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Review Article

CONTINUOUS SPINAL ANESTHESIA: A NEED FOR A RE-EMERGENCE?

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ABSTRACT

Continuous spinal anaesthesia is the technique of producing and maintaining spinal anaesthesia with small doses of local anaesthetic injected intermittently into the subarachnoid space through a catheter. As the injection is intermittently given than continuous, intermittent or fractionated spinal anaesthesia is a more appropriate word than the routinely used continuous spinal anaesthesia. The history starts from 1906 when it was administered first by Henry Dean. There are numerous surgical and obstetric indications for the use of the same apart from chronic pain. The indications may be numerous but in certain clinical situations like previous spinal surgery, significant cardiac disease, morbid obesity, difficult airway and difficult epidural catheter placement; it may prove more beneficial. The equipment may be cumbersome in some instances, but the use of epidural catheters instead of routinely described spinal catheters has made a breakthrough. The detailed advantages outweigh complications. Flow of cerebrospinal fluid as a definite end point, complete muscle relaxation and a titrated lesser drug dosage are its clear advantages. The use of lower concentration of local anaesthetic drugs is certain to decrease the neurological complications. Still there is a thought block among anaesthesiologists about the incidence of headache and infections after its use which has been proved to be less. With the resurgence of regional anaesthesia worldwide, the technique needs to have a re-emergence to be more commonly used in the coming years.

Keywords: Anesthesia, Regional, Continuous spinal.

HISTORY

Continuous spinal anesthesia (CSA) as an alternative to general anesthesia (GA) is a method almost as old as the technique of spinal anesthesia itself. August Bier described the first spinal anesthetic with cocaine in 1899 and in 1906 Henry Percy Dean described a technique in which spinal anesthesia could be extended [1,2]. Philadelphia surgeon, William Lemmon devised an apparatus for CSA in 1940 [3]. Lemmon began with the patient in the lateral position. The spinal tap was performed with a malleable silver needle, which was left in position. As the patient was turned supine, the needle was positioned through a hole in the mattress and table. Additional injections of local anesthetic could be performed as required. In 1944, Edward Tuohy of the Mayo Clinic introduced two important modifications of the continuous spinal techniques [4]. He developed the now familiar Tuohy needle as a means of improving the ease of passage of lacquered silk ureteral catheters through which he injected incremental doses of local anesthetic. The number of failures, the technical problems, the degree of trauma, and the increased likelihood of loss of cerebrospinal fluid (CSF) inherent in the methods of CSA put the same into a long period of quiescence. To counter the above problems, in 1987, Hurley and Lambert reported their work on the successful use of a micro-catheter in CSA [4]. Rigler *et al*. reported four cases of cauda equine syndrome (CES) with CSA to put the brakes on its development [5]. Palmer successfully administered CSA for 300 parturients with the use of 28 G catheters [6]. With a lot of potential and proved advantages, CSA still continues to throw inhibitions in the minds of practitioners regarding post-dural puncture headache (PDPH) and neurological damage.

INDICATIONS

The indications may be primarily divided as follows [5]:

a. Surgical
b. Obstetric
c. Pain relief.

The easier technique, extended duration, guaranteed analgesia, minimal hemodynamic, and respiratory disturbance makes it the method of choice in patients undergoing major lower abdominal and lower limb surgeries with cardio respiratory diseases. The possibility of titrated local anesthetic injection and its cardiac benefits suits even in trauma patients. Labor analgesia can be provided with either an opioid-only technique or with an opioid–local anesthetic combination. CSA can also be used for high-risk cesarean patients [7] Post-operative pain relief can be given through intrathecal catheters either as intermittent injections or infusion. The use of opioids and local anesthetics are reported [8]. The mixtures of morphine–bupivacaine and morphine buprenorphine have been used for weeks in chronic pain relief for cancer patients [9,10].

Successful CSA in a cesarean section for a 29-year-old primigravida parturient with a history of a scoliosis operation at the level of T3-L3 is reported [7]. A patient with an obstructed femoral hernia and intercurrent respiratory failure was successfully anesthetized with continuous spinal technique [11]. The technique provided excellent intra-operative anesthesia and early post-operative analgesia, while avoiding further respiratory compromise. CSA has an important role in selected patients with cardio respiratory disease undergoing laparotomy that would be considered unlikely to survive GA [12].

EQUIPMENT AND TECHNIQUE

Equipment for CSA ranges from a standard epidural (macro catheter) to specially designed spinal micro-catheters [13,14]. A standard epidural catheter can be used for CSA because it enables easy aspiration of CSF to confirm its correct position and better mixing of local anesthetic with CSF. Catheters range from 18 to 20 G. Pediatric epidural catheters of 24 G are also used for CSA. It's sometimes difficult for some practitioners to puncture deliberately the dura with epidural needles because of a traditional mental block. Different types of specially designed spinal micro-catheters of varying gauges are available, and they all fulfill similar purposes but preferences differ [15]. They are simply divided as.

Catheter over needle set

A catheter over needle set is marketed as Spinocath. The kit consists of a 22-gauge catheter which is mounted on a 27 G Quincke needle or a 24 G catheter mounted on a 29 G Quincke needle. The Quincke needle has a fluid exit side hole that lays within the catheter, and, in addition, the needle is connected to a braided wire. The kit also contains an 18G epidural needle which is used to access the epidural space. The spinal needle, with the catheter mounted on it, is fed through it in a manner similar to needle through needle technique used for combined spinal epidural (CSE) anesthesia. Once the dura is punctured, the needle is advanced a little. CSF is detected within the catheter, as it emerges from the fluid exit side hole in the Quincke needle. The braided wire is withdrawn which also pulls back the Quincke needle leaving the catheter within the intrathecal compartment. The epidural needle is taken out with the catheter connected to a filter ready for use [16]. Possible advantages of this technique include an unequivocal endpoint of catheter placement because of CSF aspiration with less incidence of PDPH. The postulated reason is that CSF does not leak because the dural hole created by the Quincke needle is sealed by the wider bore catheter.

Catheter through needle set

Catheters are available in varying sizes ranging from 25 to 32 G. Although these catheters have metal stylet introducers, on occasion they are difficult to insert, and they kink easily if force is exerted during insertion. Once inserted, it is difficult to aspirate CSF from the catheter. However, if sufficient time is allowed, an occasional CSF dripping may be seen from the end of the catheter [16]. Although CSF emergence is an unequivocal end point of a spinal catheter placement, but in routine clinical practice this could be impractical. It is possible to overcome any resistance encountered during insertion of a 28-gauge catheter by removing the catheter from the needle, withdrawing the needle slightly confirming CSF flow and then reinserting the catheter. The second option is to inject a small amount of local anesthetic via the spinal needle and then insert the catheter. The potential disadvantage of the first approach is that if the needle is accidentally withdrawn more than intended, the hole of the Sprotte needle may still be half way through the dura and the catheter may coil up in the epidural space. The potential disadvantage of the second technique is that the injected drug may not displace the possible blocking tissue and that the catheter needs to be secured in a time prior to the onset of the full motor block. If not secured in time, an unsteady motor blocked patient may make positioning for surgery difficult. Another concern is that the catheter may still not have been positioned in the subarachnoid space, so that once the effect of the initial drug wears off, additional doses given via the catheter will be ineffective. This will create a situation of starting GA. If there are definitive concerns in the institution of GA, access to the subarachnoid space can be attempted again. Although there are conflicting reports, no matter which catheter is inserted, it is better to insert the catheter in the sitting position. Insertion of a catheter more than 3 cm into the subarachnoid space increases the chance of a catheter being caudally directed. In addition, curled up catheter may snare nerve roots on its removal. Pooling of local anesthetic in the sacral sac is a potential unsafe consequence of a caudally directed catheter. Because a high concentration of local anesthetic confined to a small area has the potential to inflict neurotoxic damage to the cauda equine. The direction taken by the catheter cannot be anticipated, and that the final position of its tip does not influence the distribution of hypobaric local anesthetics in the subarachnoid space. However, the high incidence of inadequate determination of the level of lumbar puncture, associated with the cephalad threading of a catheter, can represent a potential risk of damage to the spinal cord [17].

Epidural catheter inside needle technique

The catheter is inserted into the subarachnoid space after a deliberate dural puncture with an epidural needle. It is suggested that the bevel of the epidural needle should be such that the puncture is made parallel to the dural fibers. These sets are widely available, and little additional training is required for those familiar with inserting a normal epidural catheter. CSF aspiration gives an unequivocal confirmation of catheter placement in the correct location [18].

The other method is as follows: A 22-gauge Touhy epidural needle is inserted at the L3-4 interspace into the subarachnoid space. A 27-gauge catheter can be inserted through the needle into the subarachnoid space. The difference is the type of the catheter.

After confirmation of aspiration cerebral spinal fluid through the catheter, 2.5 mg of plain bupivacaine 0.5% is injected through the catheter. After assessment of systemic blood pressure and sensory level, a second dose of 2.5 mg of plain bupivacaine 0.5% was given 5 minutes later. Five minutes after the second dose, 2.5 mg plain bupivacaine can be administered if the required anesthetic level is not achieved. The addition of opioids like fentanyl is usually done to decrease the dose of local anesthetics. In this way, the dose of the local anesthetic can be decreased to a minimum to attain the necessary effect. The above-described method is an outline of many a method followed and described. The individual anesthetist and the needs of the patient are bound to modify the drug and dose in a minor way.

Suggested dosage technique of CSA in labor pain relief [19-21]:

Intermittent bolus: Plain bupivacaine 1.75-2.5 mg with fentanyl 15-20 μg as needed (roughly each 1-2 h).

Continuous infusion: 0.05-0.125% bupivacaine + fentanyl 2-5 μg/mL at 0.5-3.0 mL/h and titrated to a T8-T10 sensory level.

The epidural catheter and filter has 1-2 mL of dead space and hence a continuous spinal catheter should be flushed with 2 mL of saline after each bolus dose. A continuous infusion creates a closed system to decrease infections and answers the problem of flushing.

PROS AND CONS

CSA is still unpopular among anesthesiologists even though the advantages seem to supersede its drawbacks.

The main advantages of CSA over epidural and single dose spinal anesthesia are its easier technique and the possibility of providing an adequate level and duration of anesthesia with small incremental doses, a method that greatly reduces the possibility of high spinal anesthesia but with better hemodynamic stability. The successful use of CSA technique for femoro-popliteal bypass in a patient with congestive heart failure and pulmonary hypertension points to the technique's satisfactory cardiac profile [22]. Even in trauma patients, the incremental use of drugs improves safety.

The technique avoids general anesthesia in surgeries of long duration. This is beneficial in that it avoids all the drugs which include anesthetics, inhalational agents, and non-depolarizers. The net gain is enhanced safety in respiratory diseases coming for other prolonged surgeries. The autonomic response to intubation and extubation are non-existent with this CSA. Successful use of CSA has been demonstrated in patients with severe aortic stenosis for non-cardiac surgeries [23]. In a patient with the coexisting chronic obstructive pulmonary disease, complications associated with GA and positive pressure ventilation are avoided even for surgeries of long duration. The rapid onset and the high success rate associated with CSA because of a definite end point augur well for many surgeons. The advantage of CSA in relation to CSE is that the CSA technique is easier to perform. Moreover, the intrathecal positioning of the catheter is easily confirmed by aspiration of CSF. In the event of an inadvertent dural tap of an attempted epidural, introduction a catheter in the intrathecal compartment is proved useful for the conduct of anesthesia with minimal side effects. CSA can provide excellent labor analgesia and surgical anesthesia if required, and is a very reliable, flexible technique with clinical uses in obstetrics. Clinically speaking, CSA can be used in any parturient but it's highly useful in certain obstetric conditions [24].

1. Previous spinal surgery
2. Significant cardiac disease
3. Morbid obesity
4. Difficult airway
5. Difficult epidural catheter placement.

The advantages of CSA compared with CEA are a complete muscular blockade and a smaller dosage of local anesthetic to obtain adequate anesthesia, without any risks of systemic toxic effects due to absorption.

Post-operative pain relief using CSA was first described by Ansbro *et al.* [25]. In a study of 100 patients undergoing lower limb orthopedic surgery, CSA provides good post-operative analgesia, associated with a low incidence of complications, and a high acceptance of CSA reported from the patients. The intrathecal analgesic regimen can also be administered continuously through a PCA pump with the facility to provide bolus doses when requested in predetermined lockout intervals [8].

With innumerable proven advantages, the technique of CSA has its own hiccups. The three main inhibitions which flash the minds of practitioners are:

1. Neurological complications [26]
2. PDPH
3. Infection.

Neurological complications

Four cases of CES occurring after CSA are reported. In all these patients, there was evidence of a focal sensory block; an additional dose of local anesthetic was given which was greater than that usually administered with a single-injection technique. The combination of maldistribution and a relatively high dose of local anesthetic could have caused neurotoxic injury. Lower concentration and manoeuvres to decrease maldistribution of local anesthetic have been advocated to reduce or avoid CES [5].

PDPH

The first and the foremost block against the administration of CSA is the thought of PDPH. The large bore catheter is supposed to cause a large hole in the dura, and the subsequent CSF leak can have two consequences. Sagging of the brain and the supporting structures cause traction of the intracranial vascular structures to produce pain in the area of trigeminal distribution. Accompanying vasodilatation promotes the same [27,28].

We may be concerned about the risk of PDPH after the use of large-gauge catheters, whereas micro-catheters have been associated with technical difficulties and neurologic side effects. However, there are reports that the over-the-needle- catheter used minimized the risk of PDPH, due to the low potential for the leakage of CSF around the catheter because the outer diameter of the catheter was larger than the diameter of the spinal needle, and this would plug the hole. Based on the results available to date in 125 patients in a multinational study, the rate of PDPH was 1.6% (2 patients) Gosch *et al*. indicated significantly shorter duration and lower intensity of PDPH after the use of an over-the-needle-catheter, compared with a catheter-through-needle [29].

Infection

The risk of infection with spinal catheters is low. A large retrospective review of 603 continuous spinal anesthetics reported only one case of aseptic meningitis [30]. In contrast, there are many case reports of epidural abscesses and infections associated with epidural catheters [31,32]. Nevertheless, use of spinal catheters also requires diligence and adherence to aseptic guidelines for their safe use.

CONCLUSION

Even though CSA is a technique with definite end point for successful anesthesia, difficulty in getting and introducing micro-catheters, mental inhibitions about the possibility of neurological complication among anesthesiologists have put this technique into a very limited use. With increasing age of surgical presentation and systemic illness, there is more need for this technique. With more studies about its safety, this technique may be more successfully administered in the near future.

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