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EVALUATION OF OPTIC SHEATH DIAMETER AS A GUIDE FOR RAISED INTRACRANIAL PRESSURE IN PATIENTS UNDERGOING PROLONGED LAPROSCOPIC/ ROBOTIC SURGERIES IN STEEP TRENDELENBURG POSITION.

Anaesthesiology

Dr. Chhavi Goel*	Senior resident Anaesthesiology Medanta- the Medicity hospital *Corresponding Author
Dr. Rajat Garg	Senior resident Anaesthesiology Indraprastha Apollo Hospital
Dr Purnima Dhar	Senior Consultant, Indraprastha Apollo hospital
Dr Chitra Chatterjee	Senior Consultant, Indraprastha Apollo hospital
Dr Anil Sharma	Indraprastha Apollo hospital

ABSTRACT

Purpose: Evaluation of optic sheath diameter as a guide for raised intracranial pressure in patients undergoing prolonged laproscopic/ robotic surgeries in steep trendelenburg position.

Background: Steep trendelenburg position of upto 40 degrees may be required for robotic and laproscopic pelvic surgeries. It may cause alteration in cerebral homeostasis and impaired cerebral auto-regulation and raised ICP. ONSD assessment can be used to assess changes in ICP.

Methods: In a prospective, observational, non-interventional and open study, ONSD of 30 patients undergoing robotic/laproscopic pelvic surgeries in steep trendelenburg position lasting more than 4 hours (Group I) was compared with 30 patients undergoing donor hepatectomy in supine position without trendelenburg position (Group II). Intra-operative haemodynamic parameters, ONSD after induction of anesthesia, 4 hours after induction and after completion of surgery was measured and compared between two groups.

Results: A small but significant increase in ONSD in prolonged steep trendelenburg position with pneumoperitoneum was observed (p value < 0.001). The magnitude of increase was not enough to be labeled as intracranial hypertension. ONSD is a good non invasive modality for assessment of raised ICP secondary to cerebral oedema. It may be used to initiate timely interventions.

Conclusion: ONSD may serve as a guide for initiating timely interventions to keep ICR within normal range.

KEYWORDS

ONSD, Steep trendelenburg position, laproscopic pelvic/ robotic surgeries.

INTRODUCTION

A steep trendlenburg position of as much as 40 degrees is a requirement for robotic and laparoscopic pelvic surgeries, such as radical prostatectomy, gynaecological pelvic surgeries etc. Though this position offers a surgical and technical advantage, it causes alteration in cerebral homeostasis.[1] In addition, the patient population undergoing these surgeries are very vulnerable to alterations in cerebral homeostasis. This geriartric surgical population may also have impaired cerebral autoregulation.[2]

Raised intracranial pressure (ICP) is believed to be one of the complications of prolonged trendelenburg position, but the exact incidence is not known, mainly because of paucity of non invasive methods to assess ICP in the operation room setting. Raised ICP can be assessed by invasive methods, but they are usually reserved for neurosurgical cases. Invasive methods carry a degree of risk which is difficult to justify in non neurosurgical cases.

Optic Nerve Sheath Diameter (ONSD), performed using ocular ultrasound, is a non invasive modality being used by emergency room physicians to screen patients with head trauma. It is believed that ONSD corresponds to a rise in ICP and this change is rapid. ONSD assessment using ocular ultrasound has been proven to be more than 80% sensitive and more than 80% specific in detecting raised ICP by many authors.[3,4,5,6]

The technique uses a high resolution 7.5-10MHz or higher linear array ultrasound transducer on a closed eye. On USG, normal ONSD is considered to be upto 5.0mm. It is measured at a point 3.0mm behind the globe which is believed to be an area of greatest ultrasound contrast and the technique is reproducible. Elevated ICP should be suspected with an ONSD of more than 5.0mm.

Theoretically, a rise in ICP should cause a delay in awakening from anaesthesia and should produce symptoms of raised ICP like agitation, sedation, confusion, blurring of vision, etc.

The intensity of these symptoms should increase with the increase in ICP.

The present study was conducted to detect any change in ONSD in prolonged steep trendlenburg position as compared to prolonged surgery in supine position without any tilt. The patients were followed up in PACU for one hour to detect any signs and symptoms suggestive of raised ICP like confusion, blurring of vision, agitation, sedation, etc.

METHODS

After Hospital Ethics committee approval and a written informed consent from the patients, the study was conducted on patients scheduled for robotic pelvic surgery. An equal number of patients undergoing donor hepatectomies were taken as controls. The study was done from october 2013 to September 2014 at Indraprastha Apollo Hospitals, New Delhi.

Study Design: Hospital based, prospective, observational, non-interventional, open study

SAMPLE SIZE CALCULATION: This study was started as a pilot study as no such study was found in the literature till the time of planning this study, to the best of our knowledge. So, we chose a sample size of total 60 patients with 30 patients in each group as per the feasibility and convenience, after consulting the statistician.

60 patients scheduled for surgeries of a duration ≥ 4 hours were included in the study.

GROUP A: 30 patients undergoing robotic/ laparoscopic pelvic surgeries in steep trendelenburg position.

GROUP B: 30 patients undergoing donor hepatectomy in supine position without trendelenburg position.

PATIENT SELECTION CRITERIA

Inclusion criteria:

1. American Society of Anaesthesiologists (ASA) Physical status I-II patients
2. Age group 20-80 years
3. Of either sex
4. atients scheduled for robotic pelvic surgery (steep Trendelenburg Position) for group A and for donor hepatectomy (supine position) for group B
5. Duration of surgery more than four hours

Exclusion criteria:

1. Patients not consenting for assessment of Optic nerve sheath diameter
2. Prior neurologic problems
3. History of head trauma
4. Patients with prior intracranial surgery
5. Patients with ocular pathology/ surgery
6. Duration of surgery less than four hours

PROCEDURE

The procedure for ONSD measurement was explained to the patient and patient information sheet was given to the patient to read. Consent for anaesthesia and performance of ocular ultrasound was taken.

After transfer to the operating room, anaesthesia was induced with fentanyl (1-2mcg/kg), propofol (2-2.5mg/kg), atracurium (0.5-0.6mg/kg), and maintained with oxygen + air with Desflurane (0.9-1.3 MAC), morphine (100mcg/kg loading dose+20mcg/kg after 4 hours) and atracurium infusion 0.5mg/kg/hour.

Monitoring included electrocardiography, blood pressure, pulse oximetry, temperature, capnography and gas monitoring. Optional monitoring included Central Venous Pressure Monitoring which was done in all donor hepatectomy patients and selected patients undergoing robotic surgeries.

We tried to maintain blood pressures at the time of assessment within +/- 10% of initial values, so as to avoid any blood pressure induced changes in ONSD. Higher blood pressure was reduced with a bolus of propofol and lower blood pressure was raised with a bolus of ephedrine.

Intravenous fluid was given at a rate of 4 ml/kg/hr of crystalloid till the patient was in trendelenburg position for group A and till the completion of liver parenchymal transection in group B. The rate of fluid administration in both the groups was then increased to 8 ml/kg/hr to compensate for the fluid deficit. The blood loss was replaced with equal amounts of colloid or blood as required. However, none of our patients required blood transfusion in both the groups.

The mechanical ventilation was titrated to keep the patient's end-tidal carbon dioxide level ($ETCO_2$) between 30-35mmHg.

Optic Nerve Sheath Diameter (ONSD) was measured before patient positioning for surgery (i.e. after induction of anaesthesia).

ONSD measurement was then repeated after 4 hours and at end of the procedure before making the patient supine (i.e. before reversing the trendelenburg tilt).

Desflurane was switched off at the time of skin closure.

Also, time to recovery from anaesthesia was recorded, which was taken as the time from switching off of desflurane and the time when patient started obeying verbal commands and opened the eyes.

After extubation, the patients were observed for any clinical signs of raised intracranial pressure, in the recovery room for a period of 1 hour.

Intra-operative parameters recorded were:
1. Heart Rate
2. Systolic and Diastolic Blood Pressure
3. MAC
4. $ETCO_2$
5. Fluid intake
6. Urine Output (if it could be measured)
7. Recovery time from Anaesthesia

The parameters assessed in the recovery room included:
1. Agitation and Sedation scores (Richmond Agitation Sedation Scale)
2. Confusion
3. Blurring of vision
4. Conjunctival oedema
5. Periorbital oedema

PROCEDURE FOR ULTRASONOGRAPHY OF EYE

The eyelids were covered with a sterile transparent dressing (Tegaderm) to prevent contamination or trauma during the scan procedure.

Ultrasound of eye was performed by a single anaesthesiologist trained in the present procedure. Eyes were taped using transparent tegaderm dressing. Ultrasonography was performed after applying adequate amount of water based gel (ultrasound gel) onto the interface of tegaderm and ultrasound probe. A 7.5 MHz linear probe of Venue 40, Point of care US machine (GE healthcare) was used.

Ultrasound examination was carried out at two axes perpendicular to each other. The first scan involved placement of probe in a line joining both canthi, ie, horizontal axis. The second scan involved placement of probe in a plane perpendicular to first plane, ie, vertical scan.

Eye was scanned to assess the normal anatomy and landmarks. Following structures were visualised from anterior to posterior direction to gain a proper orientation, before proceeding with any measurements.[7]

STRUCTURE	ECHOGENICITY	RELATIVE USG ANATOMY (NORMAL EYE)
Cornea	Hypoechoic	Thin hypoechoic layer parallel to the eyelid
Anterior Chamber	Anechoic	Anechoic area between cornea, iris and anterior reflection of lens capsule
Lens capsule	Hyperechoic	Curvilinear anterior and posterior lines enclosing anechoic lens
Iris and Ciliary body	Hyperechoic	Linear structures extending from the peripheral globe towards lens
Posterior chamber	Anechoic	Hollow spherical structure behind lens capsule
Retina/ choroid/ sclera (covering layers of eyeball)	Hyperechoic	Spherical covering outlining the eyeball, cannot be differentiated from each other
Retro-orbital region (EOM/ orbit)	Heterogenously hyperechoic	Posterior to globe
Optic nerve with its covering sheath	Anechoic linear structure enclosed in hyperechoic sheath	Linear structure radiating away from globe

A point 3mm posterior to optic disc is considered the target point. The optic nerve is considered to be most distensible and hence representative of rise in ICP at this particular point.

The transverse diameter of optic nerve sheath was measured at this level. Optic nerve is seen as anechoic (black) linear structure bounded by hyperechoic (bright) lines, ie optic nerve sheath at this level (behind the optic disc).

Ultrasound probe was then changed to vertical axis, as defined above and the measurement of ONSD in this plane was carried out. A mean of ONSD in both transverse and vertical axes was taken as final reading, representative of ONSD.

Change in ONSD was then compared statistically between the groups.

Statistical testing was conducted with the statistical package for the social science system version SPSS 17.0. Continuous variables are presented as mean ± SD, and categorical variables are presented as absolute numbers and percentage. The comparison of normally distributed continuous variables between the groups was performed using Student's t test. Nominal categorical data between the groups were compared using Chi-squared test or Fisher's exact test as appropriate. For all statistical tests, a P value of less than 0.05 was considered statistically significant.

OBSERVATIONS AND RESULTS

The data obtained was coded and entered in Microsoft Excel spreadsheet and was analysed statistically.

The patient characteristics for mean weight , height, BMI (Body Mass Index) and gender were statistically comparable in both the groups (table 1,2). The patients in group B were younger and this difference was statistically significant.

Baseline systolic blood pressure(SBP), diastolic blood pressure(DBP) and pulse rate were comparable in both the groups(table 3).

The mean duration of surgery was more than 4 hours (240 min) in both the groups, although the total duration of surgery in group B patients was more than in group A(table 4).

ONSD: There was a statistically significant increase in ONSD at 4 hours which increased even more towards the end of surgery as compared to the baseline starting values in group A patients(table 5).

In group B patients, ONSD values were significantly lower than the baseline starting values, at 4 hours which increased towards the end of surgery but remained lower than the baseline values. Also, there was a statistically significant difference if we compared the values of ONSD amongst the groups.

Time to recovery: There was a statistically significant difference in mean time to recovery from anaesthesia. Recovery from anaesthesia was delayed in patients in group A(table 6).

Sedation scores: The sedation scores were significantly lower in patients in group A(patients were more sedated) as compared to patients in group B at the time of shifting to recovery room(table 7) but the scores were similar in patients in both the groups after 1 hour of shifting to recovery room(table 8). Post extubation confusion was observed in 1 patient in group A which resolved by 1 hour. There was no patient with post operative confusion in group B(table 9).

Ocular signs: There was no patient with post operative blurring of vision in both the groups. We observed conjunctival oedema in 15 patients in group A, which persisted even after 1 hour in the post operative period. Periorbital oedema developed in 12 patients in group A, which persisted even after 1 hour in the post operative period(table 10).

DISCUSSION

The technique of ONSD measurement by ultrasound of eye is already an established screening tool for predicting raised ICP in trauma patients.

Robotic pelvic surgeries are done in a position of steep trendelenburg tilt of as much as 40 degrees along with creation of pneumoperitoneum. This position has a surgical advantage as the gut shifts away from the surgical field and visualisation of the surgical field is better. But, this position coupled with a prolonged duration of the surgery causes many physiological changes in the patient, which are more of a concern as the patient population undergoing these surgeries is often elderly and may have other co-morbidities as well.

The problems reported are: increase in MAP, SVR, ICP, IOP, and decreased Aortic diameter.[8-10]

Mavrocordotos et al, in a study of 15 neurosurgical patients reported an increase in ICP from 8.8 to 13.3 mmHg when they were placed in 30^{o} trendelenburg tilt.[11] But on the contrary, Kalmar et al investigated the combined effect of the steep Trendelenburg position and CO_2 pneumoperitoneum on cardiovascular, cerebrovascular, and respiratory homeostasis during Robotic Radical Prostatectomy and observed that the variables investigated remained within a clinically acceptable range. They concluded that the combination of prolonged steep Trendelenburg position and CO_2 pneumoperitoneum was well tolerated and the haemodynamic and pulmonary variables remained within the safe limits. Regional cerebral oxygenation was well preserved and CPP remained within the limits of cerebral autoregulation.[12]

The review of literature revealed case reports of 3 patients who underwent a prolonged robotic pelvic surgery and developed clinical signs of raised ICP which was confirmed on a CT scan. These case reports along with earlier studies with conflicting reports provoked an interest in us to conduct this study.

One of the main dangers of increased ICP is that it can cause ischemia to the brain by decreasing cerebral perfusion pressure (CPP). CPP is calculated by subtracting intracranial pressure (ICP) from mean arterial pressure (MAP) i.e. CPP = MAP-ICP.

We wanted to extend the use of ultrasound technology to our patients. Although it would not help us in knowing the value of ICP at that point of time but it would indicate a rise in ICP.

For the control group, we chose 30 patients undergoing donor hepatectomy. This procedure was chosen as the group was similar in many aspects to the test group. The surgery was prolonged (≥4 hours), patients were ASA I-II physical status and intravenous fluid requirements were similar in both the groups. However, the major difference was that the patients were of a younger age group and, therefore, had less of co-morbidities and another difference was that the donor hepatectomy was performed as an open procedure without a pneumoperitoneum. Nevertheless, we chose this population as we needed a prolonged procedure in supine position without a tilt. Most of the laparoscopic/ robotic surgeries are done in a position of some degrees of tilt which may be either a trendelenburg or a reverse trendelenburg. We could not get a control group which matched our study group in all respects. Since the aim of the study was to evaluate the change in serial measurements of ONSD in the same patient during the course of surgery, we felt that this would be a good control group. The technique of anaesthesia was similar in both the groups.

We also tried to keep hemodynamic parameters like Systolic blood pressure (SBP), Diastolic blood pressure (DBP) and Heart rate (HR) within a clinically accepted range at the time of measurement.

In addition, we measured urine output to be assured that the urine output was ≥0.5ml/kg/hour at all times in all the patients.

In an observational study by S Khanna, J Das, S Kumar, Y Mehta on patients undergoing robotic radical prostatectomy, they had concluded that there is a significant rise in ONSD values which never reached the baseline values even after 1 hour post extubation. [13] The mean ONSD values in their study changed from 4.643 to 6.029mm after 2 hours of trendelenburg tilt. The study did not mention about the technique of anaesthesia used, fluids administered, and the hemodynamic parameters observed.

In our study, we found an increase in ONSD but it was below the critical value of 5 mm. This could be because of our standardised technique by keeping intravenous fluid rate (@ 4ml/kg/hour) and maintaining normocapnia (30-35 mm Hg). On the other hand, we observed a significant decrease in ONSD values from baseline values in our control group, with a P value of <0.001, which means that the ONSD values normally tend to decrease after induction of anaesthesia and during surgery, which could be because of the effects of anaesthetic drugs. Also, mean ONSD values were similar in both the groups just after induction of anaesthesia.

We observed a significant difference in time to recovery from anaesthesia. This could be one of the effects of cerebral oedema. Also the study population in group A had a mean age of 56 years as compared to 31 years in group B, and the delayed recovery could be because of the elderly population in group A. Another important factor to be considered is that the patients in group B had undergone donor hepatectomy, and were left with a reduced liver size, which should have caused delayed recovery because of delayed metabolism of drugs like morphine. But, we observed an earlier recovery in group B, which would mean that there was a significant delay in recovery in group A patients, which could be because of position induced cerebral oedema.

None of our patients had agitation or delirium. One patient in group A showed signs of confusion just after surgery, but was settled and became normal within 15 minutes of shifting in the recovery room, without any intervention. He had undergone robotic assisted radical prostatectomy and also had delayed recovery time after anaesthesia which was 30 minutes. His ONSD measurements were less than 0.5 at all times of assessment and was discharged from PACU uneventfully. This could be because of some degree of cerebral oedema which was not enough to cause a rise in ICP, and so was not detected by ONSD measurements .ONSD detects an increase in ICP and minor degree of cerebral oedema may not cause a change in ONSD unless associated with change in ICP. . The sedation scores were comparable in both the groups with no statistical difference after 1 hour. However, patients in group A were more sedated at the time of shifting to recovery room, which could be because of more elderly population in that group and also some degree of cerebral oedema.

Also, 15 of our patients in group A had conjunctival oedema and 12 patients had periorbital oedema while none of the patients in group B had suffered these changes. This could be because of an increased venous pressure in the head and neck region in trendlenberg position, This has been reported by other studies.[9,10]

None of our patients had any evidence of trauma to the eye attributable to the use of ocular ultrasound.

It is important to mention that we did not consider nausea and vomiting as our variables for rise in ICP as they are non specific and may occur without any rise in ICP.

The cut-off values of ONSD for predicting a raised ICP vary from 0.48 to 0.59 cm in different studies.[3,4,6,14,15] We did not encounter a rise in ONSD of more than 0.5 cm in our patients except one, undergoing robotic radical prostatectomy who had an ONSD of 0.53 cm after 4 hours of tilt, which is on the higher side. His baseline ONSD was also higher, i.e 0.45 cm. Also, post operative recovery time from anaesthesia was as in other patients, i.e.20 minutes. But the patient did not have any agitation or excessive sedation, and patient was shifted from PACU uneventfully. We were concerned for this patient as the literature mentions a value around 0.50 to be predictive of a raised ICP, though different studies have shown different cut off values for predicting raised ICP.

Although the increase in ONSD values in our study was statistically significant, the values were well within the normal reported values in literature. Overall, all the patients were discharged from PACU uneventfully in 2 hours.

Thus, we can say that the serial change in ONSD is more important than an absolute single value, though this has to be validated. Also, since we are not sure of the exact cut off value of ONSD for predicting raised ICP, we can say that a value of 0.53 cm in our study with no clinical signs of raised ICP can be considered within a high normal range of ONSD, though our sample size was not big enough to validate this.

CONCLUSION

This study shows that the increase in ICP, which is expected in a position of prolonged steep trendelenburg tilt, is not alarming, if we take measures to control CO_2 values and restrict the amount of intravenous fluids to be given. But some degree of cerebral oedema does occur, which could be responsible for delayed recovery from anaesthesia, and post operative confusion, which we observed in our study. The rise is not significant enough to warrant pharmacological intervention.

The measurement of ONSD by ocular ultrasound is an easy to master, quick, and reproducible technique and can be done in any patient position. It does not involve extra cost as most of the operating rooms are equipped with point of care ultrasound machines. We recommend the use of this modality for monitoring cerebral hemodynamics in other situations as well, such as, neurosurgery, pre-eclampsia, bilateral neck dissection, acute liver failure, etc. or wherever a rise in ICP is expected.

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