Clinical Evaluation of Continuous Spinal Anesthesia Compared to Epidural Anesthesia in Mild to Moderate Preeclamptic Patients Undergoing Cesarean Section

Thesis

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بسم الله الرحمن الرحيم

﴿ قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا
إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ
الْعَلِيمُ الْحَكِيمُ ﴾

صدق الله العظيم

(البقرة:٣٢)

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Contents

Abstract

Continuous spinal anesthesia using catheter over needle technique (Spinocath) in anesthetic management of mild to moderate preeclamptic patients undergoing cesarean section provides more hemodynamic stability, effective motor and sensory blockade and less incidence of complications compared to continuous epidural anesthesia.

Keywords:

- Continuous Spinal
- Spinocath
- Epidural
- Ceserean Section
- Preeclampsia

Aim of the Work

The aim of this work is to compare the hemodynamic changes, efficacy of motor and sensory blockade, patient satisfaction and incidence of complications (PDPH, persistent paresthesia) during and after continuous spinal anesthesia using catheter over needle technique versus continuous epidural anesthesia in mild to moderate preeclamptic patients undergoing cesarean section.

Review of Literature

Historical Development of Continuous Spinal Anesthesia

The history of spinal anesthesia can be considered since the discovery of CSF by Domenico Cotugno in 1764 or the isolation of Cocaine from Erythroxylon coca in 1860 by Neimann.

Anyway the first spinal analgesia by J.Leonard Corning in 1885 occurred when he pierced the dura accidentally while experimenting with cocaine on the spinal nerves of a dog. Later he deliberately repeated the intrathecal injection and called it spinal anesthesia and suggested it might be used in surgery.

The first planned spinal anesthesia for surgery in man was performed by August Bier in 1898, when he injected 3 ml of 0.5% cocaine solution into a 34 year old man. After using it on 6 patients he and his assistant each injected cocaine into the other´s theca.

However spinal anesthesia little used due to the toxicity of cocaine until Graston Labat, 1921, introduced neocaine crystals dissolved in CSF. (1)

Walter Lemmon was the first to publish account of continuous spinal anesthesia. Although Dean had described this technique as early as 1907. Dean described the continuous spinal anesthesia (CSA) technique stating: “One can leave a needle in the canal during the operation, and at any moment some more drugs can be injected without moving the patient”.

Walter Lemmon described the use of malleable needle and special mattress as a practical method for CSA.

Lemmon´s technique consisted of placing a 17, 18 or 19 gauge malleable [German silver: an alloy consisting of 60% Copper, 25% Zinc and 15% Nickel] needle in subarachnoid space. The needle was connected by 30 inch long, thick walled rubber tubing to a syringe containing local anesthetic. The patient was then placed on a special split mattress.

Although Lemmon´s technique costituted a considerable advance, it was not without problems. The special split mattress was cumbersome and the fear of dislodging or breaking of the needle precluded wide adoption of the method.

Captain Edward B.Tuohy in 1944 described the first contiuous spinal anesthesia technique in which a subarachnoid catheter was used. Tuohy placed a 15 gauge needle into the lumbar subarachnoid space. After removal of the stylet, a No.4 urethral catheter was advanced about 5 cm beyound the needle tip and the needle withdrawn over the catheter.

In 1947, Saklad, intoduced the concept contiuous intraspinal segmental anesthesia utilizing a 16 gauge spinal needle and 35 F catheter. He advanced the catheter to an extraordinary distance of 15 to 35 cm from tip of the needle to achieve segmental blockade of thoracic dermatomes. Difficulty of successful and atraumatic advancing of the catheter such a great distances was the major disadvantage of this technique. (2)

In 1950, Dripps reviewed reports on single injection spinal anaesthesia (SSA) and CSA with a malleable needle and catheter techniques.(3) He found an 8% (43 of 506) incidence of failed anaesthesia with CSA compared with 1.9%(37 of 1921) with SSA. Also, he found more technical difficulties with the catheter technique and a significantly higher incidence of transient paraesthesia (33%) than with single injection technique (13%).(3) Over the next 25 yr, CSA was used little, as reflected by the paucity of references in the literature, and it is hard not to conclude that this was a direct result of Dripps´ article.

In 1952, in a series of 600 poor-risk surgical patients (24% were younger than 60 yr of age) who had CSA using 16-gauge Huber point needles, Brown found a failure rate of only 2%, and a 14% incidence of transient paraesthesia on threading the catheter.(4) The PDPH rate was 9.8%, and there were four cases of extraspinal neuropathies (three sixth nerve palsies and one peroneal) which recovered spontaneously.

In 1972, Giuffrida and colleagues described the use of CSA for Cesarean section in 75 patients using 21-gauge Huber point needles and 24-gauge catheters.(5) There were no failures, PDPH was reported in 12 patients (16%) and there were no neurological complications . In the same year, Kallos and Smith reported no failures, no complications and no PDPH in a series of 121 patients who had CSA for hip

surgery.(6)They used 20-gauge nylon epidural catheters which were inserted through 18-gauge Hustead or Tuohy needles.

In 1981, Rao and El-Etr investigated the incidence of neurological complications arising from anticoagulant therapy after epidural and subarachnoid catheterization in 3164 and 847 patients, respectively (catheter size was not specified). Twenty patients experienced minor complications, five of which were neurological (four after epidural, one after subarachnoid blocks), and 15 low back pain (nine epidural, six subarachnoid) which were self-limiting and resolved with time. There was no incidence of peridural haematoma leading to spinal cord compression. There was no report on the incidence of PDPH.(7)

In 1987, Denny and colleagues, in the first prospective study of PDPH after CSA, assessed 117 patients with a mean age of 63 yr and found only one patient, a 29-yr-old man, who developed PDPH.(8)

They used 18-gauge Hustead or Tuohy needles (which were inserted with the bevel parallel to the longitudinal fibres of the dura) with 20-gauge nylon epidural catheters inserted 2-4 cm into the subarachnoid space. Difficulty in threading the catheter was experienced in five patients (4.3%) and there were six (5.1%) failures with the technique (which led to general anaesthesia), but no neurological sequelae. Denny and colleagues postulated, as an explanation for the unexpectedly low incidence of PDPH, that the spinal catheter, if left in situ long enough, might induce an inflammatory reaction around the puncture site, and "that when the catheter is removed, edema or fibrinous exudate resulting from the inflammatory reaction seals the hole in the dura, thus preventing leakage of cerebrospinal fluid (CSF)". It was concluded that "with a PDPH incidence of less than 1% and the possibility of safely controlling the level of anesthesia, continuous spinal anaesthesia offers an excellent method for long operations, particularly in elderly or severely ill patients".(8)

A similar low incidence of PDPH was reported in 1991 by Mahisekar and colleagues in a retrospective series of 226 patients after CSA with 18-gauge Tuohy needles and 20-gauge catheters, performed from 1981 to 1985. They reported no other complications.(9) The hypothesis proposed by Denny and colleagues that the prolonged presence of the spinal catheter may prevent PDPH was supported by a retrospective study by Cohen and co-workers, which shower that prolonged placement of large-bore catheters in obstetric patients after acciddental dural puncture appeared to reduce the incidence of PDPH.

However, in a study of 87 patients, aged 40-90 yr, undergoing orthopedic procedures with CSA, performed with 18-gauge Tuohy needles and 20-gauge nylon catheters, Liu and colleagues found that prolonged spinal catheterization did not reduce the incidence of PDPH (9.2%).(10)

In 1989, Sutter, Gamulin and Forster, in a retrospective series of 457 patients who had CSA using 20-gauge catheters, reported not only greater cardiovascular stability but a significantly lower failure rate (1.7%) than the 9% in 274 similar patients who received epidural anesthesia. No infections or neurological complications were found, but the incidence of PDPH was not reported.(11)

In 1995, Van Gessel, Forster and Gamulin showed that it was feasible to use CSA in a teaching environment. They detected no incidence of PDPH after CSA with 20-gauge catheter in 100 patients aged more than 65 yr. They demonstrated that although the failure rate for their residents was 6%, the technique was 100% successful in experienced hands.(12)

In 1997, Horlocker and co-workers, in a retrospective series of 474 patients who had CSA with 20-gauge catheters, reported a low PDPH incidence (3.4%) and a failure rate of 3.4%. However, one patient developed aseptic meningitis and another, a 70-yr-old, 109-kg female with a history of lumbar radiculopathy, developed a cauda equina-like syndrome (CES) after administration of 5% hyperbaric lidocaine (lignocaine) 120 mg.(13)

In summary, experience of CSA using 20-gauge catheters in elderly patients shows that the technique is safe and easy to use. The major complication was PDPH, which varied from 0 to 9.2%, but with the exception of one case of CES with tetracaine(14) and one with 5% lidocaine,(13) there wereno major neurological complications. The overall reported failure rate was 2.5%, which is similar to single injection techniques.(15)

Bizzarri and colleagues in 1964 reported a modification standard continuous spinal technique, which involved use of a special 20 to 21 gauge thin walled spinal needle and a soft radio opaque catheter. This was the smallest catheter that had been employed to date.

In 1987 Peterson and colleagues described the use of currently available epidural equipment, 18 and 20 gauge plastic catheters, in continuous spinal anesthesia. They demonstrated the rather surprising

finding of post dural puncture headache of less than 1%. This made the CSA with standard epidural equipment a popular technique in some centres.

In 1987 Hurley and Lambert reported their results from preliminary work with microcatheter technique.

Microcatheters

After publication of the prospective study by Denny and colleagues in 1987,(8) and the introduction of the microcatheter technique in 1990, there was a resurgence in popularity of CSA with both large-bore and microcatheters (28-32-gauge).

The spinal microcatheter was described first by Hurley and Lambert.(16) Their aim was to develop a sufficiently fine-bore catheter (32-gauge Rusch) which could be threaded through an appropriately fine spinal needle (26-gauge) into the CSF. Theoretically, compared with large-bore catheters, this would enable CSA to be performed in younger patients with a reduced risk of PDPH. Their initial study with the 32-gauge microcatheter in 58 patients in 1990 showed a 20% incidence of technical complications, which included failure to thread the catheter, inability to inject the local anaesthetic and inadequate anesthesia, resulting in an incidence of failed spinal block of 15% and a 3.4% incidence of broken catheters.(16) Similar experiences were also reported by others.(17) The 32-gauge spinal microcatheter was difficult to handle, CSF could not be aspirated and it had a very high internal resistance, making injection of local anaesthetic very slow.

A 28-gauge catheter which could be passed through a 22-gauge spinal needle was then developed (Kendall). This catheter proved easier to use and did not have as many technical complications. Recent studies with 28-gauge catheters have shown a technical complication rate similar to that of large-bore catheters, including the incidence of PDPH.(18)

However, it was not long before cases of neurological complications, in the form of cauda equina syndrome, were described after CSA with microcatheters.(14)

In 1992 the United States Food and Drug Adminstration (FDA) decided to withdraw all small bore catheter from the market after some

reports of cauda equina syndrome in which small bore catheters were used to deliver 5% lidocaine with 7.5% glucose into the intathecal space. Some European countries decided also to withdraw the small bore catheters, however others did not (like U.K., Germany and Switzerland).(19)

Furthermore, manufacturers of local anaesthetics declared that their products were not indicated for the use with CSA. In all, approximately 12 cases of caudaequina syndrome after CSA with microcatheters have been reported (20). This reinforced the misconception that CSA was a dangerous technique. However, with experiences gained from more than 3000 patients in the course of five years, CSA appears in a totally different as an effective and safe technique when performed correctly using the Spinocath over needle system. In a review from 2003, Bevacqua also underlined CSA is a useful and safe technique under routine clinical conditions (21).

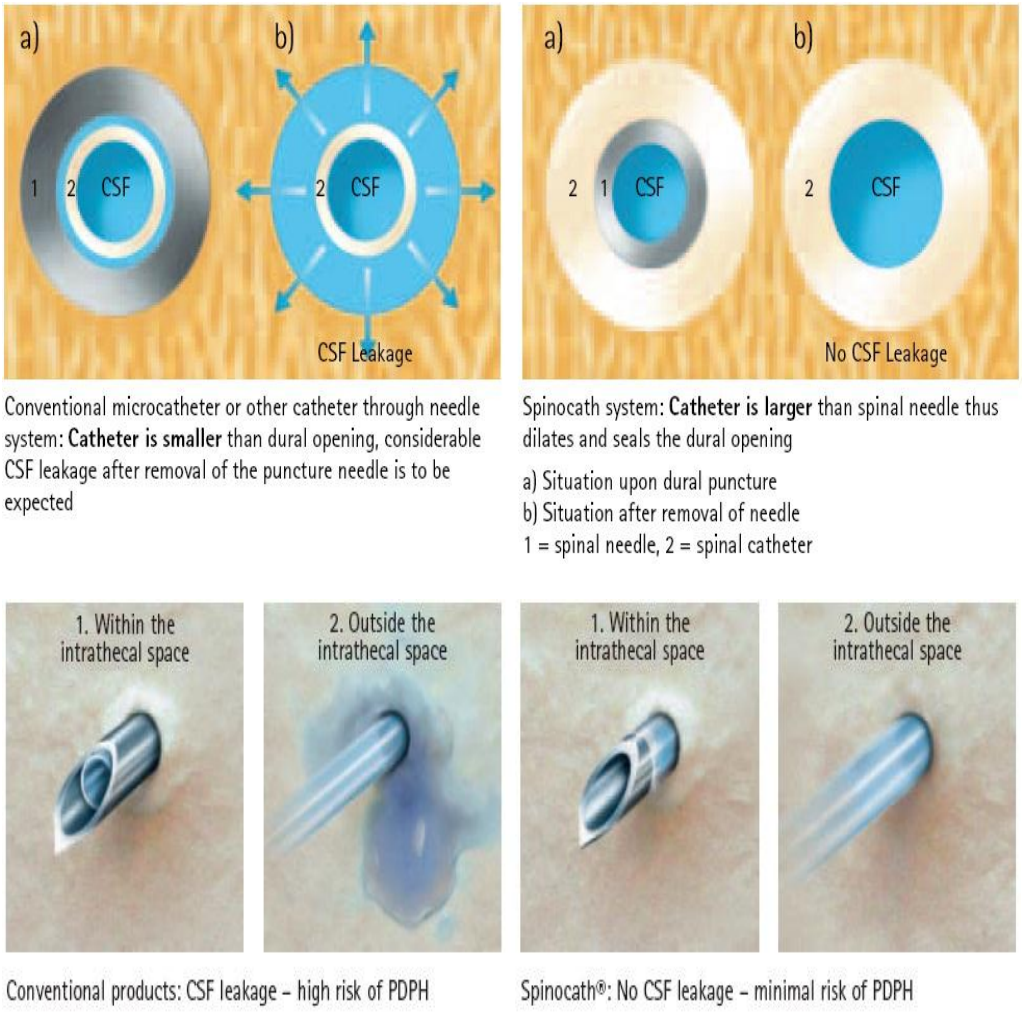
In 1996, there was gradual re-introduction and popularization of CSA but as an incremental technique that avoid continuous infusion, hyperbaric solutions, or high doses and high concentrations of local anesthetic solutions.(22)

Year	Investigators	Description
1907	Henry P. Dean	Intermittent-injectio continuous spinal anesthesia for surgical anesthesia via a needle left in situ in the spinal canal.
1944	William T. Lemmon, Henry G. Hager	Described use of malleable needles with attached rubber tubing for continuous spinal anesthesia for surgical anesthesia; required a special mattress with a cut-out to accommodate the needle in the patient's back; first reported use in obstetric population for cesarean delivery.
1944	Mahlon C. Hinebaugh, Warren R. Lang	First reported use of continuous spinal anesthesia for labor analgesia; used method of Lemmon and Hager.
1944	Edward Touhy	Used 4-French ureteral catheter in subarachnoid space for continuous spinal anesthesia for surgical anesthesia; passed catheter via a 15-g needle.
1964	Dante Bizzarri, Joseph G. Guiffrida	Reported use of a 0.010-inch diameter (24-g) catheter that could be passed through a 20- to 21-g spinal needle; used for surgical anesthesia.
1987	Roland J. Hurley. Donald H. Lambert	Use of a 32-g microcatheter for surgical anesthesia.
1991	Mark L. Rigler, Kenneth Drasner et al.	Reported cauda equina syndrome in 4 patients after continuous spinal anesthesia with 28-g and 20-g catheters for surgical anesthesia.
2008	Valerie A. Arkoosh, Craig M. Palmer et al	Continuous spinal anesthesia for labor analgesia with sufentanil and bupivacaine in over 300 parturients with 28-g catheter.

Table 1. Notable Milestones in Use of Continuous Spinal Anesthesia

A new catheter-over-needle design (Spinocath, B. Braun) has been developed in 2006 to minimize problems and complications of continuous spinal anesthesia with microcatheters , which include difficult catheter insertion, failure of insertion, breakage, inadequate anesthesia, postdural puncture headache, and, rarely, development of cauda equina syndrome.(23)

Spinocath features a unique catheter-over-needle design; the catheter is positioned over the spinal needle. After puncturing that dura mater the needle is withdrawn from the catheter, which simultaneously seals the hole in the dura (24). In this way, CSF (cerebrospinal fluid) leakage is prevented right at the start of the procedure, reducing the risk of postdural puncture headache (PDPH) to minimum.(25)



Conventional microcatheter or other catheter through needle system: **Catheter is smaller** than dural opening, considerable CSF leakage after removal of the puncture needle is to be expected

Spinocath system: **Catheter is larger** than spinal needle thus dilates and seals the dural opening

a) Situation upon dural puncture
b) Situation after removal of needle
1 = spinal needle, 2 = spinal catheter

Conventional products: CSF leakage – high risk of PDPH

Spinocath®: No CSF leakage – minimal risk of PDPH

Figure(1):catheter over and through needle.

Spinocath provides the anesthesiologist with accurate feedback. The pronounced dura click, and the visual check of CSF flashback in a second, confirming the intrathecal catheter position (26).

Continuous spinal anesthesia (CSA) is an underutilized technique in modern anesthesia practice. Compared to epidural anesthesia, CSA provides safer preoperative confirmation of catheter position, faster onset of action and more reliable blockade. Moreover, only 1/10 to 1/5 of anesthetic is required, resulting in a much lower risk of systemic toxic reactions. In contrast to single-dose spinal anesthesia, with CSA the anesthetic can be administered during the operation. Repeat dosing to prolong and control the duration and level of blockade is possible at any time, thereby improving overall anesthesia control. The block also subsides more rapidly. The risk of cardiovascular side effects and respiratory compromise is significantly reduced (27).

CSA has seen a waxing and waning of its popularity in clinical practice since its initial description in 1907. After case reports of cauda equina syndrome was reported with the use of spinal microcatheters for CSA, these microcatheters were withdrawn from clinical practice in the United States but continued to be used in Europe with no further neurologic sequelae(28).

Because only large-bore catheters may be used in the United States, CSA is usually reserved for elderly patients out of concern for the risk of postdural puncture headache in younger patients (29). However, even in younger patients, sometimes the unique clinical benefits and haemodynamic stability involved in CSA outweigh concerns regarding postdural puncture headache (30). Clinical scenarios in which CSA may be of particular benefit include patients with mild to moderate aortic stenosis undergoing lower extremity surgery and obstetric patients with complex heart disease (31).

Continuous spinal anesthesia using Spinocath is effective and allows titration of the duration and level of anesthesia with minimum side effects.

Perhaps more accurately termed fractional spinal anesthesia, CSA involves intermittent dosing of local anesthetic solution via an intrathecal catheter. Where traditional spinal anesthesia involves a single injection with a somewhat unpredictable spread and duration of effect, CSA allows titration of the block level to the patient's needs, permits a spinal block of