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Case Report

# Optical Nerve Sheath Diameter (ONSD) Ultrasonography as Intracranial Non-Invasive Pressure Measurement in Post–Operative Patient EDH Evacuation in ICU

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**Abstract**

Intracranial Pressure (ICP) monitoring is an important component in the management of severe Traumatic Brain Injury (TBI) in ICU. Periodic ICP monitoring in patients with severe TBI who were treated in ICU resulted in lower mortality rates than those who were not measured. ICP can be measured by invasive or non-invasive methods. Invasive measurements related to higher cost, while non-invasive tests such as MRI and CT scans are associated with radiation exposure. ONSD ultrasound is an alternative examination that is practical, inexpensive, without radiation, and can be performed bedside. We report a case in the ICU of RSUD Dr. Saiful Anwar Malang, male, 44 years old, had a traffic accident, and was diagnosed with severe TBI with GCS E2V2M4, right frontotemporal 36cc epidural hematoma, cerebral edema, and left posterolateral 4th rib fracture. The patient underwent epidural hematoma surgical evacuation. Postoperatively, the patient was treated in ICU. We performed periodic ONSD ultrasound and with the guidance of these examinations the patient's management could be adjusted. Within 48-hours postoperatively the patient could be extubated and then moved to ward. ONSD ultrasound could be done bedside so that clinicians could quickly and precisely adjusted the management according to the dynamic condition of the patient.

**Keywords**: ICP Monitoring, Intensive Care Unit (ICU), Optical Nerve Sheath Diameter (ONSD), Severe Traumatic Brain Injury (TBI), Ultrasonography (USG)

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## Introduction

Intracranial Pressure (ICP) monitoring is an important component in the management of severe Traumatic Brain Injury (TBI) in ICU. To patient with traumatic brain injury it is important to know about intracranial pressure and keep it low to guarantee adequate condition of Cerebral Perfusion Pressure (CPP). It is also mentioned that periodic measurement of intracranial pressure in patient with traumatic brain injury who is treated in ICU will give important additional information in patient management which will be resulted in lower rate of mortality compared to patients with traumatic brain injury in ICU who do not get intracranial pressure measurement.[1] Beside that, one of the main parameters of traumatic brain injury patient with ventilator and given Spontaneous Awakening Trial (SAT) is there is no intracranial pressure increasing.[2] Intracranial pressure measurement can be done by invasive and non-invasive methods. There are several invasive methods to measure ICP. Depending on the techniques, ICP measurement can be conducted in different intracranial anatomy locations which are intraventricular, intraparenchym, epidural, subdural, and subarachnoidal. The common technique is External Ventricular Drainage (EVD) and Microtransducer ICP Monitoring Device. Meanwhile non-invasive can be done using

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CT-Scan, MRI, or ultrasonography.[3] Invasive measurement requires high cost and it is not possible to be done in some areas in Indonesia. Meanwhile non-invasive like MRI and CT Scan are associated with radiation exposure. Besides, unstable condition of patient makes it impossible for moving process to radiology room for MRI or CT Scan. Other non-invasive method that can be done is measuring ONSD using ultrasonography. ONSD ultrasound is an examination that is practical, inexpensive, without radiation, and can be performed bedside.[4] Changes in intracranial pressure is transmitted into optic nerve sheath which contains CSF from subarachnoid room. When pressure in CSF compartment increases there is vein drainage disorder which manifesting as swelling in the optic disc.

This swelling can be visualized by doing fundoscopy, a technique that has been existed for over than 100 years. Unfortunately, fundoscopy is difficult to do without spreading the eye drop, the measurement is subjective and depends on the operator. Changes in the optic nerve sheath itself can be measured by using ultrasound.[5] Sheath structure form optic nerve is a hypoechoic image which is outside optic nerve and runs parallel with the structure. Measurement is done in 3 mm distance from optic nerve head. Then draw a straight line with vertical line from both edges of sheath.[6] ONSD with cut off > 5 mm can predict intracranial pressure > 20 mmHg with sensitivity 93% and specification 74%.[7] In this case report, we try to implement ONSD ultrasonography measurement as non-invasive intracranial pressure measurement in patient with traumatic brain injury post-operative evacuation EDH who was treated in ICU. With periodic ONSD measurement it is expected to support patient treatment with traumatic brain injury in ICU so that patient can be better.

**Case**

History

Male, age 44 years old, body weight 60 kg, had a traffic accident 8 hours before admitted to the emergency room in RSUD Dr. Saiful Anwar Malang. Patient was hit on his left side and fell from his motorbike to the right side. In the accident patient was using a helmet but it was fell off him.

Physical examination

After examination and treatment were given in the emergency room, our assessment showed that the patient had traumatic brain injury with GCS E2 V2 M4, epidural hematoma regio frontotemporal right with volume 36cc (image 1), edema cerebri, and fracture costa 4 posterolateral left. Patient was then having epidural hematom evacuation surgery. The surgery was lasted for 4 hours with operative durante bleeding 1300 cc. Post-operative patients was treated in ICU.

Post-surgical management

Patient's clinical condition after 1 hour surgery was given 7.5 mm ETT, with 20 cm depth. Patient was given ventilation control with ventilator mode P- SIMV breath frequency 16 times per-minute, pressure insiprasi/ pressure support 12/12 $cmH_2O$, PEEP 3.0, and $FiO_2$ 45% resulted saturation $O_2$ perifer 97–99%, $ETCO_2$ 32, with blood gas analysis pH 7,36; $pCO_2$ 34,6; $paO_2$ 184,7; $HCO_3$ 20,1; BE -2,8; $SaO_2$ 99,9%; and artery lactat 1,9. Hemodinamic patient was stable with warm perfusion, dry, red, blood tension 110/50 mmHg, pulse rate 78/minute with vasopressor support. GCS patient in the present time is still in sedative condition with midazolam 3 mg/hour with RASS score -3 and analgetic fentanyl 50 mcg/hour with CPOT 0.

Physical examination showed pupil anisokor 4 mm / 2mm, normal positive light reflects. Urine production was 60 cc/hour clear, with normal positive borborygmi. Then our patient was having ONSD ultrasonography examination to evaluate intracranial pressure post-operative. From the measurement results there were ONSD left eye 5,1 mm (image 2) and right eye 5,7 mm (image 3). With ONSD result higher than 5 mm it was predicted that the patient intracranial pressure was more than 20 mmHg, therefore we postponed weaning and continued sedation and we gave the patient treatment to reduce TIK rise with head up 30 degrees, mannitol was given as diuresis osmotic, and kept the patient

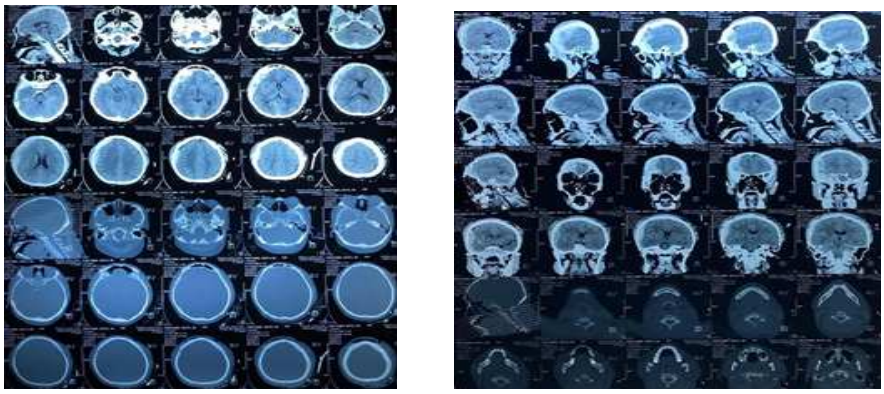

**Figure 1. Pre-operatif Head Scan Shows Epidural Hematoma with Volume 36 cc on the right**

in the condition normocapnea, normovolemia, normoglikemia, normotensi, and normotermia and also to avoid the condition of hypoxia. On the following day, 24 hours post-operative, we did ONSD ultrasonography measurement again to evaluating therapy response and determining the next treatment. From the measurement result, we got ONSD right eye 4,7 mm (image 4) and left eye 3,9 mm (image 5). With ONSD result under 5 mm it was predicted that the patient intracranial pressure was under 20 mmHg, therefore we started to do the process of weaning, dan slowly

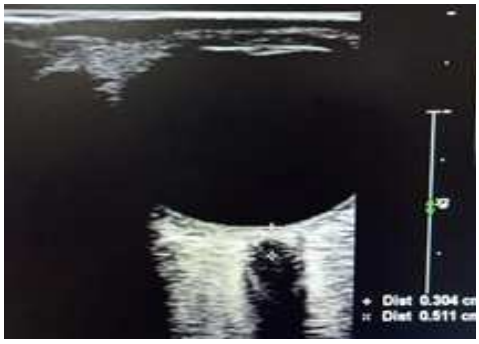

**Figure 2. ONSD Ultrasonography left eye 1 hour post-operative with diameter 5,1 mm shows the prediction of intracranial pressure > 20 mmHg**

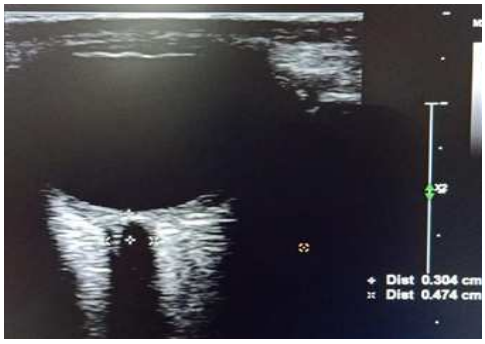


**Image 4. ONSD Ultrasonografi right eye 24 hours post-operative with diameter 4,7 mm shows prediction of intracranial < 20 mmHg.**

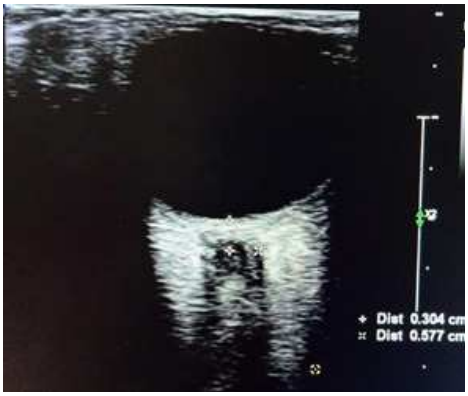


**Figure 3. ONSD Ultrasonography right eye 1 hour post-operative with diameter 5,7 mm shows prediction of intracranial pressure > 20 mmHg**

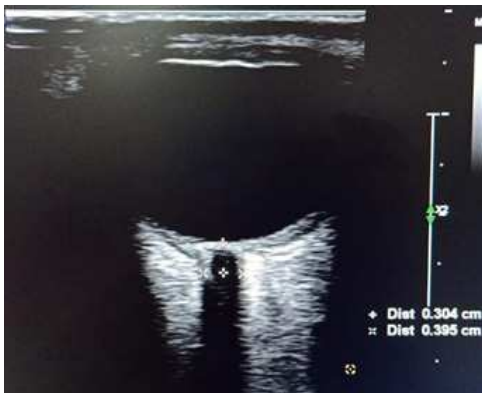


**Figure 5. ONSD Ultrasonografi left eye 24 hours post-operative with diameter 3,9 mm shows prediction of tekanan intracranial < 20 mmHg**

reducing the sedative. Eight hours later patient was given extubation and he was moved to the ward on the next day.

## Discussion

Intracranial pressure measurement is an important parameter and is obliged to be done mainly to patients who have high risk of intracranial pressure rise, one of them is to patients with traumatic brain injury. According to American Brain Trauma Foundation, intracranial pressure observation is indicated in all cases of traumatic brain injury with score Glasgow Coma Scale (GCS) between 3–8 and abnormal CT scan, which shows hematoma, contusion, edema, herniasi, or sisterna basalis compression.[3] With so many alternatives of intracranial pressure measurement then clinicians must be able to choose what kind of treatment they will give the patients. Invasive method is said to require high cost and has higher infection risk compared to the non-invasive method.

Meanwhile the non-invasive measurement method MRI or CT Scan are associated with radiation exposure, tool sportability, and patients transfer risk. Although CT Scan is still a standard examination but it needs patient transfer to the treatment room therefore it is difficult to be done when patient condition is not stable either in IGD or in ICU. ONSD ultrasonography gives non-invasive intracranial pressure measurement as alternative that can be done on bedside and more practical.[10] In this case report, we did ONSD ultrasonography post-operative in ICU therefore it could predict patient intracranial pressure quicker. In the first examination the intracranial pressure was more than 20 mmHg, so in this condition we decided to postpone weaning, continued sedation and gave treatment to reduce intracranial pressure. Then, 24 hours later we did the ONSD measurement again to evaluate therapy response.

In the second measurement there was intracranial pressure under 20 mmHg with ONSD right eye and left eye under 5 mm. We decided to start weaning, slowly reduced sedation, and conducted extubation. ONSD measurement can give information on whether clinicians can continue sedation or not. In patient with intracranial pressure rise who is treated in ICU, agitation condition, pain, and desynchronize towards ventilator can increase the intracranial pressure. Therefore the giving of sedation and adequate analgetic becomes appropriate treatment in that condition. Sedative and analgesic medicines can reduce intracranial pressure by various mechanism. First, sedative and analgesic reduce $CMRO_2$ until decreasing cerebral blood flow (CBF). CBF decreases will be resulted in cerebral blood volume reduction which cause intracranial volume reduction and also intracranial pressure reduction.[9] Second, sedative and analgesic can control pain and agitation, which can cause surge of intracranial pressure. Third, analgesic can increase tolerance towards endotracheal pipe, reducing agitation and cough so that patients can avoid intracranial pressure, that can reduce outflow vena jugularis. For all these reasons, then sedative and analgesic can protect the brain from intracranial hypertension and brain hypoperfusion.[8]

With the guidance of ONSD ultrasonography clinicians can predict patient intracranial pressure therefore they can determine whether sedative and analgesic on patients can be continued or reduced. In this case, because according to second ONSD examination it was under 20 mmHg then we started weaning and reduced sedative until patient's consciousness reached GCS E3 Vx M5 without sedative. In this condition we decided to do extubation. After extubation patient's condition was stable with GCS E3 V4 M5 and the following day patient was moved to the ward.

## Conclusion

ONSD measurement by using ultrasonography is an alternative of measurement of non-invasive intracranial pressure which are accurate, practical, fast and can be done bedside. This method is very useful mainly for patients with unstable condition either in emergency room or ICU. Besides that, by doing bedside treatment, then clinicians can adjust appropriate treatment for dynamic patients in faster way.

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