INTRODUCTION

Benign prostatic hyperplasia (BPH) is common in men above 60 years of age, and the incidental rate is around 60%. The incidence further increases to 90% when the age is 80 years and above. Transurethral resection of the prostate (TURP) is a surgical procedure most commonly done for BPH. The perioperative morbidity and mortality after this procedure is often high due to the high rate of comorbidities in the patients. Regional anaesthesia with subarachnoid block is the optimal choice of anaesthesia for these patients. The advantage of subarachnoid block over general anaesthesia is that transurethral resection syndrome can be identified earlier as the patient is conscious.

The bladder is innervated by sympathetic and parasympathetic fibres. Sympathetic fibres from T11 to L2 carry pain from bladder distension. Parasympathetic fibres from S2 to S4 carry stretch sensation. So, a regional block up to T10 level is sufficient for TURP.

Dural sac cross-sectional area measured using ultrasound to modify the dosage of local anaesthetic in spinal anaesthesia for transurethral resection of prostate surgery: A prospective, double blind, randomised controlled study

Ravikanth Pula, Sunanda Gooty, Nagarjuna Thakur, Sharathchandra B
ESIC Medical College and Super Speciality Hospital, Hyderabad, Telangana, India

ABSTRACT

Background and Aims: The area of lumbar spinal canal decreases with age, and hence the level of sensory blockade is higher in the elderly after spinal injection. The present study optimised the dose of local anaesthetic in elderly patients based on the lumbar dural sac cross sectional area (DSCSA) determined using ultrasound. Methods: Sixty patients of age above 60 years undergoing transurethral resection of prostrate (TURP) surgery in a tertiary care hospital were included in the study. Patients were categorised into two groups of 30 each based on a computer-generated random number table. In the control group (C), 2 ml of 0.5% hyperbaric bupivacaine was given and in the ultrasound group (U), the drug dose was modified according to DSCSA which was measured using the formula area = \( \pi \times \frac{diameter}{2} \)². Results: The DSCSA and bupivacaine dosage were significantly lower in group U compared to control group (\( P = 0.0001 \)). The maximal level of cephalad spread of sensory blockade was significantly lower in ultrasound group, than in control group (\( P = 0.002 \)). The two-segment block regression time and motor recovery time was less in group U. Higher mean arterial pressure (105.8 ± 9.66 mmHg; \( P = 0.007 \)), and a lower decrease from baseline (14.15 ± 7.55%; \( P = 0.041 \)) was noted in group U after subarachnoid block. Conclusion: The estimation of DSCSA is an effective parameter and can be used to modify the dose of local anaesthetic for subarachnoid block in elderly patients undergoing TURP surgery.

Key words: Anaesthesia, arterial pressure, bupivacaine hydrochloride, transurethral resection of prostate, ultrasonography
An increase in level of block above T10 may mask capsular perforation.

The most common risk factor after subarachnoid block is hypotension which may affect the functions of critical organs. As the systemic vascular resistance decreases by 25% in elderly patients, it is important to optimise the dosage of local anaesthetic for subarachnoid block. The concentration and volume of the drug used for subarachnoid block are major factors which affect the spread of local anaesthetic.

Previous studies have shown that dural sac cross sectional area (DSCSA) is a sensitive measurement parameter for lumbar canal stenosis, which is more common in the elderly. A 30% decrease in DSCSA is seen in patients with lumbar canal stenosis. DSCSA can be accurately measured by ultrasound imaging. The degree of lumbar canal stenosis can be evaluated by measuring sagittal antero-posterior diameter.

We decided to evaluate the effect of DSCSA based dosing of local anaesthetic in elderly patients undergoing TURP surgery with subarachnoid block.

**METHODS**

This was a prospective, double blind, randomised controlled study conducted in a tertiary care hospital from December 2020 to December 2021, after obtaining institutional ethics committee approval (ESCMC/SNR/IEC/-F0241/12-2020). A total of 60 patients were enrolled for the study after taking informed consent. Inclusion criteria for the study were patients of age more than 60 years and American Society of Anesthesiologists (ASA) physical status I–III undergoing TURP with subarachnoid block. The exclusion criteria were patient refusal for enrolment, infection at the site of injection, patients on anticoagulant therapy, patients with raised intracranial pressure. The study was conducted in accordance with the principles of the Declaration of Helsinki.

All the patients enrolled for the study were randomised and divided into two groups: ultrasound group (group U) and control group (group C) using a computer-generated random number table. G*Power software (ver. 3.1.9.7; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany; http://www.gpower.hhu.de/) was used to estimate the sample size. Based on the dosage of hyperbaric bupivacaine and sensory level in a previous study, and with an alpha error of 0.05 plus a power of 0.8, we got a sample size of 30 patients in each group. The patients were monitored using electrocardiogram, pulse oximeter (SpO₂) and non-invasive blood pressure once they were shifted into the operation theatre. A single anaesthesiologist performed all the intra-thecal procedures. Subarachnoid block was performed at L3-L4 space in sitting position using 27-gauge Quincke-Babcock needle. In group U, sagittal antero-posterior diameter of the dural sac was measured at L3-L4 space in sitting position by ultrasound (Mindray M7 Premium curvilinear probe 2-5 MHz, Shenzhen Mindray Bio-Medical Electronics Co., Ltd, PR. China). The dosage of hyperbaric bupivacaine was optimised in group U according to DSCSA measured using the formula \( A = \pi \left( \frac{D}{2} \right)^2 \), where diameter (D) is the distance between anterior complexes and posterior complexes. A baseline dose of 10 mg of hyperbaric bupivacaine was chosen for DSCSA of 150 mm². Based on the proportionate reduction in area, a decrease in the dose of hyperbaric bupivacaine was mathematically calculated. In group C, 2 ml (10 mg) of 0.5% hyperbaric bupivacaine was given (DSCA was considered as 150 mm²). Mean arterial pressure (MAP) and heart rate (HR) were measured every 2.5 min for up to 20 min, then every 5 min till 30 min, and were measured every 15 min until the end of surgery. Sensory blockade levels for the patients were measured every 2.5 min up to 30 min and every 15 min till the end of surgery, with a cotton swab soaked in alcohol. At the end of 20 min, if the level regressed below T10, patients were injected with fentanyl 1 µg/kg intravenously. Modified Bromage scale was used at every 2.5 min after spinal anaesthesia to measure the motor block.

The study aimed to modify the drug dosage of local anaesthetic in spinal anaesthesia based on DSCSA to achieve a T10 blockade. The primary objective was to compare sensory level, motor level and two segment regression time between ultrasound (U) group and control (C) group. The secondary objective was to compare intraoperative MAP and HR between and the groups.

Graphpad InStat version 3.0 (GraphPad Software, San Diego, CA) was used for statistical analysis. Demographic characteristics, ASA physical status, duration of surgery, dose of anaesthetics and DSCSA (mean ± standard deviation (SD)) were analysed using independent samples t-test. Sensory blockade level was assessed using Mann Whitney U test. \( P \) value < 0.05 was considered as statistically significant.
Pula, et al.: Dural sac cross sectional area to modify local anaesthetic dosage

RESULTS

A total of 72 patients were eligible for the study. About 6 among them refused to participate and other patients did not meet the ASA grade of inclusion criteria [Figure 1]. Demographic data, ASA status and duration of surgery were comparable between both the groups [Table 1]. DSCSA and bupivacaine dosage was decreased significantly in group U when compared to group C ($P = 0.001$).

The maximal level of sensory blockade was significantly lower in ultrasound group [median (interquartile range), T8 (T8–T10)], when compared to control group [T6 (T4–T10) ($P = 0.002$)]. Onset time to maximal sensory block was lower in group U [8.50 ± 2.97 min] compared to group C [10.25 ± 4.13 min], but the data did not show any statistical significance between the two groups. The two segments regression time of sensory block was delayed in group U than group C ($P = 0.001$). The total motor recovery time was also less in ultrasound group than control group [Table 2 and Figure 2].

MAP and HR were analysed for the first 30 min during surgery. There was no significant difference in the HR between the groups. A slightly higher MAP with statistical significance ($P = 0.007$) was noted in ultrasound group when compared to control group [Table 3, Figure 3a, b]. Maximal decrease in MAP after subarachnoid block i.e., percentage decrease from baseline value was high in group C (16.34 ± 10.07) than group U (14.15 ± 7.55; $P = 0.041$).

DISCUSSION

The study results showed that in the control group, cephalad spread of the drug reached a maximum level of T6, whereas in the ultrasound group, the cephalad spread reached a maximum level of T8 [Table 2]. A study conducted by Ipsita C et al. found that 7.5 mg of 0.5% bupivacaine was sufficient for a sensory block for TURP surgeries in elderly patients. As the same dose would be more in patients with lumbar spinal canal stenosis, and may lead to higher level of anaesthesia than required for the TURP, we followed the formula $A = \pi \left(\frac{D}{2}\right)^2$ to measure DSCSA and subsequently modified the dosage of hyperbaric bupivacaine.

In the study done by Wang WB et al., DSCSA in geriatric patients undergoing TURP was measured. They used isobaric bupivacaine for subarachnoid block and concluded that estimating DSCSA can reduce the dosage of the local anaesthetic agent required. In

| Parameters          | Group C (n=30) | Group U (n=30) | $P$  |
|---------------------|----------------|----------------|------|
| Age (years)         | 67.2±5.48      | 65.95±4.42     | 0.432|
| Weight (kg)         | 69.0±8.73      | 70.2±7.40      | 0.642|
| Height (cm)         | 160.25±7.54    | 163.35±8.47    | 0.229|
| ASA physical status | 2.1±0.64       | 2.05±0.69      | 0.814|
| Duration of surgery (min) | 50.85±6.38 | 50.9±7.65 | 0.982|
| DSCSA (mm$^2$)      | 150.0±0.0      | 110.45±23.09   | 0.0001*|
| Dose of the drug (mg) | 10.0±0.72     | 7.1±1.42       | 0.0001*|

Values expressed as Mean±SD. SD=Standard deviation, DSCSA=Dural sac cross-sectional area, ASA=American Society of Anesthesiologists, *$P<0.05$ considered as statistically significant
the present study, we used hyperbaric bupivacaine instead of isobaric bupivacaine. By measuring DSCSA, we have reduced the dose of hyperbaric bupivacaine required for TURP surgeries without any complications. Helill SE et al. compared hyperbaric bupivacaine versus isobaric bupivacaine for the level of anaesthesia.\(^8\) They concluded that hyperbaric bupivacaine can achieve higher level of blockade in comparison to isobaric bupivacaine with similar volume and dose. In the present study, we used hyperbaric bupivacaine at a lower dose to achieve the desired level for TURP surgery.

Young Su L et al. used DSCSA to predict lumbar canal stenosis and further concluded that DSCSA is a more sensitive measurement parameter to evaluate lumbar canal stenosis.\(^9\) Similarly, in the present study, we have estimated the DSCSA anticipating that with increasing age, the spinal canal narrows and in turn influences the dosage of the local anaesthetic administered. In the present study, in Group U, there is a clear-cut reduction in the dosage of the local anaesthetic given, which in turn reflected in the level of anaesthesia. Higher cephalad spread of anaesthesia increases the incidence of complications like bradycardia and hypotension and prevents detection of capsular rupture in TURP surgery. It is very important for the anaesthesiologist to consider the age of the patient to give a modified dose of drug to achieve an adequate level without complications.

It is observed that the DSCSA size is decreased by 30% in elderly patients when compared to a younger population. In group U patients, DSCSA was 110.45 ± 23.09 mm\(^2\) [Table 1]. Therefore, we suggest that DSCSA size can be measured before giving anaesthesia, and the dose can be adjusted based on its size to achieve optimal blockade and haemodynamic stability in elderly patients. Also, we suggest that a higher cephalad blockade level above T10 is not necessary for patients undergoing TURP surgery. A study has shown that a sensory block from T12–L1 was adequate for TURP patients.\(^7\)

In the present study, the change in MAP from baseline was lower in the ultrasound group than in the control group, indicating that hyperbaric bupivacaine is associated with lower incidence and severity of hypotension compared to isobaric bupivacaine.

**Table 2: Comparison of sensory and motor block**

|                          | Group C (n=30) | Group U (n=30) | P     |
|--------------------------|----------------|----------------|-------|
| Maximal sensory level    | T6 (T6–T10)   | T8 (T8–T10)   | 0.002*|
| Onset time to maximal sensory block (min) (mean±SD) | 10.25±4.13 | 8.50±2.97 | 0.132 |
| Regression of sensory block by 2 segments (min) (mean±SD) | 55.5±10.99 | 46.0±12.63 | 0.001* |
| Total motor recovery (min) | 175.3±41.07 | 142.0±34.78 | 0.0087* |

SD=Standard deviation, n=number, *P<0.05 considered as statistically significant

**Table 3: Haemodynamic characteristics**

|                          | Group C (n=30) | Group U (n=30) | P     |
|--------------------------|----------------|----------------|-------|
| Baseline MAP (mmHg)      | 97.8±8.08      | 105.8±9.66     | 0.007*|
| Baseline HR (beats/min)  | 86.05±9.40     | 86.15±15.09    | 0.980 |
| Maximal decrease in MAP  | 16.34±10.07    | 14.15±7.55     | 0.041*|

Values in the table are expressed as Mean±SD. MAP=mean arterial pressure, n=number, SD=standard deviation, HR=Heart rate. *statistically significant
The regression time was significantly lower in group C [Table 2].

TURP is commonly done in elderly patients aged above 60 years, and they often have other comorbidities. Therefore, it is important to control the level of blockade in these patients to maintain haemodynamic stability after subarachnoid block. Anaesthesiologists often face a dilemma in deciding the appropriate dose, as a lower dose of anaesthetic may produce an insufficient spinal block. However, this can be overcome by co-administering additive drugs like opioids to achieve the desired level of block. Nevertheless, some studies have shown complications like nausea, vomiting, excessive sedation, etc., with the co-administration of additive drugs.\textsuperscript{11-14}

The present study has limitations such as a lower sample size and inclusion of patients with moderate build. Nonetheless, the DSCSA in obese individuals can be analysed in further studies.

**CONCLUSION**

Ultrasound guided DSCSA measurement is an effective parameter for modifying the dosage of hyperbaric bupivacaine for subarachnoid block in elderly patients undergoing TURP surgery to achieve a sensory level of T10.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

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