Zagazig University Medical Journal
www.zumj.journals.ekb.eg

ORIGINAL ARTICLE

The Sensitivity of Optic Nerve Computed Tomography Scan vs Optical Coherence Tomography in Diagnosis of Idiopathic Intracranial Hypertension

Ahmed Mohammad Alaa Eldin[1*], Nesma A.M. Ghonemi[2], Mohammed E. M. Mahdy[2]
[1]*Radiodiagnosis Department, Faculty of Medicine, Zagazig University, Zagazig, Egypt*
[2] *Neurology Deparment, Faculty of Medicine, Zagazig University, Zagazig, Egypt*

Corresponding author:
Ahmed Mohammad Alaa Eldin, Radiodiagnosis Department, Faculty of Medicine, Zagazig University, Zagazig, Egypt
ahmedalaaeldin1978@gmail.com

Submit Date	2019-09-22
Revise Date	2019-11-11
Accept Date	2019-11-16

ABSTRACT

Background/Aim: This study aimed to evaluate the usage of optic nerve sheath diameter (ONSD) and Spectral-domain OCT for initial detection of elevated intracranial pressure (ICP) in patients with IIH as an alternative to lumbar puncture. **Methods**: Forty patients presented with headache and fulfilled modified Dandy criteria for IIH underwent post contrast multislice orbit computed tomography (CT) scan & spectral domain OCT (SD-OCT) scanning. Routine lab, and plain chest X-ray were done to exclude those patients with end organ failure. **Results**: The estimated statistical cutoff value of ONSD was 5.5 mm with sensitivity of 84.4% and a specificity to diagnose optic nerve thickening by 100% in the left side and 85.7% in the right side. **Conclusions:** The addition of OCT to ONSD by post contrast multislice CT can increase its diagnostic ability for the cases with IIH, which may reduce the need for invasive diagnostic techniques like lumbar puncture.

Keywords: Multidetector CT (MDCT), optic nerve sheath diameter ONSD, Optical Coherence Tomography (OCT), idiopathic intracranial hypertension (IIH).

INTRODUCTION

Idiopathic intracranial hypertension (IIH) is defined -according to modified Dandy criteria- as the presence of clinical signs and symptoms of increased intracranial pressure including headache, nausea, vomiting, transient visual disturbances like mild visual loss, papilledema, and unilateral or bilateral 6th cranial nerve paresis [1,2] and is generally affecting overweight women in childbearing period [3].

Normal neuroimaging is essential for diagnosis except for empty sella turcica. Idiopathic intracranial hypertension is considered a diagnosis of exclusion, especially when no cranial neuropathies or papilloedema have been determined [4-5].

If a patient is complaining of only persistent severe headache, then the diagnosis is delayed as in such cases lumbar puncture and a head CT scan for these patients is usually negative, putting the clinicians in a diagnostic challenge. Measurement the optic nerve sheath diameter (ONSD) using orbit CT scan can provide a solution in this case, as It is considered as a non-invasive method of intracranial pressure (ICP) monitoring based on that the presence of enlarged ONSD indicates the elevated ICP [6-12].

Another non invasive rapid method for evaluation of patients with IIH is Optical Coherence Tomography (OCT), in which light is used to obtain in vivo images. The reflected light from tissue is an indicator for density and depth of that tissue [13].

Spectral-domain OCT demonstrates structural changes due to papilledema, providing reliable volume and thickness measurements of retina and the optic nerve head. Moreover, can reliably provide additional parameters of the optic nerve imaging, including volume and height measurements with greater sensitivity of the response to treatment and the long-term visual outcome in patients with IIH [14].

Aim of the work: is evaluate the usage of optic nerve sheath diameter (ONSD) measured by computed tomography and

Spectral-domain OCT for detection of elevated intracranial pressure (ICP) in patients with IIH as an alternative to lumbar puncture.

METHODS

Ethical statement

This prospective study was conducted according to international guidelines that approved by the Research Ethics Committee. Informed consents were obtained from all patients prior to the study. We followed the ethical principles of the Declaration of Helsinki during the preparation of this study.

Study population

This study included 40 female patients (aged ≥18 years) presented with headache and fulfilled modified Dandy criteria for IIH. Patients were recruited from Neurology Outpatient Clinic and Neurology inpatients ward of Zagazig University Hospitals. During history taking, complaints which were usual for raised ICP (headache, nausea, vomiting, etc.) were detected and all patients were generally and neurologically examined. Routine lab and plain chest X-ray were done to exclude patients with end organ failure. Also patients with known ophthalmological disorders such as glaucoma, hypertensive or diabetic retinopathy ,patients with migraine or those having contraindications for IV contrast enhanced CT were excluded. All patients underwent initial non-contrast head CT scan. All patients with suspected IIH were examined by an ophthalmologist, even if they did not report any visual symptoms. Patients who complained of headache associated with tinnitus and dizziness were also examined by an otorhinolaryngologis.

We collected and analyzed data on the following variables: (1) ONSD in the middle third of the intraorbital path (the point where the ophthalmic artery crosses the optic nerve served as an anatomical landmark); (2) presence/absence of papilledema; and (3) patients' age .

We analyzed CT scans obtained by 128 multidetector machine (ingenuity, Philips healthcare ,veenluis, best , Netherlands), with an initial single slice section of 3 mm and an area of interest slice section of 0.6 mm. The initial step in radiological differential diagnosis was to exclude any cerebral organic pathology by non contrast brain computed tomography (eg. hemorrhagic or non-hemorrhagic lesions, contusions, brain oedema and space occupying lesions). If no pathology was found, then the ONSD was measured bilaterally by the computer program after intravenous contrast material injection as (0.5- 1 ml / Kg body weight) then orbit CT scan is done.

Our patients underwent spectral domain OCT (SD-OCT) scanning dual beam Spectralis laser tracking tomography Spectralis®, using a commercially available device (3D OCT-1000; Topcon Corp., Tokyo, Japan). The scanning protocol involved the acquisition of a 6 × 6 mm cube scan of the optic nerve head (ONH) and macula with a scan density of 512 × 128 pixels. Criteria for acceptable OCT images included the following: absence of large eye movements, defined as an abrupt shift completely disconnecting a large retinal vessel; consistent signal intensity level across the scan; and absence of black bands (caused by blinking). Average RNFL was automatically calculated by the software. Papilloedema was measured by identification of the recumbent “lazy V” pattern of the subretinal hyporeflective space and the subretinal hypo reflective space width.

Statistical analysis

The collected data were computerized and statistically analyzed using SPSS program (Statistical Package for Social Science) version 18. Qualitative data were represented as frequencies and relative percentages. Quantitative data were expressed as mean ± standard deviation (SD). Independent T-test and Mann Whitney test were used when appropriate. Pearson correlation coefficient was used to calculate correlation between quantitative variables. Receiver operating characteristic (ROC) curve was used to identify optimal cut-off values and area under the curve (AUC) of different parameters with maximum sensitivity and specificity for prediction of the outcome. The validity of data was calculated using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and

accuracy. A *p*-value ≤0.05 indicates significant results.

RESULTS

Our study included 40 female patients with clinico-radiological diagnosis of IIH with their age range from 22 to 42 years, their main complaints were visual complaints as blurred vision and transient visual obscurations in 16 patients (40%), and headache in 15 patients (37.5%), while 9 patients (22.5%) had both complaints .

The ONSD was nearly in the same range in both eyes (4-10 mm for right and 4-11 mm for left) when measured by CT with contrast at the crossing point of ophthalmic artery (Table 1). More than 82% (33) of patients diagnosed by OCT to have papilloedema while in 17% (7) of patients not . There was a statistical significant relation between the ONSD by OCT in both right and left sides with the diagnosis of IIH (P =0.003 for right, P= 0.001 for left) while there was no significant relation between pseudo tumor cerebri (PTC) and patient's age (P= 0.921) (Table 2).

The estimated statistical cutoff value of ONSD was 5.5 mm with sensitivity of 84.4% and a specificity to diagnose optic nerve thickening by 100% in the left side and 85.7% in the right side (Table 3,4).

Table (1): Optic nerve sheath diameter of studied patients using contrast enhanced CT orbit:

Variable	Value (mm)
RT ONSD:	
Mean ± SD	6.03 ± 1.05
Range	4 – 10
LT ONSD:	
Mean ± SD	**5.98** ± 1.19
Range	4 - 11

RT: right, LT: left, ONSD : Optic nerve sheath diameter.

Table(2): Relation between age, Optic nerve sheath diameter and idiopathic intracranial hypertension by optical coherence tomography:

	Idiopathic intracranial Hypertension		t	p
	Yes	**No**		
Age:				
Mean ± SD	**31.52** ± 5.51	**31.29** ± 5.41	**0.100**	**0.921**
Range	22 - 41	26 – 42		
RT ONSD:				
Mean ± SD	**6.24** ± 1	**5** ± 0.58	**3.154**	**0.003***
Range	5 - 10	4 – 6		
LT ONSD:				
Mean ± SD	**6.24** ± 1.12	**4.71** ± 0.49	**3.514**	**0.001****
Range	5 - 11	4 – 5		

RT: right, LT: left, ONSD : Optic nerve sheath diameter.
*p<0.05 is statistically significant **p≤0.001 is statistically highly significant

Table (3): Performance of right optic nerve sheath diameter in diagnosis of optic nerve thickness by CT orbit with contrast:

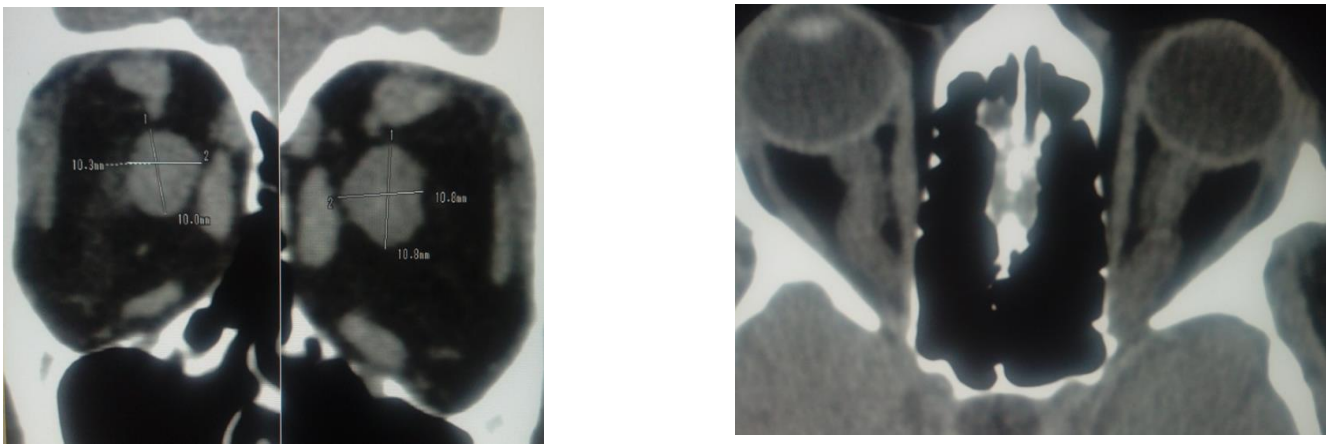
Cutoff	AUC	Sensitivity	Specificity	PPV	NPV	Accuracy	p
5.5	**0.881**	**84.8**	**85.7**	**96.6**	**54.5**	**85**	**0.002***

AUC: area under curve , PPV: positive predictive value., NPV: negative predictive value.

Table (4): Performance of left optic nerve sheath diameter in diagnosis of optic nerve thickness by CT orbit with contrast:

Cutoff	AUC	Sensitivity	Specificity	PPV	NPV	Accuracy	p
5.5	**0.946**	**84.8**	**100**	**100**	**58.3**	**87.5**	**<0.001****

AUC: area under curve , PPV: positive predictive value., NPV: negative predictive value.



(A) (B)

Figure 1. (A) Coronal & (B) axial post contrast CT examination of the orbit revealed bilateral enlarged optic nerve sheath diameter measuring 10.3 mm to the right & 10.8 mm to the left

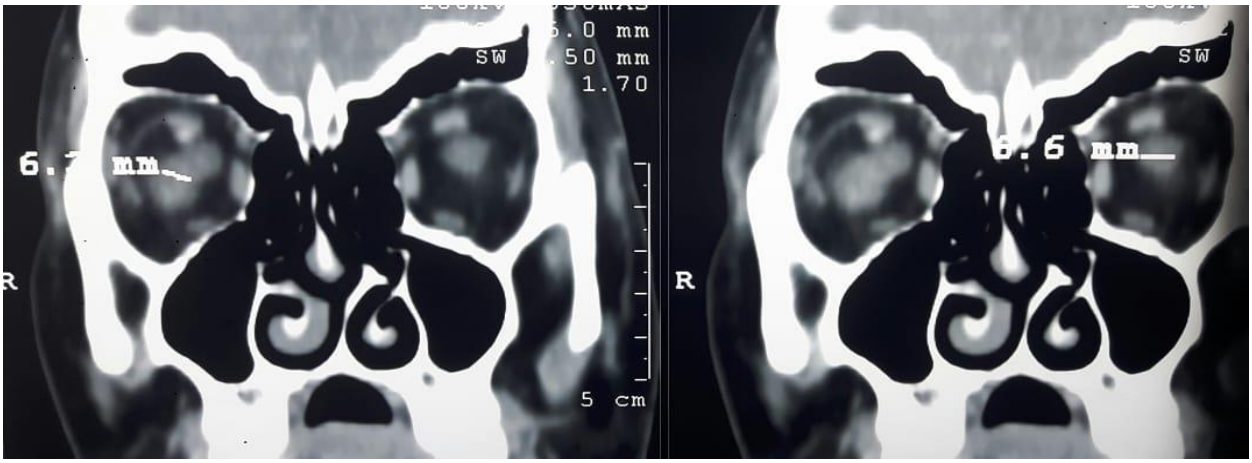


Figure 2. Coronal post contrast CT examination of the orbit revealed bilateral enlarged optic nerve sheath diameter measuring 6.7 mm to the right & 6.6 mm to the left

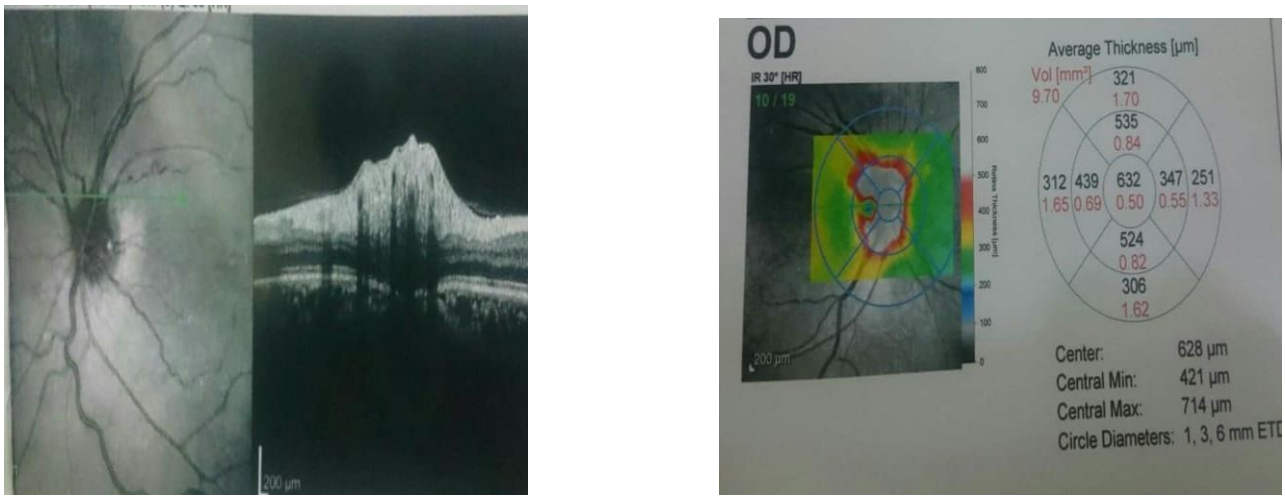


Figure 3. OCT revealed papilloedema with thickened retinal nerve fiber layer.

DISCUSSION

The diagnosis of IIH is mainly made by measurement of raised intracranial pressure (ICP) [15]. This is considered critical as the early diagnosis and treatment of the increased pressure can protect against optic nerve damage [10]. Lumbar puncture ,as a diagnostic tool for the detection of IIH, is considered accurate but its performance is limited in patients with obesity, thrombocytopenia, bleeding tendencies or those on regular anticoagulants and also considered as invasive procedure that carry the risk of post-spinal tap headache, nerve root irritation, spinal subdural hematoma, and infection [15].

Our study included 40 patients with a clinical diagnosis of IIH according to modified Dandy criteria, their mean of age was 31.47 ± 5.42 years. In this study, we found a highly statistically significant positive correlation between presence of papilloedema by OCT and the increased ONSD by CT with contrast (p< 0.003f for the right eye and <0.001 for the left), and after an extensive search in the available online resources and data bases, this study could be the first study to correlate between the diagnosis of papilloedema by OCT and the increased ONSD by CT with contrast, and also the first in Egyptian patients. Based on the estimated cutoff point for the ONSD (5.5 mm), we found that the sensitivity of ONSD by CT as a detector for increased ICP is 84.8 % for both eyes, while its specificity was 85.7 % in the right eye (P<0.002), and 100% for the left eye (P<0.001) with an accuracy 85 and 87.5. This was matched with the results of Bekerman and his colleagues [16], who found that ONSD by CT with contrast was specific in 94.3% of 35 cases they included .Our study was limited by its relative small number of cases, and didn't consider the follow up with the used diagnostic techniques .

CONCLUSION

the addition of OCT to ONSD by CT+C can increase its diagnostic ability for the cases with IIH, which may reduce the need for invasive diagnostic techniques like LP.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Funding information: None declared

REFERENCES

1. Johnston I, Owler B & Pickard J. The Pseudotumor Cerebri Syndrome: Pseudotumor Cerebri, Idiopathic Intracranial Hypertension, Benign Intracranial Hypertension and Related Conditions. Cambridge: Cambridge University. Press. 2007; Doi:10.1017/CBO9780511544996
2. Friedman DI, Liu GT & Digre KB . Revised diagnostic criteria for the pseudo tumor cerebri syndrome in adults and children. Neurolog 2013;81:1159–1165
3. Corbett J. Idiopathic intracranial hypertension. J Neuro-ophthalmol 2012 ;32:e4-e6.
4. Mollan SP, Markey KA, Benzimra JD, Jacks A , Matthews TD, Burdon MA et al . A practical approach to, diagnosis, assessment and management of idiopathic intracranial hypertension. Pract Neurol 2014;14:380–90.

5. Thurtell MJ, Bruce BB, Newman NJ & Biousse V **.** An update on idiopathic intracranial hypertension. Rev Neurol Dis 2010; 7:e56–68.

6. Kimberly HH, Shah S, Marill K & Noble V **.** Correlation of optic nerve sheath diameter with direct measurement of intracranial pressure. Acad Emerg Med 2008; 15:201–4.

7. Williams P .Optic Nerve Sheath Diameter as a Bedside Assessment for Elevated Intracranial Pressure, Case Reports in Critical Care 2017; vol. 2017, Article ID 3978934, 2 pages, . https://doi.org/10.1155/2017/3978934.

8. Bartsikhovsky T, Klar MM, Bekerman I, Nagieva S, Tal S . Diagnostic tool for initial evaluation of the intracranial pressure on computed tomography in pediatric patients with headache. PLoS ONE 2019; 14(5): e0216812. https://doi.org/10.1371/journal.pone.0216812

9. Legrand A, Jeanjean P, Delanghe F, Peltier J, Lecat B, Dupont H . Estimation of optic nerve sheath diameter on an initial brain computed tomography scan can contribute prognostic information in traumatic brain injury patients. Crit Care 2013;17: R61.

10. Vaiman M, Gottlieb P, Bekerman I . Quantitative relations between the eyeball, the optic nerve, and the optic canal important for intracranial pressure monitoring. Head Face Med 2014;10:32.

.

11. Sekhon MS, Griesdale DE, Robba C, McGlashan N, Needham E, Walland K, . Optic nerve sheath diameter on computed tomography is correlated with simultaneously measured intracranial pressure in patients with severe traumatic brain injury. Intensive Care Med 2014;40:1267–74.

12. Vaiman M, Abuita R, Bekerman I .Optic nerve sheath diameters in healthy adults measured by computer tomography. Int J Ophthalmol 2015;8:1240–4.

13. OCT Sub-Study Committee for the NORDIC Idiopathic Intracranial Hypertension Study Group. Baseline OCT measurements in the Idiopathic Intracranial Hypertension Treatment Trial, part I: quality control, comparisons, and variability. Invest Ophthalmol Vis Sci 2014 ;55:8180– 8188. DOI:10.1167/iovs.14-14960

14. Heidary G and Rizzo GF. Use of Optical Coherence Tomography to Evaluate Papilledema and Pseudopapilledema Seminars in Ophthalmology 2010; 25:(5-6), 198–205.143**.**

15. Cooper N . Lumbar puncture. Acute Med 2011 ; 10: 188–193.

16. Bekerman I, Sigal T, Kimiagar I, Almer ZE & Vaiman M . Diagnostic value of the optic nerve sheath diameter in pseudotumor cerebri. Journal of Clinical Neuroscience 2016; 30: 106–109

To Cite This Article: Ahmed MA*, Nesma AM., Mohammed EM.The Sensitivity of Optic Nerve Computed Tomography Scan vs Optical Coherence Tomography in Diagnosis of Idiopathic Intracranial Hypertension.ZUMJ 2020;26(1);108-113.DOi:10.21608/zumj.2019.16891.1520.