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Comparative assessment of 2-chloroprocaine versus hyperbaric bupivacaine for administration in subarachnoid block for pregnant females undergoing elective caesarean section

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Abstract
Characteristics may limit its use for ambulatory surgery, including delayed ambulation, risk of urinary retention, and pain after block regression. The changing trend of surgical practice from an inpatient to outpatient convention has urged us to modify our anesthetic drug to suit the ambulatory setting. The primary goal of ambulatory anesthesia is rapid recovery leading to early patient discharge with minimal side effects. Hence based on above findings the present study was planned for Comparative Assessment of 2-Chloroprocaine 1% versus Hyperbaric Bupivacaine 0.5% for Administration in Subarachnoid Block for Pregnant Females Undergoing Elective Caesarean Section.

The present study was planned in Department of Anaesthesiology and Critical Care, Darbhanga Medical College and Hospital, Darbhanga, Bihar, India. Total 80 females undergoing the elective lower segment caesarean surgery under subarachnoid block were enrolled in the present study. The females were divided on two study groups as Group I and Group II. Group I females were injected 2.5 ml of 1% preservative free 2-chloroprocaine and Group II were injected 2ml of 0.5% hyperbaric bupivacaine intrathecally. Patient in sitting or lateral position with the help of an assistant, under aseptic precaution and draping subarachnoid block was performed using 25 G Quincke's spinal needle at L3 -L4 or L2 -L3 spinal inter space and after ensuring free flow of clear CSF.

The data generated from the present study concludes that low dose 1% 2-chloroprocaine 25 mg can be a good alternative to 0.5% hyperbaric bupivacaine 10 mg for intrathecal use in an uncomplicated elective lower segment caesarean section.

Keywords: 2-Chloroprocaine, Hyperbaric bupivacaine, Subarachnoid block, Lower segment caesarean section, etc

Introduction

Subarachnoid (spinal) block is a safe and effective alternative to general anesthesia when the surgical site is located on the lower extremities, perineum (eg, surgery on the genitalia or anus), or lower body wall (eg, inguinal herniorrhaphy). Because of the technical challenges of readily identifying the epidural space and the toxicity associated with the large doses of local anesthetics needed for epidural anesthesia, spinal anesthesia was the dominant form of neuraxial anesthesia well into the 20th century [1].

Subarachnoid block can be used as the sole source of anesthesia. Alternatively, spinal and epidural anesthesia can be used jointly, taking advantage of the qualities of both techniques: the rapid, dense sensorimotor blockade of a spinal anesthetic and the opportunity to redose the patient with an epidural catheter anesthetic. [2].

Spinal anesthesia produces intense sensory and motor blockade as well as sympathetic blockade. As opposed to epidural anesthesia, in which medications are instilled outside the dura mater, the goal of spinal anesthesia is to instill the desired medications into the cerebrospinal fluid (CSF). The sensorimotor block produced requires smaller doses of local anesthetics (hence, local anesthetic toxicity is rarely a concern) and is often more dense in character.

Although the focus of this topic is subarachnoid block, comparison with epidural anesthesia may be informative. For instance, brief periods (less than 24 hours) of postoperative analgesia can be facilitated by adding an opioid to the local anesthetic injected into the cerebrospinal fluid. Prolonged postoperative analgesia is best ensured by insertion of an epidural catheter, using an opioid and local anesthetic combination infused continuously over the first few postoperative days. See the table below for a comparison of subarachnoid and epidural anesthesia.

Spinal anesthesia is a safe and effective alternative to general anesthesia when the surgical site is located on the lower extremities, perineum (eg, surgery on the genitalia or anus), or lower body wall (eg, inguinal herniorrhaphy). Cesarean deliveries are routinely performed under spinal anesthesia, as are total hip arthroplasty and total knee arthroplasty [3-4].

Advantages include avoidance of general anesthesia and the airway management concerns that accompany general anesthesia. However, that is not to suggest that spinal anesthesia is always the best course in a patient likely to have difficulties with endotracheal intubation. All patients with difficult airways, no matter what anesthetic plan is chosen, should have a well thoughtout plan for airway management, should it be needed.

Additional benefits may include reducing the metabolic stress response to surgery, reduction in blood loss, decrease in the incidence of venous thromboembolism, reduction in pulmonary compromise (particularly in patients with advanced pulmonary disease), and the ability to monitor the patient’s mental status.

Strong contraindications include patient refusal, lack of patient cooperation, difficulties with positioning, and increased intracranial pressure. Other contraindications include situations that require some risk-benefit analysis include hypovolemia, coagulation disturbances, stenotic valvular disease, bacteremia, and infection at the site of needle insertion.

Spinal anesthesia has also been noted to result in symptomatic deterioration in patients with multiple sclerosis [5]. Patients with chronic low back pain may decline spinal anesthesia out of concerns for increased low back pain. Performing spinal anesthesia in patients with degenerative lumbar spine disease or a prior history of lumbar surgery may prove technically difficult, but these are not necessarily contraindications.

Allergy to local anesthetics may also be a contraindication, but true allergies are usually found with ester-based local anesthetics (eg, tetracaine), not the amide-based local anesthetics (eg, bupivacaine), so finding a suitable local anesthetic is not challenging [6, 7].

Although one-shot injection techniques are the norm, continuous spinal anesthesia has enjoyed periods of popularity while also being demonized. In the early 1990s, spinal microcatheters (27-G) were introduced but were followed by an increased incidence of postoperative cauda equina syndrome [8]. In cases in which cauda equina syndrome developed postoperatively, microcatheters were used; in response to an unsuitable rise in anesthetized dermatomal levels, unusually large of doses of local anesthetics (usually lidocaine) were administered to effect a sufficient spinal anesthetic.

What may have happened was that insufficient turbulence was created through injection through the microcatheter, the local anesthetic pooled distally in the lumbar intrathecal space (below the natural lumbar lordosis), and with repeated local anesthetic doses, administered in hopes of advancing the dermatomal level of local anesthetic effect, toxic local anesthetic levels were created in the region of the cauda equina.

Continuous spinal techniques may be regaining a slow resurgence in popularity, but patients should be carefully chosen. Instead of microcatheters, larger conventional epidural catheters should be used. Because of the larger rent in the dura, postdual puncture headache is an increased risk; therefore, patients who are less likely to have postdual puncture headache, such as older patients, are better candidates. The wisdom that excessive doses of local anesthetics are best not injected into the intrathecal space has been hard earned [9].

With any sympathectomy, blood pressure is expected to decrease secondary to increased venous capacitance and decreased peripheral vascular resistance. Incidence of hypotension is estimated at 35%. Bradycardia secondary to blockade of sympathetic-mediated cardioaccelerator nerves (T1-T4) may contribute to decreased cardiac output. The incidence is around 13%, and bradycardia is more likely to be found in children or adults with baseline heart rates less than 60 per minute and may be reversed with the anticholinergic medications atropine or glycopyrrolate [10].

Even in patients with ischemic heart disease, cardiac output appears maintained [10]. It is important but as yet unclear what level of blood pressure is appropriate under subarachnoid block. As this remains unclear, practitioners will invariably choose to support the patient’s blood pressure through use of vasopressor medications (the mixed alpha- and beta-agonist ephedrine and/or the alpha-agonist phenylephrine) and intravenous fluids. However, the value of intravenous fluid resuscitation in supporting blood pressure has been in dispute [11]. Perhaps because of the rapid redistribution of crystalloid out of the intravascular space, preloading the patient with these solutions may have minimal benefit for prevention hypotension. Prehydration with colloid solutions may be more effective. In a study of pregnant patients undergoing spinal anesthesia for cesarean section, having patients sit up for 5 minutes before placing them supine reduced requirements for intravenous fluids andephedrineanddecreased nausea, vomiting and dyspnea [12].

Tidal volumes tend to remain unchanged during subarachnoid block, although expiratory reserve is diminished secondary to paralysis of abdominal musculature. The gut is contracted due to unopposed parasympathetic activity. Hyperperistalsis may contribute to nausea and vomiting but, perhaps more commonly, nausea and vomiting are indicators of hypotension. Renal function is preserved.

Although hypotension and bradycardia are most likely to occur soon after performance of the subarachnoid block, the vasodilated state persists throughout the spinal anesthetic. Hence, blood loss secondary to the surgical procedure must be closely monitored and replaced with a balanced crystalloid or colloid solution or packed red blood cells if the blood loss is severe.

Major complications with subarachnoid block are rare [13]. Should local anesthetic reach the brainstem, the patient may develop dysphonia, dyspnea, progressive upper extremity weakness, experience loss of consciousness and loss of airway protection, and require definitive airway control. Hypotension, bradycardia, and cardiac arrest are also risks. Respiratory arrest may be secondary to hypoperfusion of brainstem respiratory centers. Pupillary dilation in the setting of loss of consciousness suggested the diagnosis of "total spinal."

Once the airway is controlled and the patient mechanically ventilated, attention should be directed towards addressing significant changes in heart rate or blood pressure as described previously. Total spinals tend to be short in duration; not uncommonly, once the surgery is complete the total spinal has resolved, the patient’s mentation has returned, and the patient may be extubated.

Concerningly, patients under spinal anesthesia are more sensitive to sedation and are at increased risk of respiratory depression. Caplan *et al* published a review of otherwise healthy patients who experienced cardiorespiratory arrest [14]. Despite being otherwise healthy and having witnessed cardiac arrest, outcomes were devastating. Many died and most of the remainder were discharged to assisted living settings with persistent neurologic complications. This altered sensitivity to sedative medications was later verified [15]. The purported mechanism was loss of peripheral input into the brainstem center responsible for maintaining arousal (the reticular activating system).

Caplan *et al* also identified the difficulty in resuscitating patients under spinal anesthesia. These vasodilated patients do not respond to conventional doses of pressor medications as outlined in traditional Advanced Cardiac Life Support algorithms and are a reflection of basically different mechanisms leading to cardiac arrest in the perioperative environment [16].

Other complications include direct injury to spinal nerves, postdural puncture headache, neuraxial hematoma, meningitis or neuraxial abscess, adhesive arachnoiditis and cauda equina syndrome, and transient neurologic syndrome. Because these patients become vasodilated, they are at risk for hypothermia; active warming measures should be employed on these patients just as they are in patients receiving general anesthesia. The hypothermia is due to vasodilation as well as loss of thermoregulation.

The incidence of postdural puncture headaches after spinal anesthesia is about 1%. Because of the larger needles used for epidural anesthetics, the incidence of postdural puncture headaches (should the dura mater be pierced) is higher with epidural anesthetics. Postdural puncture headaches are associated with leakage of cerebrospinal fluid. They tend to be intense, positional (worse when upright), and often localized to the occipital region and neck. Diplopia (thought secondary to traction on the sixth cranial nerve) and blurred vision may be reported. The frequency is increased in women, younger patients, parturients, and obese patients.

The incidence of postdural puncture headaches with spinal anesthesia has been decreasing recently due to changes in the shape of spinal needles. Previously, the needles were beveled, but now they tend to be shaped like a pencil point. The rent in the dura is associated with less leakage of cerebrospinal fluid.

Before the diagnosis of postdural puncture headache is made, other causes of severe headache (hypertension or other central nervous system maladies) should be considered and pursued if necessary. Treatment of postdural puncture headache consists of hydration, analgesics, and caffeine, given either orally or parentally. If conservative therapy fails, epidural blood patches are indicated and result in improvement in headache in over 90% of patients affected [17].

Much attention has been given to considering whether spinal (or epidural) anesthesia is appropriate in patients receiving anticoagulants. The American Society of Regional Anesthesia has led educational efforts in this regard [18]. Whether regional anesthesia can be safely undertaken while the patient is anticoagulated is a function of the dose of the particular medication and frequency of dosing, whether more than one anticoagulant is being administered concurrently, and the time since the last anticoagulant dose.

In general, as the patient receives more medications with bleeding potential, the lower the platelet count (eg, less than 75-100 per mm3). In the presence of hepatic or renal disease or other conditions that affect coagulation, any neuraxial technique becomes more contraindicated. Obviously, analysis of coagulation function is necessary in many of these patients.

In comparison to an epidural technique that can be performed at any level of the vertebral column, spinal anesthetics are always performed below L1 in an adult and L3 in a child to avoid needle trauma to the spinal cord. A useful landmark is the line from the top of both iliac crests, which coincides with the L3-L4 interspace. Either a midline or paramedian approach can be used.

The patient may be placed in either the lateral decubitus position or sitting up with support from an assistant. Many favor the sitting position because it facilitates more accurate identification of the spinal anatomy. This position is definitely preferred when only dense blockade of the perineal anatomy is needed. However, an advantage of the decubitus position is the ability to more easily sedate the patient. Occasionally, spinal anesthetics are performed in the prone position. The patient is asked to curl his or her back dorsally, opening up the vertebral interspaces.

The goal is to inject the chosen medication(s) into the cerebrospinal fluid-filled subarachnoid space. To achieve this, the spinal needle will pass through skin, subcutaneous tissue, supraspinous ligament, interspinous ligament, ligamentum flavum, dura mater, and subarachnoid membrane.

Spinal anesthesia is a reliable and safe technique for perianal surgeries. Nevertheless, some of its characteristics may limit its use for ambulatory surgery, including delayed ambulation, risk of urinary retention, and pain after block regression. The changing trend of surgical practice from an inpatient to outpatient convention has urged us to modify our anesthetic drug to suit the ambulatory setting. The primary goal of ambulatory anesthesia is rapid recovery leading to early patient discharge with minimal side effects. Hence based on above findings the present study was planned for Comparative Assessment of 2-Chloroprocaine 1% versus Hyperbaric Bupivacaine 0.5% for Administration in Subarachnoid Block for Pregnant Females Undergoing Elective Caesarean Section.

Methodology

The present study was planned in Department of Anaesthesiology and Critical Care, Darbhanga Medical College and Hospital, Darbhanga, Bihar, India. Total 80 females undergoing the elective lower segment caesarean surgery under subarachnoid block were enrolled in the present study. The females were divided on two study groups as Group I and Group II. Group I females were injected 2.5 ml of 1% preservative free 2-chloroprocaine and Group II were injected 2ml of 0.5% hyperbaric bupivacaine intrathecally. Patient in sitting or lateral position with the help of an assistant, under aseptic precaution and draping subarachnoid block was performed using 25 G Quincke's spinal needle at L3 -L4 or L2 -L3 spinal inter space and after ensuring free flow of clear CSF.

Results & Discussion

Spinal anaesthesia is often addressed as one of the most desired modes of delivering anaesthesia due to its high reliability, straightforward technique, avoidance of undesirable complications of general anaesthesia, in addition to being more economical. Quest for search of an ideal spinal anaesthetic possessing qualities of rapid onset, minimal complications and rapid recovery to enable faster ambulation and discharge, has been long underway. 5% Lidocaine, owing to its rapid onset and potency, was widely used to achieve subarachnoid block for ambulatory procedures in the past. However, reports of neurologic deficits associated with spinally administered lidocaine generated concern regarding the potential toxicity of this agent [18]. Additionally, the recognition that transient neurologic symptoms (TNS) often occurred following spinal administration of lidocaine, prompted more enthusiasm to search for better alternatives [19].

Bupivacaine has been employed commonly for sub arachnoid block. However, with the emerging trends and inclination towards ambulatory surgeries favouring early discharge, the long duration of action of this drug does not make it a popular choice for the same [20].
Chloroprocaine, an amide local anaesthetic has a profile resembling that of lidocaine in terms of onset and duration. Doses varying between 30 to 60 mg produce therapeutic effects similar to lidocaine [21]. However, neurologic injury had been identified in about 8 cases who were given a chloroprocaine solution contained sodium bisulfite as the preservative via epidural route, limiting the use of this drug in clinical practice.
Majority of infra-umbilical surgeries are done under spinal anesthesia as a first technique of choice, as it is easy to administer, less expensive, blunts stress response to surgery, provides good intra and post-operative analgesia without sedation and avoid the hazards associated with general anesthesia [22] including sore throat, airway trauma and muscle pain. Unfortunately, there is no local anesthetic that provides spinal anesthesia with early onset, adequate duration and depth, early recovery and freedom from the side effects [23-24].
Due to its early onset and shorter duration of action, intrathecal lignocaine has been used since years as first choice of local anesthetic but its major disadvantage was transient neurologic symptoms (TNS) which restricted its use in spinal anesthesia nowadays [25].
As an alternative to lignocaine, smaller doses of hyperbaric bupivacaine have been used but its major disadvantage was prolonged motor block and insufficient analgesia along with retention of urine post operatively which lengthen the patient stay in hospital [26].
Amino-ester local anesthetic 2-chloroprocaine has early onset and short duration of action. Several case reports of neurological toxicity were noted in 1980, due to inadvertent intrathecal 2-chloroprocaine injections intended for epidural delivery [27] which was attributed to its preservative sodium bisulphite. 1% 2-chloroprocaine preservative free is available as 10 mg/ml solution now a days, which is approved for intrathecal use.

Table 1: Demographic Detail

Group	Group I	Group II
Cases of	**2-Chloroprocaine**	**Bupivacaine**
No. of Cases	**40**	**40**
Age: 18 – 25 years 26 – 30 years 31 – 35 years	 16 8 16	 20 9 11
ASA Status Type I Type II	 32 8	 28 12
Weight Kg	56 – 71	57 – 69
Height cm	151 – 159	152 – 160
Duration of Surgery mins	16 – 31	21 – 33
Duration of Analgesia mins	39 – 85	128 – 208

Table 2: Side Effects

Group	Group I	Group II
Cases of	**2-Chloroprocaine**	**Bupivacaine**
No. of Cases	**40**	**40**
Hypotension	25	22
Bradycardia	8	8
Nausea	4	2
Vomiting	2	7
Transient neurological symptoms	1	1

Literature suggests a dose ranging between 30 and 60 mg of CP for procedures lasting 60 min or less, while 10 mg is considered the no-effect dose, there are only few studies in literature which have compared these two drugs but we tried comparing minimum dose of each drug required to achieve spinal anesthesia sufficient for perianal surgeries.
The incidence of postoperative pain can be effectively decreased by prolonging the sensory block and thus providing better postoperative analgesia by addition of adjuvants such as fentanyl to ropivacaine as found in a study conducted by Seetharam and Bhat, consistent with our study findings [28].
Previous studies of 2-CP suggested that 40 mg would be the minimum dose required to achieve a reliable and sufficient sensory and motor block for short duration surgeries. Ben David *et al*. showed that hyperbaric bupivacaine 7.5 mg was sufficient to provide satisfactory anesthesia for arthroscopic knee surgery. Hence, the dose of local anaesthetic administered in our study was clinically equivalent and efficacious [29].
In an attempt to find the minimum effective dose for intrathecal injection, Kopacz tested 10 and 20 mg of plain 2-CP. The lower dose, 10 mg, should be considered the no-effect dose for spinal anesthesia, though it provided some transient motor weakness. Similarly, the 20 mg dose did not reliably produce dense motor block, even though it was able to produce a cephalad level of sensory anesthesia of at least L1 in all subjects [30].
Casati *et al* tested three different doses (30, 40, and 50 mg) for intrathecal administration in 45 patients undergoing elective lower limb procedures lasting less than 60 minutes and with a required dermatomeric level at T10. As expected, spinal block resolution and time to recovery of ambulation results were dose-related. Casati *et al* included patients undergoing procedures lasting between 45 and 60 minutes, finding that 33% of patients in the 30 mg group required intraoperative analgesic supplementation as a result of insufficient analgesia. The authors concluded that the 30 mg dose may not be suitable for lower limb procedures lasting ≤60 minutes [31].
Our study was limited by a few factors. We did not follow up the patients beyond the period of their discharge from the hospital through follow up phone calls to evaluate any neurologic toxicity or other adverse effects. (Even though none of the patients had any complaints pertaining to anaesthesia during their surgical outpatient department follow up).

Conclusion

The data generated from the present study concludes that low dose 1% 2-chloroprocaine 25 mg can be a good alternative to 0.5% hyperbaric bupivacaine 10 mg for intrathecal use in an uncomplicated elective lower segment caesarean section.

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