Review Article

Anesthetic considerations of parturients with obesity and obstructive sleep apnea

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Abstract

Obstructive sleep apnea (OSA) is characterized by upper airway collapse and obstruction during sleep. It is estimated to affect nearly 5% of the general female population. Obesity is often associated with OSA. The physiological changes associated with pregnancy may increase the severity of OSA with a higher risk of maternal and fetal morbidity. However, very few parturients are diagnosed during pregnancy. These undiagnosed parturients pose great challenge to the attending anaesthesiologist during the perioperative period. Parturients at risk should be screened for OSA, and if diagnosed, treated. This review describes the anaesthetic concerns in obese parturients at risk for OSA presenting to the labor and delivery unit.

Key words:Obesity, obstructive sleep apnea management, perioperative period, pregnancy

Introduction

Obstructive sleep apnea (OSA) is characterized by upper airway collapse and obstruction during sleep, associated with recurrent oxygen desaturation and arousal from sleep. The incidence of OSA in the general female population varies from 2% to 5% with the prevalence of 5% to 6% among women of reproductive age.[1] In a study involving 5000 adult patients, 93% of women with moderate to severe OSA were not diagnosed preoperatively. These patients pose a significant challenge to anaesthesiologists during the perioperative period.[2] Parturients with OSA usually snore while sleeping because of increased upper airway resistance. Snoring is associated with a higher incidence of gestational hypertension, preeclampsia, and fetal growth retardation when compared to non-snorers.[3] Similarly, 75% of parturients with diagnosed OSA give birth to babies with lower mean Apgar scores and birth weights compared with women without OSA.[4] Obesity, as measured by the neck or (non-pregnant) waist circumference, is often associated with OSA.[5]The early diagnosis of OSA in parturients is essential to minimize complications during the peripartum period. This review describes the anaesthetic concerns in obese parturients at risk for OSA, and presenting to the labor and delivery unit.

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Prevalence of obstructive sleep apnea

Currently, there are no large prospective population-based epidemiologic studies addressing the prevalence of OSA in parturients. The prevalence based on existing literature is variable. In the Wisconsin sleep cohort study which involved 800 women 30-39 years of age, the prevalence of mild OSA [defined as an apnea-hypopnea index (AHI) AHI ≥ 5 events/hour of sleep] was found in 6.5 per cent (95% CI 1.4-11%) of the women. Moderate to severe OSA [defined as AHI > 15 events / hour of sleep] was found in 4.4 per cent (95% CI 1.1-7.3%).[1] A recent prospective cohort study showed a two fold increase in risk for obstructive sleep apnea syndrome (OSAS) in overweight parturients (Body Mass Index - BMI : 25-30Kg/m^2) compared with women of normal weight during pregnancy (8.5% vs. 21%, $P < 0.01$).[6]

Effect of pregnancy on obstructive sleep apnea

The upper airway congestion and physiologic hypervolemia of pregnancy may increase the risk of OSA among parturients [Figure 1]. Levels of estrogen and progesterone rise significantly during the course of pregnancy. Increase in estrogen induces hyperemia, nasopharyngeal mucosal edema, and vasomotor

rhinitis, which can lead to a narrowing of the upper airway with increased airflow resistance.[7] Progesterone may have some protective effect because it enhances respiratory center sensitivity to carbon dioxide and increases minute ventilation. Increased ventilatory drive along with resultant respiratory alkalosis during pregnancy has been postulated to cause instability in respiratory control pathways.[8] A decrease in functional residual capacity in OSA parturients along with caudal traction on the trachea and pharynx exerted by the lung during inspiration enhances the collapsibility of the pharynx. Small airway closure at the lung volumes greater than the functional residual capacity, particularly in late pregnancy, results in ventilation perfusion mismatch.[9] These changes reduce maternal oxygen reserves. Episodes of apnea and hypopnea, coupled with low maternal oxygen reserves, may increase the risk of maternal hypoxemia and compromise oxygen delivery to the fetus. However, the preference of the parturients' for lateral sleep posture to maintain uterine blood flow along with fetal movements during pregnancy lessens the risk of OSA in obese parturients [Table 1].

Effect of obstructive sleep apnea on pregnancy

Parturients with OSA have an increased risk of complications of pregnancy during the perinatal period [Table 2]. A recent cohort study of obese parturients reported an increased risk of gestational diabetes mellitus, pregnancy induced hypertension, pre-eclampsia, preterm labour at less than 34 weeks gestation, caesarean section, instrumental delivery and postpartum infection compared with parturients of average weight. These women are also prone to develop overt diabetes and chronic hypertension in the future.[10] In a case-control study involving 42 parturients, 17 pre-eclamptic women were compared with 25 normotensive parturients with uncomplicated pregnancies for evidence of OSA. The authors focused that pre-eclamptic parturients had significantly more apnoeic episodes per hour as well as more oxygen desaturations.[11]

Table 1: Factors that influence the risk of Obstructive sleep apnea in parturients

Factors that increase the risk of OSA	Factors that decrease the risk of OSA
Elevated estrogen causing nasopharyngeal oedema	Elevated progesterone with increased minute ventilation
Preexisting obesity.	Preference for lateral sleep posture to maintain uterine blood flow.
Gestational weight gain	Uterine contraction.
Decreased functional reserve capacity	Fetal movement.
	Increased frequency of urination.
	Decreased rapid eye movement sleep time

Table 2: Perinatal complications of Obstructive sleep apnea parturients with obesity

Maternal complications	Fetal complications
Recurrent early miscarriage	Fetal macrosomia
↑ Risk of spontaneous abortion	Shoulder dystocia
Pregnancy induced hypertension	Congenital malformations
Gestational diabetes	Unexplained still birth
↑ risk of aspiration	
↑ Preterm delivery	
↑ risk of cesarean section	
↓ chance of vaginal birth after caesarean section	
Thromboembolism	
Postoperative infection and depression	

Effect of obstructive sleep apnea on fetus

Neonates of obese parturients have been shown to be large for gestational age, with a high incidence of birth injury, including shoulder dystocia as well as premature deliveries [Table 2]. Similarly, a high incidence of congenital malformations, including spina bifida, cleft lip, cleft palate, and heart defects have been documented.[10] The impact of maternal oxygen desaturation on fetal heart rate is inconsistently reported in literature. In an overnight sleep study involving 35 parturients with underlying OSA, four women desaturated, three of whom had accompanying fetal heart rate decelerations.[4] However, a prospectively acquired cohort study involving 20 OSA parturients failed to demonstrate abnormal fetal heart deceleration with maternal apneic episodes after 3 hours of monitoring.[12]

Screening of obstructive sleep apnea

Parturients with a pre-existing tendency towards sleep disordered breathing, but not diagnosed with OSA, may develop OSA during pregnancy. The severity of OSA also increases in women who already have OSA.[13] Parturients with a history of habitual snoring, interrupted breathing during sleep, impaired day time performance, morning headache and irritability, should elicit a high degree of suspicion for OSA [Figure 1]. Systemic hypertension and increased neck

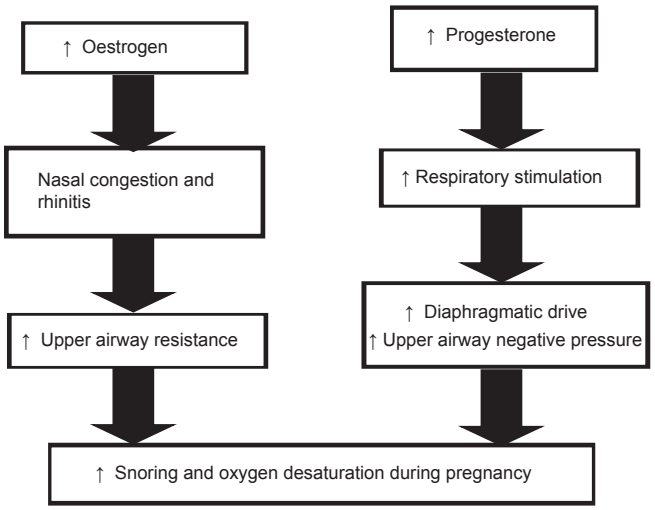

Figure 1: Hormonal changes during pregnancy in obese parturients predisposing them to Obstructive sleep apnea

circumference (> 40 - 42 cm) at the cricoid cartilage level during pregnancy are consistent with the presumptive diagnosis of OSA. It is essential to obtain a meticulous sleep history for women with pre-existing obesity and a large neck size and who develop gestational hypertension or preeclampsia. The Berlin questionnaire is a 10-item self-reporting instrument (5 on snoring, 3 on excessive daytime sleepiness, 1 on sleepiness while driving, and 1 inquring history of hypertension. The questionnaire stratifies patients into high or low risk of having OSA based on their endorsement of symptom severity.[14] Although validated in primary care settings, its use is limited due to the complicated scoring system with a large number of questions.The use of Berlin questionnaire in parturients is recently questioned. In a retrospective analysis of 301 pregnant and post-partum women, 23% were found to have a high risk score on the Berlin questionnaire. Among the women at high risk, there was a high prevalence of habitual snoring (61%), observed apneas (7%), and daytime sleepiness (24%). The authors emphasized that the risk increased with age ($P< 0.05$) and obesity ($P< 0.001$).[6] In a recent prospective trial involving 100 parturients, the screening of parturients using the Berlin questionnaire poorly predicts OSA. The sensitivity and specificity of diagnosing OSA in parturients using the Berlin questionnaire was 35% and 64%, respectively, when compared to polysomnography.[12] The snoring component of the Berlin questionnaire correlated better with oxygen desaturation < 95% ($P = 0.03$). A recent systematic review on the screening of OSA has described that the STOP-Bang [Table 3]and Berlin questionnaires were found to have the highest sensitivity and specificity, respectively, in predicting moderate or severe OSA in a non-obstetric surgical population.[15] Further studies are warranted to assess the validity of these screening questionnaires in obese parturients. Polysomnography is the gold standard for the diagnosis of OSA, and is indicated in parturients with hypertension, previous pregnancies with unexplained intrauterine growth restriction, and persistent sleep-related symptoms (hypersomnia or insomnia) associated with snoring or obesity.[16] However, it is not readily available and expensive.

Preoperative continuous positive airway pressure therapy and outcome

In a randomised controlled trial involving 16 parturients of chronic snoring with a past history of hypertension or documented hypertension at the first antenatal visit were randomly allocated to polysomnography and continuous positive airway pressure (CPAP) treatment in addition to standard antihypertensive therapy or to antihypertensive therapy alone (no polysomnography, no CPAP). CPAP improved the maternal quality of life, mood and 24 hour blood pressure control.[17,18]Seven parturients with chronic hypertension and snoring were allocated to CPAP treatment. None of them had an AHI > 5, a usual threshold to define OSA in the non pregnant population. Nine parturients with chronic hypertension served as controls. Systolic and diastolic blood pressure levels decreased starting at the 30th week of gestation in the treated group, whereas blood pressure levels increased at the point in the usual care arm. At 35 weeks, CPAP-treated women required less blood pressure medication and had a significantly lower mean daytime blood pressure, 87 mmHg compared to controls who had a mean blood pressure at 108 mmHg.[19] Similarly, the perinatal outcomes (Apgar scores, birth weight, health care utilization, pre-eclampsia) favoured the treatment group in this small trial. These results are especially important in the context of pregnancy when physicians and women alike want to avoid medication, and when antihypertensive drugs are known to impede the fetal growth.[20] In a case-series of 12 parturients with OSA in whom CPAP was initiated prior to, or early in pregnancy, there was an improvement in sleepiness, fatigue over time with a good tolerance of therapy.[21] In another case series with early CPAP intervention among 12 parturients at risk for pre-eclampsia and documented OSA, blood pressure was well-maintained in parturients with chronic hypertension with CPAP, and there was no need for additional blood pressure medication in the third trimester.[22]

Preoperative assessment

A multidisciplinary approach involving the obstetrician, anaesthesiologist, neonatologist and sleep physician will minimize OSA related complications during the peripartum period. Parturients with OSA need careful airway assessment since the incidence of failed intubation in obese parturients may be eight times higher than the non-obese parturients.[23,24] A retrospective review of failed intubations in parturients described that nearly 90% of parturients who had failed intubations, had a BMI of more than 30 kg/m^2.[25] Routine preoperative investigations are sufficient in asymptomatic or

Table 3: STOP-Bang scoring model

S	Snoring: Do you snore loudly (louder than talking or loud enough to be heard through closed doors?	Y	N
T	Tired: Do you often feel tired, fatigued, or sleepy during daytime?	Y	N
O	Observed: Has anyone observed you stop breathing during your sleep?	Y	N
P	Blood pressure: Do you have or are you being treated for high blood pressure?	Y	N
B	BMI: BMI more than 35 kg/m^2	Y	N
A	Age: Age over 50 years	Y	N
N	Neck circumference: Neck circumference greater than 40 cm	Y	N
G	Gender: Male	Y	N

High risk of OSA: Yes to ≥ 3 questions; Low risk of OSA: Yes to < 3 questions. Where, BMI = Body Mass Index; Y = yes; N = No Adapted with permission from Chung et al. Anaesthesiology 2008; 108: 812-21

mild OSA parturients. However, parturients with moderate to severe OSA need optimization of comorbid conditions prior to elective surgery [Figure 2].

Considerations during regional anesthesia

The American Society of Anaesthesiologists guidelines recommend regional anesthesia to reduce the possibility of negative adverse events associated with systemic opioids.[26] Parturients with a low risk of OSA may safely undergo mild-moderate risk surgery under regional anesthesia when possible [Figure 2]. An epidural catheter placed preoperatively could minimize the intraoperative and postoperative opioid requirements, and serve to increase early the ambulation and discharge from hospital. However, parturients with known OSA or those at high risk of OSA need vigilant monitoring when they undergo elective or emergency surgeries. The use of oral / parenteral opioids along with neuraxial opioids may pose the OSA parturients at a risk of respiratory depression, as most opiates including morphine, meperidine, hydromorphone, and fentanyl cause a dose-dependent reduction of respiratory drive, respiratory rate, and tidal volume that in turn can lead to hypoventilation, hypoxaemia, and hypercarbia. However, the use of short acting neuraxial opioids with low dose morphine (< 150mcg) with monitoring of maternal oxygenation and respiratory rate, are found to be safer during the peripartum period. Similarly, there is an accumulating evidence to suggest that the use of multimodal analgesia may be more beneficial in parturients with OSA in minimizing the opioid-related side effects while also providing effective analgesia. However, nonsteroidal anti-inflammatory agents (NSAIDs) may be avoided in mid / late trimester because of the possible preclosure of patent ductus arteriosus in fetus.

Considerations during labour analgesia

Labor analgesia is of significant importance for the positive experience of childbirth for mothers. Anticipated technical difficulties should not preclude the use of epidural analgesia in OSA parturients. Obese parturients with co-existing OSA pose great challenge to anaesthesiologists as these parturients may make regional anesthetic administration more difficult compared to non-obese parturients. The need for an optimally functioning epidural catheter is emphasized by the fact that obesity is associated with an increased incidence of fetal macrosomia, which is a known risk factor for more painful contractions and complicated labour.[27] The assessment of the severity of labor pain using the McGill pain questionnaire has shown a positive correlation of BMI with the severity of labour pain.[28] Moreover, the increased incidence of cesarean section in these parturients further reinforces the need for a working catheter, should any operative intervention arise. The major concerns that are related to regional anesthesia in morbidly obese OSA parturients are described in Table 4.

Positioning

Bony landmarks may be difficult to palpate, making positioning extremely important. The knee–chest position required for

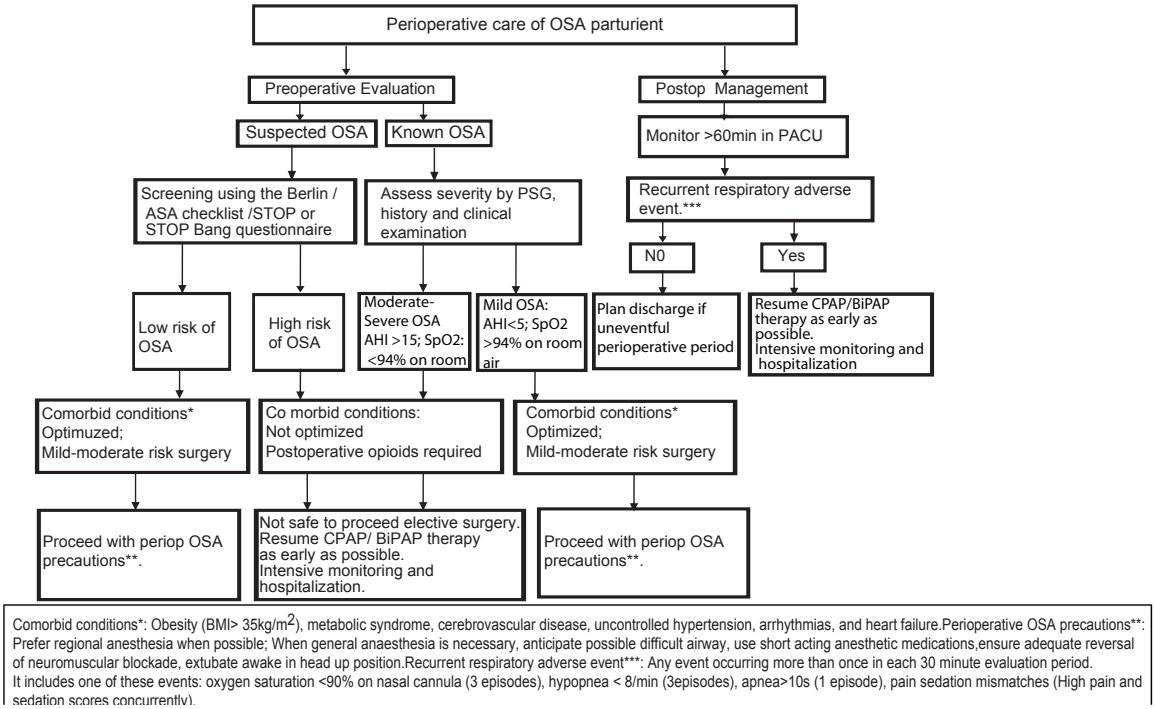

Figure 2: Flowchart showing perioperative care of Obstructive sleep apnea parturient

epidurals in the lateral position is difficult to obtain in the obese patients as the gravity of lateral position itself can drag down the pad of the fat obscuring the midline.[23] To overcome these technical difficulties, the sitting position is preferred by many obstetric anesthesiologists.

Identification of midline for needle insertion

The difficulty in location of the midline increases the likelihood of lateral projection of the needle, increasing the depth of the space and malpositioning of the catheter. Various techniques have been reported to identify the midline in difficult scenarios, which include:

1. The line joining the occiput or prominence of C-7 and the gluteal cleft can be used to approximate the position of the midline.
2. Skin indentation from the fetal heart rate monitor belt may aid as a guide to identify the iliac crest. This belt usually rests on the iliac crests over the Tuffier's line. By drawing a perpendicular line from the the cervical spinal processes down to this line, the intersection point is a reasonable spinal or epidural needle insertion point.
3. Parturient assistance in directing needle to the midline. For example, if the parturient feels the pain of the needle left of centre, the midline will be found towards the right.
4. Ultrasound imaging[29,30]

Depth of epidural space

The depth of the epidural space from skin was generally greater in obese parturients,especially when epidural technique was performed the lateral decubitus position compared with the sitting position.[31] Similarly, there is a positive correlation between obesity and the distance from skin to the epidural space, which is supported by a computed tomography (CT) study. While longer needles are occasionally necessary, patients have an epidural space deeper than 8 cm.[30,32] Therefore, it seems prudent to use a standard epidural needle for the first attempt, instead of one of the longer epidural needles available. Ultrasound imaging may assist in determining the depth of the epidural space in morbidly obese parturients.[33]

Dislodgement of the epidural catheter

Catheter dislodgment is another potential problem.As the ligamentum flavum has a mild grip on the epidural catheter, repositioning allows the epidural catheter to be pulled into the subcutaneous fat, sometimes by several centimeters.[29] Sliding of the skin over subcutaneous tissue has been proposed as an important factor in epidural catheter migration.[34] Iwama and Katayama noticed 3 cm skin movement in some patients.[35] Hamilton *et al.*, demonstrated that epidural catheters not fixed at the skin could move 1 – 2.5 cm inward when the parturient posture is changed from the sitting to the lateral recumbent position, with the greatest change seen in patients with a BMI > 30.[36] These factors should be taken into consideration when deciding upon the length of catheter to be left in the space for a successful working epidural.

Table 4: Concerns during regional anesthesia in obese parturients

- Positioning of patient
- Mid line identification
- Depth of epidural space
- Catheter dislodgement
- Failed epidural
- Accidental dural puncture
- Spread of medication
- Dosing and infusion

Failed epidural

The failure rate of epidural catheters in the general obstetric population varies between 8% and 13%, with difficulties being related to absent analgesia / anesthesia and unilateral block.[37,38] In a case control study involving 43 morbid obese parturients, 74.4% of them needed more than a single attempt, and 14% needed more than three attempts for a successful epidural placement.[39]

Accidental dural puncture

The incidence of dural puncture in non-obese parturients ranges from 0.5 - 2.5% with the rate as high as 4% in morbidly obese parturients.[40,41] In cases of accidental dural puncture, catheters may be threaded into the subarachnoid space for continuous spinal analgesia and these parturients are at risk of developing post dural puncture headache in the postpartum period. Similarly, higher levels of sensory block may be anticipated in these parturients.[42]

Dosing and infusion

Obese parturients may require less local anesthetic volume in their epidural and subarachnoid spaces in order to achieve the same level of block when compared with non-obese parturients. A high level of block has been described in spinal anesthesia with similar volumes of local anesthetic in obese parturients when compared to non-obese parturients. Similar findings were documented with epidural anesthesia.[43] Although the apparent lower spinal anesthetic dose requirement may be explained by the fact that obese parturients have smaller cerebrospinal fluid volumes than do non obese individuals,the reason for the lower epidural anesthetic dose requirement is less clear.[42] Because of variability among patients, it may be prudent to use a titrated regional technique.

Considerations during general anesthesia

General anesthesia should be avoided when possible in obese parturients with OSA due to the added risks of potential difficult ventilation and intubation in addition to airway changes with pregnancy. When general anesthesia is required, parturients should be adequately fasted as per standard guidelines.

Sedative premedications are avoided when possible. Aspiration prophylaxis and thromoprophylaxis may reduce perioperative adverse events. The perioperative management of the obese parturients with OSA presenting to labour and delivery unit and for operative deliveries is discussed in Figure 3.Apart from the standard non-invasive monitoring (pulse oximetry, non-invasive blood pressure, electrocardiogram), invasive monitoring may be required if there are co-morbidities.An arterial line may also be required in the morbidly obese parturient for accurate blood pressure monitoring as well as frequent blood sampling. The possibility of having a difficult airway mandates that proper planning and appropriate care is taken to prevent oxygen desaturation. Awake fibre optic intubation (FOB) should be considered when difficult airway is anticipated in obese parturients. When general anesthesia is administered without anticipation of difficult airway, rapid sequence intubation (RSI) is recommended. Tracheal intubation should be confirmed with capnography in addition to auscultation. When intubation is unsuccessful, maintenance of maternal arterial oxygenation is the main priority. A difficult airway cart that includes a laryngeal mask airway, gum elastic bougie, McCoy laryngoscope, video laryngoscope and equipment for emergency surgical airway should be immediately available. When general anesthesia is warranted, it is safer to administer short-acting anesthetic drugs, less-soluble inhalational agents, titrate opioids and avoid sedation [Figure 3]. The Troop elevating pillow produces a head elevated laryngoscopy position' (HELP) during intubation may improve the glottic view when compared to the standard sniffing position.[44]

OSA parturients with morbid obesity desaturate rapidly after apnoea and induction of general anesthesia. The strategies which can help to overcome this occurrence include:

- Preoxygenation with 100% oxygen which aims at increasing the functional residual capacity (FRC) and oxygen reserve and allows a higher arterial oxygen tension

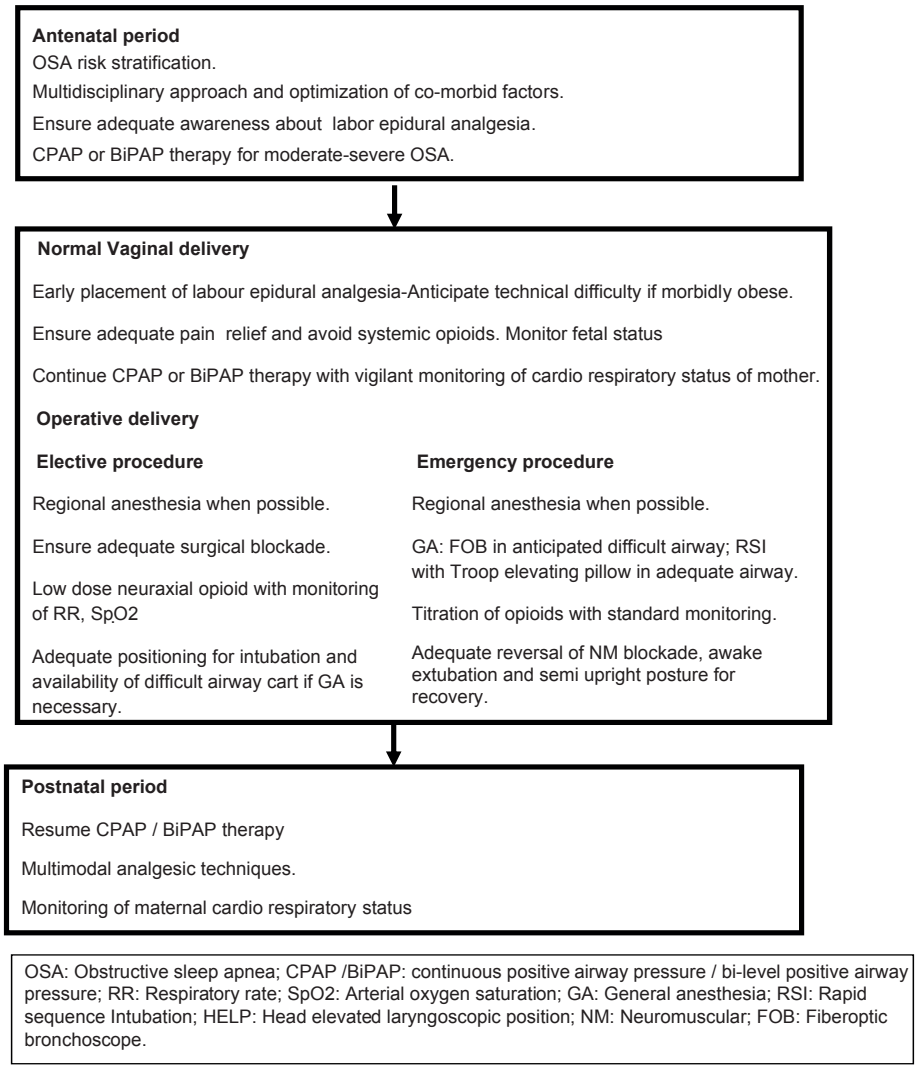

Figure 3: Perioperative anesthetic management of the parturient with obstructive sleep apnea

to develop.
- Application of CPAP during preoxygenation.
- Inducing with head up or sitting position.
- Oxygen insufflation during the period of apnea.

Periods of hypoxemia and hypercapnia should be avoided or minimised because of adverse fetal outcome.In addition, it can increase the pulmonary artery pressure andprecipitate right heart failure in susceptible patients. Ventilator settings with Positive end-expiratory pressure (PEEP) will help in preventing intra operative desaturation. Application of PEEP and aortocaval compression can lead to severe reduction in the cardiac output and profound hypotension which needs appropriate positioning, vigilant monitoring and treatment. The trachea should be extubated on 100% oxygenation only after the patient is fully awake and neuromuscular blockade completely reversed. Patient should be propped up and CPAP will help reduce the postoperative desaturation.

Postoperative care

Parturients with moderate to severe OSA receiving general anesthesia should be allowed to recover in a high dependency unit with cardio respiratory monitoring. There are no randomised controlled trials demonstrating the beneficial effects of CPAP in the postoperative period. However, there is a limited evidence of a retrospective trial that does suggest that postoperative CPAP reduces airway obstruction, major postoperative complications and the hospital stay.[15]

Postoperative epidural analgesia provides the most effective and safest analgesia. There are a plethora of medications that can be considered under a multimodal analgesic regimen, including oral nonsteroidal anti-inflammatory drugs, acetaminophen, tramadol, ketamine, gabapentin, and dexamethasone. Caution should be advocated while using drugs such as gabapentin that may cause sedation. Intravenous dexmedetomidine has been particularly beneficial because of its opioid sparing effect and the lack of respiratory depression.[45] Transversus abdominis plane block has shown to reduce the postoperative pain intensity and analgesic consumption after elective caesarean delivery in non-obese parturients.[46] However, further trials are warranted before its use in parturients with OSA.

Summary

Parturients with a low risk of OSA with optimized comorbid conditions may safely receive labour epidural analgesia and may undergo surgery with perioperative OSA precautions. Parturients with a high risk or moderate to severe OSA should be optimised before parturition. Thediagnosis of OSA in parturients should be considered in patients with a history suggestive of the disease.If the diagnosis is verified, perioperative CPAP therapy may reduce morbidity in both the mother and baby.

References

1. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle aged adults. N Engl J Med1993;328:1230-5.
2. Young T, Evans L, Finn L, Palta M. Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle-aged men and women. Sleep1997;20:705-6.
3. Franklin KA, Holmgren PA, Jonsson F, Poromaa N, Stenlund H, Svanborg E. Snoring, pregnancy-induced hypertension, and growth retardation of the fetus. Chest 2000;117:137-41.
4. Sahin FK, Koken G, Cosar E, Saylan F, Fidan F, Yilmazer M,*et al.* Obstructive sleep apnea in pregnancy and fetal outcome. Int J Gynaecol Obstet 2008;100:141-6.
5. Isono S. Obesity and obstructive sleep apnoea: Mechanisms for increased collapsibility of the passive pharyngeal airway. Respirology 2012;17:32-42.
6. Kapsimalis F, Kryger M. Sleep breathing disorders in the U.S. female population. J Women's Health (Larchmt) 2009;18:1211-9.
7. Elkus R, Popovich J Jr. Respiratory physiology in pregnancy. Clin Chest Med 1992;13:555-65.
8. Contreras G, Gutierrez M, Beroiza T, Fantín A, Oddó H, Villarroel L, *et al.* Ventilatory drive and respiratory muscle function in pregnancy. Am Rev Respir Dis 1991;144:837-41.
9. White DP. Pathogenesis of obstructive and central sleep apnea. Am J Respir Crit Care Med 2005;172:1363-70.
10. Mandal D, Mandal S,Rakshi A, Dey RP, Biswas SC, Banerjee A. Maternal obesity and pregnancy outcome: A prospective analysis. J Assoc Physicians India 2011;59:486-9.
11. Yinon D, Lowenstein L, Suraya S, Beloosesky R, Zmora O, Malhotra A, *et al.* Pre-eclampsia is associated with sleep disordered breathing and endothelial dysfunction. Eur Respir J 2006;27:328-33.
12. Olivarez SA, Maheshwari B, McCarthy M, Zacharias N, van den Veyyer I, Castur L,*et al.* Prospective trial on obstructive sleep apnea in pregnancy and fetal heart rate monitoring. Am J Obstet Gynecol2010;202:552.e1-7.
13. Silverberg DS, Iaina A, Oksenberg A. Treating obstructive sleep apnea improves essential hypertension and quality of life. Am Fam Physician 2002;65:229-36.
14. Netzer NC, Stoohs RA, Netzer CM, Clark K, Strohl KP. Using the Berlin questionnaire to identify patients at risk for the sleep apnea syndrome. Ann Intern Med 1999;131:485-91.
15. Abirashmi A, Khajehdehi A, Chung F.A systematic review of screening questionnaires for obstructive sleep apnea. Can J Anaesth 2010;57:423-38.
16. Santiago JR, Nolledo MS, Kinzler W, Santiago TV.Sleep and sleep disorders in pregnancy. Ann Intern Med 2001;134:396-408.
17. Giles TL, Lasserson TJ, Smith BH, White J, Wright J, Cates CJ. Continuous positive airways pressure for obstructive sleep apnoea in adults. Cochrane Database Syst Rev2006;3:CD001106.
18. Bazzano LA, Khan Z, Reynolds K, He J. Effect of nocturnal nasal continuous positive airway pressure on blood pressure in obstructive sleep apnea. Hypertension2007;50:417-23.
19. Poyares D, Guilleminault C, Hachul H, Fujita L, TakaokaS, Tufik S, *et al.* Pre-eclampsia and nasal CPAP: part 2.Hypertension during pregnancy, chronic snoring, and early nasal CPAP intervention. Sleep Med2007;9:15-21.
20. von DP, Ornstein MP, Bull SB, Logan AG, Koren G, Magee LA. Fall in mean arterial pressure and fetal growth restriction in pregnancy

hypertension: a meta-analysis. Lancet 2000;355:87-92.
21. Guilleminault C, Kreutzer M, Chang JL. Pregnancy, sleep disordered breathing and treatment with nasal continuous positive airway pressure. Sleep Med2004;5:43-51.
22. Guilleminault C, PalombiniL, Poyares D, Takaoka S, Huynh NT, El-Sayed Y. Pre-eclampsia and nasal CPAP: part 1.Early intervention with nasal CPAP in pregnant women with risk-factors for pre-eclampsia: preliminary findings. Sleep Med2007;9:9-14.
23. Saravanakumar K, Rao SG, Cooper GM. Obesity and obstetric anaesthesia. Anaesthesia2006;61:36-48.
24. Munnur U, de Boisblanc B, Suresh MS. Airway problems in pregnancy. Crit Care Med 2005;33:S259-68.
25. Juvin P, Lavaut E, Dupont H, Lefevre P, Demetriou M, Dumoulin JL, *et al.* Difficult tracheal intubation is more common in obese than lean patients. Anesth Analg 2003;97:595-600.
26. Gross JB, Bachenberg KL, Benumof JL, Caplan RA, Connis RT, Coté CJ,*et al.*Practice Guidelines for the Perioperative Management of Patients with Obstructive Sleep Apnea: A Report by the American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Obstructive Sleep Apnea. Anesthesiology 2006;104:1081-93;quiz 1117-8.
27. Hess PE, Pratt SD, Lucas TP, Miller CG, Corbett T, Oriol N,*et al.* Predictors of breakthrough pain during labor epidural analgesia. Anesth Analg 2001;93:414-8.
28. Melzack R, Kinch R, Dobkin P,Lebrun M, Taenzer P. Severity of labour pain: influence of physical as well as psychologic variables. Can Med Assoc J 1984;130:579-84.
29. Badve M, Shah T, Jones-Ivy S, Vallejo MC. Ultrasound guided epidural analgesia for labor in a patient with an intrathecal baclofen pump. Int J Obstet Anesth. 2011; 20:370-2.
30. Soens MA, Birnbach DJ, Ranasinghe JS, van Zundert A.Obstetric anesthesia for the obese and morbidly obese patient: An ounce of prevention is worth more than a pound of treatment. Acta Anaesthesiol Scand 2008;52:6-19.
31. Hamza J, Smida M, Benhamou D, Cohen SE. Parturient's posture during epidural puncture affects the distance from skin to epidural space. J Clin Anesth 1995;7:1-4.
32. Watts RW. The influence of obesity on the relationship between body mass index and the distance to the epidural space from the skin. Anaesth Intensive Care1993;21:309-10.
33. Balki M, Lee Y, Halpern S, Carvalho JC.Ultrasound imaging of the lumbar spine in the transverse plane: Correlation between estimated and actual depth to the epidural space in obese parturients. Anesth Analg 2009;108:1876-81.
34. Faheem M, Sarwar N. Sliding of the skin over subcutaneous tissue is another important factor in epidural catheter migration. Can J Anesth 2002;49:634.
35. Iwama H, Katayama T. Back skin movement also causes 'walking' epidural catheter. J Clin Anesth 1999;11:140-1.
36. Hamilton CL, Riley ET, Cohen SE. Changes in the position of epidural catheters associated with patient movement. Anesthesiology 1997;86:778-84.
37. Eappen S, Blinn A, Segal S. Incidence of epidural catheter replacement in parturients: a retrospective chartreview. Int J Obstet Anesth 1998;7:220-5.
38. Riley ET, Papasin J. Epidural catheter function during labor predicts anesthetic efficacy for subsequent cesarean delivery. Int J Obstet Anesth 2002;11:81-4.
39. Perlow JH, Morgan MA. Massive maternal obesity and perioperative cesarean morbidity. Am J Obstet Gynecol 1994;170:560-5.
40. Hood DD, Dewan DM, Kashtan K. Anesthesia outcome in the morbidly obese parturient. Anesthesiology 1993;79:1210-8.
41. Faure E, Moreno R, Thisted R. Incidence of postdural puncture headache in morbidly obese parturients. Reg Anesth 1994;19:361-3.
42. Hogan QH, Prost R, Kulier A, Taylor ML, Liu S, Mark L. Magnetic resonance imaging of cerebrospinal fluid volume and the influence of body habitus and abdominal pressure. Anesthesiology 1996;84:1341-9.
43. Hodgkinson R, Husain FJ. Obesity and the cephalad spread of analgesia following epidural administration of bupivacaine for Cesarean section. Anesth Analg 1980;59:89-92.
44. Collins JS, Lemmens HJ, Brodsky JB, Brock-Utne JG, Levitan RM. Laryngoscopy and morbid obesity: a comparison of the sniff and ramped position. Obes Surg 2004;14:1171-5.
45. Hofer RE, Sprung J, Sarr MG, Wedel DJ.Anesthesia for a Patient with Morbid Obesity using Dexmedetomidine without Narcotics. Can J Anaesth 2005;52:176-80.
46. Eslamian L, Jalili Z, Jamal A, Marsoosi V, Movafegh A. Transversus abdominis plane block reduces postoperative pain intensity and analgesic consumption in elective cesarean delivery under general anesthesia. J Anesth 2012; 26:334-8.

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