

Effect of Electroconvulsive Therapy on Serum Electrolytes and Glucose Levels in Adolescents with Major Depressive Disorder

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Abstract

Introduction: Adolescence is remarkably a risky period for the development of psychopathologies. Electroconvulsive therapy (ECT) is considered one of the most effective treatments for patients with depression. The aim of this study is evaluation of Na, K, Ca and glucose changes before and after ECT in adolescents with major depressive disorder.

Materials and Methods: In this quasi-experimental study, to evaluate the effect of ECT on serum electrolytes and blood glucose, 50 adolescents with major depressive disorder admitted to the psychiatric ward of Ahvaz Golestan Hospital ECT candidates (22 boy and 28 girl) were evaluated for six months. Blood samples were taken from patients, before induction of anesthesia and after ECT. All patients were anesthetized with similar drugs and same procedure. The data collected were analyzed using SPSS software and then subjected to statistical analysis (paired t-test).

Finding: Glucose levels ($p=0.000$) and Potassium ($P=0.005$) showed a significant increase but Sodium ($P = 0.001$) showed a significant decrease. Calcium with ($P=0.192$) showed no significant decrease.

Conclusion: Since the ECT in adolescents with major depressive disorder is performed under general anesthesia, it is essential that a complete physical examination and laboratory tests should be done before doing it. Due to changes in the value of serum Electrolytes and glucose that occurs under ECT, therefore attention to these electrolytes, especially sodium and potassium, during and after this treatment is important.

Key words: Adolescents, Blood glucose, Electroconvulsive therapy, Major depressive, Serum electrolytes

INTRODUCTION

Adolescence is a period of deep emotional and physical changes. This moment of psychological vulnerability favors the development of serious and potentially damaging psychopathologies (1). In addition, major depression affects near 8% of adolescents, more commonly during puberty. Forty percent of them present recurrent attacks, and a third will experience at least one suicide attempt (2). It is expected that by 2020, major depressive disorder is considered as

the second most common disease after coronary artery disease in the world (3). At present, several medical and non-medical treatments for depression are raised. Although administration anti-depressant drugs has increased in recent decades, but not enough to treat these patients successfully and completely, This shows the necessity of using complementary therapies (4). ECT as a treatment for depression is raised (5). ECT is one of the most common medical procedures requiring general anesthesia that around 100,000 people in the United States are treated with this method(6). This process is an effective methods of non-pharmacological in the treatment of patients who suffer from certain mental disorders (7). ECT used in some mental illnesses such as severe depression, especially when the patient does not respond to medical treatment(8-12) or in the pregnant women due to medical complications, Or when is risk of injury to the patient and others, And requires the patient to fast exit status(11,13-15), Or in the

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drug resistance (16,17). In addition to the many positive effects of ECT can also cause side effects. The side effect of this treatment is mortality, headache, nausea, vomiting, confusion, delirium and madness, memory loss, tooth fractures and back pain and muscle aches, often the effects of succinylcholine-induced muscle depolarization. These side effects are a problem for most of the first session of treatment (18). ECT also cause cardiovascular complications such as high blood pressure and heart rate. (19) Today, with the use of anesthesia interventions, ECT has been carefully modified and adjusted. So that ECT is a safe and effective non-drug treatment for patients with mental disorders (20). Today, Treatment with ECT under general anesthesia with muscle paralysis widely used in psychiatry (21, 22). Because general anesthesia with muscle paralysis made it safe and comfortable and reduce side effects and optimize its performance (23). In addition, the therapeutic effect of ECT is faster than drugs. But in order to optimize the management of patients undergoing ECT anesthesia, Understanding the physiological response to electrical stimulus and understanding the pharmacological effects of drugs used is very important to reduce the side effects of ECT (24). The exact effects of ECT on brain is still unknown. (25) In any case, the study of electrocardiography and measurement of sodium and potassium before ECT is an effective screening method to confirm this treatment. However, in some studies, states that ECT has little effect on electrolytes (26). Some studies have shown that ECT increases in serum potassium. Although the duration of the seizure No effect on increases potassium (27) or this increase was not statistically significant (28). But Shukla in 1982 and Goudarzi in 2011 have stated that ECT both alone and in combination with anesthetic (thiopental and succinyl choline) increased blood potassium and this increase is statistically significant (29-30).some data suggest an increase in blood sugar levels due to ECT (31-36). Also, some studies suggest that this method has no effect on blood sugar (36-39). However, patients undergoing treatment with ECT, are Fasting. But if this treatment affect on blood sugar level, Diabetic patients undergoing this type of treatment, must be paid in blood sugar levels before treatment. On the one hand changes in glucose and electrolytes such as sodium, potassium and calcium creates many problems for patients. Increase blood glucose levels (hyperglycemia) can cause diabetes. Low blood sugar (hypoglycemia), Makes acute disorders of the central nervous system and permanent brain injury. Increases in serum sodium create restlessness, weakness, restlessness, lack of consciousness, hallucinations and delusions. Decrease in blood sodium (hyponatremia) creates brain damage and compression of brain structure. The most important complication of increased blood potassium effects on the myocardium. Decreased blood potassium

(hypokalemia severe) leading to cardiopulmonary arrest and death. Increase blood calcium (hypercalcemia) leading to reduction of neuromuscular irritability, heart Dysrhythmia and heart block. Low blood calcium leading to seizures, depression, memory impairment, confusion, delusions and hallucinations (40). All changes in the anesthetic can affect and impair anesthesia management. On the other hand, patients need to have general anesthesia for ECT and have been fasting over night. And stress can cause changes in blood sugar and fasting May also cause changes in electrolyte levels, Evaluation of sugar and electrolytes is very important. Due to conflicting information about the effects of ECT on the changes in electrolytes and blood sugar has been published and has limited information about the effect of this treatment on the adolescence depressed patients, and according to the complications that create the imbalance of glucose and electrolytes for patients, The aim of this study was to evaluate changes in serum glucose and electrolytes in adolescence with major depressive disorder under ECT.

MATERIALS AND METHODS

This cross-sectional study (experimental) was conducted in 2015 for six months on 50 adolescence non-diabetic patients (22 boy and 28 girl/mean age (16.4±1.1) with major depression who were hospitalized in Ahvaz Golestan hospital psychiatric wards. The patients were candidates for a time ECT. The sample size was calculated with a confidence level of 95%, standard deviation of 6 and Accuracy 1 from the following formula:

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}}\right)(\sigma)^2}{d^2} = \frac{\left(\frac{1}{96}\right)^2 (6)^2}{1^2} \rightarrow n = 48 = 50$$

Inclusion criteria for this study include: absence of disease (particularly electrolyte disorders and diabetes), as well as the absence of disease renal, hepatic, endocrine diseases, and not used of Glucocorticoids and Mineralocorticoid. with patients (and their relatives) spoke about the research objectives and methods of implementing it and then written consent was obtained. Patients were informed that this study no cost to them. Patients were fasting for 8-10 hours on the ECT and the age group 13 to 18 years and anesthesia class one and two were selected. The first blood sample was taken before induction of anesthesia. The induction was carried out after administration, sodium thiopental (3-5 mg/kg), succinylcholine (0.5 mg/kg) and 1mg atropine. Patients were ventilated with pure oxygen and ECT was performed for 5 seconds. 15-20 minutes after finishing the seizures, a second blood sample was

taken (41). To prevent possible residual effects of anesthetic drugs on serum electrolytes for each patient, was used to IV line one for administration of anesthesia drugs and other to get blood samples. Then blood samples were sent to the laboratory to determine the amount of electrolytes (sodium, potassium and calcium) and blood sugar. Blood glucose levels were measured using the glucose oxidase method and kit of glucose and electrolytes with Flame photometer. Monitors for ECT, such as arterial oxygen saturation, non-invasive method for measuring systolic and diastolic blood pressure, ECG before, during and after ECT was performed. Data was collected through questionnaire. Questions were asked of patient by face to face method. Another way of collecting data was Tests to determine the patient's electrolyte and blood glucose. The SPSS 15 software was used for data analysis. Data were analyzed using paired T test. The significance level was considered $p < 0/05$.

RESULTS

In Table 1 is presented the demographic characteristics and changes in vital signs and blood sugar levels before and after ECT. In these patients, increased mean arterial pressure, mean heart rate, respiratory rate and mean average serum glucose after a once ECT. All these changes, both for boy and for girl were statistically significant.

In Table 2 is presented the mean and standard deviation of sodium, potassium and calcium, both before and after a once ECT. According to information obtained glucose levels ($p = 0.000$) and Potassium ($P = 0.005$) showed a significant increase but Sodium ($P = 0.001$) showed a significant decrease. Calcium with ($P = 0.192$) showed no significant decrease. Significant changes were noted in pre and post ECT in glucose and sodium between boy and girl. Also significant changes were noted in pre and post ECT in potassium in boy. But no significant changes were noted in pre and post ECT calcium level.

CONCLUSION

The results of the present study showed that ECT did cause a significant change in electrolyte such as sodium, potassium and calcium and blood glucose, These results are matching up with what have been reported by many other Research all over the world (). In present study, was observed ECT can change blood sodium levels (significantly decrease), calcium (decrease) and potassium (significantly increase) in adolescents. In study by Aggarwal *et al.*, Entitled "Changes in serum potassium after electroconvulsive therapy" Was found that the potassium in all 3 groups (ECT with anesthesia drugs, ECT alone and anesthesia drugs without

Table 1: The demographic characteristics and changes in vital signs and blood sugar levels before and after ECT

Sex	Boy	Girl
Count (percent)	22 (44%)	28 (56%)
Age (mean±SD)	16.1±2.5	15.9±2.1
Mean arterial pressure mean±SD (mmHg)		
Before ECT	12.3±3.4	11.8±2.3
After ECT	13.9±4.2	13.1±3.2
P value	P=0.005	P=0.001
Heart rate mean±SD (bpm)		
Before ECT	80.4±2.3	78.5±1.2
After ECT	96.4±3.1	94.5±4.2
P value	P=0.000	P=0.000
Respiration rate mean±SD		
Before ECT	12.8±4.1	13.1±3.2
After ECT	15.4±3.2	16.2±2.2
P value	P=0.002	P=0.002

Table 2: The mean and standard deviation of sodium, potassium and calcium, both before and after a once ECT

Time parameter	Mean±SD		P value
	Before ECT	After ECT	
sodium in all patients	135.43±7.22	131.70±8.47	0.001
Potassium in all patients	4.11±0.56	4.33±0.63	0.005
Calcium in all patients	9.81±0.72	9.76±0.81	0.192
Blood sugar	91.53±15.23	97.24±13.41	0.000

Time parameter	Mean±SD		P value
	Before ECT	After ECT	
Sodium			
Boy	136.52±6.23	133.61±7.53	0.003
Girl	135.63±5.34	132.43±4.72	0.004
Potassium			
Boy	4.21±0.44	4.32±0.55	0.006
Girl	4.02±0.51	4.04±0.43	0.11
Calcium			
Boy	9.73±0.61	9.65±0.71	0.192
Girl	9.99±0.55	9.83±0.62	0.15
Blood sugar			
Boy	92.41±21.23	98.8±31.7	0.001
Girl	90.32±33.21	96.6±33.5	0.001

ECT) increased The largest increase in the group who had received with anesthesia drugs. the lowest increase in the group who did not receive ECT. Thus, according to results of this study, the patients who are under anesthesia with ECT or before ECT have high potassium most consider to be the potassium level (29). Soltani (2011) studied the effects of ECT on electrolyte changes. Significant changes were noted in pre and post ECT in glucose between men and women and sodium in men and women and potassium in men. But no significant changes were noted in pre and post ECT calcium level and in potassium level

in women (31). Senouci and colleagues (2013) concluded that ECT increases serum sodium levels (33). According to research cited and the results of this study revealed that ECT significant increases potassium. This is mandatory when prior to ECT blood potassium is high. Therefore in Patients who are ECT candidates Blood potassium should checked and If higher than normal, ECT done with caution. Potassium increase in boy adolescents was significant which similar Soltani (31) study is. The results of this study suggest that ECT causes significant decrease in blood sodium which was different from the result of Soltani (31) and Abdullh (42) study. This difference may be because our study sample was adolescents, while Soltani and Abdullh study samples were adult. This decrease will be more important that before the induction of anesthesia for ECT, blood sodium level is lower than normal. Also In this study, According to sex was found that sodium reduction was significant. It was also found that ECT reduces the amount of calcium, but this reduction was not statistically significant. According to age and sex was found that calcium reduction was not significant which is similar Soltani (31) and Abdullh (42) study this decrease is important when the patient's blood calcium level less than normal before induction of anesthesia for ECT. In present study, was observed ECT can change blood sodium levels (significantly decrease), calcium (decrease) and potassium (significantly increase) in adolescents. Change in the levels of electrolytes such as sodium, potassium and calcium, from complications of this procedure. Although these changes are normal range in all patients and there is no concern for more change in electrolytes but the need to pay more attention to patients who are at the end of the normal range. Electrolyte changes in some studies compared with the present study was different. The reason for this issue can be that samples of present study were major depression while in Abdullh study sample were 3 types of mental disorders (major depression, mania and schizophrenia). Also in the Abdull study second blood samples were taken from all patients immediately after ECT while in present study second blood sample was taken 15-20 minutes after finishing the seizures and difference in the intensity and duration of ECT.

In present study, was observed ECT can significantly increase blood sugar levels in adolescents. Soltani et al (2012) reported a significant relationship between blood glucose levels before and after ECT (31). Some case reports, states that blood sugar and insulin requirements in diabetic patients increases, after one time (44) or many times (43,45,35) treatment with ECT. How many times treatment with ECT, no significant effect on blood glucose levels or insulin requirements. However, in some of these patients, blood glucose and insulin requirements increased, and in others they decreased blood glucose (45). Data related to

diabetes who received many times treatment with ECT indicates ECT does not have the same effect on patients and may be dependent on the conditions improve or worsen blood sugar levels. The effect one time treatment with ECT on blood glucose levels in diabetic patients has not been much studied and more research is needed. The results of several studies in non-diabetic patients, indicating that blood sugar levels increases immediately 30 minutes after one time treatment with ECT and reaches a peak and after 1-3 hours again returns to Primary level (41, 43-50). According to the results of our study, 20 minutes after one time treatment with ECT, blood glucose increased about 8%, and this increased with $P < 0.001$ statistically significant. Our findings in this study are in line with previous findings in non-diabetic subjects. Especially in study Williams, observed blood glucose levels after one time treatment with ECT increases nearly 10% and highest increase in about 15 minutes after treatment (41). Rasmussen, in a study on non-diabetic subjects with various diseases psychological, Found blood glucose levels in these patients after about 20 minutes increases nearly 9% that was statistically significant with $P < 0.001$ (25). In study Ghanizadeh (2012) that was performed on 99 mental patients non diabetic found blood sugar 20 minutes after one time treatment with ECT from 95.9 ± 36.1 mg/dl to 115.07 ± 30.4 mg/dl increase. This increase was statistically significant (51). The exact mechanism of this increase is not fully understood, but may be due to increase gluconeogenesis hormones such as catecholamines (52-53) and cortisol (54-55) that is induced by seizures. In the some studies obtained different results. In Vatankhah study was no significant relationship between the changes of blood glucose before and after ECT in non-diabetic patients (56). This difference may be because our study sample was adolescents, while Vatankhah study samples were adult. Also in Vatankhah study method of measuring blood glucose levels was using a glucometer while in present study blood glucose level was measured using the glucose oxidase method and kit of glucose. In Vatankhah study sample were 3 types of mental disorders (major depression, bipolar mood disorder and schizophrenia) while samples of present study only were major depression. In Abdull study showed that ECT did cause a significant decrease in blood glucose immediately after ECT (42). In the Abdull study samples had high mean of age (45.5 year) while samples of present study were adolescents with mean age 16.1 years. Also in the Abdull study second blood samples were taken from all patients immediately after ECT while in present study second blood sample was taken 15-20 minutes after finishing the seizures. Committee of APA (American Psychiatric Association) suggests that the blood sugar levels in diabetic patients should be assessed before and during ECT but did not mention to assess level of blood sugar after ECT (57). Although blood sugar and insulin requirements during

course of treatment ECT not significant changes, but these changes vary between individuals especially adolescence. However, several factors complicate the issue, including the effect one or many times treatment with ECT on sugar, In addition, patients may be diabetic or non-diabetic, Diabetic patients are diabetes type I, which require insulin or type II may require or not to be insulin and also may variables such as age, sex, height and weight are effective in the field.

CONCLUSION

Since the ECT in adolescence with major depressive disorder is performed under general anesthesia, several drugs have consumed, there is possibility of changes in electrolytes and blood sugar so it is necessary to check the factors before anesthesia. If the necessary measures carried, ECT is a safe treatment. Although seems that ECT can make changes in the levels of electrolytes and blood sugar (31). Electrolytes play a very vital role in the normal functions of many organs particularly the heart, the neurons, the muscles and the kidneys (58). Therefore the changes in electrolytes, particularly sodium and potassium are very important for normal functions organs and also during anesthesia in adolescence. The pre ECT physical exam and blood samples are required. Considering that the prevalence of psychiatric disorders, especially depression is developing in adolescents and in addition administration anti-depressant drugs, ECT as a complementary treatment for depression is raised (5). So the necessary precautions should be taken into consideration. If a person with electrolyte disorders referred for ECT should be done with Full caution. This means that required check electrolytes before, during and after ECT to prevent harmful effects hyponatremia, hyperkalemia and other electrolyte abnormalities. However, more research is needed to proving this serious problem.

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