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This article is being republished as the optic nerve sheath diameter was reported to be 3.4 to 5.4 centimetres (cm) throughout the article text. The correct unit of measurement for the optic nerve sheath diameter is 'millimetre (mm)' at all places in the article text. The values of 0.3-0.54 cm seen in Figure 1 are correct.

Case Report

Optic nerve sheath diameter-guided extubation plan in obese patients undergoing robotic pelvic surgery in steep Trendelenburg position: A report of three cases

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ABSTRACT

Robotic pelvic surgery requires steep Trendelenburg positioning with pneumoperitoneum which causes raised thoracic and intracranial pressures. In obese patients, the basal thoracic pressures are high. Increased intrathoracic pressure can decrease the cranial venous flow leading to deficient intracranial absorption of cerebrospinal fluid and a further increase in intracranial pressure. Operating times are also longer due to unfavorable anatomy. Such patients frequently have a delayed awakening from anaesthesia due to a combination of factors such as hypercapnoea, acidosis, and raised intracranial pressures. Normocapnoea can be achieved in a ventilated patient towards the end of surgery. In cases where the anaesthetic agents have been washed out and normocapnoea has been achieved, the intracranial pressure may be an important factor causing delayed emergence. The sonographically measured optic nerve sheath diameter correlates with the intracranial pressure. We report three cases of robot-assisted pelvic surgery in obese patients where we used the optic nerve sheath diameter as a guide for the timing of extubation.

Key words: Delayed awakening, obesity, optic nerve sheath diameter, robotic pelvic surgery

INTRODUCTION

Robotic pelvic surgery has a lower rate of surgical complications and length of hospital stay compared with open methods.[1] However, its unique requirements such as a steep Trendelenburg position creates anaesthetic challenges such as raised airway and intracranial and abdominal pressures.[2] Obesity causes a reduction in functional residual capacity and chest wall compliance. Robotic surgery in such patients can result in further

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Table 1: Ventilatory parameters and blood gases

Time points	Case	IP/PEEP (cm H_2O)	IAP (cm H_2O)	TV (ml)/RR (per min)	I:E	SpO_2 (%)	$EtCO_2/PCO_2$ (mmHg)	PO_2 (mmHg)	pH	ONSD (mm)
Baseline	1	-	-	-	-	94	44.5	76.8	7.3	3.2
	2	-	-	-	-	95	47.8	72.7	7.4	3.5
	3	-	-	-	-	95	45	78	7.32	3.4
30 min after intubation	1	32/0	-	450/15	1:2	97	36/52	116.2	7.33	-
	2	28/5	-	420/15	1:2	94	38/40.2	90.6	7.4	-
	3	26/0	-	480/15	1:2	95	35/45.2	78.6	7.32	-
30 min after docking	1	42/0	10	440/16	1:2.5	100	42/54.8	114	7.26	-
	2	42/5	10	350/20	1:2	98	45/53.4	82.5	7.28	-
	3	34/0	12	420/18	1:2	96	38/48.8	88.6	7.24	-
2-4 h after docking	1	38/0	12	440/18	1:2.5	100	46/55.1	90.2	7.24	-
	2	45/5	10	330/20	1:2	99	48/52.6	73.9	7.29	-
	3	40/0	12	420/18	1:2	95	40/50.4	85.5	7.22	-
8 h after docking	1	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-
	3	41/0	12	436/18	1:2.5	92	40/54.1	126.4	7.27	-
30-60 min after undocking	1	25/5	-	500/15	1:2	100	38/46.5	114.4	7.28	5.1
	2	28/5	-	420/18	1:2	98	35/50.8	102.2	7.29	4.4
	3	28/5	-	472/16	1:2	96	39/48.2	130.4	7.29	5.4
Pre-extubation	1		-	480/15	1:2	100	-/45.5	145.4	7.32	3.6
	2	30/5	-	450/15	1:2	98	35/49.2	115.2	7.3	-
	3	25/5	-	512/16	1:2	98	-/42	134	7.36	3.5

IP – Inspiratory pressure; PEEP – Positive end expiratory pressure; IAP – Intraabdominal pressure; TV – Tidal volume; RR – Respiratory rate; I: E – Inspiratory: expiratory ratio; SpO_2 – Blood oxygen saturation; $EtCO_2$ – End-tidal carbon dioxide; PCO_2 – Partial pressure of carbon dioxide; PO_2 – Partial pressure of oxygen; ONSD – Optic nerve sheath diameter

increases in peak inspiratory pressure and decrease tidal volume leading to perioperative pulmonary complications. Carbon dioxide retention, airway oedema, and delayed awakening due to raised intracranial pressures (ICP) make extubation risky[3] in such patients. The ICP can be measured indirectly by correlating it with the sonographically measured optic nerve sheath diameter (ONSD).[4-7]

CASE REPORTS

We report three cases where we followed different ventilatory strategies and an extubation plan based on the rise in ONSD. Laboratory investigations and cardiac stress echocardiography were within normal limits in all patients. Standard monitoring and a uniform plan of induction with propofol, fentanyl, and atracurium was followed. Ventilatory settings and serial blood gases are shown in Table 1. Intraoperative blood loss was minimal with good urine output and stable haemodynamics in all cases.

Case 1

A 70-year-old hypertensive patient with carcinoma endometrium was planned for robotic hysterectomy. She weighed 139 kg with a history of snoring and a body mass index (BMI) of 49.4 kg/m^2. Pulmonary function tests showed small airway obstruction with the ratio of the forced expiratory volume in 1 s (FEV1) to forced vital capacity (FVC) as 60% of predicted.

Volume-controlled mode was used for ventilation during surgery. Anaesthesia was maintained with dexmedetomidine and desflurane titrated to a minimum alveolar concentration of 1 to 1.2 via an 8 mm ID endotracheal tube. Surgery lasted 6 h with a console time of 3 h. Pelvic lymphadenopathy could not be done because of gross fatty deposition in the pelvis. Blood gases done after undocking showed acceptable values of oxygenation, pH, and normocarbia. Considering the short console time, lesser than planned extent of surgery and high chances of pulmonary complications with prolonged ventilation, tracheal extubation was planned. However, as the patient was not conscious even 1 h after reversal of neuromuscular blockade and return of acceptable spontaneous minute volumes, she had to be ventilated postoperatively. The ONSD at this time point was elevated at 5.1 mm. She was extubated after 12 h of elective ventilation.

Case 2

A 57-year-old diabetic patient of carcinoma endometrium was planned for robot-assisted radical hysterectomy with lymph node exenteration. Her body weight was 137 kg with a BMI of 55.5 kg/m^2. She had a history of sleep apnoea. Pulmonary function tests showed mild restriction with an FVC of 79% of predicted and an FEV1:FVC ratio of 108% of predicted.

Baseline ONSD was 3.5 mm. Anaesthesia was maintained via an 8-mm ID endotracheal tube on pressure controlled ventilation with desflurane titrated to a bispectral index of 40–50, and dexmedetomidine. Surgery lasted 7.5 h. The ONSD was 4.4 mm at 30 min after undocking. The pre extubation values of bispectral index and blood gases were acceptable. She was extubated uneventfully on the operating table after complete awakening.

Case 3

A 70-year-old hypertensive and diabetic male patient of carcinoma rectum was planned for robotic abdominoperineal resection. He was a known asthmatic with poor effort tolerance. He weighed 117 kg with a BMI of 39.44 kg/m^2. Pulmonary function test showed an FVC of 70% of predicted and moderate reversibility with bronchodialators.

The patient had a baseline ONSD of 3.4 mm. We ventilated the lungs on the volume controlled mode via a 7.5-mm ID endotracheal tube. Sevoflurane was titrated to a minimum alveolar concentration of 1 to 1.2. Intravenous fentanyl and atracurium and epidural levobupivacaine were also administered.

Surgery lasted 11.5 h. The console time was 8 h with a 10-min period of abdominal desufflation after six hours of docking. The ONSD measured 30 min after undocking was 5.4 mm [Figure 1]. Hence, we decided to electively ventilate the patient. After 10 h of overnight ventilation, the patient was extubated uneventfully. The pre-extubation ONSD was 3.5 mm and arterial blood gases were acceptable.

DISCUSSION

Robotic surgery has improved patient outcomes, especially in pelvic surgeries. Obesity compounds the problems of high thoracic, abdominal, and intracranial pressures. Operating times are longer due to the inherent surgical access difficulties in an obese anatomy compounded by compromises in intra-abdominal pressure and degree of head down that may be required to maintain acceptable blood CO_2 levels. Unless ventilatory parameters and pulmonary gas exchange are carefully monitored and meticulously optimised, interruptions in Trendelenburg position and surgery or conversion to laparotomy may be required. Extubation of the trachea remains a challenge. Wysham *et al*.[8] evaluated pulmonary complication rates in obese women undergoing robotic gynecological surgery and found nine cases of delayed extubation.

Recovery from anaesthesia can be delayed in such patients despite normalizing the pH and blood gases towards the end of surgery. This may be because of an increase in ICP due to longer console times in steep head down position.[9] Cerebral blood flow changes 1.8 mL/100 g/min for each 1 mmHg change in the partial pressure of CO_2.[10] CO_2 insufflation to induce pneumoperitoneum increases the cerebral blood flow and ICP.[11,12] In obesity, the basal intrathoracic pressures are higher which can decrease the cranial venous flow leading to deficient intracranial absorption of cerebrospinal fluid and further rise in ICP.[13] Raised ICP can severely compromise the cerebral perfusion pressure leading to ischemia of the brain parenchyma and delayed emergence.[14] In such situations, we have two options: postoperative ventilation or lowering of ICP using drugs such as mannitol in selected patients. However, it is difficult to predict which patients may have a raised ICP.

Dubourg *et al*.[5] reported that ultrasonography of ONSD shows a good level of diagnostic accuracy for detecting ICP. The optic nerve is surrounded by cerebrospinal fluid and duramater. The intracranial cerebrospinal fluid pressure variations are transmitted to the space around the optic nerve, and thus, influences the ONSD.[6,7,15] Histological studies revealed a segment 3 mm behind the globe of the optic nerve where maximal diameter fluctuations could be expected.[6,13] Studies[5,6,16] have shown that the sonographically measured ONSD is a reliable surrogate marker for ICP in anaesthetised patients in the Trendelenburg position. Rajajee *et al*.[4] have shown that an ONSD of more than 4.8 mm is a good indicator of an ICP more than 20 mmHg with 96% sensitivity and 94% specificity. Normal value of ICP is 5–15 mmHg.

We have reported three cases in obese patients where we used the ONSD as a parameter to decide our

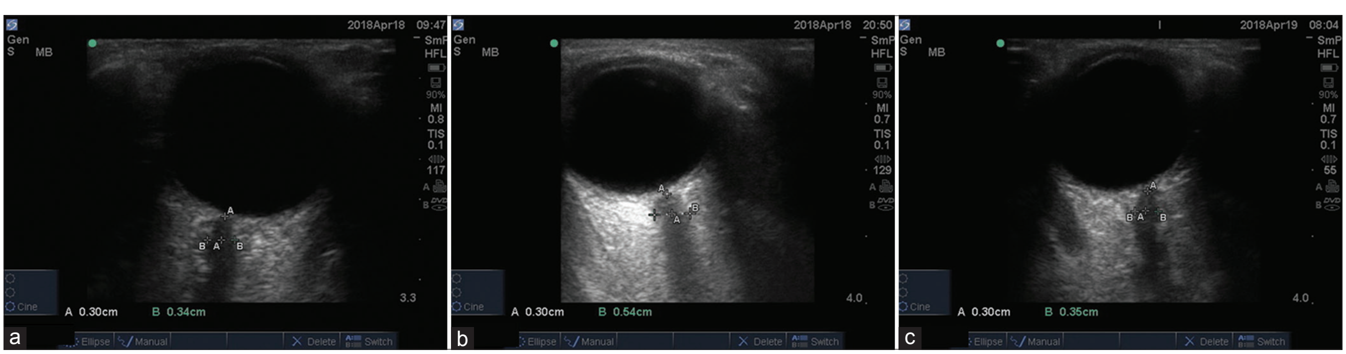

Figure 1: Sonographic image showing optic nerve sheath diameter (cm) in Case 3 (a) baseline, (b) after undocking, and (c) after 10 hours of postoperative ventilation

extubation strategy. We measured the ONSD of both eyes sonographically at a point 3 mm behind the retina using a 13–6 MHZ ultrasound probe placed transversely over the closed eyelid. The average value was taken as the ONSD at that point of time.

The depth of anaesthesia was titrated to either MAC or bispectral index and values favorable for extubation were attained towards the end of the surgery. All our patients had normocarbia, normothermia, and euglycemia before extubation was attempted. In our first case, the ONSD was not measured following undocking. Despite achievement of acceptable spontaneous minute volumes and blood gases, the patient did not wake up. Her end-operative ONSD was 5.1 mm. Our second case had an ONSD of 4.4 mm at 30 min after undocking. She had an uneventful extubation. Our third patient had the longest operating time of 11.5 h. As the ONSD measured after undocking was high at 5.4 mm, we electively ventilated him postoperatively. Both patients could be extubated the following morning after their ONSD had normalised. Thus, we associate raised ICP as the cause for delayed emergence, even though none of our patients had any neurological sequelae.

Brain compliance and physiology of cerebrospinal fluid flow changes with age, and hence, ICP is described as a decreasing function of age.[17] The two patients who could not be extubated on the table were in the seventh decade and would have had similar brain physiology. Our second patient was younger with possibly better cerebral autoregulation. This may have led to her successful end-operative extubation. Ours was an observational study correlating the ONSD with readiness for extubation. Hence, no interventions like mannitol were used.

CONCLUSION

The ONSD, a surrogate for ICP, may be a valuable indicator for the timing of extubation in these patients. Further studies are required to evaluate its role in perioperative monitoring.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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