempt was defined as needle insertion proceeded by complete withdrawal of the spinal needle from the patient's skin. Any redirection that is any change in needle trajectory that did not involve complete withdrawal of the needle from the patient's skin, was also considered as an attempt.

ORIGINAL ARTICLE

Time taken for the spinal procedure is from the first needle insertion till completion of intrathecal injection.

STATISTICAL ANALYSIS: The data from Group A or clinical group and Group B or ultrasound group was subjected to statistical analysis. The statistical analysis was carried out using SPSS 16 software. We based the sample size calculation on previous studies⁽³⁾ in the general patient population, where first attempt success rates were 32% and 65% with the surface landmark-guided technique and ultrasound-guided technique, respectively.

The sample size was calculated to be 50 in each group (total 100) assuming an alpha error or confidence level of 5%. The statistical power being 92.2 %. Continuous data were tested for normality using the Shapiro–Wilk W statistic. Normally distributed outcome data were summarized as mean _ SD and were compared between groups using the independent-measures ‘t’ test at 95% confidence levels. Non-normally distributed data were summarized as median and were compared using the Mann–Whitney U test. A two-tailed P value less than 0.05 was taken to indicate statistical significance. The statistical analysis of our study is as follows:

Parameter	Group A	Group B
Age		
55-70 yrs	38	37
71-90 yrs	12	13
Gender		
Males	33	31
Females	17	19
BMI		
< 25	37	37
> 25	13	13
Difficult surface landmarks	16	16

Parameter	Group A	Group B	‘p’ value
Time for Spinal anesthesia	4.12 mins	2.012 mins	0.001
Average no. of attempts	4.24	2.52	0.027
Space change needed in	14	2	0.001
Needle change needed in	3	0	0.001

RESULTS: There was no statistically significant difference between Group A and B with respect to clinical parameters such as age, gender and BMI.

The average time taken for ultrasound examination was 5.0332mins.

Statistically significant difference was observed between group A and B with respect to clinical parameters such as; in the time taken for spinal anesthesia, the average no. of attempts, change of intervertebral space and needle. As seen from the table above, in Group A; the time taken for spinal anesthesia, the average no. of attempts, change of intervertebral space and needle were more and thus statistically significant as compared to Group B.

There was no change in operator or abandonment of the procedure in either group.

ORIGINAL ARTICLE

DISCUSSION: The first spinal anesthesia was administered in 1885 by James Corning, a neurologist in New York, when he accidentally pierced the duramater while experimenting with cocaine on the spinal nerves of a dog.⁽⁵⁾ The first planned spinal anesthesia was performed by Augustus Bier on 16th August 1898 using cocaine.⁽⁶⁾

Since then, spinal anesthesia as a technique has come a long way and with the introduction of newer and safer drugs; is now being extensively used for surgeries of lower limbs and abdomen.

All along, surface anatomical landmarks have been used as a guide for directing the spinal needle in to the subarachnoid space, but many a time, this may be difficult as the landmarks may be difficult to palpate in the geriatric patients. Landmark-based approaches do not take into account all anatomical variations or abnormalities, and frequently lead to incorrect identification of a given lumbar interspace.⁽¹⁾ Thus Landmark quality is the most significant predictor of difficult central neuraxial blockade.⁽⁷⁾

In addition to causing discomfort to the patient, multiple attempts at spinal needle placement can cause other complications associated with spinal anesthesia, such as a post dural puncture headache, spinal hematoma etc.

In the elderly, there is a general consensus on spinal anesthesia being more difficult to perform. According to a report by UN, India has around 100 million elderly at present and the number is expected to increase to 323 million by 2050, which is 20% of the total population. Increasing numbers of elderly people are undergoing surgeries due to increased health awareness and improvements in the field of medicine.

In the geriatric patients, even if the space is palpable by surface landmarks; on introducing the spinal needle, still, many a time we encounter resistance just a little below the skin. This is due to the fact that the ligaments may be highly thickened or calcified at certain regions and thus prevent entry of the spinal needle in to the subarachnoid space, when a spinal tap is attempted through that space. The performance of spinal anesthesia is marginally more difficult in the elderly.⁽²⁾

Additionally, neuraxial block is also said to be more difficult in the elderly because of a reduced ability to flex the lumbar spine.⁽²⁾

Hence this calls for the need of other techniques which can be an aid in needle placement. In the recent years, ultrasound is being used in anesthesia to aid central venous cannulation⁽⁸⁾ and also to facilitate needle placement for various peripheral nerve blocks.^(9,10)

Certain studies have shown that a preliminary scout scan of the spine is helpful.⁽³⁾ Ultrasound can also help in more accurate identification of the intervertebral levels.⁽¹⁾ Pre-procedural ultrasound imaging can be utilized to locate the ideal space for placement of the spinal needle. Additionally, ultrasound can be used to estimate the depth to the intrathecal or epidural space.⁽¹¹⁾

This in turn can help in the estimation of the needle insertion depth required to reach the intrathecal space.

It is especially of great benefit when the surface landmarks are indistinct or there is deformity of the spine.

A study by Chinn has also reiterated that ultrasound imaging facilitates Spinal Anesthesia in adults with difficult surface anatomic landmarks.⁽³⁾ Similarly there are multiple case reports which demonstrate the utility of ultrasound as a guide for performance of spinal anesthesia.^(12,13)

ORIGINAL ARTICLE

Pre-procedural ultrasound imaging is said to be of benefit when applied to obstetric epidural catheter insertion, reducing needle insertion attempts, block-associated pain and increase patient satisfaction.^[14,15]

Hence we wanted to test the efficacy of ultrasound in the location of the ideal space for placement of the spinal needle in geriatric population. We initially started our pilot study in patients over the age of 65yrs. But looking back, anesthesiologists had encountered difficulty even in patients who were in their 50s and hence we finally decided to conduct the study in patients at and above the age of 55yrs.

Our study group constituted one hundred ASA I, II patients, aged between 55–90 yrs undergoing elective surgeries under spinal anesthesia.

Patients who refused spinal anesthesia, had coagulopathy, local infection, neurologic disease, allergy to local anesthetics, had previous spine surgery or abnormalities of lumbar spine were excluded.

Informed consent was taken. Clinical assessment was done by an anesthesiologist with an experience between 5-10 years and patient details such as name, age, gender, height, weight and Body mass index (BMI) were recorded. BMI was calculated using the formula: weight in kg / height in meter square. Clinical examination & observations included abnormalities of the lumbar spine and ease of palpation of surface landmarks – a subjective assessment, marked as Easy / Difficult /impossible to palpate.

Atallah et al. have previously developed a difficulty scoring system for predicting difficult spinal anesthesia where patients are given a score ranging from 0 to 4 for each of the variables namely age, BMI, surface landmark palpability, spinal bony deformity, and radiological characteristics.⁽⁴⁾

But his studies as well as other studies by Sprung et al have shown that the ease of palpation of spinal bony landmarks classified as easy, difficult, or totally impalpable spinous processes, is the most significant independent predictor of difficulty with spinal anesthesia administration.^[4,16]

Based on this, 32% of our patients were found to be 'difficult'. There were 16 patients each in both the groups. Two patients had surface landmarks impossible to identify—a 72 yrs old obese female with a BMI of 40.42 and an 80yr male with a BMI of 26.

Pre-operative difficulty scoring was applied and used as one of the criteria for dividing these patients equally between both the groups in order to reduce bias.

The ultrasound assessment was carried out using Mind ray ultrasound. We used a curvilinear 2–5 MHz transducer as this gives a wide field of view and deeper penetration, thereby providing good visualization of the structures. An initial depth was set at 10cms and further; focus, gain and depth were adjusted to optimize image quality.

Acoustic impedance is the measure of resistance of a substance to propagation of sound wave through it. Acoustic impedance of bone is 7.80. In ultrasonographic picture, bony surfaces are hyperechoic and appear white. They completely obscure any deeper structures. Hence there is a dense acoustic shadowing beneath that appears black.

Connective tissue structures such as ligaments and fascia are also hyper echoic. Their acoustic impedance is 1.63. But since their acoustic impedance is lesser compared to bone, deeper structures can still be visualized through them. In certain patients, especially geriatric, the ligamentum flavum may be highly thickened and calcified, thus increasing the acoustic impedance.

ORIGINAL ARTICLE

This prevents the ultrasound beam from traversing through it and hence in such cases, prevents visualization of deeper structures.

Fat and Cerebrospinal fluid are hypoechoic i.e they have very low acoustic impedance (1.38) and hence appear black. The acoustic impedance of air is lowest at 0.0004.

The lumbar spine was imaged in two views, i.e., parasagittal oblique view and transverse midline views.

TRANSVERSE VIEW: The beam is orientated parallel to the transverse or horizontal plane in the interlaminar region. The shadow of the spinous process will give way to a vertical line. Beyond this are seen the other contents, namely the ligamentum flavum, posterior duramater, intrathecal space, anterior duramater, posterior longitudinal ligament and posterior aspect of the vertebral body in order. But they may not always be visible as separate structures due to limitations of ultrasound resolution and hence appear as a single linear structure. Grau and colleagues suggest that the ligamentum flavum and the dura are similar in density, and thus are iso-echoic in appearance in sonograms.^[15]

Echogenicity of a musculoskeletal structure can be differentiated by the “greyscale levels”. Strength of echos is indicated by proportional brightness of dots and small differences in acoustic impedance are displayed as if they were shades of grey. The human eye is unable to differentiate all the 256 greyscale levels that are displayed in a ultrasound image.^[17]

Defining echogenicity of a musculoskeletal structure by differentiating the greyscale levels qualitatively with the human eye, particularly when the greyscale levels between two structures are very similar, is inaccurate.^[18]

Hence ligamentum flavum - posterior duramater complex appear as a single linear structure and termed posterior complex or PC whereas anterior duramater, posterior longitudinal ligament and posterior aspect of the vertebral body appear as one structure and termed anterior complex or AC.

Certain researches have used computer-assisted greyscale analysis for differentiation between myopathies and neuropathies and this is said to be a very sensitive and quantitative method of analysing musculoskeletal ultrasound images.⁽¹⁹⁾ But a computer application for evaluation and analysis of greyscales of neuraxial structures is unknown and thereby the need to rely on the human eye.

Identification of an appropriate L3-L4 interspace is traditionally done using the iliac crest but a transverse scan can also be used for the same purpose and is much more accurate. Many studies have shown that clinical estimation of the lumbar intervertebral level using surface landmarks, such as the intercrystal line, is inaccurate.^(1,20) Certain other studies have shown that, when an error does occur in the clinical estimation of the lumbar intervertebral level using surface landmarks, such as the intercrystal line; the actual intervertebral level tends to be higher than presumed, rather than lower.^(21,22,23)

It has been suggested by Arzola et al that only a TM scan is sufficient when performing pre-puncture imaging for a midline approach to neuraxial blockade.⁽¹¹⁾ But we also performed a Para median sagittal oblique view scan wherein the beam is oriented in the sagittal plane of the spine lateral to the median and aimed towards the median plane.

ORIGINAL ARTICLE

This view allows us to identify the lumbar intervertebral levels and is useful in confirming the level identified on the transverse scan. The interlaminar distance can be calculated by this view.

Our ultrasound scan quality was good to very good, wherein we could clearly visualize the structures at 2 or all the 3 lumbar intervertebral spaces scanned.

The ultrasound study was carried out in the sitting position in the patients as this was to be the same position in which the spinal anesthesia was going to be performed. The various measurements were done using the inbuilt electronic caliper in the ultrasound machine, at L2L3, L3L4 and L4L5 intervertebral spaces. Time taken for Ultrasound examination was also noted. In our study, the average time taken was 4.5mins.

With the above data, the following information was deduced:

- **Suitability of a particular spinal space for giving spinal anaesthesia:** The nature of ligamentum flavum – whether highly thickened and calcified or not is determined. Thickening, calcification or even ossification; is determined by the fact that a hyperechoic picture is obtained and if so, the ultrasound beam does not pass through it and hence anterior complex cannot be visualised. The clinical significance of this fact is that, if the ligamentum flavum is very calcified, the spinal needle cannot pass through it and thus getting a spinal tap in that space can be difficult. Such spaces are avoided.
- **Depth of intrathecal space:** The distance to the intrathecal space can be calculated as follows:
 - Distance to mid-point of intrathecal space = (Skin – PC distance) + $\frac{1}{2}$ (PC – AC distance).
 - Using this information, the distance that the needle has to travel to reach the intrathecal space is determined.

The ligamentum flavum is a yellow elastic ligament extending from C2 to S1. It is longitudinally arranged. The normal ligament is highly elastic, with network of elastic connective tissue accounting for 60% to 70% of the dry weight and has very little blood flow. It functionally allows flexibility and stabilization of the spine.^(24,25)

However, with ageing, the viscoelasticity of the elastic fibers diminish but the normal longitudinal arrangement is maintained. There is a decrease in the number of elastic fibers and an increase in collagen fibers.⁽²⁶⁾ Fibrosis is the main cause of ligamentum flavum hypertrophy, and fibrosis is caused by the accumulation of mechanical stress with the aging process, especially along the dorsal aspect of the ligamentum flavum with TGF-beta released by the endothelial cells stimulating fibrosis, especially during the early phase of hypertrophy.⁽²⁷⁾

LF thickening can be secondary to facet degenerative changes, and inflammatory changes may be an inciting factor for LF thickening.⁽²⁸⁾ Recent studies have revealed that bone morphogenetic proteins and transforming growth factors play an important role in the matrix hyperplasia and ossification of the spinal ligament.⁽²⁹⁾

Ligamentum Flavum (LF) thickness is seen to increase with age. A study by Sakamaki et al showed that the thickening of LF at L4-5 had already started in patients in the 30-39 age bracket and increments at L4-5 and L3-4 were larger than that at L2-3 and L5-S1.⁽³⁰⁾ A study by Altinkaya also documented that LF thickness at all levels increased significantly with age.⁽³¹⁾ A study by Safak et al on the thickness of 1, 280 ligaments at the L4-L5 and L5-S1 levels using MRI concluded that there were no significant differences in LF thickness with respect to gender.⁽³²⁾

ORIGINAL ARTICLE

Altinkaya et al documented that patients with a BMI of 25 kg/m or greater had the thickest LF at the L3-L4 level. They also clarified that "LF thickness" and "LF hypertrophy" are used interchangeably in the literature, although they are not necessarily the same thing. Thickness may increase by buckling without a change in the mass of the LF, and whether LF thickening is due to tissue hypertrophy or buckling remains controversial.⁽³¹⁾

In addition to thickening, the LF can become calcified or even ossified, making spinal needle entry all the more difficult. Calcification is the process in which calcium salts build up in the LF and cause it to harden. Pathological calcification is observed when the vascularity of the LF is further reduced by the fibrosis, with advancing age. Calcification is relatively common with advancing age and is not found to cause neurological disturbances.

Ossification is a process of laying down new bone material and may occur in any region where there are fibroblasts and excess of calcium salts. Most of the published papers regarding Ossification of the ligamentum flavum (OLF) has been described especially in Japan and less common in non-Japanese people. Okada et al believe that hypertrophy of the ligamentum flavum precedes the development of Ossification (OLF).⁽³³⁾ Ossification of the ligamentum flavum (OLF) is a pathological condition that causes neurological symptoms (radiculopathy and/or myelopathy) and usually occurs in the thoracic and less frequently in the cervical spine.⁽³⁴⁾

Japanese investigators Inamasu et al. in 2006 found asymptomatic OLF to be a relatively common condition in the elderly population (6.2% in male and 4.8% in female patients).⁽³⁵⁾ A study by Kyongsong et al. in 2008 concluded that asymptomatic OLF occur in 38.5% in thoracic areas, 26.5% in lumbar and only 0.9% in cervical regions.⁽³⁶⁾

Another reason for calcified spine is Fluorosis, which is endemic in India. In the state of Tamilnadu, 9 districts namely – Krishnagiri, Dharmapuri, Erode, Salem, Coimbatore, Trichy, Madurai, Vellore and Virudhunagar districts are identified as Fluorosis affected. A government survey indicated that 93% of the population – both children and adults, in these areas had dental fluorosis. Skeletal fluorosis was seen in 33.8% of adults. Skeletal fluorosis occurs when Fluoride levels in water exceed 3-6mgF/lit and it affects the bones and spinal ligaments also.

In our study, 72 % of patients had hyperechoic LF that obscured all structures beyond in atleast 1 level, of the 3 levels ultrasonographically scanned and visualized. This usually occurred in patients of beyond 60yrs age group, equally common in males and females, more commonly in L3L4 level.

Thus by using ultrasound, we preferred to attempt spinal anesthesia in those spaces where all the structures could be clearly visualized and avoided spaces where hyper echoic LF prevented visualization of structures beyond it. As already mentioned, our ultrasound scan quality was good to very good, being performed by an experienced operator and hence the possibility of poor scan quality causing non visualization of spinal structures is ruled out.

The distance to the intrathecal space can be calculated using ultrasound, as follows:

- Distance to mid-point of intrathecal space = (Skin – PC) + $\frac{1}{2}$ (PC - AC).
- Using this information, the distance that the needle has to travel to reach the intrathecal space is determined.

In our study population, the depth of intrathecal space from the skin ranged from 3.1 cms to 7.23 cms. The antero posterior diameter of the thecal sac ranged from 5 to 10 mm, similar to certain

ORIGINAL ARTICLE

other studies.^(37,38) A variable degree of tissue compression occurs by the transducer during scanning and hence according to some studies, the antero-posterior diameter of the thecal sac may range from 6 to 12 mm.^(37,38)

“Ideal space” as chosen by ultrasound is that space in which the posterior complex is not abnormally hyper echoic and the anterior complex beyond it can be clearly visualized; the interlaminar spaces are wide and depth to the intrathecal space is less. This space is marked using skin marking pencil.

Group A constituted a total of 50 patients, of which, 38 patients were in the age group 55-70yrs and 12 patients in the age group 71-90 yrs. There were 33 males and 17 females. Group B constituted a total of 50 patients, of which, 37 patients were in the age group 55-70yrs and 13 patients in the age group 71-91 yrs. There were 31 males and 19 females. 74% of our patients had a BMI of less than 25 and the rest 26% had a BMI above 25 and up to 40, with an equitable distribution between both Group A and B. There was no statistical difference between the groups with regard to any of these parameters. This was expected, since the group allocation was based on their Age group – 55 to 70yrs & 71 – 90yrs; BMI - < 25 & > 25, gender and Atallahs difficult spinal anesthesia score.

In the group with a BMI above 25 and up to 40; there were 7 males and 5 females in the age group 55-70yrs and 1 female patient in the 71-90 yrs age group in Group A; versus; 5 males and 7 females in the age group 55-70yrs and 1 female patient in the 71-90yrs age group in Group B; making a total of 13 patients each, in group A and group B. Of these; there were 5 patients – 2 males and 3 females in the age group 55-70 yrs with a BMI more than 30 in Group A and 8 patients – 3 males and 4 females in the age group 55-70 and 1 female of 72 yrs, with a BMI of more than 30 in group B. This patient – a female aged 72yrs in group B had a BMI of 40.42, the highest in our study population.

Spinal anesthesia was performed in the operating room with all patients having a good IV access and being attached to monitors such as ECG, NIBP, and pulse oximetry. After routine skin preparation and full aseptic precautions with gloves, gown and mask, spinal anesthesia was performed in sitting position, by an anesthesiologist with 5 - 10 years' experience; using a 25-gauge spotte spinal needle and by the median approach.

As already mentioned, in Group A or clinical group, the operator attempts spinal anesthesia in any space - L2L3, L3L4, or L4L5 as chosen by clinical examination. In Group B or ultrasound group the operator attempts the spinal anesthesia in any space - L2L3, L3L4, or L4L5 as chosen by ultrasound. Each redirection was also considered as an attempt. If the operator failed initially, he or she was allowed to attempt a different lumbar inter vertebral space, make changes in the needle gauge, reposition the patient, call for assistance or abandon the procedure if deemed necessary.

The average time taken for spinal anesthesia was 4.12 mins and 2.012 mins in Group A and B respectively and the average number of attempts was 4.24 vs. 2.52 in Group A and B respectively, both being statistically significant.

Change in lumbar intervertebral space while performing spinal anesthesia was required in 14 patients (28%) in Group A and 2 patients (4%) in Group B, this being statistically significant. Of these 2 patients in Group B; one was a 72yr old female with a BMI of 40.42 and the other being a 55yr old female with a BMI of 31.99. A bloody tap was encountered in both these patients in the second attempt and hence the next best space as per ultrasound findings was tried and spinal tap successful in 6-7 attempts.

Spinal needle was changed to 23G from 25G in 3 patients in Group A following a number of

ORIGINAL ARTICLE

unsuccessful attempts with 25G whereas none of the patients required a needle change in Group B.

Weed et al. proposed a separate “difficulty” criteria where in spinal procedure is difficult if ≥ 10 needle passes are required or if associated with spinal needling time of >400 seconds or cases where CSF failed to be obtained; based on which they found 28% of their patients to be difficult when using a landmark based approach.⁽³⁹⁾

If this criteria was applied to our study population, we found that 17 patients (34%) in Group A or clinical group fell in the “Difficult” zone. But none in Group B required more than or equal to 10 needle passes or more than 400 seconds of spinal needling time as suggested by Weed for his difficulty criteria. A bloody tap was seen in the second attempt in 2 patients in Group B and hence the next best space as per ultrasound findings was tried and spinal tap successful in 6-7 attempts with a spinal needling time of less than 350 seconds.

Our first attempt success rate was 36% for Group A or clinical group and 58% for Group B or ultrasound group; similar to a study by Chinn Jinn⁽³⁾ wherein the authors conducted a similar study in 120 orthopedic patients and their first-attempt success rate was 65% - twice as high in group ultrasound than in Land Mark group (32%).

None of the patients in either of the groups needed a change in the operator and none of the procedures were abandoned.

The difficulty we faced when we attempted spinal anesthesia in older population and in older patients with BMI more than 25; was less in Group B; because ultrasound was used to determine the ideal space – a space in which the posterior complex is not highly thickened or calcified – a feature which makes spinal needle entry difficult; the space in which the interlaminar spaces are wide and depth to the intrathecal space is less. So the chance of failure of the procedure is also less.

Though we spent an average of 4.5mins for each pre procedural ultrasound study for Group B patients, this was offset by the fact that other monitored out comes fared far better compared to group A and patient satisfaction rate was higher in Group B.

However, the ultrasound-guided technique has its limitations. First being the learning curve. Interpreting the images needs training. We took the guidance of a trained sonoriologist and by the 15th scan, we could interpret the images with the same accuracy as the sonoriologist. Nevertheless he guided us all through the study.

The second limitation is obesity vs ultrasound scan quality. Stiffler et al evaluated the utility of ultrasound in identifying relevant anatomical structures - spinous processes and ITS for lumbar puncture and they concluded that the usefulness of ultrasound was inversely related to BMI.⁽⁴⁰⁾

Imaging the vertebral canal in obese patients can be difficult because a phase aberration effect caused by the varying speed of sound in the irregularly shaped adipose layers has been described.⁽⁴¹⁾ Perhaps more precise ultrasound machines manufactured in the future can overcome this limitation. Though 26% of our study population had a BMI of more than 25, with suitable adjustments in gain, focus etc, the quality of ultrasound image obtained by us was good enough to distinguish the various spinal structures.

Relation of age to ultrasound image quality of the spine is unknown. The other limitation in ultrasound usage is cost constraints which could prevent accessibility of this tool in many hospitals. Never the less, this is a very valuable skill to acquire and a useful tool especially for use in the older and obese patients.

Limitations of our study:

1. Our technique is limited by the fact that it is only a pre procedural scan and needle insertion is not guided by ultrasound in real-time.
2. We did not study the efficacy of ultrasound scanning when patients are placed in the lateral decubitus position.
3. We did not study the efficacy of ultrasound scanning when spinal needle was inserted via paramedian approach. Some studies have shown that the paramedian approach to surface land mark guided neuraxial blockade, is superior to the midline approach but some have not.^(42,43,44). According to Ki Jinn Chin et al,⁽³⁾ the appropriate needle trajectory in the paramedian approach is determined partly by triangulation based on the location of the spinous processes and the estimated depth to the vertebral canal and thus may offer little advantage in patients with poorly palpable surface landmarks.

INFERENCE / CONCLUSION: Pre-procedural ultra-sound imaging predicts difficult spinal anesthesia in older patients and can be utilized to locate the ideal space for placement of the spinal needle.

REFERENCES:

1. C. R. Broadbent, W. B. Maxwell, R. Ferrie, D. J. Wilson, M. Gawne-Cain, and R. Russell, "Ability of anaesthetists to identify a marked lumbar interspace," *Anaesthesia* 2000, vol. 55, no. 11, pp. 1122–1126.
2. Tessler MJ, Kardash K, Wahba RM, Kleiman SJ, Trihas ST, Rossignol M. "The performance of spinal anesthesia is marginally more difficult in the elderly." *Reg Anesth Pain Med* 1999; 24: 126–30.
3. Ki Jinn Chin, A. Perlas, V. Chan, D. Brown-Shreves, A. Koshkin, and V. Vaishnav, "Ultrasound imaging facilitates spinal anaesthesia in adults with difficult surface anatomic landmarks," *Anesthesiology* 2011, vol. 115, no. 1, pp. 94–101.
4. M. M. Atallah, A. D. Demian, and A. A. Shorrab, "Development of a difficulty score for spinal anaesthesia," *British Journal of Anaesthesia*, vol. 92, no. 3, pp. 354–360, 2004.
5. Corning J.L.N.Y.Med.J.1885, 42, 483 (reprinted in 'Classical File', *Survey of Anesthesiology* 1960, 4, 332)
6. Bier A.Versuche "uber cocainisierung des Rukenmarkes." *Deutsch Zeitschrift fur chirurgie* 1899; 51: 361 (translated and reprinted in 'Classical File', *Survey of Aneesthesiology* 1962, 6, 352)
7. de Filho GR, Gomes HP, da Fonseca MH, Hoffman JC, Pederneiras SG, Garcia JH. "Predictors of successful neuraxial block: a prospective study." *Eur J Anaesthesiol* 2002; 19: 447–51.
8. Hind D, Calvert N, McWilliams R, Davidson A, Paisley S, Beverley C, et al. Ultrasonic locating devices for central venous cannulation: meta-analysis. *BMJ* 2003; 327:361.
9. Karmakar MK, Kwok WH, Ho AM, Tsang K, Chui PT, Gin T. Ultrasound-guided sciatic nerve block: description of a new approach at the subgluteal space. *Br J Anaesth* 2007; 98: 390–5.
10. Karmakar MK, Ho AM, Li X, Kwok WH, Tsang K, Kee WD. Ultrasound-guided lumbar plexus block through the acoustic window of the lumbar ultrasound trident. *Br J Anaesth* 2008; 100: 533–7.

ORIGINAL ARTICLE

11. Arzola C, Davies S, Rofaeel A, Carvalho JC: Ultrasound using the transverse approach to the lumbar spine provides reliable landmarks for labour epidurals. *Anesth Analg* 2007; 104: 1188 – 92
12. Chin KJ, Macfarlane AJ, Chan V, Brull R: The use of ultrasound to facilitate spinal anesthesia in a patient with previous lumbar laminectomy and fusion: A case report. *J Clin Ultrasound* 2009; 37:482–5
13. O'Donnell D, Prasad A, Perlas A: Ultrasound-assisted spinal anesthesia in obese patients. *Can J Anaesth* 2009; 56:982–3
14. Grau T, Leipold RW, Conradi R, Martin E. Ultrasound control for presumed difficult epidural puncture. *Acta Anaesthesiol Scand* 2001; 45: 766–71.
15. Grau T, Leipold RW, Conradi R, Martin E, Motsch J. Efficacy of ultrasound imaging in obstetric epidural anesthesia. *J Clin Anesth* 2002; 14: 169–75.
16. J. Sprung, D. L. Bourke, J. Grass et al., "Predicting the difficult neuraxial block: a prospective study," *Anaesthesia and Analgesia* 1999, vol. 89, no. 2, pp. 384–389.
17. Russ JC. Acquiring Images. In Russ JC, *The Image Processing Handbook*, 5th ed., Chpt 1. Boca Raton, FL: CRC Press, 2007; 1–76.
18. Smith-Levitin M, Blickstein I, Albrecht-Shach AA, Goldman RD, Gurewitsch E, Streltsoff J et al. Quantitative assessment of gray-level perception: observers' accuracy is dependent on density differences. *Ultrasound Obstet Gynecol* 1997; 10: 346–9.
19. Maurits NM, Bollen AE, Windhausen A, De Jager AE, Van Der Hoeven JH. Muscle ultrasound analysis: normal values and differentiation between myopathies and neuropathies. *Ultrasound Med Biol* 2003; 29: 215–25.
20. Kim HW, Ko YJ, Rhee WI, et al. Interexaminer reliability and accuracy of posterior superior iliac spine and iliac crest palpation for spinal level estimations. *J Manipulative Physiol Ther* 2007; 30: 386–9.
21. Lirk P, Messner H, Deibl M, et al. Accuracy in estimating the correct intervertebral space level during lumbar, thoracic and cervical epidural anaesthesia. *Acta Anaesthesiol Scand* 2004; 48: 347–9.
22. Whitty R, Moore M, Macarthur A. Identification of the lumbar interspinous spaces: palpation versus ultrasound. *Anesth Analg* 2008; 106: 538–40.
23. Furness G, Reilly MP, Kuchi S. An evaluation of ultrasound imaging for identification of lumbar intervertebral level. *Anaesthesia* 2002; 57: 277–80.
24. Olszewski AD, Yaszemski MJ, White AA. The anatomy of the human lumbar ligamentum flavum: new observations and their surgical importance. *Spine*. 1996; 21: 2307–2312.
25. Yong-Hing K, Reilly J, Kirkaldy-Willis WH. The ligamentum flavum. *Spine*. 1976; 1: 226–234.
26. Kashiwagi K. [Histological changes of the lumbar ligamentum flavum with age] *J Jpn Orthop Assoc*. 1993; 67: 221–229.
27. Sairyo K, Biyani A, Goel V, Leaman D, Booth R Jr, Thomas J, Gehling D, Vishnubhotla L, Long R, Ebraheim N. Pathomechanism of ligamentum flavum hypertrophy: a multidisciplinary investigation based on clinical, biomechanical, histologic, and biologic assessments. *Spine (Phila Pa 1976)*. 2005 Dec 1; 30 (23): 2649–56.
28. F.H. Chokshia, R.M. Quencera and W.R.K. Smokerb The "Thickened" Ligamentum Flavum: Is It Buckling or Enlargement? *AJNR* 2010, 31: 1813–1816.

ORIGINAL ARTICLE

29. Ralph J. Mobbs , Marcel Dvorak b Ossification of the ligamentum flavum: Diet and genetics. *Journal of Clinical Neuroscience* (2007), 14: 703–705
30. Sakamaki T, Sairyo K, Sakai T, Tamura T, Okada Y, Mikami H. Measurements of ligamentum flavum thickening at lumbar spine using MRI. *Arch Orthop Trauma Surg.* 2009 Oct;129 (10):1415-9.
31. Altinkaya N, Yildirim T, Demir S, Alkan O, Sarica FB. Factors associated with the thickness of the ligamentum flavum: is ligamentum flavum thickening due to hypertrophy or buckling? *Spine (Phila Pa 1976)*. 2011 Jul 15;36(16):E1093-7.
32. Safak AA, Is M, Sevinc O, Barut C, Eryoruk N, Erdogmus B, Dosoglu M. The thickness of the ligamentum flavum in relation to age and gender. *Clin Anat.* 2010 Jan; 23(1): 79-83.
33. Okada K, Oka S, Tohge K, Ono K, Yonenobu K, Hosoya T: Thoracic myelopathy caused by ossification of the ligamentum flavum: Clinicopathologic study and surgical treatment. *Spine* 16:280-287, 1991.
34. Kruse JJ, Awasthi D, Harris M, Waguespack A. Ossification of the ligamentum flavum as a cause of myelopathy in North America: report of three cases. *J Spinal Disord.* 2000; 13: 22-25.
35. Inamasu J, Bernard G. A review of factors predictive of surgical outcome for ossification of the ligamentum flavum of the thoracic spine. *J Neurosurg Spine.* 2006; 5: 133-9.
36. Kyongsong K., Toyohiko I. Cervical ligamentum flavum ossification - Two case report. *Neurol Med Chir.* 2008; 48: 183-7.
37. Arzola C, Davies S, Rofaeel A, Carvalho JC. Anthropometric variables and lumbar dural sac width using ultrasound. *Can J Anesth* 2006; 53: 26291.
38. Arzola C, Balki M, Carvalho JC. The antero-posterior diameter of the lumbar dural sac does not predict sensory levels of spinal anesthesia for Cesarean delivery. *Can J Anesth* 2007; 54: 620–5.
39. J. T. Weed, A. H. Taenzer, K. J. Finkel, and B. D. Sites, "Evaluation of pre-procedure ultrasound examination as a screening tool for difficult spinal anaesthesia, " *Anaesthesia* 2011, vol.66, pp. 925–930.
40. Stiffler KA, Jwayyed S, Wilber ST, Robinson A. The use of ultrasound to identify pertinent landmarks for lumbar puncture. *Am J Emerg Med* 2007; 25: 331–4.
41. Saranteas T: Limitations in ultrasound imaging techniques in anesthesia: Obesity and muscle atrophy? *Anesth Analg* 2009; 109: 993– 4.
42. Blomberg RG, Jaanivald A, Walther S: Advantages of the paramedian approach for lumbar epidural analgesia with catheter technique. A clinical comparison between midline and paramedian approaches. *Anaesthesia* 1989; 44: 742– 46.
43. Rabinowitz A, Bourdet B, Minville V, Chassery C, Pianezza A, Colombani A, Eychenne B, Samii K, Fourcade O: The paramedian technique: A superior initial approach to continuous spinal anesthesia in the elderly. *Anesth Analg* 2007; 105: 1855–7.
44. Cook TM: Combined spinal-epidural techniques. *Anaesthesia* 2000; 55: 42– 64.

ORIGINAL ARTICLE

AUTHORS:

1. S. Sree Ranjini
2. A. C. Malarvizhi

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Anaesthesiology, Tagore Medical College, Rathinamangalam, Chennai.
2. Assistant Professor, Department of Anaesthesiology, Tagore Medical College, Rathinamangalam, Chennai.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. S. Sree Ranjini,
#275/276, 11th Cross,
Jayendra Nagar, Sembakkam,
Chennai 600073.
Email: dr.s.sreeranjani@gmail.com

Date of Submission: 08/07/2014.

Date of Peer Review: 09/07/2014.

Date of Acceptance: 15/07/2014.

Date of Publishing: 22/07/2014.