

Changes of Total Calcium Levels During Abdominal Gynaecologic Surgeries According to the Type of Anesthesia

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Abstract

Background: Calcium plays an important role in many biophysiological mechanisms .The present study was carried out to assess alterations in total serum calcium level before and after operations in consider to the type of anesthesia.

Materials and Methods: This descriptive study was conducted in 74 women scheduled for abdominal gynaecological surgeries during one year at Al-Zahra Maternity Hospital in Rasht, Iran. All patients were in ASA (American Society of Anesthesiologists) class I and II. Seventy four cases were randomly underwent general anesthesia (GA) (n=37) or spinal anesthesia (SA) (n=37). Blood samples (2 cc), were obtained an hour before the anesthesia and two hours after that. Then, blood samples were sent to the laboratory to determine total serum calcium level, magnesium (Mg) and albumin level using photometric methods. Data were analyzed using the Vilksnon non-parametric and Pearson's correlation test. P-values less than 0.05 have been considered as statistically significant.

Results: Mean total serum calcium levels \pm SE at pre and postoperative period were 8.75 ± 0.32 mg/dl and 8.4 ± 0.46 mg/dl, respectively. There was a significant difference in total serum calcium level before and after all types of surgeries ($P < 0.001$). There was a significant trend to decrease in calcium levels after all abdominal gynaecological operations, but there was a significant correlation between general anesthesia and reduction of serum calcium level ($p = 0.026$) . Based on outcomes, general anesthesia is accompanied by more calcium reduction than spinal anesthesia.

Conclusion: Serum calcium levels tend to decrease after all abdominal gynaecological surgeries, but general anesthesia results in more calcium reduction than Spinal anesthesia. Further studies are needed to illustrate the association between different methods of anesthesia and Ca^{++} changes

Keywords: Calcium; Abdominal Gynaecological surgery; General Anaesthesia; Spinal Anaesthesia

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Introduction

Calcium is one of the most important minerals, the fifth most common element and the most prevalent cation found in the body with very important roles (1-7). Therefore, measurement of serum calcium level could be helpful to evaluate the body health state (3, 8, 9) .Furthermore, total serum calcium may decrease

in as many as 80% of critically ill and postsurgicalpatients (10, 11) .There are numerous factors that have been suggested to create hypocalcaemia such as; changes in albumin affinity for calcium chelation by citrate from blood transfusions, or resistance to parathyroid hormone

(PTH) or vitamin D action (13, 14). In the absence of massive blood transfusion, only slight decreases in calcium levels within the normal range have been reported during surgical procedures, mostly attributed to pH variations caused by general or spinal anesthesia (12). Indeed, as it is known, type of anesthesia has an important role on pH changing and, sometimes it is different in General or Spinal anesthesia. So, it may influence postoperative calcium levels (1, 2).

Hypocalcaemia is self-limiting in most patients, but there is a special concern about symptomatic hypocalcaemia due to manifestations delay and the following prolonged patient hospitalization or readmission (15). Maybe, in consider to the well timed detection, the precious ion is replaced with routine calcium or Vitamin D supplements to prevent the development of symptomatic hypocalcaemia and increase the likelihood of early hospital discharge, patient's well being, as well as decrease the costs. There are several studies that illustrated low postoperative calcium levels in different type of surgeries, but there are few studies on serum calcium levels changes after abdominal gynaecological surgeries which they also did not consider the type of anesthesia.

The role of calcium is well recognized in health state or biochemical processes and postoperative wellbeing, but it is not evaluated as routine laboratory test in abdominal gynaecological operations. Therefore, it is necessary to know how serum calcium level can be changed throughout anesthesia in abdominal gynaecological surgeries. So we decided to design the current study to evaluate and compare the extent of changes in the serum calcium levels during general and spinal anesthesia in females scheduled for minor and major abdominal gynaecological surgeries. Due to the changes of this vital ion, replace in time and avoid prejudicial effects of calcium deficit in women who are prone to hypocalcemia especially in Guilan, Iran.

Materials and methods

The current descriptive study was carried out after Al-zahra hospital and Guilan University of Medical Sciences ethics Committee approval and taking written consent inform. Convenience sampling was performed at maternity ward in Alzahra hospital. Seventy four cases scheduled for elective abdominal gynaecological surgeries were randomly divided into general anesthesia group (n= 37) and spinal anesthesia (n= 37). All patients were in ASA (American Society of Anesthesiologists) class I or II. Patients with prior history of abdominal operations, major organ system dysfunction such as kidney dysfunction, neuropathy, myopathy, pulmonary

hyperventilation, and alkalosis, and hypomagnesemia, history of previous medications such as calcium channel blockers were excluded from the study. Also, patients were put aside from the study if they needed massive blood transfusion. Anesthesia protocols were standardized. Patients were NPO (non per os) for 6 hour before the operation. General anesthesia (GA) was induced with thiopental sodium (5-7 mg/kg) and tracheal intubation was facilitated by succinylcholine (1mg/kg). Moreover, for maintenance of anesthesia, a mix of nitrous oxide 50% and oxygen 50%, atracurium (0.5 mg/kg) and isoflurane (0.5-1%) were used. Fentanyl (0.1 mg/kg) was taken for analgesia intravenously at beginning of anesthesia process and subsequent incremental doses were given in consider to sweating, lacrimation or 30% increase in baseline heart rate (HR). Total dose of atracurium and fentanyl were recorded accurately. Heart Rate (HR), pulse oximetry and Noninvasive Blood Pressure (NIBP) were evaluated carefully during operations. Neostigmine (0.05 mg/kg) and atropine (0.01mg/kg) were administered to reverse the effects of neuromuscular blockade at the end of one operation. Spinal anesthesia (SA) was performed with Intrathecal epinephrine (0.2 mg) + lidocaine (5% 2 ml), and in case of necessity, narcotics and parenteral anxiolytic were also administered. To prevent probable meddlesome, only synthetic colloids, crystalloids and blood products were used and massive blood transfusion or fluid replacements were avoided. Demographic data, duration of the surgeries, urine output, and amount of blood loss were recorded individually, as well as, vital signs, and physical situation. The surgeries were categorized to minor abdominal gynaecological surgeries including: Tubal ligation (TL), Myomectomy, Ovarian Cyst and Major abdominal gynaecological surgeries such as Cesarean and Hysterectomy. Blood samples were obtained at two stages: an hour before the anesthesia (2 ml) and two hours after that (2 ml). blood sampling was done in supine position and NPO (non per os) for preventing some problems that could change total serum calcium and bias outcomes such as body posture, vein stasis, nutrition situation, and received heparin. All samples were analyzed with biochemistry kits (Parsazmun, Iran) at the same laboratory center. Total serum level of magnesium, calcium and albumin were measured through photometric method accurately. Normal range of magnesium, calcium and albumin were considered 1.7- 2.3 mEq/L (0.75-1.25 mmol/l), 8.5-10.5 mg/dl and 3.4-4.7 g/dl, respectively. Data were analyzed applying Vilkalson non-parametric and Pierson correlation test to compare changes of main variables and quantitative parameters between the times of blood sampling. Data were analyzed using SPSS version 16.0

(Chicago Illinois, USA). P-value less than 0.05 has been considered as statistically significant.

Ethics Statement

All patients provided their informed consent and the study was carried out in accordance with approved ethical committee of the Guilan university of Medical Sciences.

Results

The results have demonstrated a significant correlation between calcium alterations and the type of anesthesia. Also, there was a significant correlation between general anesthesia and alternation of total serum calcium level.

Table 1. Demographic data of subjects.

Relative frequency	Number	Percentage	
Age	<25 years	15	20.46
	25–30 years	40	54.54
	>30 years	17	25
Marital Status	Married	73	98.6
	Single	1	1.4
			12.2
Previous surgery	9	10.8	
Past medical disorders	10	10.8	
Spinal anesthesia	40	54.05	
General anesthesia	34	45.92	
History of previous anesthesia	8	10.8	

The total serum calcium level showed a tendency to decrease in both general anesthesia (GA) and spinal anesthesia (SA) patients after the operations, but general anesthesia was found to be accompanied by more calcium reduction than spinal one at the same

time ($p=0.026$). Moreover, mean arterial blood pressure were significantly lower in patients receiving general anesthesia than patients having spinal anesthesia. ($p=0.03$). The patients' mean age (age \pm SD) was 26.6 ± 6.1 years. The youngest and the oldest patients were 18 and 45 years old, respectively. Approximately, out of 75% of cases were younger than 30 years. In consider to marital status 98.6% was married and 1.4% was single (Table1). Prior operation (except of abdominal surgery) and past medical disorders were found in 12.2% and 10.8%, respectively and 8% had previous history of anesthesia. Cases were candidate for major or minor elective gynecologic surgeries under general or spinal anesthesia (Cesarean 80%, hysterectomy 9.45%, and laparoscopy 9.4%).

Kolmogorov–Simirnov test was applied to assess normal distribution of variables including albumin, calcium, magnesium and vital signs. As results demonstrated, variables did not follow a normal distribution. The Vilkacson non-parametric test was substituted to compare the average of variables, before and after the surgeries precisely. Moreover, Pearson Correlation Coefficient test was used to measure the strength of a linear association between demographic quantitative parameters such as age, weight, prior surgery, and previous anesthesia and main variables such as albumin, calcium, magnesium, blood pressure, pulse, respiratory rate, and temperature.

Results showed that mean total serum calcium levels \pm SE (or SD where indicated) at pre-and postoperative period have been 8.75 ± 0.32 mg/dl and 8.4 ± 0.46 mg/dl, respectively. There was a significant difference in total serum calcium level before and after all types of surgeries ($P<0.001$). We did not observe any significant correlation between main variables except for temperature ($P=0.07$) at pre- and postoperative period (Table 2).

Table 2. A comparison between main variables before and after surgeries.

Main variable	Before surgery	After surgery	P value
Albumin (mmol/l)	4.002 ± 0.461	4.007 ± 1.07	$P<0.001$
Calcium (mmol/l)	8.75 ± 0.323	8.4 ± 0.46	$P<0.001$
Magnesium (mmol/l)	1.87 ± 0.32	1.55 ± 0.34	$P<0.001$
Blood pressure (mmHg)	11.7 ± 1.34	96.37 ± 1.8	$P = 0.03$
Pulse (/min)	83.28 ± 8.23	87.04 ± 9.53	$P<0.001$
Respiration (/min)	18.74 ± 4.93	21.33 ± 2.1	$P = 0.10$
Temperature ($^{\circ}$ C)	37.38 ± 0.87	37.14 ± 0.93	$P = 0.07$

All values are mean \pm SD

Preoperative mean total serum calcium levels in general and spinal anesthesia were 8.73 ± 0.32 mg/dl and 8.54 ± 0.34 mg/dl, respectively. Also, mean total serum calcium levels in general anesthesia were 8.38 ± 0.42 mg/dl and in spinal one were 8.52 ± 0.44 mg/dl at postoperative period (Table 3). Tables 2 and

3 show that levels of calcium have significantly decreased at postoperative period in both general and spinal anesthesia. But calcium changes were more significant in GA than SA ($p=0.026$).

Table 3. Balance of electrolytes, albumin, and changes in vital signs according to the type of anesthesia.

Changes with vital signs	General anesthesia	Spinal anesthesia	P- value
Diff-albumin (mmol/l)	0.46 ± 0.89	0.53 ± 11.2	0.84
Diff-Calcium (mmol/l)	0.4 ± 0.89	0.34 ± 0.53	0.82
Diff-magnesium (mmol/l)	0.32 ± 0.81	0.31 ± 0.38	0.98
Diff-blood pressure (mmHg)	42 ± 34.1	20.94 ± 20.11	0.03
Diff-pulse (/min)	1.2 ± 10.7	3.9 ± 7.9	0.47
Diff-respiration (/min)	7 ± 6.6	3.28 ± 22.4	0.31
Diff-temperature ($^{\circ}$ C)	0.8 ± 0.69	0.26 ± 1.2	0.55

All values are mean \pm SD

Diff: difference between two type of anesthesia (general & spinal)

In general anesthesia group, mean blood pressure was 110.9 ± 1.39 mmHg and 100.47 ± 1.4 mmHg at preoperative and postoperative times, respectively. Also, in spinal anesthesia mean blood pressure was 110.7 ± 1.24 mmHg at preoperative and 90.47 ± 1.5

mmHg at postoperative period. According to the type of anesthesia, there was a significant correlation between, pre and postoperative period, in blood pressure changes ($P < 0.001$). (Table 3)

Table 4. Electrolyte Changes according to the type of surgery.

Main variables	Major Surgery		P- value	Minor Surgeries		P- value
	Before	After		Before	After	
Albumin (mmol/l)	4.006 ± 0.461	4.004 ± 1.07	$P < 0.001$	4.005 ± 0.45	4.003 ± 1.06	$P < 0.001$
Calcium (mmol/l)	8.75 ± 0.323	8.4 ± 0.46	$P < 0.001$	8.64 ± 0.34	8.57 ± 0.34	$P < 0.06$
Magnesium (mmol/l)	1.87 ± 0.32	1.75 ± 0.34	$P = 0.05$	1.87 ± 0.32	1.75 ± 0.36	$P = 0.05$
Blood pressure(mmHg)	110.9 ± 1.34	96.47 ± 1.8	$P < 0.001$	110.7 ± 1.24	94.47 ± 1.6	$P < 0.06$
Pulse(/min)	83.28 ± 8.23	86.04 ± 9.53	$P = 0.10$	82.28 ± 8.13	85.04 ± 9.43	$P = 0.20$
Respiration(/min)	18.64 ± 4.93	21.43 ± 2.1	$P = 0.07$	18.05 ± 4.73	20.43 ± 2.4	$P = 0.08$
Temperature-($^{\circ}$ C)	37.36 ± 0.87	37.12 ± 0.93	$P < 0.001$	37.31 ± 0.77	37.28 ± 0.92	$P < 0.06$

All values are mean \pm SD

According to outcomes, mean total serum calcium levels were 8.75 ± 0.32 mg/dl and 8.4 ± 0.46 mg/dl before and after major surgeries, respectively. Before and after minor operations mean total serum calcium levels were 8.64 ± 0.34 mg/dl and 8.57 ± 0.34 mg/dl, respectively. There was a significant correlation between decreased total serum calcium levels and type

of surgeries. Calcium changes was more significant in major surgeries than minor one ($p < 0.0001$). (Table 4) Mean serum Albumin levels were 4.005 ± 0.461 g/dl at preoperative and 4.003 ± 1.06 g/dl at postoperative period in general anesthesia group. Also, in spinal anesthesia group mean serum Albumin levels were 4.006 ± 0.45 g/dl and $4.001 \pm$

1.04 g/dl at pre and post time, respectively (Table 3). There was no significant clinical hypocalcaemia in patients.

Discussion

In current study total calcium level significantly decreased during general anesthesia. Total serum calcium changes have been evaluated between general anesthesia and spinal anesthesia patients during abdominal gynaecological surgeries. Statistic outcomes have shown a significant trend to decrease in calcium level at pre and postoperative period in both GA and SA groups. But, the study illustrated that total serum calcium level significantly decreased during GA and this reduction was more significant than SA. As it is obvious, calcium is a very important cation with a lot of vital activities, and its crucial role on postoperative well-being and early discharge is undeniable. Therefore, control of calcium in normal ranges has a noticeable effect on postoperative comfort, well-being and outcome.

There are few studies on changes of serum calcium level based on the type of surgery, without considering other interventional factors. To the best of our knowledge, there was no study on serum calcium level changes considering the type of anesthesia. Lepage *et al* observed decrease in ionized and total calcium in patients after major and minor abdominal surgeries, without considering the type of anesthesia (8). In another study, Zologa *et al* illustrated that 71% of 156 predominantly surgical intensive care unit (ICU) patients were hypocalcaemic by the total serum calcium level (11). On the other hand, in the absence of massive blood transfusion, only slight decreases in calcium levels within the normal range have been reported during surgical procedures, mostly attributed to pH variations (13, 14). We were unable to evaluate ionized calcium levels in both two types of anesthesia (general and spinal) in our study because the lack of instruments result in to ignore PH factor role in this investigation.

The amount of total calcium level is affected by total protein concentration particularly albumin and in this scenario false low calcium levels may be reported (16). In addition, magnesium and calcium metabolism are closely related, therefore, changes in magnesium levels could impress the amount of serum calcium level through changes in Parathyroid hormone (PTH) secretion. Hence, magnesium and albumin levels were also accurately measured by photometric methods to prevent pseudo hypocalcaemia outcomes (10, 15).

We excluded all conditions that lead to alkalosis, but albumin loss was inevitable during the study. In this respect, albumin changes, magnesium alterations,

loss of renal function, or malnutrition could play an obvious role on serum calcium level in our study. We noticed depletion in albumin and magnesium levels; thus, urine loss or malnutrition could not be improbable (17-19). Therefore, for low socioeconomic class, malnutrition or less magnesium and calcium levels cannot be ignored. The study has demonstrated a significant decrease in magnesium serum level before and after surgery (15).

Hypocalcaemia is a serious imbalance because it involves in action potential of cardiac cells and excitation-contraction of skeletal muscles, so it may cause many disorders such as potentiate cardiac arrhythmias, seizures, hypotension, myocardial dysfunction (15, 20, 21). As it is clear, minimal calcium (Ca^{++}) depletion in patients who are prone to hypocalcaemia, may leads to a prolonged recovery period or well-being after the surgeries. We are faced with high incidence of hypocalcaemia in Guilan which leads to some difficulties for patients and care givers. Maybe well-time detection, could protect patients against adverse effects of hypocalcaemia, decrease hospital expenditures and convalescence, and ameliorate patients' welfare and health.

Conclusion

Anesthetists and surgeons are recommended; to be aware of electrolyte imbalance induced by type of anesthesia in patients prone to hypocalcaemia. It is also necessary to monitor this issue to avoid adverse effects. However, further studies are required to prove this relationship.

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Authors' Contributions

Main Author contributed to researching data, writing draft and discussing the content. Corresponding Author making study design, searching data and contributing to discussing of the content.the manuscript. HN, FL and HK Z all contributing to edit the manuscript.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding publication of this paper.

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