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The Effect of magnesium sulphate on intubating condition for rapid-sequence induction; comparative study of magnesium sulphate versus ketamine in rapid sequence induction

Thesis

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List of Abbreviations

Abbr.	Full-term
DBS	**:** Double Burst stimulation
LSD	**:** Least significant difference
$MgSO_4$........	**:** Magnesium sulphate
NMB...........	**:** Neuromuscular blockers
NNMBs	**:** Non-depleorizing neuromuscular blockers
PTC	**:** Post tetanic count
RSI	**:** Rapid sequence intubation
SD	**:** Standard deviation
SPSS...........	**:** Statistical package for social science
TOF............	**:** Train of four

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Introduction

Patients who need tracheal intubation in the emergency department or the operating room often require a rapid sequence induction technique to protect against aspiration of gastric contents or to facilitate urgent airway protection in cases of imminent airway closure, haemodynamic instability, failing gas exchange and surgical emergencies **(Stollings et al., 2014).**

The rapid sequence intubation technique involves the prompt sequential administration of a predetermined dose of hypnotic agent and muscle relaxant followed by tracheal intubation within 1 min of giving the muscle relaxant. Frequently, modifications of this sequence are made, such as: titration of the hypnotic agent in situations of haemodynamic instability; the additiouun of an opioid to induce amnesia (all hereafter termed 'modified' rapid sequence intubation) **(Frerk et al., 2015).**

Neuromuscular blockers (NMB) became an essential part of the anaesthetist armamentarium, they aid endotracheal intubations, mechanical ventilation, decrease anaesthetic requirement, prevent patient movement without voluntary or reflex muscle movement, facilitate surgery, and decrease oxygen consumption. Changes in the direction of drug development have occurred as a result of the ingenuity of pharmaceutical chemist to meet clinical needs **(Donati, 2000).**

Succinylcholine is the first-choice neuromuscular blocking agent for rapid-sequence intubation **(El-Orbany et al., 2010).** It’s contraindicated in patients with major burns (beyond 48 hours), major crush injuries, and spinal cord injuries due to the risk of hyperkalaemia **(Naguib et al., 2009).**

Several alternative methods of facilitating neuromuscular block have been introduced to improve intubating condition during rapid-sequence intubation including rocuronium.

Ketamine pre treatment accelerates neuromuscular block by increasing cardiac output and blood pressure and there by facilitating rocuronium delivery to the relevant neuromuscular cleft, leading to a faster neuromuscular block **(Topcuoglu et al., 2010).**

Magnesium sulphate (Mg So4) has two distinctive advantages when used during tracheal intubation. First, it potentiates the effects of neuromuscular blockers (NMBAs) such as rocuronium. Second, MgSo4 has anti-adrenergic effects by decreasing catecholamine release from adrenal medulla or adrenergic nerve endings, and it causes vasodilation and anti-arrhythmic effect on the heart **(Czarnetzki et al., 2010).**

Aim of the Work

The aim of this study has been to test the efficacy of magnesium sulphate (MgSo4) versus ketamine to assess intubating condition (primary outcome), rocuronium onset, rocuronium duration, train-of-four ratio upon intubation, and hemodynamic variables (secondary outcomes) for rapid sequence induction.

Neuromuscular Transmission

The process of Neuromuscular Transmission (Figure 1): As acetylcholine is released into the synaptic cleft, some of the molecules diffuse across to the post junctional membrane. Each molecule interacts with two critical sites on the receptor, the negatively charged anionic site and the esteratic site. An increase in permeability of the postsynaptic membrane to sodium and potassium decreases the resting membrane potential **(Bloch-Gallego, 2015).** The increase in permeability of the postsynaptic membrane causes depolarization. There is a fall in the resting membrane potential toward zero. Once the critical membrane or threshold potential (about 45mv) is reached, a propagated increase in conductance in the neighbouring muscle membrane is created. This depolarization continues into the terminal cisternae where it initiates the release of calcium from the sarcoplasmic reticulum that promotes the formation of the actomyocin.

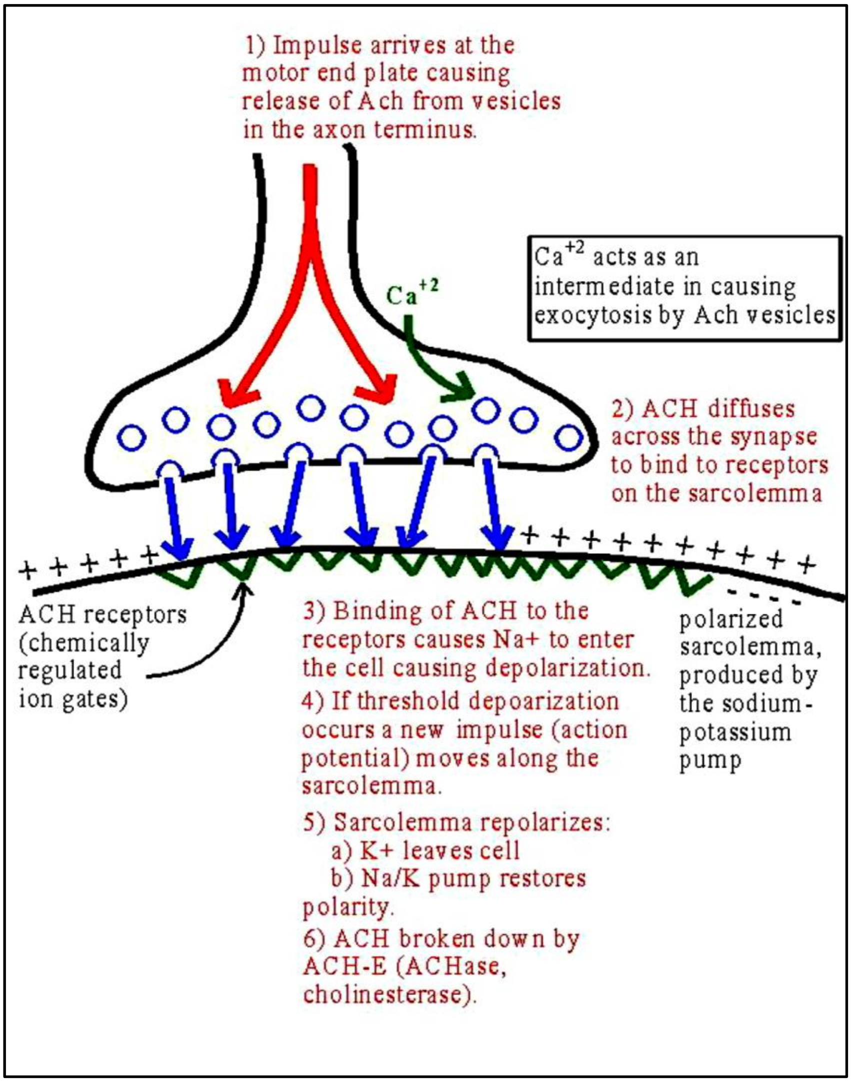

Figure (1): Neuromuscular transmission **(Bloch-Gallego, 2015).**

Neuromuscular Monitoring

Neuromuscular function is monitored by evaluating the neuromuscular response of muscle to supramaximal electric stimulation of a peripheral motor nerve. The reaction of a single muscle fiber to a stimulus follows an all or none pattern. By contrast, the response of a whole muscle depends on the number of muscle fibers activated. If a nerve is stimulated with sufficient intensity, all muscle fibers supplied by the nerve will react, and the maximum response will be triggered. After administration of a neuromuscular blocking drug, the response of the muscle decreases in parallel with the number of fibers blocked. The reduction in response during constant stimulation reflects the degree of neuromuscular blockade. For the preceding principle to be in effect, the stimulus must be truly maximal throughout the period of monitoring. Therefore, the electrical stimulus applied is usually at least 20 to 25 % above that necessary for a maximal response. For this reason, the stimulus is said to be supramaximal and must be at least 50 mA across a 1000 Ohm load **(Viby-Mogensen et al., 1996).**

The character of the wave form produced by the electrical impulse and the length of the stimulus are also important **(Maclagan, 1976).** The impulse should be monophasic and rectangular, as a biphasic pulse may cause a burst of action potentials in the nerve (repetitive firing), thus increasing the response to the stimulation. The optimal pulse duration is 0.2 to 0.3 ms. A pulse exceeding 0.5 ms may stimulate the muscle directly or cause repetitive firing **(Naguib et al., 2017).**

Patterns of nerve stimulation

<u>Single-twitch stimulation (Figure 2)</u>:

In the single twitch mode of stimulation, single supramaximal electric stimulus is applied to a peripheral motor nerve at frequencies ranging from 1.0Hz (once every second) to 0.1 Hz (once every 10 seconds). If the rate of delivery is increased to more than 0.15 Hz the evoked response will gradually decrease and settle at lower levels **(Ali and Savarese, 1980).**

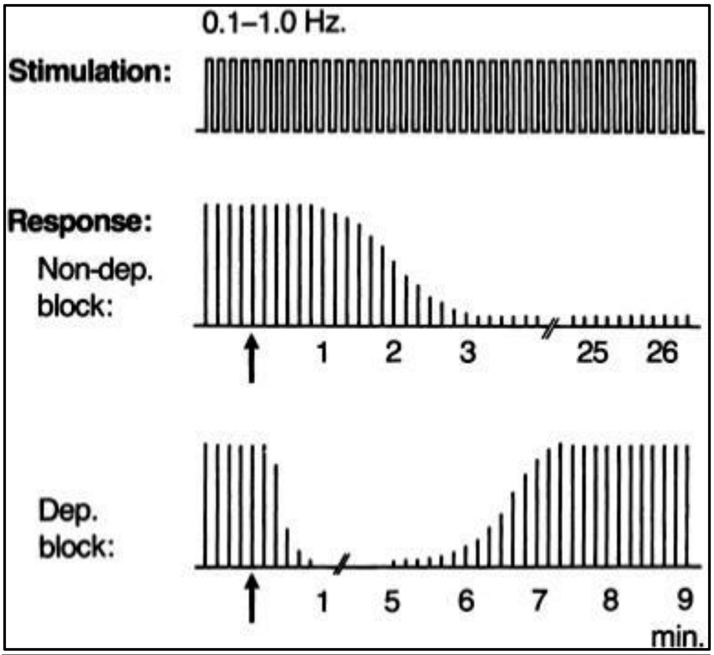

Figure (2): Single-twitch stimulation **(Ali and Savarese, 1980).**

Train-of-four stimulation (TOF):

In TOF nerve stimulation **(Figure 3),** introduced by **Ali et al (1975)**, four supramaximal stimuli are given every 0.5 second (2Hz). When used continuously each set (train) of stimuli is normally repeated every 10th to 12th second. Each stimulus in the train causes the muscle to contract, and “fade” in the response provides the basis for evaluation.

That is, dividing the amplitude of the fourth response by the amplitude of the first response provides the TOF ratio. In the control response (the response obtained before administration of muscle relaxant), all four responses are ideally the same **(Meretoja et al., 1994)** and the TOF ratio is 1.0. During a partial nondepolarizing block, the ratio decreases “fades” and is inversely proportional to the degree of blockade. During a partial depolarizing block, no fade occurs in the TOF response; ideally the TOF ratio is 1.0 **(Lee, 1975).**

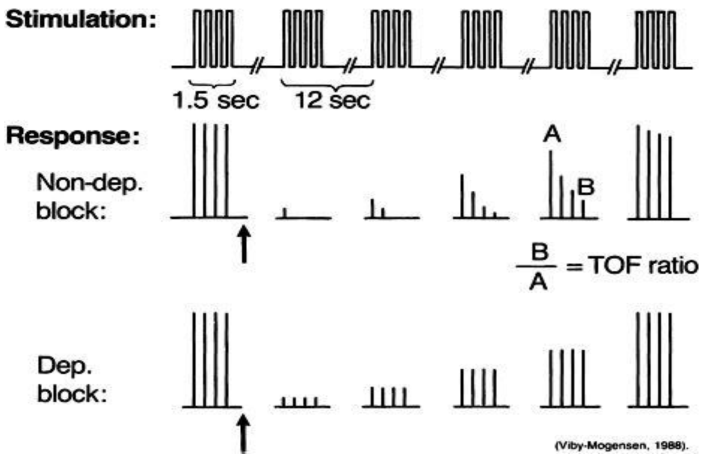

Figure (3): Train-of-four stimulation (TOF) **(Viby- Mogensen, 1985).**