SPECIAL ARTICLE

Airway and obstetric anesthesia: a review

Fauzia A. Khan

Professor, Department of Anesthesiology, Aga Khan University, Stadium Road, Karachi (Pakistan)

Correspondence: Professor Fauzia A. Khan, Department of Anesthesiology, Aga Khan University, PO Box. 3500, Stadium Road, Karachi – 74800 (Pakistan); Phone: 021 34 864 631; E-mail: fauzia.khan@aku.edu

ABSTRACT

This review highlights the physiological changes in the airway, associated with pregnancy and delivery of the baby, in the parturients. The strategies to address anticipated and unanticipated difficult airway management have been discussed. The need to have comprehensive guidelines and/or algorithms is stressed. The review covers the updates from the recent research studies.

Key words: Airway; Airway Management; Acid aspiration syndrome; Intubation; Pre-eclampsia

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INTRODUCTION

The issues related to the airways in obstetric patients are somewhat different from the rest of the anesthetic population. Pregnancy and labor are associated with several anatomical and physiological changes. Currently the gold standard in obstetric anesthesia is the regional techniques; however, tracheal intubation and general anesthesia (GA) may still be required in several situations e.g. a contraindication to the use of regional blocks, or the patient preference etc.

ANATOMICAL & PHYSIOLOGICAL CHANGES[1-4]

Almost all of the body systems are affected in pregnancy and are modified to cope with the altered homeostasis in the parturients and to prepare her for the ultimate culmination, e.g. the delivery of the baby.

General Changes

There is a generallized weight gain due to fat deposits and fluid retention. Breast enlargement occurs which may cause difficulty in insertion of a laryngoscope blade with the commonly used handle.

Changes in Lung Volumes

Minute ventilation (MV) increases by 30% in the seventh week of pregnancy but the respiratory rate remains unchanged. This is due to the increased level of progesterone associated with pregnancy. MV increases by 50% at term. There is little change in *lung volume and capacities* in early pregnancy. At term *Functional Residual Capacity* decreases by 15-20%. This is mainly due to a decrease in expiratory reserve volume. *Vital capacity* remains unchanged.

The FEV_1 and *flow volume loops* do not show any change. The *oxygen uptake* increases by 20% at term.

Changes in Airway Mucosa

There is engorgement of mucosa throughout the upper respiratory tract. This may result in narrowing of the glottic opening due to edema of the vocal cords. This is exaggerated in pre-eclamptic toxaemia (PET), and toxemia.

Changes Leading to Risk of Aspiration

Release of gastrin by the placental tissue increases *acidity*, chloride and enzyme content to above normal levels. In addition the angle of *gastroesophageal junction* changes and it becomes incompetent. As the size of the uterus increases there is further mechanical displacement of the pylorus. This results in heart burn in 45-70% of the pregnant patients, *fall in stomach pH* to < 2.5, and *gastric volume* > 25 ml.

Hormonal changes by 12-14th week of pregnancy result in *prolongation of stomach emptying* time. These patients also become prone to *silent regurgitation*. Twenty seven percent of the patients have hiatal hernia.

Changes during Labor

During labor, minute ventilation increases by 300%.

The oxygen consumption increases by 60%. Pain, fear and drugs given during labor can further delay stomach emptying.

Anesthetic Implications of These Changes

The decrease in FRC and increase in oxygen consumption results in early desaturation when a pregnant patient becomes apneic. Preoxygenation is mandatory in these patients and apnea time should be kept to a minimum. Mucosal engorgement can result in traumatic bleeding following suctioning, airway insertion, laryngoscopy and intubation. Narrowing of glottic opening requires a smaller diameter tracheal tube. The incidence of difficult and failed intubation is more common.

There is an increased chance of aspiration related to tracheal intubation due to delay in stomach emptying, increased gastric volume, low pH, and dysfunction of lower esophageal sphincter.

If these patients have to be ventilated the minute volume should be kept more than 40% compared to non-pregnant patients in order to prevent respiratory acidosis.

Recent Publications

In a recent study the acoustic reflection method was used in 50 patients to assess the mean pharyngeal cross-sectional area between the first and third trimesters. Normal pregnancy was found to be associated with a significant reduction in this cross-sectional area resulting in increase in Mallampatti score. No change was seen in tracheal diameter. The data suggest that in pregnant patients difficult intubation is more related to laryngoscopy rather than tracheal intubation.[5]

The effects of preoxygenation and apnea were investigated during rapid sequence induction in term pregnancy, in labor, obesity, sepsis, PET, maternal hemorrhage and multiple pregnancy. Patients in labor, morbid obesity and sepsis had accelerated preoxygenation and deoxygenation during apnea. PET prolonged preoxygenation and tolerance of apnea. Hemorrhage and multiple pregnancy had little effect. This paper demonstrated how different conditions in pregnancy modified the response to preoxygenation.[6]

HEMODYNAMIC RESPONSE TO TRACHEAL INTUBATION

In ASA 1 and 2, normotensive pregnant patients, the hemodynamic/presser response to tracheal intubation may be of no importance. However, patients with PET, toxemia of pregnancy or hypertensive disorders may be vulnerable to cardiac arrhythmias, cerebrovascular accidents, pulmonary edema or decrease in uterine blood flow.[7] Several *drugs* have been used to attenuate this response in pregnancy. These include hydralazine,[8] nitroglycerine,[9] labetalol,[10] magnesium sulphate,[11] esmolol,[12] fentanyl and alfentanil.[13] Drugs have also been used in combinations e.g. esmolol and lignocaine.[5]

Recent Publications

In the last 5 years many papers have been published on the use of remifentanil, dexmeditomidine, and landiolol. Yoo et al determined ED 50 and ED 95 of remifentanil in 75 females with severe PET in a randomized trial. The intubation induced increase of HR and BP was dose dependent and the ED 50 and ED 95 was 0.59 and 1.34 μg/kg respectively.[14]

Heesen et al[15] conducted a systematic review for defining effects of remifentanil on maternal stress response and neonates. Remifentanil was found to attenuate the response (both BP and HR) with no effect on Apgar scores.

El Tahan looked at the effect of dexmeditomidine on intubation response in 68 parturients undergoing C section using rapid-sequence induction.[16] Dexmeditomidine 0.4-0.6 μg/kg/hr 20 min before induction was effective in attenuating the maternal hemodynamic and hormonal responses under sevoflurane anesthesia. No adverse effects on neonates were observed. Suehiro et al in their study found no adverse effects of a single IV dose (0.2 mg/kg) of a short acting selective □-blocker landiolol given prior to intubation on uterus and on neonates.

DIFFICULT AIRWAY IN OBSTETRICS

Definition

Difficult airway is defined as a clinical situation which includes one or more concepts of failed intubation, difficult intubation (DI), difficult laryngoscopy and/or mask ventilation.[18]

There is no consensus on a universal definition of difficult or failed intubation in obstetrics. Several different definitions have been used in literature, some of the examples are; 'inability to place the endotracheal tube',[19] 'inability to intubate following a single dose of succinylcholine',[20] 'patient needing three or more direct laryngoscopic attempts', 'use of additional airway equipment after the direct laryngoscopic attempts', 'conversion to regional anesthesia due to inability to intubate etc.[21]

Incidence

The incidence of DI is eight times greater in obstetric patients with risk ranging from 0.05-0.3%.[22] The incidence of failed intubation varies from 1 in 250 to 1 in 300.[23,24] A recent survey from UK reported no case of failed intubation in 3430 cases of GA.[25]

Predictors of DI in Obstetrics

Predictors of difficult intubation in obstetrics are the same as in most non-pregnant patients. No single criterion is sufficiently predictive, and several criteria need to be used.[26] Basaranoglu et al evaluated five bedside predictors in females undergoing emergency C-section under GA. These included Mallampati score, sternomental distance, thyromental distance, interincisor gap and atlantooccipital extension. Patient characteristics like age, height, weight, BMI or weight gain were found not to be associated with difficulty. The positive result of all five predictors combined had a low sensitivity of 0.21 (95% C1 0.05-0.51) indicating that 79% of the DI will be missed.[27] Nafisi et al conducted a prospective observational study in two university hospitals, where they evaluated eight potential risk factors for DI; short neck, obesity, facial edema, swollen tongue, receding mandible, and single missing or protruding maxillary incisors. They concluded that receding mandible was the only risk factor for DI.[28]

Mallampati Classification in pregnancy and labor

Mallampati classification has a limited discriminatory power but is still widely used for preoperative assessment of airway. It estimates the size of the tongue in relation to the oral cavity.[29] The change in Mallampati class during pregnancy was first reported by Pilkington.[30] He showed an increase in Mallampati class between 12-30 weeks of gestation. Later Boutonmet et al (31) evaluated upper airway changes during pregnancy, labor and post labor in the same cohort of patients. They showed that the Mallampati class did not change in 36.8% of the females. In the remaining females it increased during pregnancy and labor and decreased after delivery. The changes were not fully reversed up to 48 hrs after delivery. The clinical implication of these findings was to re-evaluate the airway before any anesthetic management within 48 hrs of delivery. Pilkington showed that increased body weight was predictive of airway changes but the study by Boutonmet could not confirm this relationship.

Management of Obstetric Difficult Airway

In clinical practice two scenarios are possible, and the approach of the management varies in the both;

a. Anticipated difficulty
b. Unexpected difficulty

Anticipated difficult airway[18,32]

The options available to the anesthetist in a patient who presents with a known difficult airway are;

1. Regional anesthesia
2. Awake intubation followed by GA
3. GA
4. Local infiltration anesthesia

1. *Regional Anesthesia:* Spinal anesthesia is the most commonly used anesthetic technique for both emergency and elective C-sections, as the risk of acid aspiration is decreased. Epidural is also acceptable but the block takes time to establish.

   The important point to remember is that patients should be prepared as for GA and the complications of the two techniques should be kept in mind.

2. *Awake Intubation followed by GA:* This requires proper preparation and is time consuming. Patient tolerance to the procedure may vary. There is low risk of aspiration in an awake alert patient. Topical anesthesia may be the only technique required. Once the trachea is adequately anesthetized, further management can vary depending on the experience of the anesthetist. These include fibreoptic laryngoscopy or direct laryngoscopy. Various authors have described these techniques in greater detail.[33]

3. *GA:* Evaluation of degree of anticipated difficulty is required. The key to successful management is preparation. All equipment for emergency management of airway should be available. Difficulty maybe at various levels, e.g. during mask ventilation, difficulty in positioning, insertion of laryngoscope, or difficulty in inserting the tracheal tube. These will be discussed in detail under the heading of unanticipated DI.

4. *Local infiltration and field block*: Cesarean delivery is theoretically possible under this block but is rarely practiced these days due to unfamiliarity with the procedure.

Unexpected Difficult Airway

Each institution should have approved guidelines for managing DI. It will be encountered when a

grade 2b, 3 or 4 view of the epiglottis is obtained on laryngoscopy. If grade 2b or 3 view is encountered, tracheal intubation should be attempted with a gum elastic bougie while maintaining cricoid pressure. Time limitation should be kept in mind so that maternal or fetal hypoxemia does not occur. If intubation is unsuccessful, a call for help should be given and mask ventilation with 100% oxygen instituted.

If mask ventilation is possible, another attempt to intubation can be done but multiple attempts should be avoided. In between attempts the following should be reviewed; head positioning, application of external laryngeal pressure, altering the cricoid pressure, or use of an alternate laryngoscope blade. If tracheal intubation fails, the patient should be woken up and other options considered.

In case of fetal distress *if mask ventilation is easily performed,* use of a supraglottic airway (e.g. LMA, PLMA, and SLMA) and maintaining anesthesia with a volatile anesthetic in 100% oxygen is another option.

If mask ventilation is not possible, one option is to place an oropharangeal airway and start two person mask ventilation or insertion of an LMA.

The urgency of the event e.g. a rapidly deteriorating patient may require transtracheal jet ventilation (TTJV) or emergency cricothyroidotomy.[34]

Biro et al have proposed a scheme for DI recognized in the first attempt of laryngoscopy. [35] They propose a fibreoptic or videooptical instrument equipped with a guide for railroading the ETT. A supraglottic airway can be used as a second line device if first line fails. If both fail then a blind supraglottic airway device is recommended. In a *'cannot intubate, cannot ventilate'* (CICV) situation a fourth line device for TTJV is used.

Equipment

A vast array of equipment is now available to manage difficult intubation. In addition to the basic airway equipment present in all operating rooms, a specific difficult airway trolley or cart should be readily available on the floor. This should be checked regularly. The following equipment is desirable on the difficult intubation cart;

- A short handled laryngoscope
- Adult flexible fibre optic laryngoscope
- Newer generation airway devices e.g. video laryngoscopes
- Second generation supraglottic airway devices e.g. SLMA, I-gel
- Cricothyrotomy kit
- Jet ventilation apparatus with high pressure oxygen insufflation
- Alternative intubating devices

The choice of equipment present on the cart depends on the local decision makers but all users should be aware of the location of the trolley and the functioning of the equipment present.[37] An institutional training program is desirable for all. Bullough conducted a survey of 187 obstetric units in UK in 2009 to assess the presence of intubation equipment. Difficult airway equipment trolleys had all equipment in 90% of the units, but a dedicated fibre optic bronchoscope was present in only 8% obstetric operating rooms.[38]

Failed Intubation Drill/Difficult Airway Algorithms

In 1980, Tunstall proposed a failed intubation drill which proposed turning the patient in the left lateral position, emptying the stomach using a nasogastric tube and continuing with inhalational anesthesia.[40] Several authors have come up with minor modifications to this drill.[41-44]

Other Routes of Intubation

Nasotracheal intubation in pregnancy: Nasotracheal intubation is relatively contraindicated in pregnancy, because due to associated nasal congestion the mucosa tends to bleed easily.[35]

Extubation of a difficult airway

Care should be taken at the time of extubation in a patient who was difficult to intubate. The endotracheal tube should be left in place till the patient is awake and responsive.

Recent Publications

In case of failed intubation, the final step in management is a surgical airway technique. Long et al looked at the characteristics of cricothyroid membrane in females of child bearing age, as no previous studies had addressed this in the obstetric population.[39] The mean distance from the skin to membrane was similar in females and males [16.2 (3-33) mm vs. 13.9 (3-37) mm]. The study highlighted the variation in the depth of the cricothyroid membrane, and the vertical height may be small. This may account for the high failure rate of the technique of emergency cricothyroid puncture.

SUPRAGLOTTIC DEVICES IN OBSTETRICS

The main concern with the use of LMA in obstetric patients has been the risk of aspiration. Traditionally LMA has been recommended and used as a rescue device in difficult or failed obstetric intubation.[45] It has also been reported that the use of ETT did not reduce the incidence of maternal death due to aspiration.[46]

The risk of regurgitation and aspiration is higher in pregnant patients due to reduction of lower esophageal sphincter pressure and barrier pressure. In addition there is a delay in gastric emptying and an increase in gastric volume in patients in labor. For this reason tracheal intubation with crash induction and cricoid pressure is generally practiced both for elective or emergency C-sections under GA. LMA has been recommended as a rescue device in difficult or failed obstetric intubation. Gataure et al reported its use in 21 out of 24 patients of failed intubation in obstetrics.[46] Classic LMA was the most commonly used rescue airway device (8%) in failure to intubate patients in a recent national survey in a UK audit based on UK Obstetric Surveillance System (UKOSS).[38]

LMA offers several advantages over tracheal tube in general population, it interferes less with pulmonary physiology, less hemodynamic responses, and lower morbidity.[47] Han et al reported the use of classic LMA in 1067 consecutive ASA I-II patients undergoing elective C-section.[48] Patients had no history of pharyngeal reflux, body mass index of <30, and no history of difficult airway. The patients underwent a rapid sequence induction with thiopentone 3-4 mg/kg, succinylcholine 1.5 mg/kg and cricoid pressure. LMA size 3 for patients weighing < 45 kg and size 4 for ≥ 45 kg was used and inserted according to the manufacturers recommendation. LMA insertion was successful in the first attempt in 98% of cases and the LMA provided effective airway in 99.3%. No clinical evidence of regurgitation was seen. Incidence of bleeding and sore throat was 0.3% and 0.5%. They concluded that the use of LMA in healthy selected obstetric patient was safe.

The LMA ProSeal™ (PLMA) was an improvement on the classic LMA and provides a better seal as well as a gastric drain port for the GIT. Its use has again been reported as a rescue device in failed intubation in obstetrics.[49] Halaseh used reusable PLMA in 3000 elective C-section at a lower risk of regurgitation in a single centre.[50] The success rate of insertion was 100%. One patient had regurgitation during fundal pressure application. In 8 patients (0.3%) the PLMA had to be changed to a larger size due to leakage.

The LMA Supreme™ (SLMA) is a single use supraglottic device which also provides good seal and gastric drainage. Yao et al used it in 700 non-obese pregnant patients with > 4 hrs of fasting and antacid prophylaxis, scheduled for uncomplicated C-section.[57] In 98% patient the device was inserted on the first attempt and mean time for effective airway control was 19.5 sec (±3.9). Anesthetists performing insertion had more than two years' experience. Ventilation was adequate in all patients. At the end of surgery 2.6% had blood on SLMA and 3.4% had sore throat. Eighty five percent of the patients were satisfied with the technique. Propofol, rocuronium, and fentanyl were used for the anesthetic management.

NEWER AIRWAY DEVICES IN OBSTETRICS

Few studies have evaluated the role of videolaryngoscopes in obstetric care. Airwayscope, a video laryngoscope was used for emergency awake intubation in two pregnant patients under LA.[52]

Videolaryngoscopy was also evaluated by Aziz et al in their obstetric unit. It was used in 18 cases and resulted in successful intubation on the first attempt in all 18 patients. Sixteen of these cases had predictors of difficult intubation.[53]

Most of the published literature on newer airway devices relates to case reports. Airtraq™ laryngoscope was used as a first choice in 28 years parturient with kyphosis and expected DI.[54,55] Browning et al reported the use of Pentax® Airway Scope in a morbidly obese parturient.[56]

AIRWAY IN SPECIAL CIRCUMSTANCES

Not all obstetric patients will offer standard conditions for anesthesia to the anesthesiologists. PET and toxemia of pregnancy are two conditions in which airway management becomes a more than ordinary experience. The patients have deranged physical parameters, e.g. high BP and HR, a higher body fluid and lower protein levels etc., which may make adequate oxygenation and airway protection a very real challenge.

Airway in Patients with PET & Toxemia of Pregnancy

PET occurs in 5-8% of pregnancies. Severe PET may be associated with pharyngolaryngeal edema, necessitating a smaller sized tracheal tube compared to a non-eventful pregnant patient.[57,59] It is also desirable to manage the blood pressure during laryngoscopy and intubation, as an excessive adrenergic response can lead to intra-cerebral bleed in patients with severe PET. If short acting opioids are used for obtunding this response facilities for neonatal resuscitation should be available.[58,59]

Airway in Obese / Morbidly Obese Obstetric patients

The problems associated with obesity and morbid obesity in pregnant patients are: higher incidence of diabetes, hypertension and PET, as well as increased incidence of C-sections. Patients with PET show upper airway narrowing during sleep. Izci et al have postulated that these changes in upper airway resistance episodes during sleep may contribute in further increase in BP.[60] In case of GA the incidence of difficult and failed intubation is higher than non-obese pregnant patients.[61]

Patients with large neck circumference and/or high Mallampati score may be difficult to intubate.[62] In addition adequate mask ventilation can also be an issue.[63]

The "ramped" position has been recommended in morbidly obese patients for intubation as it gives a better laryngoscopic view compared to "sniffing position".[64] It is also recommended to have another experienced anesthesiologist present during induction in such patients.[61]

OBSTETRIC MORBIDITY/MORTALITY & AIRWAY MANAGEMENT

Analysis of morbidity and mortality is an important tool to review major and preventable issues. The most common cause of anesthetic mortality in obstetric practice is due to respiratory problems.[36]

The obstetric anesthesia claims for injury in the 'ASA Closed Claims Database' when compared the period from 1990-2003 with that before 1990, showed a dramatic decrease in respiratory complications from 24% to 4%. The claims related to gastric aspiration and inadequate oxygenation also decreased in the former period. This was thought to be mainly due to popularity of regional anesthesia in obstetrics.[65] Respiratory events were again the most common cause of anesthesia related maternal deaths in USA when 1979-1990 was compared with1991-2002. Mortality rates fell from 16.8/million to 6.5/million.[66] The causes of death in the later period were induction problems or intubation failure (23%), respiratory failure (20%) and high spinal or epidural (16%).

The Confidential Enquires into Maternal and Child Health report from 2006-2008 in UK reported two deaths from failure to ventilate (2/7) and one from aspiration after extubation.[67]

Mc Donnell in 2009 conducted an observational prospective study in 2005-6 in 13 maternity hospitals in Australia. Data from 1095 females receiving GA for C-section was observed. No cases of serious airway related morbidity were observed.[68] There were four failed intubations (0.4%).

CONCLUSION

There are several anatomical and physiological changes related to the airway that are associated with pregnancy. The anesthesiologist should be aware of the implications of these changes in relation to anesthetic management. Proper preoperative assessment, preparation for difficulty airway management and familiarity with protocols and newer airways devices, helps in decreasing morbidity and mortality in this group of patients.

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