Oculomotor Consequences of Posterior Fossa Tumor Resection
Surgery In Pediatric Patients

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INTRODUCTION

• Pediatric brain tumors are the largest group of solid neoplasms and account for 20% of all tumors in childhood.¹
• Visual symptoms of Posterior Fossa (PF) tumors include diplopia, unstable visual images, and blurred vision.²
• Vestibular symptoms include nausea, imbalance, vertigo, and inability to stabilize vision during self-motion.³
• Due to the severity of these problems, PF tumors typically require aggressive surgical resection to maximize the likelihood of survival.⁴
• Data are limited regarding visual and oculomotor outcomes in pediatric patients with PF masses, despite the potential for visual morbidity.⁵

The purpose of this study is to evaluate the existence of oculomotor deficits in a sample of children with PF tumors, define the effect of surgical resection of the tumor, and assess the potential for adaptive recovery following surgical intervention.

HYPOTHESES

1. Surgical resection of PF tumors in pediatric patients will result in significant oculomotor deficits.
2. Oculomotor deficits will not resolve over time because the connections responsible for recovery will be compromised by the tumor and the associated surgical management.

PARTICIPANTS

• Retrospectively reviewed clinical data from 37 children (mean age at operation = 8.4 years ± 4.6 years)
• Testing completed between 11/2001 and 05/2006
• 16 tested 0-21 days pre-surgically
• 22 tested 29-1981 days post-surgically
• 7 tested pre- and post- surgically
• 3 tested at several points post-surgery
• Histological Diagnostic Categories:
  • 17 children with medulloblastoma, 16 with astrocytoma, 4 with ependymoma, 4 with brainstem glioma, 1 with neuroblastoma, and 2 with other unspecified PF tumors.

Oculomotor Testing

• Nystagmus recording at multiple target positions.
• Horizontal sinusoidal smooth pursuit (peak target velocities of 10, 20, and 30°/s).
• Horizontal and vertical optokinetic nystagmus (Stimulus velocities of 15, 30, and 45°/s).
• Horizontal and vertical saccades (target step amplitudes of 5-25°).

METHODS

Vestibular Testing

• Sinusoidal en-bloc vertical axis rotary chair vestibulo-ocular reflex (VOR).
• Nystagmus recording in the dark.

All testing was completed in the Roger Johnson Clinical Oculomotor Laboratory at Seattle Children’s Hospital in association with surgical resectioning of the tumor.

RESULTS

HORIZONTAL SMOOTH PURSUIT

Gaze Holding Nystagmus

Figure 1: Horizontal smooth pursuit gains for a target velocity of 10, 20, and 30°/s. Mean and standard deviation for pre- and post-surgical subjects are indicated. After correcting for multiple comparisons, differences between groups were not significant. For reference, in our laboratory smooth pursuit gains are low in normal children less than 1 year of age, and > 0.8 in older children.

Figure 2: Gaze holding abilities were measured in the primary gaze and eccentricities of ±15° right, left, up, and down while freezing on a point in the dark. Mean and standard deviation of slow phase velocity (SPV) for each group are indicated. Differences between groups were not significant. Within subjects analysis indicated that there were no significant differences in SPV following surgery or longitudinally.

Figure 3: The ability to use vestibular cues to maintain stable eye position during head motion was assessed by whole body (en bloc) rotation in the dark. Mean and standard deviation of VOR gains to a 10, 20, and 30°/s stimulus velocity are plotted. After correcting for multiple comparisons, differences between pre- and post- surgical groups were not significant.

Figure 4: Vertical and horizontal OKN gain responses of subjects before and after surgery. Gains were reduced across all stimulus velocities in all subjects. For comparison, OKN gains for normal young children are on average >0.7, with higher gains at lower stimulus velocities. After correcting for multiple comparisons, differences between groups were not significant.

Figure 5: Box and whisker plots for saccade gains grouped by category. Gains of < 100 % indicate the saccade was hypometric, gains of > 100 % indicate the saccade was hypermetric. After correcting for multiple comparisons, differences between groups were not significant.

RESULTS: SUMMARY

Patients with PF tumors display:
• Gaze holding instability.
• Reduced optokinetic nystagmus gains.
• Hypermetric or hypometric saccades, with increased latencies and gain asymmetries.
• Reduced smooth pursuit gains, and unusual tracking strategies.
• An intact vestibulo-ocular reflex with changes in gain.
• Longitudinal data did not demonstrate any significant differences in eye movement abilities over time, supporting that the impact of PF tumors and their interventions on visual and oculomotor outcomes are significant, disabling, and long-standing.

CONCLUSIONS

• The ability to maintain stable eye position when viewing a moving object is crucial for functioning in everyday life. Children with PF tumors display a wide range of oculomotor abnormalities that are critical for effective eye movement.
• The observed abnormalities in eye movements are consistent with PF tumor involvement of midline cerebellar structures and relative sparing of brainstem structures.
• Resection of PF tumors produces deficits in all conjugate eye movement systems and patients display a wide range of oculomotor and vestibulo-oculomotor movements.
• There is no evidence from these data that the abnormalities resolve over time. It is possible that the surgical intervention may actually increase the abnormalities. It is likely that the adaptive, motor learning machinery that allows for recovery is compromised by the surgical intervention.
• Future studies should assess the relationship between tumor type, extent of tumor growth, and surgical approach on oculomotor outcomes with a larger subject group to further define the time frame and progression of recovery.

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