USAARL-CNPA-BC--2023-29

Retinal Structural Integrity and Visual Field Function in Patients with Mild Traumatic Brain Injury (mTBI)

Toan M. Trinh & Suresh Viswanathan

Notice

Qualified Requesters

Qualified requesters may obtain copies from the Defense Technical Information Center (DTIC), Fort Belvoir, Virginia 22060. Orders will be expedited if placed through the librarian or other person designated to request documents from DTIC.

Change of Address

Organizations receiving reports from the U.S. Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about laboratory reports.

Disposition

Destroy this document when it is no longer needed. Do not return it to the originator.

Disclaimer

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Human Subject Use

In the conduct of research involving human subjects, the investigator(s) adhered to the policies regarding the protection of human subjects as prescribed by Department of Defense Instruction 3216.02 (Protection of Human Subjects and Adherence to Ethical Standards in DoD-Supported Research) dated 8 November 2011.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
14-08-2023	Briefing Charts	01-10-2021 - 30-09-23

4. TITLE AND SUBTITLE

Retinal Structural Integrity and Visual Field Function in Patients with Mild Traumatic Brain Injury (mTBI)

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Trinh, T. M.[1,2], & Viswanathan, S.[2]

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Aeromedical Research Laboratory
P.O. Box 620577
Fort Novosel, AL 36362

8. PERFORMING ORGANIZATION REPORT NUMBER

USAARL-CNPA-BC--2023-29

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Medical Research and Development Command
Military Operational Medicine Research Program
504 Scott Street
Fort Detrick, MD 21702-5012

10. SPONSOR/MONITOR'S ACRONYM(S)

USAMRDC MOMRP

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

DISTRIBUTION STATEMENT A. Approved for public release: distribution is unlimited.

13. SUPPLEMENTARY NOTES

[1]U.S. Army Aeromedical Research Laboratory, [2]State University of New York College of Optometry

14. ABSTRACT

The visual system is vulnerable to traumatic brain injury. Optical coherence tomography (OCT) is an objective, non-invasive imaging technology to capture and evaluate ocular structures with precision and high resolution. Also, standard automated perimetry (SAP) is widely used to screen and manage afferent disorders, including optic nerve conditions. The purpose of this study was to evaluate optic nerve, macular thickness, and visual field functions in patients with chronic mild traumatic brain injury (mTBI). The peripapillary retinal nerve fiber layer (pRNFL) and macular thickness were measured using the HRA-SPECTRALIS from Heidelberg Engineering. Standard automated perimetry was assessed using the Humphrey Field Analyzer from Carl Zeiss Meditec with Swedish Interactive Threshold Algorithm (SITA). The study found a reduction in the global pRNFL and visual field sensitivity and their deviation from age-expected values in patients with chronic mTBI compared to age-matched, healthy controls suggest that OCT and SAP can be utilized to assist in monitoring neurodegeneration and functional deficits after mTBI. Alterations in the axoplasmic flow in the prelaminar and post-laminar optic nerve may lead to thinning of the peripapillary RNFL. The reduction in the RNFL thickness could be a structural biomarker of the neurodegeneration after mTBI.

15. SUBJECT TERMS

Mild traumatic brain injury (mTBI), optical coherence tomography (OCT), standard automated perimetry (SAP), Swedish Interactive Threshold Algorithm (SITA), visual field (VF)

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Loraine St. Onge, PhD
UNCLAS	UNCLAS	UNCLAS	SAR	1	19b. TELEPHONE NUMBER *(Include area code)* 334-255-6906

This page is intentionally blank.

Retinal Structural Integrity and Visual Field Function in Patients with Mild Traumatic Brain Injury (mTBI)

Toan M. Trinh, OD, PhD, FAAO[1,2] Suresh Viswanathan, PhD[2]

[1]U.S. Army Aeromedical Research Laboratory, Fort Novosel, AL
[2]State University of New York College of Optometry, New York, NY

Background

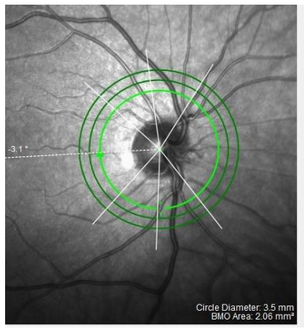
The visual system is vulnerable to traumatic brain injury. Optical coherence tomography (OCT) is an objective, non-invasive imaging technology to capture and evaluate ocular structures with precision and high resolution. Also, standard automated perimetry (SAP) is widely used to screen and manage afferent disorders, including optic nerve conditions.

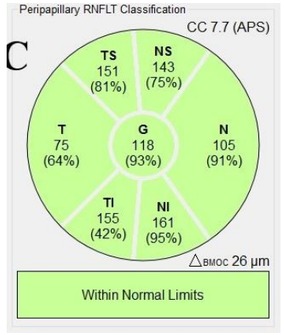
The purpose of this study was to evaluate optic nerve, macular thickness, and visual field functions in patients with chronic mild traumatic brain injury (mTBI).

Methods

The peripapillary retinal nerve fiber layer (pRNFL) and macular thickness were measured on the dominant eye for 15 mTBI subjects (ages 40.13 ± 15.99 years) and 20 controls (ages 43.05 ± 13.12 years) using the HRA-SPECTRALIS from Heidelberg Engineering. Standard automated perimetry was assessed using the Humphrey Field Analyzer from Carl Zeiss Meditec with Swedish Interactive Threshold Algorithm (SITA) Standard 24-2 and 10-2 for the same eye.

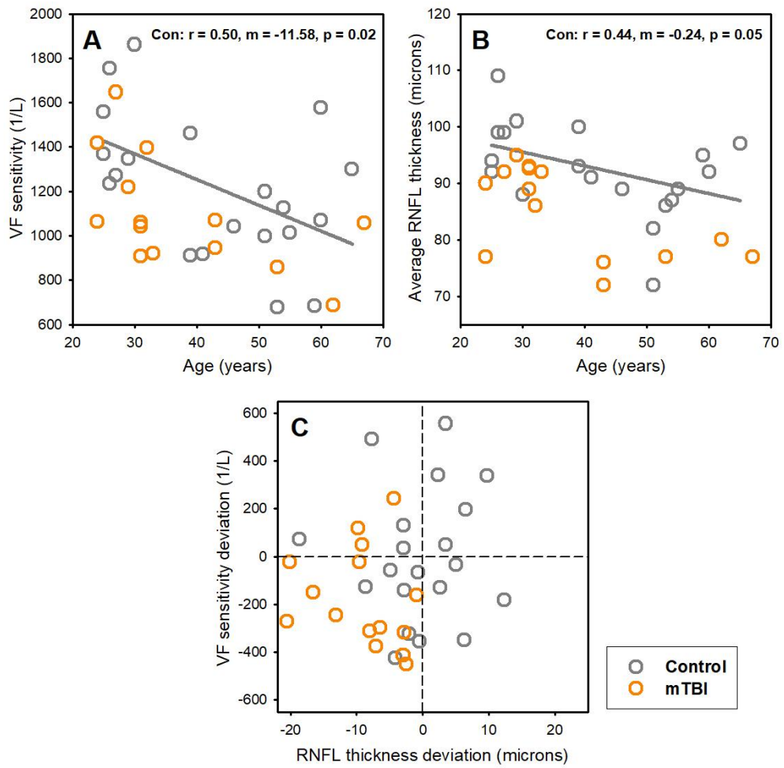
The OCT and visual field measurements were extracted for each mTBI and control subject. Student t-tests were used to compare the parameters between control and mTBI groups. Type I error α = 0.05 was used for statistical significance and a Holm-Bonferroni correction was applied to adjust for multiple comparisons.





Results

- Global pRNFL and temporal-superior (TS) sector were thinner in mTBI subjects at 3.5 millimeter (mm), 4.1 mm, and 4.7 mm circle diameter around the optic nerve compared to controls.
- No significant macular thinning was observed in the subjects with mTBI compared to visually normal controls.
- Visual field (VF) sensitivity (1/Lambert or 1/L) of the mTBI subjects was on average lower than the normal values expected for their age by 174.0 ± 207.0 units and the RNFL thickness was reduced on average by 9.0 ± 6.0 microns relative to age-expected values.



Results Continued

- Mean visual field sensitivity (**A**) and average RNFL thickness for 4.1 mm diameter ring (**B**) as a function of age. The linear regressions fit to the data had slopes that were significantly different from zero.
- The deviation of the VF sensitivity from age-expected values plotted as a function of the deviation of the RNFL thickness from age-expected values for the mTBI and control subjects (**C**). The vertical and horizontal dashed lines indicate the zero difference between actual and age-expected values of RNFL thickness and VF sensitivity.
- 12/15 (80%) mTBI subjects demonstrated reduction in both measures relative to age-expected values and the remaining 3 (20%) demonstrated RNFL thickness below and VF sensitivity above age-expected values.

Discussion

- Reduction in the global pRNFL and visual field sensitivity and their deviation from age-expected values in patients with chronic mTBI compared to age-matched, healthy controls suggest that OCT and SAP can be utilized to assist in monitoring neurodegeneration and functional deficits after mTBI.
- Alterations in the axoplasmic flow in the prelaminar and post-laminar optic nerve may lead to thinning of the peripapillary RNFL.
- The reduction in the RNFL thickness could be a structural biomarker of the neurodegeneration after mTBI.

This page is intentionally blank.

U.S. Army Aeromedical Research Laboratory
Fort Novosel, Alabama

All of USAARL's science and technical information documents are available for download from the Defense Technical Information Center.

https://discover.dtic.mil/results/?q=USAARL

Army Futures Command
U.S. Army Medical Research and Development Command