Original Research Article

Comparison of effect of isobaric bupivacaine vs hyperbaric bupivacaine on haemodynamic variables in thorcic combined spinal epidural anaesthesia for laparoscopic cholecystectomies

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ABSTRACT

Background: Regional anaesthesia has always been an attractive option for laparoscopic surgeries in patients who are not fit for general anaesthesia. Also, regional anaesthesia has certain advantages over general anaesthesia like lesser oropharyngeal morbidity, lesser blood loss and decreased chances of thrombosis. Lumbar spinal anaesthesia has been synonymous with the term regional anaesthesia for laparoscopic surgeries for quite some time now. In the light of recent works by Imbelloni and Zundert, thoracic spinal anaesthesia has been shown to be a promising alternative not only for healthy patients but for high risk patients as well. Baricity defines the density of the drug with respect to CSF density. This undoubtedly makes it is one of the most important factors that influence drug distribution in the subarachnoid space. Drugs of differing baricities have been studied previously in lumbar spinal anaesthesia. We aimed at studying the behaviour of isobaric and hyperbaric bupivacaine using a different approach which in this study was thoracic combined spinal epidural anaesthesia. Authors evaluated the haemodynamic changes as well as neurological and any other post operative complications that occurred in any of the patients.
Methods: There were 60 ASA I and II patients undergoing elective laparoscopic cholecystectomy who were chosen for this study. They were randomly divided into two equal groups - group I and group H. Thoracic combined spinal epidural anaesthesia (CSE) was performed at T9-T10 / T10-T11 interspace. Patients in group I received 1.5ml of isobaric bupivacaine 0.5% (5mg/ml) + 25µg (0.5ml) of fentanyl and group H patients were given 1.5ml of hyperbaric bupivacaine 0.5% (5mg/ml) + 25µg (0.5ml) of fentanyl.
Results: There was no significant difference among the haemodynamic variables between the two groups and no neurological complication was seen in any patient.
Conclusions: Thoracic combined spinal epidural anaesthesia allows haemodynamic stability in laparoscopic cholecystectomies with minimal neurological and post operative complications irrespective of baricity of the drug used.

Keywords: Haemodynamics, Hyperbaric bupivacaine, Isobaric bupivacaine, Laparoscopic cholecystectomy, Thoracic combined spinal epidural anaesthesia

INTRODUCTION

Providing spinal anaesthesia by depositing drug directly into CSF via a needle inserted into subarachnoid space was introduced in1898 by August Bier. It was proposed that since the spinal cord ends at the level of L1 introducing the needle below this level would be safe as it greatly reduces the chances of damaging the neural tissue. Hence, for long lumbar subarachnoid space has

remained the conventional choice for performing as well as studying spinal anaesthesia.

In 1909, Jonnesco introduced puncture of the spinal cord at two levels- high puncture (T1-T2) and low puncture (T12-L1).[1] However, the idea of introducing the needle above the cord termination was criticised and rejected for the fear of spinal cord injury. Recently the anatomy of the spinal cord was investigated using MRI by Lee and Imbelloni.[2,3] It was found that the spinal cord runs straight through the vertebral column. Thus, there is relatively more distance between the posterior surface of the cord and the surrounding meningeal tissue at the midthoracic level in the apex of thoracic kyphosis. This indicates that there is a greater margin of safety in introducing a needle in thoracic thecal space than in the lumbar thecal space. These findings were further substantiated by studies which show that the incidence of paraesthesias with thoracic puncture is half that seen with lumbar puncture.[4] The thoracic approach has now been shown to be a safe and effective alternative to lumbar approach for administering regional anaesthesia. It has been shown to provide rapid onset, haemodynamic stability and faster recovery of the block.[5]

Drugs of different baricities have been studied previously in lumbar spinal anaesthesia.[6,7] These studies showed hyperbaric drug to produce a greater spread and thus greater haemodynamic changes than the isobaric drug. Thoracic thecal space is different from lumbar in that there is lesser CSF volume and thoracic roots are thinner than lumbar.[8,9] Hence, in this study we aimed at evaluating the effect of drugs of different baricities on haemodynamic variables in thoracic combined spinal epidural anaesthesia. Also, this study aimed at evaluating the incidence of paraesthesias and any neurological or other post operative complications with the thoracic approach.

METHODS

The study began after obtaining approval from institutional ethical committee. Inclusion and exclusion criteria were defined for the selection of patients for the study. Inclusion criteria selected were -ASA1 and 2 patients aged 18-65 years and with BMI <30kg/m^2. Exclusion criteria were patients belonging to ASA status 3 and 4, acute inflammation of the gall bladder and pancreas, cardiac patients and obese patients with BMI >30kg/m^2. All of them were informed in detail about the procedure and written and informed consent was obtained from all of them. The patients were then divided randomly by computer generated numbers into two equal groups.

Patients were premedicated with tablet alprax 0.25mg and pantoprazole 40mg on the night prior to surgery. The next day patients were shifted to pre operative room where an 18 gauge IV cannula was secured. Pre-loading with Ringer lactate was started at 20ml/kg over 30 minutes. At the same time pre medication was given with Ondansetron 0.1mg/kg and Ranitidine Hydrochloride 50mg intravenously. Patients were then counselled about thoracic spinal epidural and informed about the probability of conversion to GA, if needed.

Patients were then shifted to the operation theatre. All routine monitoring namely, non invasive blood pressure (NIBP), pulse oximetry (SpO$_2$), end tidal Carbon dioxide (ETCO$_2$) and electrocardiogram (ECG) was started. Prior to instituting the block inj. Midazolam 1mg i.v. was given to the patient.

In all the patients CSE was performed in the sitting position. The space chosen was either T9-T10 or T10-T11 interspace. The CSE block was administered using portex combined spinal/epidural minipack with 27 G lock pencil point spinal needle and 18 G Tuohys epidural needle. Group I received 1.5ml (7.5mg) of isobaric preservative free bupivacaine 0.5% (5mg/ml) + 0.5ml (25μg) of Fentanyl through the spinal needle. While in case of group H, 1.5ml (7.5mg) of 0.5% hyperbaric bupivacaine (5mg/ml) and 0.5ml (25μg) fentanyl was given into the subarachnoid space. The epidural catheter was then threaded into place through the tuohys needle and fixed at 4cm within the epidural space.

Immediately, the patient was made to lie supine with a 10 -20 degrees head down tilt. Oxygen at four to five litres/minute was given to the patient by the face mask.

Onset of sensory block (sensation to pinprick with hypodermic needle) and motor block (modified Bromage scale) was assessed. Surgery was commenced once a target sensory block of T4-T12 was achieved. If the desired sensory block height was not attained after 15 minutes, 4-8ml saline epidural top up was given to extend the block.

Limiting intra-abdominal pressure to a maximum of 10 mm Hg helped in decreasing the diaphragmatic irritation due to pneumoperitoneum. The same was also achieved by providing minimal right up tilt to the table. Also, after visualising the abdominal cavity the surgeon sprayed 10ml 1% lidocaine under the right side of the diaphragm. This was to further decrease the chances of shoulder pain due to diaphragmatic irritation.

Intraoperatively all the haemodynamic parameters -heart rate, SBP, DBP, MAP were monitored every two minutes for first ten minutes, then every five minutes for next fifteen minutes and thereafter every ten minutes till the completion of surgical procedure.

Inj. Midazolam 1mg intravenous boluses upto a total of 5mg was used to treat intraoperative anxiety. For patients who complained of shoulder pain Fentanyl 25μg intravenous boluses were used upto a total of 100μg. Any event of hypotension (decrease in mean arterial pressure more than 20% from baseline value) was treated with

fluid bolus 10ml/kg ringer lactate or Mephentermine 6mg boluses upto total 30mg and bradycardia (heart rate below 20% of baseline) with atropine 10µg/kg intravenously. The patients were monitored in PACU till sensory level regressed two dermatomes below the peak block height.

Post operatively epidural catheter was used for analgesia top-up using 5ml of 0.125% Bupivacaine when VRS score >3. The catheter was then removed the next morning after surgery. The patients were discharged 24 hours post surgery after excluding any post operative complications and neurological sequelae.

The follow-up of patients was done telephonically on 3rd and 7th postoperative day and they were inquired about postdural puncture headache (PDPH), any neurologicaldeficit/symptom or any other complication.

RESULTS

A total of 60 patients were enrolled in the study and no patient was excluded. No difference was observed in the demographics between the groups with respect to gender, age, height and weight. (Table 1). The non parametric data was compared using Chi-square test and Mann-whitney U test. Parametric data was analysed using student t test using SPSS 16.0 software.

Table 1: Demographics comparison between the two groups.

	Hyperbaric bupivacaine	Isobaric bupivacaine	P value	Significance
Age	46.33	45.30	0.724	NS
Weight	71.83	69.81	0.457	NS
ASA (1/2)	18/12	17/13	0.634	NS
Sex (F/M)	17/13	15/15	0.342	NS

NS-nonsignificant; S-significant

The observed overall incidence of paraesthesia was 4%. Thoracic combined spinal epidural block was performed in the first attempt in 55 patients at T9-T10 interspace and in the remaining five patients after the failure of the first attempt a second attempt was made at T10-T11 interspace.

The comparison of perioperative characteristics between the two groups has been discussed in Table 2. The preoperative heart rates between groups A and B were found to be comparable. The heart rates at different time intervals intra-operatively were comparable between the two groups with no significant difference. Bradycardia occurred in 2 (6.6 %) patients in the isobaric group and 1 (3.3%) patient in hyperbaric group, the difference was statistically insignificant (P=0.284) (Table 2). Overall incidence of bradycardia in this study was 5% which responded to a single dose of atropine.

The comparison of Systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP) between groups A and B showed that the difference in SBP, DBP and MAP pre-operatively was comparable and statistically insignificant. Intraoperatively there was no significant difference in SBP, DBP, MAP between the two groups (Table 2). No episode of hypertension was recorded in any of the patients. The overall incidence of hypotension was 15%. All of them responded to fluid bolus and none required mephenteramine.

No patient developed nausea, vomiting or pruritis during the surgical procedure. The overall incidence of shoulder pain was 16.6%.

No patient developed headache. All patients developed spinal anesthesia; there were no patchy blocks and in no case conversion to GA was done (Table 2). No patient who experienced paresthesia complained of neurological symptoms at follow-up. There were no serious complications such as epidural hematomas, infection, or permanent nerve injuries in any patient (Table 2).

Table 2: Characteristics in perioperative period.

	Hyperbaric group	Isobaric group	P value	Significance
Surgical time (min)	25	27	0.42	NS
Shoulder pain (no. of patients)	4	6	0.53	NS
Hypotension (%)	13.3%	16.67%	0.512	NS
Bradycardia (%)	3.33%	6.67%	0.284	NS
Conversion to GA	nil	nil		
Neurological complications	nil	nil		

NS-nonsignificant; S-significant

DISCUSSION

Imbelloni et al, studied the distance between the duramater and spinal cord at 2nd, 5th and 10th thoracic segments.[2] It was found that the maximum separation between the cord and duramater occurred at T5. Thus, it was found that there is greater depth between posterior surface of spinal cord and dura at T2, T5 and T10. He further concluded that the oblique placement of thoracic vertebral spines necessitates 45 degree angle of needle introduction. This further increases the distance between the neddle tip and the cord. Lee et al, investigated the anatomy of the spine in different postures- sitting, lateral decubitos and supine.[3] They found that sitting (head down) posture increases the thoracic curvature of the spine. This further increases the posterior separation of the duramater and spinal cord hereby increasing the margin of safety. Hence in this study thoracic CSE was

performed in the sitting position. The tenth interspace was chosen as it lies in the center of the surgical field as shown by Zundert et al.[10] Furthermore use of a CSE system limits the length of needle which can project beyond the tip of the epidural needle thus minimizing the risk of contact with neural tissue.

The high index of safety afforded by the thoracic puncture is reflected in the very low incidence of paraesthesias in this study - 4%. This is similar to the low incidence of 6.6% observed by Imbelloni et al, who performed low thoracic puncture in 300 patients.[4] Also there were no post operative neurological complications in any patient in this study which again confirms the high index of safety in performing thoracic CSE.

Cause of hypotension in spinal anaesthesia is blockade of sympathetic efferents. This results in vasodilatation with corresponding decrease in venous return. Hypotension is a well known adverse effect of spinal anaesthesia. It is however easily overcome by the administration of vasopressors and fluid boluses, and therefore it does not essentially affect the planned procedure. Cause of bradycardia in patients under thoracic CSE is sympathectomy induced blockade of the cardioaccelerator fibres arising from T1 to T4. The heart rate may also decrease because of a fall in right atrial filling (due to vasodilatation), which decreases outflow from intrinsic chronotropic stretch receptors located in the right atrium and great veins. The second effect may be less prominent theoretically in patients under thoracic spinal as compared to lumbar spinal because of less extensive vasodilatation due to segmental blockade.

Baricity is the ratio of density of local anaesthetic to density of CSF. This means baricity determines how dense (heavy) the drug is compared to CSF. Thus, it becomes one of the important factors to influence the drug distribution once it enters the thecal space. If more segments are blocked, it means more sympathocoliosis, more vasodilatation and hence more haemodynamic changes as shown by Solakovic N.[11] Hyperbaric drug is heavier than CSF. So, it follows the curvatures of the spine and tends to gravitate to the dependent regions of the vertebral column. The lumbar lordosis produces "splitting" of the local anaesthetic solution with some portion flowing caudad toward the sacrum and the remainder flowing cephalad into the thoracic kyphosis. This explains bimodal distribution of block with hyperbaric solution; one group with blocks centered in the low thoracic region and a second group with blocks centered in the high thoracic region.[12,13] Thus hyperbaric drug results in greater spread which translates into greater sympathectomy and eventually greater haemodynamic changes.

On the other hand, isobaric drug is of the same density as CSF which means gravity and spinal curvatures have minimal effect on its distribution. Thus, isobaric drug remains in the vicinity of the site of administration.

Hence lesser segments are blocked producing lesser haemodynamic changes.

The behaviour of drugs of different baricities have been studied previously in lumbar spinal anaesthesia and the results have been highly variable. While some show hyperbaric drug to produce greater haemodynamic variability than isobaric whereas others show no significant haemodynamic difference between the two.[6,7,14] In contrast to the variable results obtained in lumbar spinal anaesthesia, the findings seen with thoracic spinal anaesthesia have been uniform.

There was no significant difference in the haemodynamic variables between the two groups in this study. The overall incidence of bradycardia was 5% and hypotension was 15%. Our findings are similar to Imbelloni et al, who while comparing isobaric and hyperbaric bupivacaine in thoracic spinal anaesthesia for orthopaedic surgeries found that neither of the drug produced significant haemodynamic changes.[15] This haemodynamic stability has been observed by many workers as an advantage of thoracic spinal anaesthesia. Imbelloni et al, while comparing conventional dose and low dose bupivacaine in spinal anaesthesia for laparoscopic cholecystectomy concluded that thoracic approach allowed a lower drug dose to be used because of the proximity of the site of drug injection to the target dermatomes to be blocked.[16] Low-dose spinal anaesthesia provided better hemodynamic stability, less hypotension, and a shorter duration of sensory and motor block than with the conventional-dose spinal anaesthesia.

The low incidence of haemodynamic variability in this study can be explained by the fact that thoracic approach allows a lower drug dose to be used because of the proximity of the site of drug injection (T9-T10/T10-T11) to the target dermatomes (T4-T5). This has advantage of limiting sympathectomy to fewer segments with consequent less vasodilatation and thus less haemodynamic changes.

Also, thoracic thecal space has lesser CSF producing minimal dilution of the drug and the thoracic roots being thinner are more prone to easy blockade.[9] These factors decrease the dose of drug required to produce efficient and desired block level. Lesser drug dose and lesser segments blocked means more haemodynamic stability.

CONCLUSION

Thoracic spinal epidural anaesthesia administered in laparoscopic cholecystectomies allows haemodynamic stability irrespective of baricity of the drug used.

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