The Role of Constriction Velocity in Automated Pupillary Assessments

Sonja Stutzman[1], Michelle Hill[2], Ifeoluwa Shoyombo[1], Arianna Barnes[3], Venkatesh Aiyagari[1], Folefac Atem[1], DaiWai Olson[1]

The University of Texas Southwestern Medical Center (Dallas, TX) [1] Riverside Methodist Hospital (Columbus, OH) [2] Mission Viejo Hospital (Mission Viejo, CA)[3]

UT Southwestern
Peter O'Donnell Jr. Brain Institute

Purpose

This study aims to better understand the relationship between constriction velocity and the pupillary assessment. Additionally, the poster describes ways that clinicians can interpret pupillary assessments to aid in understanding discrepancies in CV and NPi.

Background

Pupillary assessment are a standard of care and part of the neurological exam. Previous research has shown inconsistencies in pupillary exams, especially when the pupil is not "normal."1 Pupillometers are the new wave of technology that provide more accurate and precise data that can be tracked over time. The Neurological Pupil Index (NPi) is an algorithm that allows clinicians to see what is happening with pupillary changes and track these changes over time, yet little is known about the individual variables of NPi and how to interpret these when they do not correlate (e.g., NPi, size, and constriction velocity). Constriction velocity (CV) is one variable that shows the reactivity of the pupil to light, which indicates contractions of the iris muscle, which is a reaction from the ipsilateral ciliary ganglion in the brain.2 Inconsistences in NPi and CV have not been explored.

Methods

The data is part of the multi-center prospective registry. The END PANIC registry houses: pupilometer variables and clinically related variables (e.g., BP, ICP, procedures, medications). The registry houses data from three sites and has been collecting data for 2.5 years. Pupillometer data that is collected is time stamped and can be matched with time stamped clinical values regarding clinical decision making. This analysis from 1,474 adult patients from three hospitals includes 54,102 pupilometer readings.

Support for this research is provided by NeurOptics Inc.

Table 1. Correlations between CV and NPI

	Left Eye				
Right Eye	Npi <3 CV<0.8	Npi <3 CV>0.8	Npi >3 CV<0.8	Npi >3 CV>0.8	Total
Npi <3 I CV<0.8	8,637	652	752	1,678	11,719
Npi <3 I CV>0.8	625	725	46	1,038	2,434
Npi >3 I CV<0.8	1,258	204	4,268	2,627	8,357
Npi >3 I CV>0.8	2,346	925	2,256	25,178	30,705

Results

For the purpose of this study Npi >3 and CV >0.8 are considered normal. For both eyes, the mean CV was 1.4 mm/s (sd=0.8), the mean NPi was 3.7 (sd=1.3), and the mean pupil size was 3.3 mm (sd=1.25). There was a statistically significant relationship between CV and NPi for the left (r^2=0.06, p<0.001) and right (r^2=0.05, p<0.001) eye. Controlling for baseline pupil size improved both correlations (left eye r^2=0.7, right eye r^2=0.7; p<0.001). There were statistically significant differences in pupil size, Npi, and CV across hospitals, likely due to a larger sample size.

Table 2. Correlations between CV and NPI and Size

Left Eye	NPi > 3.0	NPi < 3.0	Small	Right Eye	Npi > 3.0	Npi < 3.0
CV > 0.8	1,721	29	<2	CV > 0.8	1,563	144
CV < 0.8	2,235	8,433		CV < 0.8	3,657	6,095

Left Eye	NPi > 3.0	NPi < 3.0	Regular	Right Eye	Npi > 3.0	Npi < 3.0
CV > 0.8	28,283	2,131	2-6	CV > 0.8	28,376	1,959
CV < 0.8	5,084	3,820		CV < 0.8	6,133	3,505

Left Eye	NPi > 3.0	NPi < 3.0	Large	Right Eye	Npi > 3.0	Npi < 3.0
CV > 0.8	517	346	>6	CV > 0.8	650	447
CV < 0.8	3	613		CV < 0.8	3	683

Table 3. Demographics

Variables	N	Mean(SD) or %
Age	1474	57.5 (17)
Sex		
Male	723	49.1%
Female	751	50.9 %
Race* **		
Caucasian	1049	71.2%
African American	255	17.3%
Asian	48	3.3%
Other	72	4.9%
Diagnosis* **		
ICH	139	9.4%
SAH	81	5.5%
Ischemic Stroke	252	17.1%
Tumor	351	23.8%
Other	538	36.5%
Length of Stay**	1372	9.7 (10.2)

* Results were significant Chi-square Alpha = 0.05
** 50 obs. in Race , 113 obs in Diagnosis, 102 observations in LOS were missing due to loss of data

Table 4. Site Demographics

Variable		UTSW	Mission	Ohio
Size***	Mean	3.4	3.03	3.2
	SD	(1.35)	(1.3)	(1.2)
CV***	Mean	1.3	1.4	1.4
	SD	(0.7)	(0.8)	(0.9)
Dilation Velocity***	Mean	0.6	0.6	0.6
	SD	(0.4)	(0.3)	(0.4)
Latency***	Mean	0.23	0.24	0.24
	SD	(0.08)	(0.05)	(0.08)
%Δ***	Mean	21.3	22.3	23.3
	SD	(11.3)	(9.4)	(10.1)
NPI***	Mean	3.4	4.02	3.8
	SD	(1.4)	(0.9)	(1.4)

*** Results were significant Anova Alpha = 0.05

Conclusion

The finding of a briskly reactive pupil is insufficient to conclude that the NPi will be normal, and conversely, a slugglish pupil will not always result in ab abnormal NPi. While most of readings in this sample indicated that interpreting CV as brisk, or sluggish would match the interpretation for NPi as normal or abnormal, the amount of mismatch in the results bears a clinical significance. Smaller pupils are more likely to be associated with normal NPi and Slower CV whereas large pupils were associated with abnormal NPi and brisk CV. (Table 2). Practitioners should consider the implications of these findings, in conjunction with assessment findings and primary diagnosis, whenever they interpret readings from the automated pupilometry. Additional research is required to determine the utility of CV-NPi as a potential marker for intervention or treatment.

References

1. Olson DM, Stutzman S, Saju C, Wilson M, Zhao W, Aiyagari V. Interrater Reliability of Pupillary Assessments. *Neurocritical care.* 2016;24(2):251-257.
2. Gamlin PD, McDougal DH, Pokorny J, Smith VC, Yau K-W, Dacey DM. Human and macaque pupil responses driven by melanopsin-containing retinal ganglion cells. *Vision research.* 2007;47(7):946-954.

Corresponding Author: Sonja Stutzman, Sonja.Stutzman@UTSouthwestern.edu