Normal Measurements of Size of Optic Nerve Sheath Complex Using Computed Tomography

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Objective: *To establish normal value of optic nerve sheath complex on computed tomography.*
Material and Method: *This prospective study was approved by the institutional ethics committee. Measurement of the optic nerve sheath complex at retrobulbar and waist regions was done on volunteers who came for cranial computed tomography examination at Thammasat University Hospital during May 2013-November 2013. There were 138 volunteers (75 males and 63 females) with average age of 57 years. Volunteers were excluded if they have eye symptoms or known related disease that affected optic nerves such as endocrinopathy, or if they have metallic object or prostheses that might confound the measurement. Size of optic nerve sheath complex was measured at retrobulbar and waist regions on reconstructed orbital CT images in a plane parallel to the optic nerve sheath complex. Two measurements were performed separately at 1-month intervals to evaluate reliability and reproducibility of the measurement. Then normal size and range of the optic nerve sheath complex were evaluated. Correlation between age, gender and size of the optic nerve sheath complex were also evaluated as well as difference in size of the complex between both eyes.*
Results: *Normal value of the optic nerve sheath complex (mean $\pm$ 2SDs) at retrobulbar and waist regions are 5.6$\pm$1.8 (3.8-7.4) mm and 3.7$\pm$0.8 (2.9-4.5) mm. There is no correlation between age, gender and size of the optic nerve sheath complex. No difference in size of the optic nerve sheath complex between both eyes was found.*
Conclusion: *Normal value of optic nerve sheath complex at retrobulbar and waist regions in Thai population was established. This information might be useful in diagnosis of some diseases or excluding some conditions.*

Keywords: *Optic nerve sheath complex, Optic nerve, Size, CT*

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Nowadays, several abnormalities affect the optic nerve but only some conditions or some stages of disease might alter the size of the optic nerve (e.g. optic nerve glioma, optic nerve sheath meningioma, cyst of optic nerve sheath and optic neuritis[1]). Although there were studies about size of the optic nerve sheath complex in non-Thai populations on either computed tomography or magnetic resonance imaging studies[2-5], to our knowledge, there is no established normal value of the optic nerve sheath complex in the Thai population on computed tomography. In addition, the measurement of the optic nerve sheath complex in the prior studies was only the secondary outcome.

In the present study, we hope to establish the normal value of the optic nerve sheath complex in Thais. This information might aid in diagnose some diseases or exclude some conditions (such as optic nerve sheath atrophy).

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Material and Method

Subjects

This prospective study was approved by the Research Ethics Board of our institution (Faculty of Medicine, Thammasat University).

The authors collected volunteers who came for cranial computed tomography at Thammasat Hospital, Pathumthani, Thailand from May 2013 to November 2013.

The volunteers were informed and confirmed to be free of orbital disorder or known related diseases that might affect optic nerves such as endocrinopathy from medical records and personal interviews. Furthermore, the volunteer must not have any metallic object or prostheses that can confound the measurement.

Sample size calculation

Mean and standard deviation of optic nerve sheath complex from the study of Ozgen et al[2] are 4.4 mm and 0.6 mm, respectively. We can estimate the amount of subjects from the equation below.

Sample size (n) = $z^2_{\alpha/2}\sigma^2/d^2$ with acceptable error = 0.1 mm.

Sample size (n) = $(1.96)^2\ (0.4)^2/(0.1)^2$ = 138 volunteers.

Method

Raw data of CT images were acquired from PHILIPS, BRILLIANCE 64 CT scanner, serial number 95284, with scanning parameter as follow: helical scan mode, detector configuration = 64x0.625, mAs = 400 mA and kVp = 120 kVp. The volunteers were asked to maintain forward gaze and gentle eye closure during the examination.

In the present study, the average effective dose was about 2.3 mSv. This dose is close to dose recommendations in ICRP publication No. 87 for cranial CT that is about 2 mSv. The effective doses (mSv) was estimated from effective dose (mSv) = dose length product x conversion factor [3].

Raw data were used to reconstruct on axial plane parallel to the optic nerve sheath complex in the globe with slice thickness = 3 mm, window width = 300, and window level = 60.

Measurement of the optic nerve sheath complex at retrobulbar (immediately posterior to eye globe) and waist (the half of the optic nerve sheath complex in the orbit) regions were then performed (Fig. 1, 2).

Two measurements were performed separately at 1-month intervals to evaluate the reliability and reproducibility of the measurement. The authors evaluated the correlation between age and gender to the size of the optic nerve sheath complex and also the difference between left and right eye.

Statistical analysis

Intraclass correlation co-efficiency was used to assess intraobserver reliability co-efficient.

Normal size and range of the optic nerve sheath complex was calculated from mean $\pm$ 2SDs.

Correlation between age and the size of the optic nerve sheath complex was calculated from Pearson's correlation.

Correlation between gender and the size of the optic nerve sheath complex was calculated from independent-samples t-test.

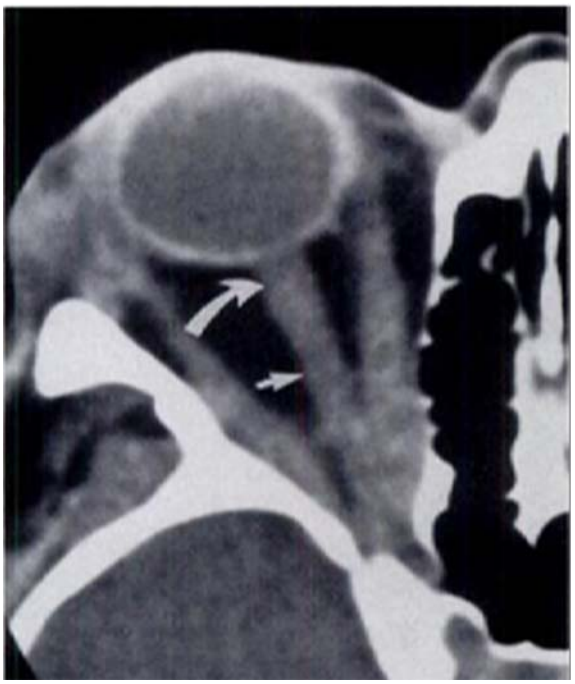

Fig. 1 Location of the optic nerve sheath complex at retrobulbar and waist regions[4].

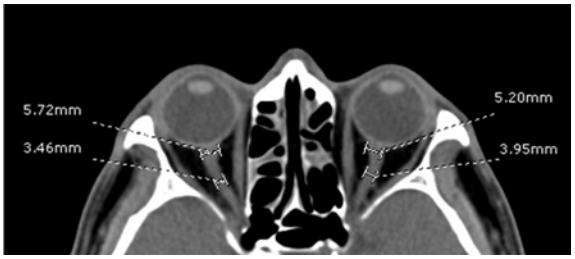

Fig. 2 Measurement of the optic nerve sheath complex at retrobulbar and waist regions in the example case.

Correlation between the sizes of the optic nerve sheath complex between both eyes was calculated from Pair t-test.

A p-value of less than 0.05 was considered statistically significant. All statistics in our study were done using SPSS for windows.

Results

The sizes of the optic nerve sheath complex at retrobulbar and waist regions were collected from 138 volunteers. There were 75 males and 63 females. Age distribution of the volunteers is shown in Table 1. The size of the optic nerve sheath complex at retrobulbar and waist regions shows normal distribution (Fig. 3, 4).

Table 1. Age distribution of volunteers

Age (year)	Frequency
0-10	0
11-20	4
21-30	7
31-40	13
41-50	14
51-60	42
61-70	28
71-80	21
81-90	9
More	0

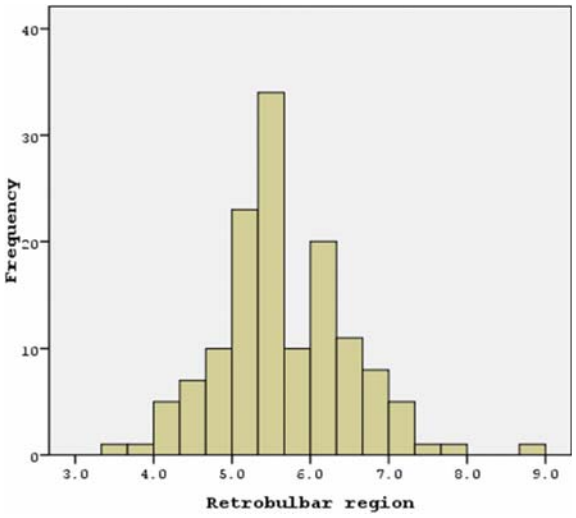

Fig. 3 Histogram plot of the size at retrobulbar region.

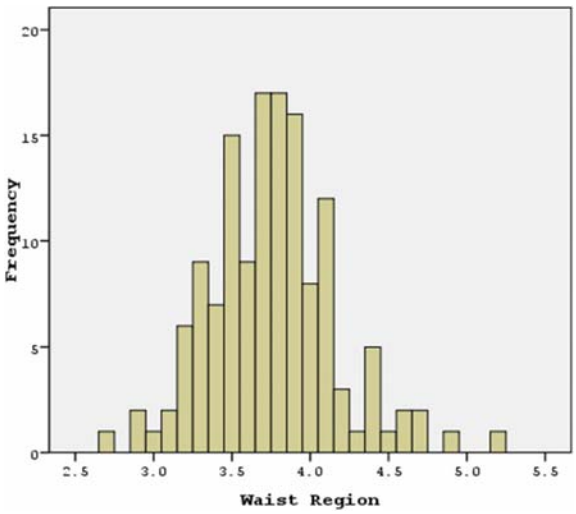

Fig. 4 Histogram plot of the size at waist region.

Intraobserver reliability co-efficients from separate sets of data are good (not less than 0.80): 0.9135 for the retrobulbar region and 0.8004 for the waist region. Normal value (mean $\pm$ 2SDs) and range of the optic nerve sheath at retrobulbar and waist regions are 5.6$\pm$1.8 mm (range: 3.8-7.4 mm) and 3.7$\pm$0.8 mm (range: 2.9-4.5 mm), respectively.

There is no correlation between age, gender and size of the optic nerve sheath complex. No difference in size of the optic nerve sheath complex between both eyes is found either (Table 2-5).

Discussion

Optic nerve sheath complex is the organ that readily visualized on the current cranial computed tomography examination. Measurement of this organ on both magnetic resonance imaging and computed tomography are widely performed.

Size of the optic nerve sheath complex on

Table 2. Pearson correlation between age and size of the optic nerve sheath complex at retrobulbar and waist regions

Size of optic nerve sheath complex	Pearson correlation (r) n = 138
Retrobulbar region	-0.21
Waist region	-0.03

Low correlation $-0.50 \leq r \leq 0.50$, Moderate correlation $0.50 < r < 0.80$ or $< -0.80 < r < -0.5$, High correlation $r \geq 0.80$ or $r \leq -0.80$

Table 3. Normal value of the optic nerve sheath complex at retrobulbar and waist regions in males and females

Gender	Retrobulbar region (mm)	Waist region (mm)
Female	5.5$\pm$1.6	3.8$\pm$0.8
Male	5.7$\pm$1.6	3.7$\pm$0.8

Table 4. Correlation between gender and size of optic nerve sheath complex at waist and retrobulbar regions with independent samples t-test

Location	t	*p*-value
Retrobulbar region	1.39	0.17
Waist region	-0.59	0.59

Statistically significant at *p*-value <0.05

magnetic resonance imaging and computed tomography shows minimal difference between the upper normal limit (less than 8.5%)[5]. The authors chose computed tomography examination as the tool in obtaining an image for evaluation because of its wide availability and shorter examination time.

In our prospective study, we could ask the volunteers to look forward during the examination. Therefore, raw image data of the optic nerve sheath complex was confidently acquired in the neutral eyes' position. Besides, we reconstructed images on the plane parallel to the optic nerve sheath complex. All of these protocols were performed in order to ensure precise measurement of the optic nerve sheath complex.

For practicality of measurement, we preferred to measure only transverse diameter of the optic nerve sheath complex rather than performing volumetric measurement. Window width and window level of the reconstructed images were at 300 and 60, respectively. These parameters are image filter protocol used at Thammasat University Hospital, which helps provide the optimal image to demonstrate the optic nerve sheath complex.

Normal size of the optic nerve sheath complex at retrobulbar region obtained from our study is similar to that of the prior studies whereas little difference of the size at waist region is observed (Table 6). This slight discrepancy may be related to diversity of the included volunteers, altered imaging technical factors and wider range of position at the waist region.

The authors' results show no correlation between age, gender and size of the optic nerve sheath complex as well as difference between both eyes. These results correspond to the previous studies.

Table 5. Difference between both eyes at waist and retrobulbar regions with paired samples t-test

Location	t	*p*-value
Retrobulbar region	-0.51	0.61
Waist region	0.32	0.75

Statistically significant at *p*-value <0.05

Limitation

As with many single center researches, to generalize this data for the Thai population is our limitation. Nevertheless statically inferential sample size was done. Establishing collaboration in research among the institutes can eliminate this problem and create more reliable and generalized study.

No demonstrable statistically significant in correlation in age related size of the optic nerve sheath complex might be the consequence of the uneven distribution of the patient age group. Any demonstrable statistical significance in correlation of age and size of the optic nerve sheath complex might be the consequence of uneven distribution of number of volunteers in each age group. Allocation of volunteers into equal distribution in each age group could be possible but a longer study time is needed (Most patients who underwent cranial CT were in the middle to older age groups).

Conclusion

In the present study, we were able to establish normal value of optic nerve sheath complex at retrobulbar and waist regions. This information might aid in the diagnosis of some diseases or in excluding some conditions. Our study design, however, is not a comparative measurement between healthy and diseased populations. Therefore, utilizing our normal value as the cut-off value to diagnose diseases might be limited.

Potential conflicts of interest

None.

References

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Table 6. Measurement of the optic nerve sheath complex data from prior studies

	Mean ± 2SD (mm)			
	Present study	Ozgen et al[2]	Robert et al[4]	Lee et al[6]
Retrobulbar region	5.6±1.8	-	5.5±0.8	-
Waist region	3.7±0.8	4.2±0.6	4.2±0.6	4.2±0.6

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การศึกษาหาค่าปกติของขนาดเส้นประสาทตาและเยื่อหุ้มด้วยเอกซเรย์คอมพิวเตอร์

อาวีมาศ วัชรากร, ศุภวัชร งามสิริสุข

วัตถุประสงค์: *เพื่อหาค่าปกติของขนาดเส้นประสาทตาและเยื่อหุ้มด้วยการตรวจเอกซเรย์คอมพิวเตอร์*

วัสดุและวิธีการ: *ผู้นิพนธ์ทำการวัดขนาดเส้นประสาทตาและเยื่อหุ้มที่ retrobulbar region และ waist region ของอาสาสมัครที่มารับการตรวจที่แผนกเอกซเรย์โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติฯ ตั้งแต่ เดือนพฤษภาคม พ.ศ. 2556 ถึง เดือนพฤศจิกายน พ.ศ. 2556 ทั้งหมด 138 ราย (ชาย 75 ราย และ หญิง 63 ราย) โดยที่อาสาสมัครจะต้องไม่มีอาการ หรือประวัติทางพยาธิสภาพที่เกี่ยวข้องกับทางเดินเส้นประสาทตา หรือโรคทางระบบต่อมไร้ท่อที่มีผลต่อขนาดเส้นประสาทตา หากพบว่ามีวัตถุใดๆที่ทำให้เกิดการบดบังภาพที่มีผลต่อการตรวจวัดเส้นประสาทตา หรือตรวจพบพยาธิสภาพในทางเดินเส้นประสาทตาจะถูกคัดออก*

การศึกษานี้จะทำการวัดขนาดเส้นประสาทตาและเยื่อหุ้มจากภาพถ่ายเอกซเรย์คอมพิวเตอร์ ในแนวที่ขนานกับเส้นประสาทตา และเยื่อหุ้มในกระบอกตาโดยผู้นิพนธ์จะทำการวัดสองครั้งห่างกัน 1 เดือน เพื่อประเมินค่าความแปรปรวนในการวัดและความน่าเชื่อถือในการวัดเพิ่มเติมนอกจากการหาค่าปกติของขนาดเส้นประสาทตาและเยื่อหุ้มเป็นหลัก และนำค่าที่ได้ไปหาความสัมพันธ์กับ อายุ เพศ และความแตกต่างระหว่างตาซ้ายและตาขวา

ผลการศึกษา: *พบว่าค่าปกติการวัด (mean ± 2SDs) ขนาดเส้นประสาทตาและเยื่อหุ้มที่ retrobulbar region และ waist region คือ 5.6±1.8 (3.8-7.4) mm และ 3.7±0.8 (2.9-4.5) mm ผู้นิพนธ์ไม่พบความสัมพันธ์อย่างมีนัยสำคัญทางสถิติระหว่าง ขนาดเส้นประสาทตาและเยื่อหุ้มในทั้งสองบริเวณ กับ อายุ เพศ หรือความต่างกันในตาสองข้าง*

สรุป: *การศึกษานี้ คณะผู้นิพนธ์สามารถกำหนดค่าปกติของขนาดเส้นประสาทตาและเยื่อหุ้มที่ retrobulbar region และ waist region ทางผู้นิพนธ์คาดหวังว่าข้อมูลนี้จะสามารถนำไปใช้เพื่อประกอบการวินิจฉัยโรคต่อไป*