EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 11
Issue: 5
139-142
Year: 2024

PROLONGED APNEA FOLLOWING SUCCINYLCHOLINE ADMINISTRATION – A CASE REPORT

Suhail Anjum Rather*[1], Dr. Abhishek Gupta[2] and Dr. Shyamal Koley[3]

[1]Anesthesia Technologist, Aamina Hospital and Nursing Home, Nowgam, Srinagar, India, and Post-Graduate Student, Department of Operation Theatre and Anesthesia Technology, University School of Allied Health Sciences, Rayat Bahra University, Mohali, Punjab, India.

[2]Assistant Professor, Department of Operation Theatre and Anesthesia Technology, University School of Allied Health Sciences, Rayat Bahra University, Mohali, Punjab, India.

[3]Professor, Associate Dean and Head, Department of Physiotherapy, University School of Allied Health Sciences.Rayat Bahra University, Mohali, Punjab, India.

***Corresponding Author: Suhail Anjum Rather**
Anesthesia Technologist, Aamina Hospital and Nursing Home, Nowgam, Srinagar, India, and Post-Graduate Student, Department of Operation Theatre and Anesthesia Technology, University School of Allied Health Sciences, Rayat Bahra University, Mohali, Punjab, India.

Article Received on 29/02/2024 **Article Revised on 19/03/2024** **Article Accepted on 09/04/2024**

ABSTRACT
We describe a case of prolonged apnea after an intubating dose of succinylcholine in a patient with an unsuspected deficit of serum cholinesterase. Succinylcholine apnea is usually apparent until the patient does not show any spontaneous respiratory efforts or change in vitals such as tachycardia, hypertension, or Carhart's notch in capnograph since the last dose of injection succinylcholine. Prolonged apnea following succinylcholine administration was first reported in 1952. A most common cause of this are atypical serum cholinesterase (inherited), low serum cholinesterase (acquired), plasma cholinesterase antagonism, cerebral depression, hypocapnia, hypercapnia, metabolic acidosis, depression of lung stretch receptors or reflex laryngeal apnea. It can be managed by maintaining intermittent positive pressure ventilation (IPPV) and sedation to be maintained till the block wears off. Fresh Frozen Plasma (FFP) contains about 36-40 units/ml. blood or blood product transfusion, in 50% of individuals, has shown to decrease the duration of neuromuscular blockade in 10-15 min.

KEYWORDS: Succinylcholine. Prolonged apnea. Serum cholinesterase.

INTRODUCTION
Succinylcholine was first introduced by Thesleff and Fold in 1951[1] and was first used clinically by Bovet, since its introduction into clinical practice in 1951.[2,3] It is considered as a neuromuscular blocking agent of choice in the techniques of rapid sequence induction, started by Snow in 1959 and subsequently by Step and Safar in 1970.[4,5] It is available in 10ml vial (50 mg/ml). It undergoes hydrolysis at room temperature and therefore should be stored at 4^0C. The onset of action is 30-60 seconds and the duration of action is usually < 10 minutes. Because of this early onset and short duration of action, it is the ideal muscle relaxant for intubation. The dose of succinylcholine is considered to be 1-2 mg/kg. It is metabolized by plasma cholinesterase, also known as pseudocholinesterase (or butyryl cholinesterase or BuChE), which is synthesized in the liver and present in plasma in abundant quantities. Therefore, to prevent its metabolism, it should be given at a faster rate. In the regular intubation dose (~1-1.5 mg/kg), succinylcholine causes a "phase I block," which is characterized by temporary muscle fasciculations followed by muscle relaxation. The sequence of a block of succinylcholine goes in a pattern wherein smaller muscles of the eyelid, jaw, and larynx are paralyzed before the muscles of the limb and trunk. The diaphragm is the last muscle to be paralyzed when respiration ceases.[6]

Among the various adverse effects of succinylcholine such as muscle pain, bradyarrythmias and prolonged apnea, the latter has been reported in certain patients. The episodes of prolonged apnea following succinylcholine administration, in patients with no risk factors or no medical or surgical history, have attributed to low levels of serum cholinesterase levels.

CASE REPORT
A 31-year-old male, ASA grade I, weight 75 kg, presented to Aamina Hospital and Nursing Home, Nowgam, Srinagar, Jammu and Kashmir, India, with complaints of severe pain in upper abdomen with tenderness and associated with nausea, vomiting and

fever. After thorough workup including USG whole abdomen, the patient was diagnosed with acute cholecystitis and was scheduled for elective laparoscopic cholecystectomy under general anesthesia. The patient`s preoperative physical evaluation and investigations were completely normal and the airway assessment revealed a normal airway (Mallampatti Classification was grade I). The patient was kept nil per orally (NPO) 8 hours prior to surgery.

On the day of surgery, an appropriate intravenous (IV) line was secured and infusion Ringer's Lactate (RL) was started. All the routine monitors (ECG, Pulse Oximeter, NIBP) were applied and the baseline vitals were recorded. The patient was pre-oxygenated with 100% oxygen for three to five minutes. The patient was premedicated with inj. fentanyl 1-2 mcg/kg, inj. glycopyrrolate 0.2 mg iv and inj. ondansetron 0.1 mg/kg. Anesthesia was induced with inj. of propofol 1-2 mg/kg iv (in incremental doses). After the loss of verbal commands, the patient was subjected to bag-mask ventilation with 100% oxygen (O_2). After a positive bag-mask ventilation test, the process of induction was facilitated with endotracheal intubation by giving depolarizing neuromuscular blocking agent inj. succinylcholine 1-2 mg/kg. Once the fasciculations reached the foot end of the patient, the intubation was done with an 8 mm cuffed PVC endotracheal tube (ETT) and the confirmation of the correct placement was checked by auscultation of bi-lateral air entry in the chest and the capnograph.

The anesthesia was maintained with nitrous oxide, oxygen, (60% N_20::40%0_2), and sevoflurane (1%) along with controlled mechanical ventilation. The patient was given antibiotic Inj. Monocef SB 1.5 gm iv over 15-20 minutes after the test dose. Analgesia was maintained with incremental doses of Injection Fentanyl 1-2 mcg/kg and injection of paracetamol 1g iv.

The patient did not show any spontaneous respiratory efforts or change in vitals such as tachycardia, hypertension or Carhart's notch in capnograph since the last dose of inj. succinylcholine. Therefore, further administration of drugs was withheld. The surgery lasted for 1 hr.

After the completion of the surgery, the patient still did not show any signs of recovery from the neuromuscular blockade. Patient was continued with controlled mechanical ventilation along with 50% Nitrous oxide, 50% Oxygen, and sevoflurane 0.5%. All measures were taken to maintain normothermia such as increasing the ambient temperature of operating room (OR), warm air blanket and warm iv fluids. After 40 minutes, decision was made to shift the patient to post anesthesia care unit (PACU) after thorough counselling of the relatives. Following laboratory investigations were also sent such as serum electrolytes, renal function tests and serum pseudocholinesterase.

The patient was transferred to the post-anesthetic care unit (PACU) intubated with IPPV via 100% O_2 with Bain's circuit for observation and further management. The patient was put on controlled mechanical ventilation with 100% O_2. Infusion injection propofol was administrated at 0.1-0.2 mg/kg/min. Internal medicine consultation was sought and the laboratory investigations including ABG (Arterial Blood Gas Analysis), 2-D Echo, serum electrolytes, renal function tests, serum pseudocholinesterase levels and administration of fresh frozen plasma were ordered. The patient was transfused 2 units of fresh frozen plasma (FFP). After 1.5 hr. in the PACU, patient started showing signs of recovery such as spontaneous respiratory efforts, eye movements, and limb movements. The propofol infusion was stopped. Once the patient was fully awake and responded to verbal commands with adequate head lift eye opening and limb movements, the patient was extubated.

The patient was nursed in propped up position, supplemented with 100% O_2 and routine monitoring of vitals was continued. The patient was kept in PACU for observation for one day and shifted to room the next day.

The laboratory values of Pseudocholinesterase level, sodium, potassium, calcium, and magnesium level were received which showed serum sodium 140 mg/dl, potassium 3.9 mg/dl, calcium 9 mg/dl, magnesium 1.9 meq/l, and serum cholinesterase 1360 $U.L^{-1}$.

The diagnosis of prolonged apnea due to low serum pseudocholinesterase levels was established and the family members of the patient were counselled regarding the same. The patient was provided with a screening and warning badge for future reference.

DISCUSSION

Succinylcholine is a depolarizing neuromuscular drug. Injection Succinylcholine is a short acting muscle relaxant, and is widely used to facilitate endotracheal intubation and RSI (Rapid Sequence Induction). Succinylcholine acts by causing temporary paralysis of skeletal muscles, facilitating intubation. Initially, it causes muscle fasciculations (phase 1 block) due to its depolarizing action at the neuromuscular junction. Prolonged succinylcholine apnea typically presents as persistent muscle paralysis beyond the expected duration of action, which is usually a few minutes. Patients may or may not exhibit signs of respiratory distress, such as cyanosis, decreased oxygen saturation, and hypoventilation. Therefore, patients receiving succinylcholine should be carefully monitored for signs of respiratory depression or failure.

After the intubating dose of succinylcholine (1 mg/kg), in a patient with normal plasma cholinesterase level, it is expected to observe a neuromuscular blockade lasting for 5-11 min. When the neuromuscular blockade lasts up to 30 min., a plasma cholinesterase deficit or an atypical enzyme in a heterozygous patient must be suspected, and

in a patient with homozygous atypical enzyme, the block will last up to 200 min, with up to 90 minutes of maximum block. [7] There were no ionic or pH alterations or any disease in this patient because he did not receive other drugs that induce or enhance the blockade.

Prolonged succinylcholine apnea can increase the risk of complications such as hypoxemia, and respiratory acidosis (severe hypoxemia or acidosis resulting from prolonged apnea can lead to cardiac dysrhythmias, bradycardia, or even cardiac arrest). Therefore, it's crucial to monitor electrolyte levels, especially potassium, and cardiac function closely in patients receiving succinylcholine. Succinylcholine apnea can be associated with other complications such as myalgias, and malignant hyperthermia. This condition is characterized by uncontrolled hypermetabolism and can lead to severe complications such as muscle rigidity, metabolic acidosis, and organ failure. Prompt recognition and treatment, including discontinuation of triggering agents and administration of dantrolene, are essential for managing malignant hyperthermia.[8]

Management of prolonged apnea after succinylcholine administration involves supportive measures to maintain adequate ventilation and oxygenation. In cases of respiratory depression or failure, airway support and mechanical ventilation may be necessary.

Certain patient factors can increase the risk of prolonged apnea during surgery. These include pre-existing respiratory conditions such as obstructive sleep apnea, obesity, or neuromuscular disorders that may impair respiratory function. To minimize the risk of prolonged succinylcholine apnea, thorough preoperative assessment is essential, which includes evaluating the patient's medical history, medication use, and any risk factors that may predispose them to complications. Factors such as genetic variations in plasma cholinesterase activity can influence the metabolism and clearance of succinylcholine, leading to differences in drug effects among patients. The duration and depth of the action of the succinylcholine can be influenced by factors affecting succinylcholine pharmacokinetics, such as metabolism and elimination. Patients with reduced plasma cholinesterase activity, either due to genetic variations or drug interactions, may experience prolonged effects of succinylcholine.

Intraoperatively, the depth of neuromuscular blockade should be closely monitored and further administration of succinylcholine or other neuromuscular blocking agents should be adjusted to maintain appropriate muscle relaxation. Close monitoring of vital signs and neuromuscular function is essential to prevent complications. Respiratory and Hemodynamic parameters are most important such as; end-tidal carbon dioxide ($ETCO_2$) levels, which are essential for detecting signs of prolonged apnea during surgery. Capnography, which measures $ETCO_2$ levels, provides real-time feedback on ventilation and can help identify apnea or hypoventilation early, allowing for timely intervention, blood pressure, pulse rate, and oxygen saturation. Prolonged succinylcholine apnea during surgery requires a multi-faceted approach to prevention, detection, and management.

In the post operative period, patients should be monitored for signs of residual neuromuscular blockade or adverse effects related to succinylcholine administration. This includes monitoring for respiratory depression, muscle weakness, and changes in vital signs during the postoperative period. When the patient has low serum cholinesterase.[9] then treatment is given to raise the level, either by intravenous injections of concentrated serum cholinesterase or by flesh blood or blood product (FFP, fresh frozen plasma) transfusion.[7,8] Management of prolonged succinylcholine apnea typically involves supportive measures such as mechanical ventilation to maintain adequate oxygenation and ventilation until the effects of succinylcholine wear off. Close monitoring of vital signs and neuromuscular function is essential to prevent complications.[9]

In this patient prolonged apnea following a single dose of suxamethonium was due to the low levels of serum cholinesterase[10] which delayed the recovery of the patient. The first aim, in this regard, was the maintenance of adequate ventilation. The patient was kept anesthetized until the patient showed signs of recovery such as breathing spontaneously, eye movements, and limb movements. Once the patient was fully awake, obeyed commands, could grip tightly, had adequate head lift, spontaneous eye opening and limb movements, the decision was made to extubate the patient.

CONCLUSION

Prolonged apnea following succinylcholine administration is a known complication and its possible cause is low level of serum cholinesterase. Thus, the patient remains paralyzed for an extended duration of time. Prolonged apnea following succinylcholine administration was first reported in 1952. A most common cause of this are atypical serum cholinesterase (inherited), low serum cholinesterase (acquired), plasma cholinesterase antagonism, cerebral depression, hypocapnia, hypercapnia, metabolic acidosis, depression of lung stretch receptors or reflex laryngeal apnea. It can be managed by maintaining intermittent positive pressure ventilation (IPPV) and sedation until the neuromuscular block wears off. Fresh Frozen Plasma (FFP) contains about 36-40 units/ml. Blood transfusion, in 50% of individuals, may decrease the duration of prolonged neuromuscular block by 10-15 minutes.

DECLARATION BY AUTHORS

The authors hereby declared that it was their original peace of research and had not been sent to any other journal for publication.

ETHICAL APPROVAL: Approved.

ACKNOWLEDGEMENT
The authors were thankful to the patients those who cooperated in the study.

SOURCE OF FUNDING: None.

CONFLICT OF INTEREST: The authors declared no conflict of interest.

REFERENCES

1. Foldes, F.F., Pearl, G., McNall, M. D, Jose, M. Borrego-Hinojosa. *Succinylcholine*: A new approach to muscular relaxation in Anesthesiology. *New England Journal of Medicine*, 1952; 247(16): 596-600.
2. Caldwell, J.E. The Continuing Search for a Succinylcholine Replacement. *Anesthesiology*, 2004; 100: 763–764.
3. Franklin, D. Richard, H. Epstein, R.Wachtel, E. Henry, R. Estimate of the Relative Risk of Succinylcholine for Triggering Malignant Hyperthermia. *Anesthesia & Analgesia;* 2013; 116(1): 118-122.
4. Snow, G. Nunn, J.F. Induction of Anesthesia in the foot-down position with a full stomach. *British Joural of Anesthesia*, 1959; 31: 493.
5. Stept, W.J. Safar, P. Rapid induction/intubation for prevention of gastric content aspiration. *Anesth Analg.*, 1970; 49: 633-646.
6. Cowan, C. A. Nine Hours Apnea following Succinylcholine. *Anaesthesm*, 1952; 9: 28.
7. Hosseini, J. Firuzian, F. Feely, J. Ethnic differences in the frequency distribution of serum cholinesterase activity. *Ir J Med Sci.*, 1997; 166(1): 10-12.
8. Evans, F.T. Gray, P.W.S. Lehmann, H. Silk. Effect of Pseudo-Cholinesterase Level on action of Succinylcholine. *British Medical Journal*, 1953; 136.
9. Thandla, R. Neuromuscular blocking drugs: discovery and development. *Journal of the Royal Society of Medicine*, 2002; 95: 363–367.
10. Harada, T. Shimonaka, H. Yamamoto, M. Akamatsu, S. Kasamatsu, M. Gotoh, M. Ozeki, Y. Onitsuka, A. Succinylcholine neuromuscular blockade in a case of pseudocholinesterase variant. *The Japanese Journal of Anesthesiology*, 1989; 38(6): 791-796.