Cerebrovascular Changes During Laproscopic Vesico-Vaginal Repair

Bharti Chauhan[1], Kunal Kumar Sharma[2], Kailash Barwal[3] and Pawan Kaundal[3]

Case Report

[1]Department of Cardiac Anesthesia, Indira Gandhi Medical College and Hospital,Himachal Pradesh, Shimla, India

[2]Neuroanesthesia Cell, Indira Gandhi Medical College and Hospital, Himachal Pradesh, Shimla, India

[3]Department of Urology, Indira Gandhi Medical College and Hospital, Himachal Pradesh, Shimla, India

ABSTRACT

Introduction: Pneumoperitoneum using carbon di-oxide produces cardiac and cerebrovascular changes that can be harmful in patients with coexisting diseases. Therefore we decided to monitor its effect on cerebral vasculature, taking trans-temporal color coded doppler sonography guided identification of Middle cerebral artery (MCA) flow velocity as an index of measurement of cerebral blood flow**.**

Case Report: After administration of general anesthesia, the MCA flow velocity trend exhibited elevation in both of the patients. The first patient had this elevation, correlating to the corresponding increase in the end tidal carbon di-oxide (EtCO2) levels. The second patient, had this elevation correlating to the decrease in the fraction of inspired oxygen (FiO2) levels. The postulated mechanism for these changes is cerebral hyperemia, which develops after induced pneumoperitoneum. The time of emergence from anesthesia was also recorded for both the cases.

Conclusions: The monitoring of cerebral blood flow velocities during prolonged laparoscopic procedures has not yet been widely studied. Its impact on emergence from anesthesia and post-operative cognitive deficits is an upcoming area of great interest. These effects of pneumoperitoneum on cerebral vasculature only get accentuated in prolonged duration of surgery.

Key Words: End-tidal carbon dioxide; middle cerebral artery flow velocity; transcranial color-coded duplex ultrasonography vesico-vaginal repair.

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Corresponding Author: Kunal Kumar Sharma, Neuroanesthesia Cell, Indira Gandhi Medical College and Hospital, Himachal Pradesh, Shimla, India, **Tel.:** +91 7018388348, **E-mail:** kunaal_kumar@yahoo.com

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INTRODUCTION

Pneumoperitoneum with carbon di-oxide (CO2) insufflation can cause cardiovascular and arterial blood gas alterations. This can likely impair cerebral perfusion[1]. Rise in blood CO2 levels can lead to cerebral hyperemia. Transcranial Doppler (TCD) is a versatile tool for gathering information regarding blood flow in the brain. The variable measured is cerebral blood velocity. Satomura and Kaneko[2] in 1961 used doppler to assess blood flow velocities. They correlated the waveform morphologies to increased vascular resistance due to arteriosclerosis. Miyazaki and Kato[3] in 1965 improvised this technique to study the changes in cerebral flow velocity patterns with age. The formal methods of intracranial blood velocity measurement and instrumentation were developed by Rune Aaslid[4] who reported its use in 50 healthy individuals thereby providing the range of normal blood flow velocities in intracranial vessels.

TCD measures the velocity of individual red blood cells in intracranial blood vessels based on the change of frequency of incident ultrasonic sound waves when reflected off the moving blood cells. The range of velocities acquired are plotted as a velocity-time graph. While the peak velocities forming the spectral envelope of the graph are used for computing the variables – systolic (SV), diastolic (DV) and mean velocities (MV). The sound waves are produced from a phased array probe with enough power to penetrate the skull.

The normal mean MCA flow velocity is 64.4 + 12.7 cm/sec in 18 to 30 year old patients[5]. Ainslie *et al*[6] reported an age related decline of 0.8 cm/sec/yr in males aged between 18 to 79 years. Bakker *et al*[7] reported a decline of 0.6 cm/sec/yr in females and 0.4 cm/sec/yr in males who were over and above the age of 55 years. Tegeler *et al*[8] reported that MCA velocity decreased by 4 to 5% each decade after the age of 30 to 80 years in healthy individuals.

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The European TCCD sonography study group has defined a format for conducting TCCD examination, although departures from the procedure are often necessary to get a good image. They define three planes for the examination from the trans-temporal window:- (i) 0 degree axial plane going through the mesencephalon; (ii) 10-15 degree axial plane going through diencephalon; (iii) a further 10-15 degree axial plane going through cella media. Therefore, TCCD utilizes the 2-dimensional (B-mode) of ultrasonography in comparison to TCD, where it is always M-mode (1-dimension).

As the duration of surgery for laproscopic VVR is more than the other conventional laproscopic surgeries, we decided to investigate the cerebral blood flow velocity trend in our patient who was scheduled for laproscopic vesico-vaginal fistula repair (VVR). The measurement was obtained non-invasively from a phased array transducer of Sonosite ultrasound machine, placed on temporal window of the patient's cranium via the procedure termed as TCCD sonography.

CASE REPORT

The first case was a 49 year old female who presented with complaint of urinary incontinence for 3 month. She had a past history of uterine adenomyosis with chronic cervicitis for which she underwent hystrectomy with bilateral salpingo-opherectomy under sub-arachnoid block, 3 months back. There was also history of intestinal obstruction, 4 years back for which she underwent laprotomy. She was in stable condition, her metabolic equivalents (METS) were more than 5. The examination of airway revealed presence of buck teeth, and modified Mallampatti score (MPS) of grade III, while the other parameters were normal. Hemogram revealed moderate anemia [Hemoglobin (Hb)= 9.4 g/dl] and both direct and indirect coomb's test came positive on the day of surgery.She underwent smooth anesthetic induction with thiopentone 270 mg, pentazocine 30 mg and succinylcholine 100 mg. The anesthetic plane was deepened further with sevoflurane until intubation with a 7.5 mm cuffed oral endotracheal tube, which was inserted under direct laryngoscopy and fixed at 18 cm. Anesthesia was maintained with oxygen-nitrous-isoflurane admixture to maintain an effective MAC between 0.8 to 1. The muscle relaxation was ensued by atracurium loading dose followed by intermittent boluses. In concern of positive Coomb's test and the necessity to minimize blood loss, an intravenous bolus dose of 1 g tranexamic acid was given slowly over 10 minutes.

20 degree trendlenburg position was given after clean draping of the abdomen. The radiological imaging had revealed the presence of two fistulae of 1 x 1 cm size, at supra-trigonal location on the posterior aspect of the urinary bladder. A five port laproscopy was planned.. After pneumoperitoneum the presence of vascular omental adhesions between the gut and parietal peritoneum was noted. The MCA flow velocity showed peak after 75 minutes from insufflation which corresponded with the peak in end tidal carbon di-oxide (EtCO2) levels (Figures 1,2) A horizontal cystostomy was done and fistulae were identified. Their margin was excised and a plane developed between vagina and bladder. The vagina was closed with vicryl 4-0 whereas the bladder cystostomy was closed with vicryl 2-0. Appendices epiploicae were kept between vagina and bladder margins. Hemostasis was achieved. A drain kept in pelvis 12 mm in situ and closed. The gauze, sponge and instruments were counted and kept aside by the scrubbed nurse.

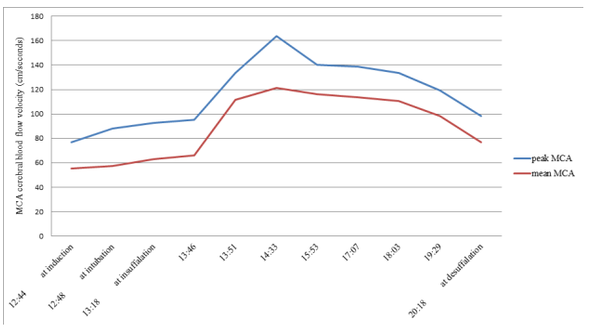

Fig. 1: Trend of MCA flow velocities with time - Case 1

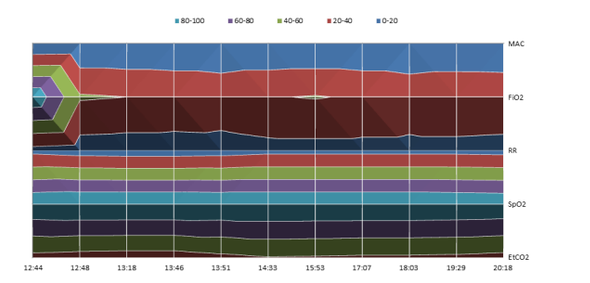

Fig. 2: Ventilatory parameters- Case 1

Intraoperative blood loss of 600-650 ml occurred. Since Coomb's test had come positive pre-operatively, therefore we used the balanced crystalloid solution of lactated Ringer 1.5 liters and colloidal solution of Hemaccel 500 ml. After completion of the surgery, the patient was reversed from muscle relaxation and extubated.

The second case was a 42 year old female who presented with similar complaints of urinary incontinence after gynecological surgery. She underwent smooth anesthetic induction with propofol 110 mg, pentazocine 24 mg, lidocard 60 mg and atracurium 25 mg, followed by deepening of anesthetic plane further by isoflurane administration prior to endotracheal intubation. Maintenance of anesthesia was carried out on oxygen-nitrous-isoflurane admixture, with patient being in 15 degree trendlenberg position. After 34 minutes from onset of pneumoperitoneum, the MCA flow velocities peaked and it corresponded to a drop in fraction of inspired oxygen (FiO2) from 37 to 32 % alongwith a change in respiratory rate from 14 to 12 (Figures 3, 4) These MCA flow velocities showed a decrease after desufflation

at the end of the surgery. The extubation was smooth and post-operative period was uneventful.

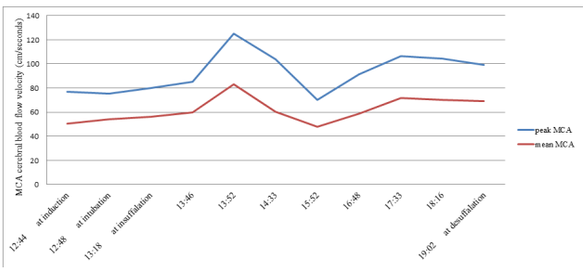

Fig. 3: Trend of MCA flow velocities with time - Case 2

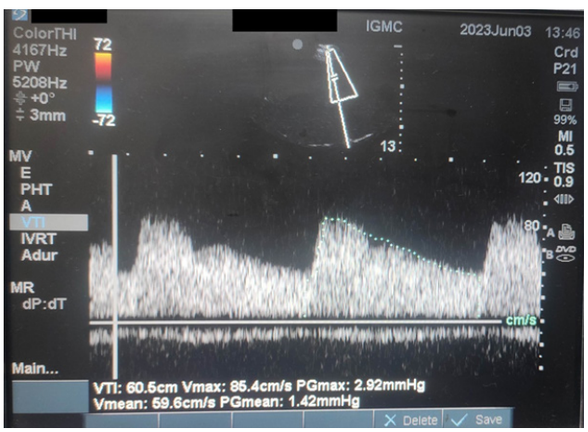

Fig.4: spectral waveform obtained after transcranial color coded duplex ultrasonography of the middle cerebral artery (MCA). The parameter Vmax corresponds to the peak MCA flow velocity (cm/s). The parameter Vmean corresponds to mean MCA flow velocity (cm/s).

DISCUSSION

In normal patients with intact cerebral autoregulation, the cerebral blood flow is preserved despite of changes in cardio-respiratory parameters[9]. This vascular regulation is typically occurring at the level of resistance vessels. Therefore it is their dilation and constriction that is reflecting as the change in flow velocity in the middle cerebral artery. Consequently, the metabolism of brain parenchyma is linked to this perfusion via the flow-metabolism coupling[10]. However, this coupling gets distorted in altered physiological states like impaired cerebrovascular reactivity to CO2. The variation in cerebral blood flow velocity has been validated with changes in cerebral blood flow by Bishop *et al*[11].

Pneumoperitoneum has the propensity to reduce the cardiac output. This can theoretically cause a decrease in effective blood flow to the internal carotid artery and vertebral artery. Also, the increase in systemic vascular resistance can alter the blood flow velocity in intracranial vasculature[12]. Whether or not is there an adaptive vasodilatation in the middle cerebral artery to mitigate this reduction in blood flow owing to the pneumoperitoneum induced altered physiology, is a question to investigate in patients with altered cerebral autoregulation owing to long standing co-existing disease.

The works by Fuji *et al*[13] and Cosmo *et al*[14] on study cohort of ASA I & II patients using TCD revealed increase in cerebral blood flow velocity and cerebral hyperemia after pneumoperitoneum.

However, the work by Colomina *et al*[15] pertaining to observation of cerebral hemodynamics during lengthy laparoscopic procedures requiring pneumoperitoneum and trendlenberg position in 17 ASA status I and II patients using TCD revealed no significant variations at any of the four time points studied during the procedure. This was perhaps attributable to the lengthy duration of the surgery in their patients, which somehow readjusted the hyperemic changes in the cerebral blood flow.

The first patient who underwent a prolonged period (10 hor) of pneumoperitoneum for vesico-vaginal repair. Her ventilatory parameters (EtCO2, SpO2, MAC and RR) were stable throughout the surgery. Although the range of EtCO2 was between 31 to 39 mmHg which was well within physiological range, the MCA flow velocity increased and it paralleled with the increase in the EtCO2 to 39 mmHg after 75 minutes from onset of pneumoperitoneum. This probably occurred due to alteration in the cerebral autoregulation capacity. Our finding varies from that observed in the study by Colomina et al because the patient was of ASA III physical status.

The second patient was of ASA II status who underwent the surgery for 6 hours, yet she too exhibited a peak in the MCA flow velocity after 34 minutes from insufflation. This paralleled with decrease in FiO2 to 32% owing to metabolism of oxygen fraction in the oxygen-nitrous-isoflurane admixture used for anesthesia maintenance. Interestingly, desufflation was done by the urologist at 15:52 hrs and this corresponded with a decrease in MCA flow velocities. These velocities again increased when subsequent re-insufflation was done by urologist for further surgery. The insufflation pressure used during her surgery was 14 mmHg.

Both the patients attained the modified observer sedation score of 5 in the post anesthesia care unit within 14 minutes and 6 minutes respectively. This might be owed to the remnant cerebral hyperemia at the end of the surgical procedure.

Conclusion: The paucity of time and the requirement of development of learning curve for TCCD has curtailed the routine examination of cerebral blood flow velocities in patients undergoing laproscopic surgeries. Current trend in clinical monitoring is more focused on hemodynamic parameter monitoring, which has the fallacy for overlooking the concept of cerebral autoregulation, which varies with the demographic parameters and the ASA status of the patient. Overlooking the neuro-monitoring can result in inadvertent prolongation of stay in post anesthesia care

units (PACU) and post-operative delirium. Further studies with randomization are warranted in this study cohort for developing safer anesthesia practice guidelines in laproscopic surgeries.

CONFLICT OF INTERESTS

There are no conflicts of interest

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