Different Regional Anesthesia Techniques for Supine Percutaneous Nephrolithotripsy

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Abstract

Background: With the introduction of new technologies in endourology, supine percutaneous nephrolithotripsy (sPCNL) is becoming a trend as it has numerous benefits in terms of safety, efficacy, and versatility. It allows anesthetists the privilege of using regional anesthesia with its advantages over general anesthesia for this procedure; as regional anesthesia lowers morbidity, analgesic requirements and the duration of hospital stay. In our study we compared two regional anesthesia techniques; continuous spinal anesthesia (CSA) versus combined spinal epidural anesthesia (CSE) for patients undergoing sPCNL. The aim of this study is to highlight the most appropriate anesthesia technique in both quality and efficacy for sPCNL.

Methods: A total of forty patients were randomly allocated to receive either CSA with a standard epidural set (Touhy needle18-G, catheter 20-G) or CSE using needle through needle technique. Demographic data, time taken for catheter insertion, difficulty of technique, the occurrence of hypotension, the total dose of ephedrine, the occurrence of post dural puncture headache (PDPH), highest level of sensory blockade, quality of motor blockade and the duration of the surgical procedure were all recorded.

Results: Patient characteristics in the two groups were similar; age, weight, height and duration of surgery. Only 3 patients in CSA were excluded and 2 in CSE for technical difficulties. The time taken for performing the blockade was shorter in CSA (2.5 ± 0.9 min) than in CSE (3 ± 1.1 min). The highest sensory level in CSA was T7 (range: T5-T8) and T5 in CSE (range: T4-T7). Motor blockade was similar in the two groups. No significant differences in the supplementary doses needed in re-lation to time, analgesia level or blockade quality. Arterial hypotension was found in 3 patients in CSA and in 5 patients in CSE, more often in CSE and a significantly higher dose of ephedrine 16.2 ± 17 mg in CSE than 10.5 ± 15 mg in CSA. And a higher incidence of PDPH in 4 patients from CSA compared to 2 in CSE.

Conclusion: From our study we found that both CSA and CSE are effective and safe techniques for PCNL in the supine position. CSA provided better cardiovascular stability. CSA is an attractive alternative to CSE in supine PCNL especially for critical patients with limited cardiac or respiratory reserve.

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Key Words: Continuous spinal anesthesia – Combined spinal epidural anesthesia – Supine percutaneous nephrolithotripsy.

Introduction

PERCUTANEOUS nephrolithotripsy (PCNL) is one of the most commonly performed procedures for the treatment of renal stones. Developments in instrumentation, irrigation systems, radiologic imaging, and urologic skills have increased the efficacy and safety of this procedure. And is considered a major operation accompanied with different comorbidities and mortalities, several attempts were made to decrease these comorbidities and mortalities and accordingly decrease cost, hospital stay and improve surgical outcome. Attempts made by surgeons include operating the patient in the supine position and attempts made by anesthetists in providing regional anesthesia rather than general anesthesia [1].

When operating in the prone position and general anesthesia is administered. Patients lay first in the supine position, changing to the prone position is time consuming with the risk of neck or limb injury and dislodgement of the endo-tracheal tube may occur. Body habitus such as ankylosing spondylitis, severe lordosis or kyphosis, or hip or lower limb contractures may make it is impossible for the patient to lay prone [2].

Operating the patients in the supine position avoids all these disadvantages plus it allows for simultaneous ureteral instrumentation if needed. If PCNL is performed initially with regional anesthesia and general anesthesia is needed, the change is easier in this position. The supine position allows better access to the airway and is less hazardous, especially for patients with compromised cardiopulmonary reserve, morbid obese, or those who require a prolonged procedure; the risk of hypot-
Regional anesthesia avoids many of the disadvantages of general anesthesia; Dangerous hemodynamic response to direct laryngoscopy and the intubation procedure, the use of volatile anesthetics that may lead to myocardial depression to a variable degree accompanied with peripheral vasodilatation. In regional anesthesia there are no neuromuscular drugs used which might influence the heart rate and no mechanical ventilation with weaning from positive pressure ventilation that might cause certain pulmonary complications especially in patients with chronic obstructive pulmonary disease (COPD) [4].

Bier was the first to describe spinal anaesthesia in 1899 using cocaine, in 1906 Henry Dean used ester local anesthetics with the exploring needle to extend the block. In 1990s with modern technology micro-spinal catheters were introduced. The fear of cauda equina syndrome, led to the ban of spinal micro-catheters. Denny doubted cauda equina syndrome etiology and named CSA as a savior in several occasions for patients from post-intubation procedure, the use of volatile anesthetics or with platelets dysfunction. Patients were randomly allocated to either CSA group or CSE group according to a computer-generated list made before the start of the study. Intravenous access was obtained by puncturing a forearm vein with a 18-G cannula. Patients were premedicated with 2mg of midazolam i.v. Infusion of Ringer’s lactate solution 500ml before the start of the regional block. All were monitored with a continuous 3-lead ECG, pulse oximetry and non-invasive blood pressure.

All techniques were performed in the L3-L4 interspace in the midline with the patient awake and sedated in the lateral position, skin infiltrated with lignocaine 1%. We used for CSA (Perifix B BRAUN Melsungen AG Germany) standard epidural set with a Touhy needle 18-G and a 80mm in length, 20-G catheter. The Touhy needle was advanced till return of cerebrospinal fluid (CSF) after puncturing the dura with the needle bevel directed laterally then the epidural catheter was threaded through the needle with its bevel directed cranially to an average length of 2 to 3cm in the subarachnoid space. CSE was performed by means of “needle-through-needle” technique using a single interspace (Espocan, B. Braun, Germany). The blockade consisted of performing a spinal block by a 27-G spinal needle that was introduced through a Touhy needle 18-G. After identifying the epidural space using loss of resistance to air technique, then the

The value of our study is that it is for our knowledge the first prospective randomized controlled study to compare those two techniques in supine PCNL, as both techniques offer the advantage of having a catheter available for repeatedly extending the blockade during surgery. CSA is achieved by producing and maintaining spinal anaesthesia with small doses of local anaesthetic injected into the subarachnoid space via a catheter intermittently. CSE on the other hand involves a subarachnoid blockade followed by epidural anesthesia [4].

Material and Methods

After obtaining institutional approval and informed consent from the patients, a total of 40 patients were prospectively included in the study. The study was carried out in the urology theatre in Kasr Al Ainy University Hospital, Cairo, Egypt. Inclusion criteria were: American Society of Anesthesiologists Classification (ASA) status class I-III, age between 20 and 50 years, and Body Mass Index (BMI) between 20 and 30kg/m^2. Exclusion criteria were: Patient refusal, neurologic or neuromuscular disease, or skin infection at the site of needle insertion or anticoagulation or with platelets dysfunction. Patients were randomly allocated to either CSA group or CSE group according to a computer-generated list made before the start of the study. Intravenous access was obtained by puncturing a forearm vein with a 18-G cannula. Patients were premedicated with 2mg of midazolam i.v. Infusion of Ringer’s lactate solution 500ml before the start of the regional block. All were monitored with a continuous 3-lead ECG, pulse oximetry and non-invasive blood pressure.

The aim of our study is to highline the most appropriate anesthesia technique for this procedure in both quality and efficacy thus we compared two different regional anesthesia techniques namely Continuous Spinal Anesthesia (CSA) and Combined Spinal Epidural Anesthesia (CSE) in supine PCNL.
The epidural catheter was threaded in the same fashion cranially to a distance of 3 to 4 cm in the epidural space.

Hyperbaric bupivacaine 3 ml of 5 mg/ml was injected into the spinal catheter in CSA and via the spinal needle in CSE. Pinprick tests done to assess the level of sensory level block, every minute for the first five minutes then every five minutes till 15 minutes. If analgesia at level T6-7 was not gained at the end of the 15 minutes, additional hyperbaric bupivacaine was administered through the spinal catheter: 5 mg (1 ml) in the CSA or plain bupivacaine 25 mg (5 ml) in the epidural catheter in CSE. After another 15 minutes the level of analgesia was reevaluated. If the level was satisfactory, surgery would start. Demographic data, time taken for catheter insertion, difficulty of technique, the occurrence of hypotension, the total dose of ephedrine or the occurrence of Post Dural Puncture Headache (PDPH), highest level of sensory blockade, quality of motor blockade assessed by Bromage scale and duration of the surgical procedure were all recorded. And if an adequate surgical anesthesia was not achieved, the technique was considered a failure. At the end of surgery, all catheters were removed. Hypotension in the form of a 30% decrease in systolic blood pressure, to the preoperative figure was treated with ephedrine 5 mg intravenously. Bradycardia a heart rate of less than 60 beats/min was treated with atropine as 0.5 mg intravenously.

The following statistical tests were applied: Student's t-test for quantitative data; demographic data and other continuous variables. For qualitative data we used chi-squared test and the Fisher’s exact test were used when appropriate. Results are expressed as mean ± SD. Differences were considered significant at p<0.05.

Results

The patients’ characteristics in the two groups were similar with regard to age, weight, height and duration of surgery. Only three patients in CSA were excluded due to difficulty in threading the catheter and two in CSE had to be excluded because of unintended dural perforation with the epidural needle. However, those excluded patients in the two groups were considered in the evaluation of technical difficulties.

The time taken for performing the blockade was shorter in CSA (2.5 ± 0.9 min) than in CSE (3 ± 1.1 min). As CSA was less in steps than CSE. Five of CSA patients exhibited paresthesia (25%). On the other hand two of CSE patients exhibited paresthesia (10%), and thus there was lower incidence of paresthesia in the CSE group. The highest sensory level in patients receiving CSA was T7 (range: T5-T8) and was T5 in patients receiving CSE (range: T4-T7) higher in CSE. According to the Bromage scale, the motor blockade was similar in the two groups. Supplemental doses were necessary in 6 CSA patients and 7 CSE patients. There were no significant differences in the supplementary doses needed in relation to time, analgesia level. Arterial hypotension was found in 3 patients in CSA and in 5 patients in CSE, and thus it occurred more often in CSE. Total ephedrine dose was 10.5 ± 15 in CSA significantly lower than in CSE which was 16.2 ± 17 (p-value 0.04). Bradycardia was observed in 2 patients from each group, PDPH in 4 patients from CSA compared to 2 in CSE. All of which improved by bed rest and conventional analgesics such as acetaminophen and non steroid anti-inflammatory drugs. There were no cases of cauda equina syndrome, trans-sient radicular symptoms or severe complications after surgery, in either group.

Table (1)

<table>
<thead>
<tr>
<th></th>
<th>CSA (N=20)</th>
<th>CSE (N=20)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age: Years</td>
<td>32±13</td>
<td>30±13</td>
<td>0.32</td>
</tr>
<tr>
<td>Body Weight: Kg</td>
<td>62±6</td>
<td>65±6</td>
<td>0.09</td>
</tr>
<tr>
<td>Body Height: Cm</td>
<td>164±4</td>
<td>165±5</td>
<td>0.43</td>
</tr>
<tr>
<td>Tech Time; Min</td>
<td>2.5±0.9</td>
<td>3±1.1</td>
<td>0.27</td>
</tr>
<tr>
<td>Duration of Surgery; Min</td>
<td>95±41</td>
<td>97±51</td>
<td>0.45</td>
</tr>
<tr>
<td>Difficulty of Technique*</td>
<td>3</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Parasthesia**</td>
<td>5</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Hypotension***</td>
<td>3</td>
<td>5</td>
<td>0.34</td>
</tr>
<tr>
<td>Total Ephedrine Given (Mg)</td>
<td>10.5±15</td>
<td>16.2±17</td>
<td>0.04#</td>
</tr>
<tr>
<td>Bradycardia</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Pdph****</td>
<td>4</td>
<td>2</td>
<td>0.33</td>
</tr>
</tbody>
</table>

CSA = Continuous spinal anesthesia.
CSE = Combined spinal epidural anesthesia.
*Statistically significant p-value <0.05.
**Odds Ratio = 0.62 95% CI (logit method) = 0.09 to 4.24.
***Odds Ratio = 3 95% CI (logit method) = 0.51 to 17.74.
****Odds Ratio = 0.52 95% CI (logit method) = 0.107868 to 2.598344.
*****Odds Ratio = 0.44 95% CI (logit method) = 0.071 to 2.75.

Discussion

Several previous studies have shown that spinal anesthesia results in less intra-operative bleeding compared with general anesthesia in certain procedures as proved by Salonia and colleagues [8] in patients undergoing radical prostatectomy. Maurer and coworkers [9], found in total hip surgery that with spinal anesthesia there were a mean reduction of 25% in blood loss, 12% in operative time, and a 50% in transfusion requirements than for general anesthesia. And concluded that regional anesthesia appeared superior to general anesthesia for this procedure.
CSE was first described in the modern practice for urological surgery [10], and become an established anesthesia technique for painless labor. CSE is often regarded as the best regional technique for orthopedic surgery [11].

For high-risk patients with unstable hemodynamic status CSA is considered a good choice owing to the fact that with the desired injection of local anesthetic drugs into the subarachnoid space in incremental fashion, controlling the level of both the sensory and the motor block can be precisely achieved. With lesser involvement of the sympathetic system a better cardiocirculatory stability and respiratory status can be reached. Making CSA superior to CSE; resulting in a higher incidence of hypotension in CSA, as the highest dermatome at any time of surgery is less by two segments in CSA than that of CSE. In a study comparing CSA with CSE in trauma patients, Wilhelm and Standl got better results with much smaller doses of local anesthetic drugs and a decreased incidence of hypotension when using CSA versus CSE; they concluded that CSE was not a better option for trauma patients than CSA [12].

In this study the role of CSA on patients for PCNL in the supine position compared with patients receiving CSE and their impact on the intraoperative anesthetic course was assessed. CSA was proved to be better in the cardiovascular status with less hypotension in 3 patients in CSA and in 5 patients in CSE, more often in CSE and a significantly higher dose of ephedrine 16.2 ± 17mg in CSE than 10.5 ± 15mg in CSA. This goes with the results found by Klimscha, et al. [13] who proved that using CSA in old patients manifested less hypotension and accordingly lesser usage of vaso pressor drugs than patients receiving epidural alone.

Different types of specially designed microcatheters for spinal uses of variable gauges are available, but not for our disposal and we found them very expensive about 6 times the price of a standard epidural set and very hard to get. Micro spinal catheters are available as catheter over the needle or catheter through needle [14].

It is believed that catheter size is the determinant factor for complication; fine catheters (28 gauges) were recommended as less traumatic, reducing the deposition of the anesthetic drugs in the cauda equina region [15]. However in vitro studies; spinal endoscopy and dye studies proved otherwise [16]. In vivo studies too confirmed the same outcome and in the clinical practice those finding would manifest by incomplete anesthesia and the probability of cauda equina syndrome. This led to the belief that larger bore catheters might be safer to use, [17]. That’s why in this study it was decided to use a standard epidural set for the CSA. Its use made the insertion and catheter threading easier, not requiring more training as the case is with the use of microcatheters, the 20-G catheter enables easy aspiration of CSP to assure correct position of the catheter, provides easy drug administration, and better mixing of local anesthetic. The technique took less time to perform compared with CSE. Drawbacks of CSA are a high incidence of PDPH which remains a possibility especially in the obstetric population. Another problem might arise when the standard epidural is used for CSA if it is left in place for post operative pain control is the potential administration of an epidural dose intrathecally.

Results from this study does not go in hands with the study done by Arkoosh, et al. [18] who compared a 32 gauge catheter for CSA with epidural anesthesia in normal labor where he faced more technical difficulties and catheter threading failure for CSA compared to the epidural. His patients were young females in labor with exaggerated lumber lordosis and congested epidural veins due to compression on the vascular drainage of the spinal cord by the gravid uterus. Kestin et al. [19] compared the rate of failure CSA using a 32-G catheter versus epidural anesthesia in 43 women in anesthesia for cesarean delivery. And also had difficulties in catheter insertion and threading in CSA group 24 accounting for a failure rate of 9%. Patients in this study are with normal vasculature and normal lumbar curvature, and as for the catheter size they both used a 32-G catheter while we used a 20-G. Usage of large gauge catheter (20-G) made anesthesia more profound due to better distribution of drugs which leads to a decrease drug concentration in the cauda equine region thus decreasing the neurotoxicity effect. This was consistent with the case reported by Reena Nayyar, PS Satyanarayana, et al., who used CSA for femoropopliteal bypass [20].

Horlocker, et al., demonstrated the neurological complications of CSA and reported an incidence of 9.6% for PDPH, when it was done in the obstetric group using micro catheters, the incidence was 33.1% with and a blood patch needed for treatment in 24.4%. With micro catheters ranging from 22-G to 24-G in young age group the incidence of PDPH was high in recent studies [21]. Other studies in the obstetric group confirmed very high incidence of PDPH using micro catheters 67% with a 22-G spinocath and 50% with a 24-G Spinocath which makes CSA an unfavorable technique for this group.
The incidence of PDPH after CSA remains a controversy with widely differing reported incidences [18,19]. In our study the incidence of PDPH in CSA was 4 cases (20%), a high ratio compared to the incidence in CSE 1 case (5%), might be explained by the damage caused to the dura by big Touhy 18-G needle and the big epidural catheter 20-G in the subarachnoid space increasing trauma to dura and allowing leakage of CSF, this high incidence of PDPH with CSA in our study could be decreased by using smaller gauge needles and catheters that will require further training to avoid technical failure and better resources to obtain them.

**Conclusion:**

The results from this study indicate that CSA and CSE are both effective and safe techniques for PCNL in the supine position. CSA provided better cardiovascular stability with a smaller dose of local anesthetic drugs administered and shorter onset time, without a high failure rate. CSA is an attractive alternative to CSE for PCNL in the elderly and high-risk patients, when hemodynamic stability is critical.

**References**


