Baroreflex Integrity: A Comparative Study between Sevoflurane and Propofol with Sevoflurane Anesthesia

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Abstract

Background: Arterial baroreflex function is an important short-term neural control system aiming at guaranteeing the homeostasis of the organism. The characterization of baroreflex is based on the assessment of the baroreflex sensitivity derived as the variation of heart period, approximated as the time interval between two consecutive R peaks on the ECG (RR), per unit change of Systolic Arterial Pressure (SAP).

Methods: This comparative study included 40 patients who were scheduled for laparoscopic gynecological surgery. Patients were divided into two groups (Sevoflurane group) and (combined Propofol & Sevo group) with 20 patient in each group. Pressor and depressor tests were done pre, intra and postoperative with recording systolic blood pressure and R-R interval as well as the diastolic overshoot in the awake state, under anesthesia and postoperatively.

Results: There were no significant differences in patient population demographic data, awake pretest SBP and HR. The results of our study suggest that there was no significant depression of baroreceptors regarding both groups, on the other hand, blood pressure was more affected when using sevoflurane alone than in the combined group.

Conclusion: Data obtained from this study showed that there was no depression of baroreceptors either in sevoflurane or in the combined group. On the other hand, haemodynamics were more affected when using sevoflurane alone than in the combined group.

Key Words: Anesthesia – Sevoflurane – Propofol – Baroreceptors.

Introduction

ARTERIAL baroreflex function is an important short-term neural control system aiming at guaranteeing the homeostasis of the organism [1]. The characterization of baroreflex is based on the assessment of the baroreflex sensitivity derived as the variation of heart period, approximated as the time interval between two consecutive R peaks on the ECG (RR), per unit change of Systolic Arterial Pressure (SAP). Usually during general anesthesia in humans baroreflex sensitivity is evaluated by administering vasoactive agents to importantly modify SAP and by observing the evoked RR changes [2].

Baroreflex Sensitivity (BRS) is the amount of change in beat-to-beat interval (RR) against a 1mm Hg systolic blood pressure deviation [3]. BRS is traditionally measured by bolus injection of vasoactive drugs such as phenylephrine which causes increase in Systolic Blood Pressure (SBP) or Na Nitroprusside (NTP) which causes decrease in systolic blood pressure. The increase/decrease in SBP tempts a decrease/increase in the corresponding RR interval (milliseconds) [4].

Sevoflurane is a volatile anesthetic agent with low blood-gas solubility (0.6). Sevoflurane is now widely used for its desirable properties of rapid induction and emergence and quick control of anesthetic depth [5].

The effects of contemporary available general anesthetics, such as propofol or sevoflurane on baroreflex control of Heart Rate (HR) have been extensively investigated in humans [6]. More importantly, how long volatile and intravenous anesthetics exert depressive effects on the baroreflex function after general anesthesia and, thus, how full recovery of baroreflex function actually takes place [7].

Patients and Methods

The study was Held at Kasr Al-Aini Hospital in Gynecology and Obstetrics Department in the period from April 2012 – Dec. 2012.
This comparative study included 40 patients who were scheduled for laparoscopic gynecological surgery.

The study was done after approval of Departmental Ethics and research committee and obtaining written informed consent from all patients enrolled in the study; held at Kasr El-Ainy Hospital, Faculty of Medicine.

**Sample size measurement:**

Our study was the first to discuss the effect of combined propofol and sevoflurane anesthesia on baroreflex integrity, so, we couldn't calculate sample size for this article.

**Inclusion criteria:**

- Adult female patients 20-40 years.
- (American Society of anesthesiologists physical status I).
- Undergoing laparoscopic gynecological surgery lasting for 1-2 hours.

**Exclusion criteria:**

- Major organ dysfunction (as hepatic, renal and respiratory dysfunction).
- Patients on steroid therapy.
- Patients with systemic illness known to affect inflammatory response as rheumatoid arthritis.
- Women with Body Mass Index (BMI) >30.
- Patients receiving cardiovascular drugs.
- Age less than 20 and above 40 years.
- Patients with dysautonomia.
- Diabetics.

**Study design:**

- Before induction of anesthesia; patients were randomly assigned to one of two equal groups each containing 20 patients. Randomization was achieved by permuted-block randomization, ensuring allocation concealment include Sequentially-Numbered, Opaque, Sealed Envelopes (SNOSE).
- Group A (n=20): This group received general anesthesia using inhalational anesthetic (sevoflurane).
- Group B (n=20): This group received General anesthesia using both propofol and sevoflurane.

**Anesthetic management:**

- Awake control study:

  Upon arrival to the pre-induction room, the patient will receive supplementary oxygen via a nasal cannula, and will be monitored with ECG and pulse oximeter. Under local infiltration anesthesia (lidocaine 2%) a peripheral venous (20 gauge) cannula was inserted, and a 20 gauge arterial cannula was inserted in the radial artery of the non dominant hand after performance of modified Allen's test. Each patient received 10ml/kg Hartmann's solution before initiation of the study.

  To assess baroreflex control of HR, pressor and depressor tests were performed using i.v. bolus injections of phenylephrine (1 µg/kg) and sodium nitroprusside (1 µg/kg) to increase and decrease Systolic Pressure (SP) by 15-30mmHg, respectively.

  The 2 components of baroreflex were measured as the R-R interval change secondary to BP changes (msec/mmHg) and baroreflex control of arteriolar constriction was assessed by measuring the overshoot in diastolic arterial pressure during the recovery phase of the cardiovascular response to the Valsalva maneuver (peak diastolic blood pressure within 30 seconds). The over-shoot during this phase is associated with the increase in blood pressure above the level at rest caused by the return of cardiac output after release of the raised airway pressure, coupled with an increased systemic vascular resistance reflecting the continuing baroreceptor reflex arteriolar constriction. Patients were trained to perform Valsalva maneuvers in the form of forced expiration against closed glottis and maintaining straining for 10 seconds in the supine position while recording HR and BP changes.

- **Induction of anesthesia:**

  All patients received 100% oxygen via face mask for 2 to 3min prior to induction of general anesthesia and they received analgesia in the form of fentanyl 3 g/kg 5 minutes before planned intubation.

  In Group A, anesthesia was induced with end tidal concentration 5% sevoflurane in oxygen.

  In Group B, anesthesia was induced with propofol (dose 1mg/kg) and end tidal concentration of 2.5% sevoflurane.

- **Maintenance:**

  In Group A anesthesia was maintained with end tidal concentration 3% sevoflurane in oxygen.

  In Group B anesthesia was maintained with end tidal concentration 1.5% sevoflurane and propofol infusion at a rate 75 g/kg/min.

  Analgesia was supplemented in the form of Paracetamol intravenously over 20 minutes after
induction (15mg/kg) in addition to diclofenac by intravenous infusion over 20 minutes (2mg/kg).

Baroreflex control of heart rate was again assessed with the pressor and depressor tests using i.v. bolus injections of phenylephrine (1 µg/kg) and sodium nitroprusside (1 µg/kg) to increase and decrease Systolic Pressure (SP) by 15-30mmHg, respectively. Baroreflex control of vasoconstriction was assessed by the application of Positive End Expiratory Pressure (PEEP) of 30cm H2O then the expiratory valve is released and the peak diastolic blood pressure overshoot in the early phase (within 30 seconds of release) was recorded.

• Postoperative management:

After discontinuation of propofol infusion or sevoflurane anesthesia and after the return of adequate spontaneous respiration and responses to verbal commands was confirmed, extubation was done and patients were transferred to the recovery room where they were left undisturbed with supplemental oxygen 2L/min.

After 20 minutes of recovery, Baroreflex control of heart rate was again assessed with the pressor and depressor tests using i.v. bolus injections of phenylephrine (1 µg/kg) and sodium nitroprusside (1 µg/kg) to increase and decrease Systolic Pressure (SP) by 15-30mmHg, respectively, also, Baroreflex control of arteriolar constriction was assessed again by valsalva maneuver the same way as in the awake preoperative state.

Results

There were no significant differences in patient population demographic data, awake pretest SBP and HR.

In the present study, simultaneous recordings of haemodynamic variables including systolic blood pressure and heart rate variability, were comparatively analyzed between patients receiving sevoflurane and combined propofol and sevoflurane with using pressor, depressor tests and Valsalva maneuver for baroreflex integrity.

In the sevoflurane group, there was significant decrease in systolic blood pressure intraoperatively compared with pre and postoperative results after the pressor and depressor tests, while significant decrease in HRV was recorded in the pre, intra and postoperative results.

In the combined group, SBP was significantly decreased intraoperatively after the pressor and depressor tests while significant decrease in heart rate variability between the pressor and depressor tests that was recorded preoperatively and intraoperatively was abolished postoperatively.

In the preoperative and postoperative period the slope was comparable irrespective of anesthetic technique (Groups A & B) and/or agent used (phenyl-ephrine and sodium nitroprusside).

In patients randomized to inhalational (Sevoflurane group) there was a positive significant correlation between changes in systolic blood pressure (SBP ΔmmHg) and R-R interval (Δmsec) following phenyl ephrine administration preoperatively, intraoperatively and postoperatively (T1-T3). Also there was a negative significant correlation between systolic blood pressure (SBP ΔmmHg) and R-R interval (Δmsec) following Sodium Nitroprusside administration preoperatively, intraoperatively and postoperatively (T1-T3).

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Fig. (3): Systolic Blood Pressure (SBP) among Group B.
* : Significantly lower compared to preoperative and postoperative values ($p=0.011, 0.012$ for phenyl ephrine & $p=0.039 <0.0001$ for sodium Nitroprusside) respectively.
C : Combined anesthesia (propofol + sevoflurane).

Fig. (4): Mean ± SD, for R-R interval (msec) among group B patients.
* : Denotes significantly higher compared to sodium Nitroprusside. $p : 0.009, 0.001$ for preoperative and intraoperative respectively.

Fig. (5): Illustrates correlation between changes in SBP 4 mmHg and R-R interval 4 msec among Group B patients (Sevoflurane n=20).

PH : Phenyl-ephrine.
S : Sodium Nitroprusside.
T1 : Preoperative.
T2 : Intraoperative.
T3 : Postoperative.
In patients randomized to combined group there was a positive significant correlation between changes in systolic blood pressure (SBP ΔmmHg) and R-R interval (Δmsec) following phenyl ephrine administration preoperatively, intraoperatively and postoperatively (T1-T3). Also there was a negative significant correlation between systolic blood pressure (SBP ΔmmHg) and R-R interval (Δmsec) following Sodium Nitroprusside administration preoperatively, intraoperatively and postoperatively (T1-T3).

Diastolic overshoot (mmHg) was comparable (p=0.067), irrespective of anesthetic technique (Groups A & B) and timings (preoperative, intraoperative and postoperative).

Table (1): Mean ± SD. For slope among during preoperative, intraoperative and postoperative among three groups all groups.

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
</tr>
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<tbody>
<tr>
<td>PH Preoperative</td>
<td>9.43±1.85</td>
<td>9.18±1.40</td>
</tr>
<tr>
<td>Na Preoperative</td>
<td>8.46±1.48</td>
<td>8.44±0.99</td>
</tr>
<tr>
<td>PH Intraoperative</td>
<td>9.23±1.74</td>
<td>9.05±1.47</td>
</tr>
<tr>
<td>Na Intraoperative</td>
<td>8.24±1.5</td>
<td>8.31±1.07</td>
</tr>
<tr>
<td>PH Postoperative</td>
<td>9.28±1.2</td>
<td>8.92±1.39</td>
</tr>
<tr>
<td>Na Postoperative</td>
<td>8.79±0.98</td>
<td>7.93±1.44</td>
</tr>
</tbody>
</table>


Table (2): Demonstrates mean ± SD. For diastolic over shoot (mmHg) among all groups.

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Intraoperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>7.9±0.6</td>
<td>7.7±0.7</td>
<td>7.6±0.7</td>
</tr>
<tr>
<td>(Sevoflurane n=20)</td>
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<tr>
<td>Group B</td>
<td>8.0±0.6</td>
<td>8.1±1.0</td>
<td>8.1±0.8</td>
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<tr>
<td>(Combined n=20)</td>
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Fig. (6): Correlation between changes in SBP ΔmmHg and R-R interval Δmsec among Group C patients (Combined n=20).

Discussion

In the present study, simultaneous recordings of haemodynamic variables including systolic blood pressure and heart rate variability, were comparatively analyzed between patients receiving sevoflurane and combined propofol and sevoflurane with using pressor, depressor tests and Valsalva maneuver for baroreflex integrity.

There were no significant differences in patient population demographic data, awake pretest SBP and HR. The results of our study suggest that there was no significant depression of baroreceptors among both groups.

The results of our study suggest that there was no depression of baroreflex integrity when using volatile anesthesia as sevoflurane or combined volatile and intravenous anesthesia, these results are in contrast with a study by Nagasaki who compared the recovery profile of baroreflex control of heart rate after isoflurane and sevoflurane anesthesia in humans, he stated that baroslopes of the pressor and depressor tests were significantly depressed compared with awake values during the entire course of general anesthesia and that two hours were required for full recovery of baroreflex function [8].

Similarly, another study by T. Nishikawa concluded that arterial baroreflex function, determined by the pressor (phenylephrine) and the depressor tests (nitroprusside), was significantly depressed during anesthesia and surgery under sevoflurane and isoflurane plus nitrous oxide in healthy surgical patients. Whereas depressor test sensitivities remained depressed after both sevoflurane and isoflurane anesthesia, the pressor test sensitivity returned to the awake baseline value more quickly on recovery from sevoflurane versus isoflurane anesthesia [9].

The use of pressor and depressor test as well as valsalva maneuver has been used in several studies for assessment of baroreflex integrity as by Kortly & Ebert [10].

Hemodynamics during anesthesia can be affected by at least three independent factors: Type of anesthesia, type of surgery and patients’ cardiovascular status. The last two factors were presumably similar among the patients as they all had reasonably normal left ventricular function and were scheduled for elective laparoscopic gynecological surgery.

Our study stated that blood pressure was significantly lower among patients confined to sevoflurane group as compared to the combined group suggesting that haemodynamics were more affected when using sevoflurane alone than in the combined group.

These results were contradictory to the results obtained by Watson and Shah where they compared 40 patients assigned into two groups undergoing spinal surgery for 1-3 hours and they stated that the cardiovascular stability was good and comparable with both sevoflurane and propofol [11].

On the other hand, another study by M. Shiminov hypothesised that sevoflurane as opposed to propofol anesthesia might lead to hemodynamic instability during Laparoscopic Radiofrequency Ablation of liver tumors (LRFA) surgery due to its possible effect on baroreceptors [12].

Conclusion:

Data obtained from this study showed that there was no depression of baroreceptors when using sevoflurane alone or with combined use of sevoflurane and propofol. On the other hand, hemodynamics were affected when using sevoflurane alone than combined use of sevoflurane and propofol.

References


