RESEARCH ARTICLE

Electrocardiographic Changes in Elective Cesarean Delivery after Oxytocin Injection: Regional Anesthesia versus General Anesthesia

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Background: There is evidence that electrocardiographic (ECG) changes occur during elective cesarean section in parturients. These changes, mostly in the form of ST-segment depression, have been noted in either regional anesthesia or general anesthesia. We performed this study to compare hemodynamic variables and electrocardiographic changes suggestive of myocardial ischemia following administration of oxytocin in elective cesarean delivery between regional and general anesthesia methods.

Methods: In this double-blinded randomized clinical trial, 130 parturients were randomly divided into two groups of general anesthesia (65 cases) and spinal anesthesia (65 cases). After delivery of the baby and placenta, firstly a bolus of 5 units of oxytocin was injected, and then 30 units of oxytocin was infused over 30 minutes in both groups. Hemodynamic variables including heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were studied. ECG recording was done twice (1 hour and 24 hour) after the operation. For those who demonstrated ECG changes, serum troponin I level was measured.

Results: The ECG changes suggestive of ischemia was higher in general anesthesia group (36.9%, 24 cases) compared to spinal anesthesia group (24.6%, 16 cases), but it was not statistically significant (P= 0.12). Troponin I levels checked for patients with ECG changes were all within normal limits.

Conclusion: Although ST depression on ECG was more prevalent in parturients who underwent cesarean section under general anesthesia compared to spinal anesthesia, the difference was not statistically significant. None of the cases demonstrated myocardial injury based on Troponin I measurements.

Keywords: electrocardiography; cesarean section; oxytocin; myocardial ischemia; general anesthesia; spinal anesthesia

There is evidence that electrocardiographic (ECG) changes occur during elective cesarean section in parturients [1-5, 11]. These changes, mostly in the form of ST-segment depression, have been noted in either regional anesthesia or general anesthesia. It is estimated that these changes occur in up to 60% of patients [4]. According to Palmer et al. [6], imbalance between oxygen supply and demand is contributing to these changes, not myocardial ischemia.

Most authors believe that these changes occur in even healthy parturients and are not necessarily reflective of ischemic changes [1-5]. In fact, in studies performed no myocardial ischemia has been noted using specific serum markers for cardiac tissue injury. For instance, Zakowski et al. [3], studied 170 parturients who underwent cesarean section and received regional anesthesia by holter monitoring in a time course of 2 hours before and 3 hours after the operation. They reported that depression or elevation of ST segment occurred 160 times in 44 patients from both groups. Most changes were reported to occur between induction of anesthesia and the end of the operation. By using creatine kinase, neither of patients had myocardial injury. They concluded that ST segment changes recorded during cesarean section are not caused by myocardial ischemia and have no clinical implication. In another study, Dogan et al. [4], compared ST changes between regional and general anesthesia in 40 elective cesarean section by applying continuous holter monitoring for up to 24 hours after the operation. They reported that just 2 cases in regional anesthesia group and 1 case in general anesthesia group had ST-segment depression. They measured troponin T levels in all studied patients which were within normal range.

On the other hand, there is evidence that injection of oxytocin intravenously (IV) can result in increased heart rate, drop in blood pressure and ischemic ECG changes [7-8]. Even a case of myocardial ischemia immediately after administration of oxytocin in cesarean section by spinal

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anesthesia has been reported [9]. IV oxytocin per se produces hypotension and tachycardia owing to relaxing effects of this vasoactive peptide on the smooth muscles of the vessels [7]. Here, we decided to compare hemodynamic effects of IV injection of oxytocin after the delivery of baby in elective cesarean section and ECG changes between spinal and general anesthesia. Our hypothesis is that if we can find less adverse effects with any of these anesthesia methods, we will be able to recommend the method that would lessen the possible adverse effects of IV oxytocin in cesarean section patients.

Methods

This double-blinded randomized clinical trial included parturients with singleton pregnancy and with American Society of Anesthesiologists (ASA) class I or II who were candidate for elective cesarean delivery at our university hospital. Exclusion criteria were contraindications to receive anesthesia (either general or spinal anesthesia), previous history of cardiovascular diseases, diabetes mellitus, addiction, failure in spinal anesthesia induction, difficulty in endotracheal intubation, and a hemorrhage of more than 2,000 ml.

Considering at least 30% change in ECG findings in spinal anesthesia and 10% in general anesthesia with $\alpha = 0.05$ and power of 80%, sample size for each study group was calculated as 65 cases. Considering a failure rate of 5% in spinal anesthesia, the sample size in spinal anesthesia group was increased to 70 cases. Finally, five patients in spinal anesthesia group were excluded due to failure in starting anesthesia. The included patients (130 cases) were randomly divided into 2 groups (65 cases in each group) by using computer based random number table. One group underwent general anesthesia while the other one underwent spinal anesthesia. The study details were described to the patients prior to cesarean delivery. Written informed consent was obtained and they were reassured that the information will be kept confidential by the research team. The medical ethics committee of Tehran University of medical sciences approved the study protocol. The study protocol was in conformity with the ethical guidelines of the 1975 declaration of Helsinki [10].

Variables studied included heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), electrocardiographic changes suggestive of ischemia (for instance inverted T wave, ST segment depression, etc) which were recorded at time 1 and 24 hours after the end of cesarean section as well as troponin I levels in those with abnormal ECG changes.

Before transferring to operation room, standard 12-lead ECG was done. Then, in the operation room, an IV line using 18-gauge catheter was established and infusion of lactated ringer's solution was initiated (5 mL/kg). The patients then underwent routine monitoring of noninvasive intraoperative blood pressure (NIBP) with 5-minute intervals, heart rate, pulse oximetry, and ECG monitoring which was started in the operation room and continued for 24 hours after cesarean delivery. In addition to pre-operation ECG, standard 12-lead ECG was obtained again 1 hour after the operation and for the second time 24 hours after the end of operation. The ECG strips were examined by a cardiologist who was unaware of the groups. For those who demonstrated changes in ECG tracings, troponin I level was measured twice (1 and 24 hours after ischemic ECG changes). Troponin I levels of more than 0.04 ng were considered positive. We asked about chest discomfort and shortness of breath during and after the operation in the spinal anesthesia group.

In regional anesthesia group, 3 ml of hyperbaric bupivacaine 0.5% (Mylan company, France) was injected intrathecally via L3-L4 or L4-L5 interspaces by 25-gauge Quincke spinal needle in sitting position. In the case of the drop of more than 25% of baseline value of systolic blood pressure, ephedrine (5-10 mg) was injected intravenously. In the case of heart rate drop to less than 50 beats per minute, 0.5 mg atropine was injected intravenously. If the patients complained of nausea and vomiting, ondansetron, 4 mg was injected intravenously.

In general anesthesia group, pre-oxygenation was done for 3 minutes. Anesthesia was induced by thiopental sodium, 5 mg/kg and succinylcholine,1.5 mg/kg. Then after 45 seconds, endotracheal intubation was done by 7-7.5 tubes, and atracurium, 0.3 mg/kg was injected. For anesthesia maintenance, isoflurane 0.7% and 50:50 nitric oxide/oxygen was used. ETCO2 was maintained at 35-40 mmHg. Management of hypotension, bradycardia, and nausea and vomiting was similar to that applied to spinal anesthesia group.

After delivery of the baby and clamping of the cord, fentanyl, 3 µg/kg and morphine, 0.1 mg/kg were administered. After termination of the cesarean section, anesthesia reversal was achieved using neostigmine, 0.04 mg/kg and atropine, 0.02 mg/kg. After delivery of the baby and placenta, firstly a bolus of 5 units of oxytocin was injected and then 30 units was infused over 30 minutes. This approach was the same in both regional and general anesthesia groups.

Statistical Analyses

The data gathered were entered into the SPSS software for windows (version 20). Descriptive indices including frequency, percentage, interquartile range, mean, and standard deviation (±SD) were used to report the data. Comparisons of qualitative and continuous variables between the two studied groups were done using the Chi-squared test and student t-test, respectively. Repeat measurement test was applied to find the trend of change in variables of SBP, DBP, and HR over time.

Results

Mean age in regional and general anesthesia groups was 27.6±5.1 years and 28.7 ±4.4 years, respectively (P= 0.188). (Table 1) presents SBP, DBP, and HR measurements at 0, 5 minutes, 10 minutes, and 25 minutes in both groups.

As shown, mean SBP was significantly lower in spinal anesthesia group compared to general anesthesia group at 5, 10, and 25 minutes. This pattern was also seen in DBP. There was an increase in heart rate over time in spinal anesthesia group, but declined in general anesthesia group. Although changes in ECG tracings suggestive of ischemia was higher in general anesthesia group (36.9%, 24 cases) compared to spinal anesthesia group (24.6%, 16 cases), it was not statistically significant (P= 0.12). Troponin I levels checked for these patients were all within normal limits.

Table 1- Comparison of hemodynamic variables at 0.5, 10 and 25 minutes between regional and general anesthesia groups

		0	5 minutes	10 minutes	25 minutes	P value
Systolic blood pressure, (mmHg)	Regional group	122.9±15.8	103.8±13.1	105.9±10.04	106.7 (±7.8)	< 0.001
	General group	123.6±12.1	127.9±12.03	129.8±14.4	114.9 (±12.4)	
Diastolic blood pressure (mmHg)	Regional group	75.1±8.8	64.05±10.5	66.5±10.7	68.9 ±8.9	< 0.001
	General group	78.8±13.9	78.9±11.8	81±13.8	72.8±8.4	
Heart rate (beats per minutes)	Regional group	95.8±11.2	86.1±13.3	92.9 ±11.9	93.5 (±10)	< 0.001
	General group	98.8±14.2	107.2±12.09	99.7±12.7	87.1±8.5	

Discussion

This study compares ECG changes after oxytocin injection between general and spinal anesthesia. We observed ST depression in 37% of general anesthesia group and in about 25% of spinal anesthesia group. In a former study by Svanström et al. [7], spatial ST-change vector magnitude (STC-VM) was recorded in women undergoing elective cesarean section with spinal anesthesia, and IV oxytocin bolus (10 units) was compared to those of control group, non-pregnant cases who received the same dose of oxytocin, and also was compared with cesarean section cases who received methylergometrine not oxytocin. They reported that in comparison to women who underwent cesarean section with oxytocin, non-pregnant control subjects who received only oxytocin showed significantly higher STC-VM (+114 vs. +77, P< 0.001). This trend was also observed in terms of heart rate. Increase in mean heart rate was significantly more prominent in control non-pregnant group versus those cesarean patients who received oxytocin (52±3 versus 28±4). Cesarean patients who received methylergometrine did not have significant change in heart rate or STC-VM. They concluded that changes observed here are due to the direct effects of oxytocin, not pregnancy.

In a trial to determine the role of oxytocin dosage and its relation with ECG changes, Jonsson et al. [8], compared IV bolus of 5 units versus 10 units of oxytocin in healthy women undergoing elective cesarean delivery with spinal anesthesia. They found that ST depression was more common in the group which received 10 units of oxytocin compared to 5-unit oxytocin group (7 cases, 13.5% versus 15 cases, 29.4%; P= 0.048). Our method was different from this study, as in our study at first 5 units were injected in IV bolus and then 30 units of oxytocin were infused over 30 minutes. ST depression frequency that we observed in spinal anesthesia group (24.6%) is similar to that seen in 10-unit group.

Oxytocin is widely used nowadays in cesarean section patients. It is well established that oxytocin has some adverse effects on cardiovascular system and may enhance changes (vascular dilation for example) which consequently result in imbalance of oxygen supply and demand. This effect can be aggravated during anesthesia. We did not observe any significant difference between spinal and general anesthesia. So we cannot recommend which anesthesia technique is superior to the other in terms of ST changes. The only significant finding we observed was a decline in SBP and DBP in spinal anesthesia group. This warrants anesthesiologists to pay attention to cesarean section women who undergo spinal anesthesia and receive oxytocin. A limitation we encountered was that we did not have access to holter monitoring for continuous monitoring of the patients.

In conclusion, we found that although ST depression on ECG was more prevalent in parturients who underwent cesarean section with general anesthesia compared to spinal anesthesia. The difference was not statistically significant. None of the cases demonstrated myocardial injury based on troponin I measurements.

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