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Maximum Inspiratory Pressure - A Simple Way of Measurement

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Abstract: ***Timeliness of extubation is a classic example of clinical judgement. The ideal time of extubation should coincide with patient's reflex ability to protect against aspiration. Maximum inspiratory pressures reflect the strength of the muscles of respiration and hence the measurement of this could be an important adjuvant in developing a standard for determining the time at which the patient can safely be extubated. We have carried out our study on 90 subjects with ASA 1& 2. They were extubated either based on clinical parameters or inspiratory pressures. We concluded that the pressure vacuum gauge can be used as guide to extubation. However, more research into this area is still required to quantitate, and set standards as to formulate criteria that would be universal and easy to determine a cost a determined in a cost effective manner.***

Keywords: Inspiratory pressure, Extubation, Pressure gauge

1. Introduction

Sufficient recovery from anaesthesia has always been a subject of debate. Whenever a patient has been intubated for the purpose of anesthesia or perpetual question facing the anaesthesiologist has always been whether the patient is fit enough to be left alone to breath and if so can he do so as efficiently as before! No mechanical or electrical device can replace the conscious observation of the patient by the anaesthetist.

Timeliness of extubation is a classic example of clinical judgement. Surgeons as well as anesthetists know that clinical outcome following extubation for identical patients and procedures are never similar since the patient's responsiveness to anaesthetic agent and sensitivity of the airway to physical stimuli are remarkably dissimilar.

The ideal time of extubation should coincide with patient's reflex ability to protect against aspiration. This is particularly important for those who are at significant risk for aspiration or regurgitation. Patients with significant riskof difficult airway in whom re - intubation is expected to be not so easy or to be extubated only when they are capable of sustaining their airway by virtue of adequate airway reflex recovery and ability to follow verbal commands.

Premature extubation is the single greatest source of danger in the post operative phase. The cardinal principle is not to lose the airway and in case of a threatened loss one should be able to re establish the airway promptly. However, in situations warranting a hemodynamic stability, it is seen that the situation would be better served by the so called deep extubation done at a time when the airway reflexes are beginning to show signs of recovery and there is sufficient tidal volume. (1, 2)

Many events can happen in the course of the anesthetic, which can change the outcome. This may be in the form of an overdose of the anaesthetic, hemodynamic instability acid base or temperature disturbances residual neuronal blockade etc. Abnormal respiratory drive and abnormal respiratory muscle mechanics as resulting from residual neuronal blockade may also play a role. Abnormal arterial oxygenation may still exist despite what seems to be an adequate ventilatory effort all these and many other factors can adversely affect the recovery of the patient. In many cases it is better to provide continued mechanical ventilation for a variable period of time depending on the condition of the patient. This decision about this should at best be a consensus between the anaesthesiologist and the operating team. After surgery, many patients have components of both impaired ventilatory drive and abnormal pulmonary mechanics (stiff lungs because of edema or trauma or residual effects of anaesthetic.) (3)

The most commonly used indices of successful extubation are

- Vital capacity not below 10 ml per kg
- Maximum inspiratory pressure more than - 25 centimetre of water
- Respiratory rate not more than 20 per minute
- Normal arterial PO2
- Good arterial oxygen saturation with an inspired oxygen concentration not more than 50%
- PEEP of less than 5 centimetres of water

Frequently it happens that a patient who has been extubated needs re intubation to meet increased needs in the post operativeperiod. This is often made difficult by the fact that the circumstances for doing this may not always been the most ideal. Often, many a patient has to be intubated while on his way out of the operation theatre or sometimes in the recovery ward, and even, at times in the wards. This

hampers the outcome of the patient and is a tremendous psychological trauma to the relatives of the patient.

2. Aim

The aim of this study was to develop a simple yet cheap way to quantify recovery from anesthetic agents and develop some way of measuring it in order to keep a record that would be universal. This study also aims to test the feasibility to establish a method to quantify recovery and the causes of failure to extubate in the post operative. And establish standards that would be universally accepted.

One of the criteria used to judge the sufficiency of recovery from anaesthetic agent has been maximum inspiratory pressure. Many methods have been put in use to measure this force in the past. Many other parameters have been in use like oxygen cost of breathing, calculation of work of breathing, rapid shallow breathing index etc. These parameters can be assessed from sophisticated monitors that exist in a good setup but these are costly and the calculation involved is cumbersome. However, we have tried to come out with an instrument that is easy to use, cheap and portable, indeed, all things that a practicing anaesthesiologist dreams about in case of monitoring equipment.

3. Material and methods

A randomized study was conducted at our institute under the auspices of the Department of Anaesthesiology over the past 2 months. A simple gauge was developed using Aneroid pressure capable of measuring pressures in the range of + 60to - 40 centimetres of water. The scavenged manometer underwent a series of structural and morphological changes which included fitting a length of 0.25inch diameter, tubing 10 centimetre in lens to the other end of which was attached a simple T piece. Patients work of breathing postextubation is best assessed by spontaneous breathing trial by T piece or zero airway pressure on ventilator (5). The T piece had universal fittings that is the standard 22 millimetre and 17millimetre fittings on either sides and easily fitted into the machine end of the universal connector of the endotracheal tubes. It also fits easily into the face mask. The entire apparatus can then be rendered airtight by intermittently occluding the other end of the T piece, which is not attached to the patient. The measurements in the pressure exerted by the patient or vacuum created can be made by intermittently occluding the end of the T peace. Some researchers have suggested that use of unidirectional valve by using a suitable connection as being the best alternative to measure this pressure (5). The gauge measures pressure in the range of +60 to - 40 cm of water with atleast count of 5 centimetres of water pressure. For convenience, the dial has different colours on the positive (pressure) and the negative (vacuum) sites thus enabling an easy visual interpretation as well. The zero reference is in the centre. This makes it possible to read out the efforts of the patient as a function of pressure or vacuum generated on sides of zero, easier.

90 patients were studied in different operation theatres who belonged to ASA 1 and || with average age 27.6 years (range 13 years to 70 years). Fixed propofol regarding the dosage of sedatives, (injection midazolam 0.03 milligram per kg IV plus injection pentazocine lactate 0.3 mg per kg IV) relaxants (injection vecuronium bromide, 0.1 mg per kg as loading dose followed by 0.025 milligram per kg IV) and adjuvant drugs like propofol, inhalational agents s necessary were used for the study. A fixed time was decided for the last dose of relaxant used in the surgery. Patient would receive the last dose of relaxant 25 minutes before attempting reversal. Patients were maintained in a state of normothermia and where stable hemodynamically throughout the duration of surgery. The continuous monitoring done for these patients included pulse oximetry, capnography and continues ECG monitoring. In the period following the surgery, the neuromuscular blockade was reversed with injection atropine 0.02 milligram per kg IV and injection new statement 0.05 mg per kg IV.

Following surgery, readings were begun when a thorough oropharyngeal suctioning was done and this was taken as the first reading (T0). This was done by attaching the manometer T piece with the finger of anesthesiologist while the patient began his attempts at respiration.3 readings were taken and the best amongst the 3 was recorded. Search readings were taken at 1: 00 minute interval for the first 15 minutes and then at 5: 00 minutes interval for the next 20 minutes. This was done to best monitor the patient in the period following the administration of injection news segment as a reversal agent and to account for fatigue in the post operative period. A temporal recording of other significant events such as obeying commands, hand raising on command sustained headlifts on command and was maintained. The point of time at which the patient was actually extubated was also recorded

Another set of patients were extubated using the clinical parameters as a guide for extubation readiness. These included obedience of command, sustained arm raising test, headlight for a period of more than 5 seconds absence of nystagmoid movements in the eyes and presence of normal upper airway reflexes as gauged by the presence of gag reflex. These patients were then subjected to measurement of the negative inspiratory pressure post extubation by attaching the manometer to the face mask and asking the patient to continue breathing throughout the mask while the anesthesiologist intermittently occluded the other end to take readings periodically.

A simultaneous recording was made also done on the DatexOhmeda respiratory gas monitoring which has an inbuilt airway pressure monitoring facility. The biggest drawback is the act that the maximum pressure range on the negative side was only - 20 centimetres of water pressure. This was the factory set maximum level, which could not be reset.

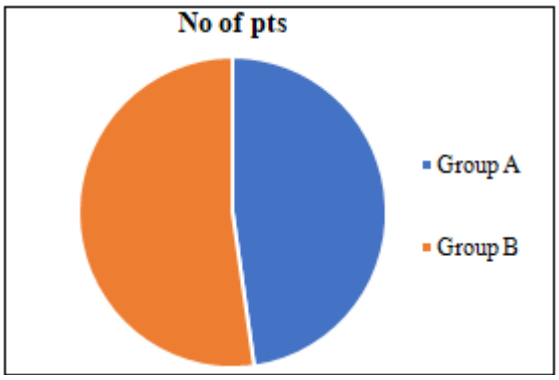
4. Discussion and Results

Patients who were otherwise hemodynamically and neurologically stable in the post operative period were extubated using either of the 2 preset conditions

These were
Group A: 43 patients were extubated only when they could attain maximum inspiratory pressures of more > - 25 cm of

water. Simultaneously, recording was done about significant events such as obeying commands, hand lift, headlift, and return of upper airway reflexes with respect to time to determine the point of recovery.

In Group B: 47 patients were extubated using the standard clinical parameters. The maximum inspiratory pressures in these patients were not used to determine the exact point in time for exhibition. However retrospective measurement was done in all these patients after extubation.



There was a high rate of success in both the patients. This was because the measurements were made in all patients for whom all the parameters that called for retention of the tube for continued respiratory support or assistance in the post operative was already corrected. In addition, the duration of the surgery was (average3.5 hours) and thus, there was a short duration of anesthesia as in many of the patients the use of inhalational agents or intravenous agents such as propofol reduces the requirement of muscle relaxing this also minimised the likelihood of residual neuromuscular blockade.

The patients develop satisfactory level of head lift at 5: 00 0.53 minutes (3 minutes to 10 minutes) after starting reversal. The arm lift was noted to be after 4.86 minute (1minute to 10 minutes). At the beginning of reversal, the pressures developed where to the tune of 5 to 10 centimetres of water, which increased to levels at which extubation was carried out in 4.13 minute (2 minutes 6 minutes). In 34 patients there was a dip observed at the end of approximately 12 minutes after neostigmine (10+/ - 2 minute) which recovered on asking the patient to take a few deep breaths there was however, no significant reduction in the saturation as observed on the pulse oximeter in this. The possible reasons for this could be the fact that the patients in this were in the period of peak action of neostigmine. Another factor acting in patients whose duration of surgery was short, was the likelihood of prolonged action of sedative hypnotic agents. There was no difference in the readings for different patients if age and sex or indeed the weight of patient were to be taken as standard.

Existing means of measurement of the negative or maximum inspiratory courts or pressures are either cumbersome or are red out directly or a multichannel digital read out display. Extensive researchers have revealed the existence of a handheld portable, batter operated digital instrument set to be used in the West, but the cost is high. This is this out of creature of most of us who could rather buy some other monitoring instrument of a similar cost this is simply because much needed research has not been conducted on this matter and its serious significance is yet not very clear. Other researchers have quoted using a similar type of a pressure vacuum gauge with different maximum pressure ranges and dial settings full with one way valve device. Indeed this has been also quoted as being the ideal method of measuring this force. Opinions regarding the use and types of one - way valve on indeed the mouthpiece for obtaining best results are varying in many literatures.

Commercial, mass scale production of such an instrument is possible and good indeed be cost effective.

Maximum inspiratory pressures reflect the strength of the muscles of respiration (6) and hence the measurement of this could be an important adjuvant in developing a standard for determining the time at which the patient can safely be extubated. Thus, the pressure vacuum gauge can be used as guide to extubation. Respiratory pressures have shown to be helpful in weaning off in ICU settings too. (7) It was found to be a helpful indicator in Spontaneous Breathing Trial (SBT) and predictor of successful extubation. (8) However, more research into this area is still required to quantitate, and set standards as to formulate criteria that would be universal and easy to determine a cost a determined in a cost effective manner.

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