Neuroradiological Correlates of Abnormal Pupillary Light Reflex Findings in Patients in the Neuroscience Intensive Care Unit (NSICU)

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Introduction

The assessment of pupil size and light reflex mechanisms have become a critical portion of the evaluation and treatment of severely ill patients in neuroscience intensive care units (NSICU) globally.[1] The importance of pupil metrics in clinical outcomes for these patients in establishing the severity of injury or illness have been shown to have great prognostic value.[2,3] Traditionally, pupillary changes secondary to cerebral mass effect are associated with an uncal herniation causing mechanical compression of CN III in turn also causing damage to the brainstem.[5,6] An alternative explanation is horizontal midbrain displacement that leads to dysfunction of the fascicular portion of the nerve. Understanding the relationship between pupil changes and the radiological midline shift is useful for clinicians in guiding diagnosis and treatment. If pupil changes can identify the presence and degree of mass effect, clinicians can efficiently order imaging that can guide management and prognosis.

Methods

This single-center retrospective pilot study of adult NSICU patients included serial pupillometer readings, enrolled in a prospective database. A neurological pupil index (NPi) of <3.0 was considered abnormal. Between 2018-2023 we identified patients who had a new onset NPi<3.0, a baseline head CT scan and a repeat CT scan <2 hours of the NPi change. These patients were compared to those who had two CT scans but did not have an NPi Change. We performed X^2 analyses comparing worsening of midline shift between groups and mixed effect linear regression models to identify an association between the change in NPi and midline shift. A McNemar test was conducted to compare sulcal effacement and a paired t-test to compare hydrocephalus. A p-value < 0.05 was considered statistically significant.

Figure 1 Differences in Midline Shift for both Patient Groups

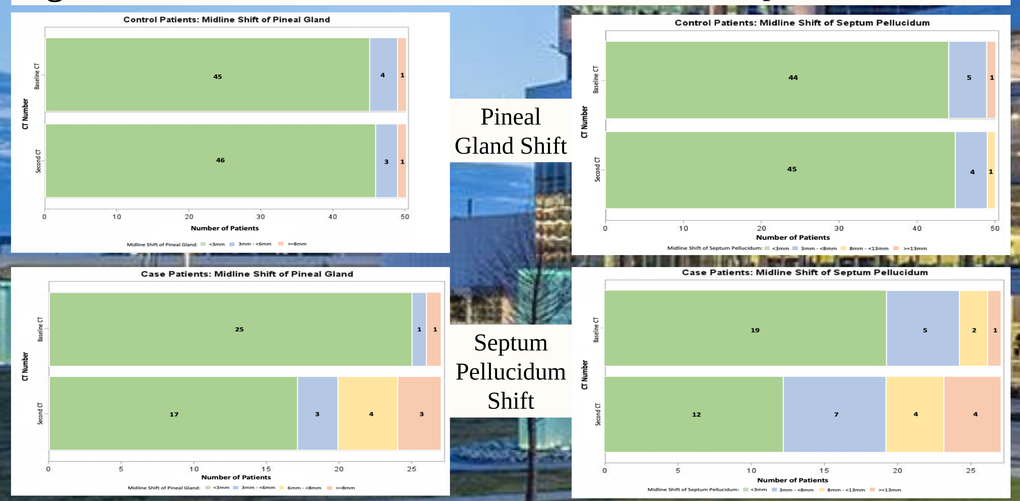

Table 1 Differences in Midline Shift

Table 1.1 All patients that had a worsening of pineal gland midline shift on second CT

Change in Pineal Gland Shift	NPI Change		
	No	Yes	Total
No	50	21	71
Yes	0	6	6
Total	50	27	77

Sensitivity: 1.00, specificity = 0.2222, PPV = 0.7042, NPV = 1.00
Chi-squared probability = 0.0012

Table 1.2 All patients that had a worsening of septum pellucidum midline shift on second CT

Change in Pineal Gland Shift	NPI Change		
	No	Yes	Total
No	50	20	70
Yes	0	7	7
Total	50	27	77

Sensitivity: 1.00, specificity = 0.2222, PPV = 0.7042, NPV = 1.00
Chi-squared probability = 0.0012

Table 2 Changes in ambient cistern patency, ventricular and sulcal effacement in patients without NPI change

Variable	Baseline CT	Second CT	P value*
Right Ventricular Effacement			
Present	6 (12.00%)	6 (12.00%)	1.0000
Absent	44 (88.00%)	44 (88.00%)	
Left Ventricular Effacement			
Present	7 (14.00%)	6 (12.00%)	1.0000
Absent	43 (86.00%)	44 (88.00%)	
Right Sulcus Effacement			
Present	7 (14.00%)	8(16.00%)	1.0000
Absent	43 (86.00%)	42 (84.00%)	
Left Sulcus Effacement			
Present	5 (10.00%)	4 (8.00%)	1.0000
Absent	45 (90.00%)	46 (92.00%)	
Right ambient cistern patency			
Patent	48 (96.00%)	45 (90.00%)	0.2500
Obliterated	2 (4.00%)	5 (10.00%)	
Left ambient cistern patency			
Patent	47 (94.00%)	46 (92.00%)	1.000
Obliterated	3 (6.00%)	4 (8.00%)	

Table 3 Changes in ambient cistern patency, ventricular and sulcal effacement in patients with NPI change

Variable	Baseline CT	Second CT	P value*
Right Ventricular Effacement			
Present	11 (40.74%)	11 (40.74%)	1.000
Absent	16 (59.26%)	16 (59.26%)	
Left Ventricular Effacement			
Present	6 (22.22%)	11 (40.74%)	0.0625
Absent	21 (77.78%)	16 (59.26%)	
Right Sulcus Effacement			
Present	11 (40.74%)	14 (51.85%)	0.2500
Obliterated	16 (59.26%)	13 (48.15%)	
Left Sulcus Effacement			
Present	11 (40.74%)	14 (51.85%)	0.2500
Obliterated	16 (59.26%)	13 (48.15%)	
Right ambient cistern patency			
Patent	18 (66.67%)	10 (37.04%)	0.0078
Obliterated	9 (33.33%)	17 (62.96%)	
Left ambient cistern patency			
Patent	18 (66.67%)	10 (37.04%)	0.0078
Obliterated	9 (33.33%)	17 (62.96%)	

Results

77 patients overall, 27 with and 50 without NPi worsening were analyzed. 41 (53.3%) were male and (66.2%) were white. The mean age in the NPI change group was 55.6 (16.0) and those without change was 63.6 (18.0). Compared to patients with no NPi change, patients with NPi worsening had a significantly higher incidence of midline shift on the second CT at every level of measuring the midline shift for both pineal gland and septum pellucidum. Regression models identified a significant correlation between change in midline shift and an abnormal NPi (r = 0.2260, P <.001). However, exploring other factors, no significant impact of hydrocephalus, ventricular or sulcal effacement or cisternal effacement on NPi worsening was noted.

Conclusion

Our study identifies midline shift as a significant predictor of abnormal NPI values rather than cisternal or sulcal effacement or hydrocephalus in NSCIU patients serving as evidence in favor of utilizing pupillometer as a tool in clinical diagnosis and treatment.

References

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